Board of Building Standards

EDUCATION COMMITTEE MEETING
AGENDA

DATE:	DECEMBER 15, 2022
TIME:	10:00 AM
LOCATION:	BBS LIBRARY, 6606 TUSSING ROAD, REYNOLDSBURG, OHIO Click here to join the meeting

Call to Order

Consent Agenda

Course Applications

ER-1 2023 NEC Code Changes Part 1 (Wink Electric)
All certifications (5 hours)
Staff Notes: This course is not presented with visuals. A detailed outline is included. Since it is based on the 2023 code, not recommended for approval at this time.
ESIAC Recommendation: Not recommended for approval
Committee Recommendation:

ER-2 2023 NEC Code Changes Part 2 (Wink Electric)
All certifications (5 hours)
Staff Notes: This course is not presented with visuals. A detailed outline is included. Since this course is based on the 2023 code, not recommended for approval at this time.
ESIAC Recommendation: Not recommended for approval.
Committee Recommendation:

ER-3 Exploring the Process of 2017 OBC and 2019 RCO (Molnar, David)
All certifications (1 hour)
Staff Notes: Chapter 1 panel discussion with audience participation. Recommend approval.
Committee Recommendation:

ER-4 Exploring the Scope of 2017 OBC and 2019 RCO (Molnar, David)
All certifications (1 hour)
Staff Notes: Chapter 1 panel discussion with audience participation. Recommend approval.
Committee Recommendation:

Old Business

New Business

Adjourn

EDUCATION COMMITTEE MEETING
CONSENT AGENDA

Course Applications

EC-1	2020 National Electric Code (International Association of Electrical Inspectors SW) All certifications (6 hours)
EC-2	Electrical Code Review (IAEI Northwest) All certifications (twelve sessions of two hours each)
EC-3	Ohio Automatic Sprinkler and Standpipe Systems (Fire Tech Productions) All certifications (13 hours)
EC-4	Ohio Diesel Fire Pump Technician (Fire Tech Productions) All Certifications (5 hours)
EC-5	Ohio Fire Alarm and Detection Equipment (Fire Tech Productions) All certifications (11 hours)
EC-6	Ohio Fire Pumps (Fire Tech Productions) All certifications (7.5 hours)
EC-7	Ohio Household Fire Warning Equipment (Fire Tech Productions) All certifications (5 hours)
EC-8	Ohio Plumbing Code Chapter 9: Vents and Venting Principles (Franklin County Public Health) All certifications (7 hours)

File Attachments for Item:

ER-1 2023 NEC Code Changes Part 1 (Wink Electric)

All certifications (5 hours)

Staff Notes: This course is not presented with visuals. A detailed outline is included. Since it is based on the 2023 code, not recommended for approval at this time.

ESIAC Recommendation: Not recommended for approval

Committee Recommendation:

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: CLIFFORD WINKEL

Organization: WINK ELECTRIC

Address: 5640 BROAD N. RIDGEVILLE OH 44039

E-mail: WINKELECTRIC@HOTMAIL.COM Telephone: 440 346 4125

Website: WINKELECTRIC.NET

Conference Sponsor (if applicable)________ Conference Email:________

Check here if Course Renewal:_____ Prior course number ________ (*i.e. BBS2018-429*)

Renewals will only be granted for identical content and certifications, within the current code cycle. Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: 2023 NEC CODE CHANGES PART I

Course instructor: CLIFFORD WINKEL

Course description:

CODE CHANGES 2023 REVIEW

Instructional hours per session: 5 Number of Sessions: 1

Course Date(s) and Location:________

Special Content:

Code Administration:_____

Existing Buildings: _____

Electrical Instruction: X

Plumbing Instruction:_____

Conference Course: ________

Conference Name: ________

Conference location:________

Course to be offered online? YES **On Demand** X **Webinar**_____

Course Website: WINKELECTRIC.NET

Detail online course participation confirmation method (*i.e. test, quizlets, participant activity confirmation*):

____

Course applicable for the following certifications

Residential Certifications Only: _____

Administrative Course, All Certifications: _____

Commercial Certifications: X

Application materials included:

_____ Course Outline or Course Learning Objectives
_____ Presentation Materials/Slides (not required for roundtable courses)
_____ Assessment Materials (for online courses)
_____ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

Clifford Winkel
5640 Broad Blvd.
North Ridgeville, Ohio 44039
440-346-4125
winkelectric@hotmail.com

BIO

Hello, my name is Cliff Winkel and I am an electrical contractor operating out of North Ridgeville, Ohio. I have been an electrician since 1990 beginning with simple house remodels and rewiring working for various companies. In 1997 I started working for an outfit out of Cleveland, Ohio which dealt with commercial, residential, and industrial applications. In 2000 I applied, tested, passed, and received my Ohio Electrical Contractor’s License (#23838) and started my own business, Winkelectric. In 2004 I applied, tested, passed and received my Ohio Electrical Safety Inspector’s License (#1862). In 2005 I applied for, and received my Approved Training Agency License (#517). I also am licensed as a fire alarm contractor and am entry level NABCEP certified in photovoltaic installations. I also currently have a NICET level III fire alarm certification. In 2005, 2009 – 2022 I taught OCLIB electrical continuing education classes for electrical contractors (focused on 2005 2008 2011 and 2014/2017/2020 code changes and grounding). From 2000 to current I am continuing work as an electrical contractor. Some of the projects I have been involved in projects including residential buildings, commercial shopping centers, cellular tower land sites, and industrial high voltage maintenance and testing work. I have been registered and operated in numerous municipalities throughout Ohio.

Clifford Winkel

Wink Electric
11/14/22

Wink Electric Class Syllabus
2023 NEC Code Changes Part I
5 hour continuing education class

Saturday 2/4/22 8A-1P, Saturday 3/4/22 8A-1P
Saturday 4/15/22 8A-1P, Tuesday 8/8/22 8A-1P
Saturday 9/23/22 7A-12P, Saturday 11/18/22 7A-12P
Instructor: Clifford Winkel

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Office Hours:

Please feel free to call our office at any time if any need arises. Our office hours are Monday through Friday 8am – 4pm. For any immediate issues, you can contact me vie cell phone at 440-346-4125

Course Objectives:

- Review National Electrical Code changes to the 2023 NEC.
- Apply covered 2023 NEC codes to circumstances in the field with discussion of practical use and actual examples of 2023 NEC applications.
- Use the ability to relate to the changes with the class from an instructor who also works in the field.
- As detailed below, there are certain changes we will be discussing. Due to the amount of changes I wish to cover, we will run a part I and a part II of this course. Both courses will be 5 hours in length to give shorter class time per day. With 5 hour classes, I believe the amount of retention will be higher opposed to a 10 hour class.

Teaching Approach and Methods:

Portions of this course will be taught in the traditional lecture note taking format. However, a large part of the class will involve class discussions, sample illustrations, handouts, and hands on code book participation. All class members will be asked to bring their 2023 NEC book. There will also be preordered 2020 NEC books available for sale on site if any class member does not own one yet. Every hour there will be a ten minute period for open discussion. At the end of the class every applicant will fill out their individual attendance form and it will be signed then, with identification verification.

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Schedule of Topics and time schedule

7AM – 8AM

Code	Discussion
General	Discuss any of the following codes pertaining to 2020 NEC code updates. Confirm with class that this will go into effect once 2020 NEC is adopted.

Wink Electric Class Syllabus
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ARTICLE 100 DEFINITIONS – Discuss all definitions now being found in article 100 of the NEC. Definitions shall not contain requirements or recommendations. If a definition only applies to one articles, the article number will appear in parentheses after the definition.

90.5 (C) Mandatory Rules, Permissive Rules – Subdivision (C) was revised to state that unless a standard referenced in the NEC contains a date, that reference is to be considered the latest edition of the standard.

ARTICLE 100 Bonding jumper, equipment bonding jumper, main bonding jumper, supply-side bonding jumper, system bonding jumper, solidly grounded, equipment grounding conductor. - Discuss revisions to definitions for simplicity.

ARTICLE 100 Accessible – Discuss revision to define obstacles which would cause installations to not be accessible.

ARTICLE 100 Class 4 Circuit – Discuss new definition.

ARTICLE 100 Counter (Countertop) – Discuss new definition pertaining to countertop installations.

ARTICLE 100 Energy Management System – Discuss new definition pertaining to energy management system installations.

ARTICLE 100 Feeder Assembly – Discuss new definition pertaining to feeder assemblies in pre-wired facilities.

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ARTICLE 100 Fibers/Flyings Combustible – Discuss new definition covering combustible fibers and flyings.

ARTICLE 100 Impedance Grounding Conductor – Discuss new definition for Grounded Conductor, Impredance.

ARTICLE 100 In Sight – Discuss revision of definition of In Sight pertaining to sections of code.

ARTICLE 100 Likely to become energized.- Discuss new definition of likely to become energized pertaining to other sections of the NEC>

ARTICLE 100 Load Management – Discuss new definition for load management

ARTICLE 100 Restricted Industrial Establishment – Discuss new definition pertaining to hazardous area locations.

ARTICLE Servicing – Discuss new definition pertaining to maintenance and repair activities.

ARTICLE 100 Transformer – Discuss new definition of transformer (which there was no definition before).

ARTICLE 100 Work Surface – Discuss new definition establishing the difference between work surface and countertop.
8:00 – 9:00

ARTICLE 110.3(A) – Examination, identification, installation, use, and listing (Product certification) of equipment – Discuss new number 8 now including cybersecurity as something that needs considered and evaluated.

ARTICLE 110.3(B) – Examination, identification, installation, use, and listing (Product certification) of equipment – Discuss new informational note discussing the use of QR codes to gather information.

ARTICLE 110.14(A) – Terminals. Discuss the use of electrical opposed to mechanical connections.

ARTICLE 110.16(B) – Service equipment and feeders supplied equipment. Discuss revised amperage threshold for labeling.

ARTICLE 110.17 – Servicing and maintenance of equipment. Discuss revised code to limit service and maintenance of equipment to qualified persons.

ARTICLE 110.20 – Reconditioned equipment. Discuss new language defining what is considered acceptable to being reconditioned.

ARTICLE 110.21(A)(1) – Equipment markings. Discuss requirements for equipment marking for affixing labels on all electrical equipment.

ARTICLE 110.21(A)(2) – Reconditioned equipment. Discuss language that clarifies that the original listing mark is to be removed or made permanently illegible.
9:00 – 10:00

ARTICLE 110.21(B)(1) – Field applied hazard marking. Discuss revision pertaining to field applied hazard markings.

ARTICLE 110.22(A) – General. Discuss revised text clarifying when the identification of a disconnecting means is required or not required.

ARTICLE 110.26 – Spaces about electrical equipment. Discuss language pertaining to doors impeding access from electrical equipment areas.

ARTICLE 110.26 (A)(6) – Grade, floor, or working platform. Discuss new language pertaining to keeping areas clear of objects.

ARTICLE 110.29 – In sight from (within sight). Discuss new language pertaining to spaces about electrical equipment.

ARTICLE 110.33(A) – Entrance. Discuss language for working space for equipment over 1000 volts.

ARTICLE 110.34(A) – Working space and guarding. Discuss revisions regarding the conditions of the work space about equipment.

10AM – 10:15 BREAK

10:15AM – 11:15AM

ARTICLE 210.2 – Reconditioned equipment. Discuss relocation from 210.15 to 210.2 as it applies to branch circuitry.

ARTICLE 210.8(A)(6) – Dwelling units kitchens. Discuss expansion of GFCI protection in kitchens (cord and plug).

ARTICLE 210.8(A) – Dwelling units bathrooms. Discuss revision of GFCI protection regarding exhaust fans.

ARTICLE 210.8(A)(8) – GFCI Protection for personnel. – Discuss weight supporting attachment fitting and GFCI protection of said fitting.

ARTICLE 210.8(B)(4) – Other than dwelling units. Discuss addition of buffet style locations requiring GFCI protection.

ARTICLE 210.8(B)(7) – Other than dwelling units sinks. Discuss addition of cord and plug connected equipment to code language.

ARTICLE 210.8(B)(13) – Other than dwelling units aquariums. Discuss addition of new item 13 discussing aquariums and bait wells.

ARTICLE 210.8(D) – Specific appliances. Discuss additional language pertaining to specific appliances listed in 218.8(D).

ARTICLE 210.8(F) – Outdoor outlets. Discuss revision regarding replacements of existing receptacles and their GFCI requirements.

ARTICLE 210.11(C)(4) – Branch circuits required. Discuss revision regarding the use of 15 amp circuits feeding garage areas.

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2023 NEC Code Changes Part I
5 hour continuing education class

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ARTICLE 210.11(C)(4) – Branch circuits required. Discuss new exception 4 allowing 20 amp garage bay circuits to feed other items.

ARTICLE 210.12 – AFCI protection. Discuss and review reformatted section.

ARTICLE 210.12(D)(3) – Other occupancies. Discuss new language adding sleeping areas to other occupancy types.

ARTICLE 210.17 – Guest rooms and suites. Discuss revision adding requirements for assisted living buildings and their receptacle layouts.

ARTICLE 210.19 – Minimum ampacity and size. Discuss revision regarding the use of circuit size vs conductor ampacity.

ARTICLE 210.23 – Permissable loads. Discuss 10 amp branch circuitry language added to the 2023 NEC.

ARTICLE 210.52(C) – Dwelling units islands/peninsulas. Discuss revisions regarding placement of receptacles in islands/peninsula areas.

ARTICLE 210.52(G) – Basements, garages, accessory buildings. Discuss clarification of the security receptacle not meeting the requirements of 210.52(G).

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ARTICLE 210.70 – Lighting outlets required. Discuss revision adding laundry areas to list of areas requiring wall mounted control devices.

ARTICLE 215.15 – Barriers. Discuss new language requiring barriers for line voltage breaker situations.

ARTICLE 215.18, 225.42, 230.67 – SPD. Discuss the expansion of SPD requirements in the 2023 NEC.

ARTICLE 220.1 – Scope. Discuss new language pertaining to calculations for health care facilities, marina, boatyards, and docking facilities.

ARTICLE 220.5 – Floor areas. Discuss new language including unused/unfinished areas of buildings to load calculations.

ARTICLE 220.57 – Electric Vehicle Supply Equipment. Discuss new section pertaining to load calculations for EVSE.

ARTICLE 220.70 – EMS. Discuss new language calculating load demands for EMS systems.

ARTICLE 220.110 – Receptacle loads. Discuss new tables pertaining to receptacle loads in patient care spaces.

11:15 – 12:15

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ARTICLE 220.120 – Marinas, boatyards, etc. Discuss relocation of 555.6 to 220.120.

ARTICLE 225.5/225.7 – Deletion. Discuss deletion of 225.5 and 225.7 referring this information to articles 215 and 220.

ARTICLE 225.41 – Emergency disconnects. Discuss new language requiring emergency disconnects for one and two family dwelling units being served by feeders.

ARTICLE 230.62(C) – Barriers. Discuss revision regarding requirements of barriers in service equipment.

ARTICLE 230.67(A) – SPDs. Discuss change in language from dwelling units to list specific occupancies.

ARTICLE 230.71(B) – Two to six service disconnecting means. Discuss language requiring transfer switches to be listed as service equipment.

ARTICLE 230.71(B) EXCEPTION – Discuss exception grandfathering older installations installed in accordance with older versions of the NEC.

ARTICLE 230.85 – Emergency disconnects. Discuss new sub divisions regarding the use of emergency disconnects.

ARTICLE 240.2 – Reconditioned equipment. Discuss relocation of 240.62 and 240.88.

ARTICLE 240.4(B) – Overcurrent devices 800 amps or less. Discuss addition of adjustable trip overcurrent devices to 240.6(A).

Wink Electric Class Syllabus
2023 NEC Code Changes Part I
5 hour continuing education class

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ARTICLE 240.4(D)(3) – 14 AWG copper clad aluminum. Discuss addition of copper clad aluminum to 240.4(D).

ARTICLE 240.6(D) – Remotely accessible adjustable trip circuit breakers. Discuss revision to allow remote access to adjustable trip circuit breakers.

ARTICLE 240.7 – Listing requirements. Discuss new section requiring listing of these GFPE and GFCI devices.

ARTICLE 240.11 – Selective coordination. Discuss new requirement clarifying feeder overcurrent devices and their interaction with service overcurrent devices.

ARTICLE 240.16 – Interrupting ratings. Discuss new requirement regarding minimum interrupting ratings.

ARTICLE 240.24(A) – Accessibility – Exception. Discuss revision regarding updating “similar enclosures”.

ARTICLE 240.2E (E) – Not located in bathrooms. Discuss revision clarifying over current devices not being acceptable in bathroom areas.

ARTICLE 242.2 – Reconditioned equipment. Discuss new language stating SPDs cannot be reconditioned.

ARTICLE 242.9 – Indicating. Discuss requirement for indicating lights for SPDs.

ARTICLE 250.24 – Grounding of AC systems. Discuss revision to clarify requirements of parallel installations.

ARTICLE 250.24 (D)(2) – Grounding of AC systems. Discuss revision clarifying parallel service conductor installations.

ARTICLE 250.50, 250.52(A)(3)(1), 250.52 (B)(2) – Grounding electrode system. Discuss change of language regarding concrete encased electrodes.

ARTICLE 250.64(G) – Enclosures with vent openings. Discuss new requirements not allowing vented areas to be used to install GEC.

ARTICLE 250.70 – Methods of grounding and bonding. Discuss revision to grounding electrode installation methods.

ARTICLE 250.94(A) – Intersystem bonding termination. Discuss revision in intersystem bonding terminal requirements.

ARTICLE 250.118(A) – Types of EGC. Discuss new item (6)(F) that was added along with the special rules associated with it.

ARTICLE 250.130 – EGC connections. Discuss revision adding snap switches.

ARTICLE 250.140 – Frames of ranges and dryers. Discuss revision trying to streamline understanding of this section.

ARTICLE 250.148 – Continuity of EGC. Discuss revision adding subdivision (A) clarifying connections of EGC in boxes.

ARTICLE 300.4 (E) EX 1/2 – Discuss revision discussing concrete located on a metal corrugated roof.

ARTICLE 300.4 (G) – Fittings. Discuss revision dealing with bushing being installed before installation.

TABLE 300.5 – Minimum cover requirements. Discuss revision adding EMT to the table.

ARTICLE 300.5 (D) – Protection from damage. Discuss deletion of “direct buried” language.

ARTICLE 300.6 (A) – Ferrous metal equipment. Discuss revision of language.

File Attachments for Item:

ER-2 2023 NEC Code Changes Part 2 (Wink Electric)

All certifications (5 hours)

Staff Notes: This course is not presented with visuals. A detailed outline is included. Since this course is based on the 2023 code, not recommended for approval at this time.

ESIAC Recommendation: Not recommended for approval.

Committee Recommendation:

Wink Electric Class Syllabus
2023 NEC Code Changes Part II
5 hour continuing education class

Saturday 2/11/22 8A-1P, Saturday 3/11/22 8A-1P
Saturday 4/22/22 8A-1P, Tuesday 8/15/22 8A-1P
Saturday 9/23/22 1P-6P, Saturday 11/18/22 1P-6P
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Schedule of Topics and time schedule

7AM – 8AM

ARTICLE 300.11 (C) – Raceways used as means of support. Discuss revision adding class 3 circuits as a conductors allowed to be supported in this fashion.

ARTICLE 300.14 – Length of free conductors at openings. Discuss revision allowing splicing of short conductors.

ARTICLE 300.17 – Number and size of conductors in raceways. Discuss revision in language safeguarding conductors during and after installation.

ARTICLE 300.25 – Exit enclosures. Discuss language adding the use of fire barriers in addition to being separated from the building.

ARTICLE 300.26 – Remote control and signaling circuits. Discuss new 300.26 with these types of circuitry.

TABLES 310.16, 310.17, 310.20 – Ampacity of conductor tables. Discuss deletion of XHWN from the 90 degree tables.

ARTICLE 312.10 – Screws and other fasteners. Discuss new section dealing with field installed screws.

ARTICLE 314.5 – Screws and other fasteners. Discuss new section dealing with screws and other fasteners entering enclosures.

ARTICLE 315.1 – Dimensions of boxes. Discuss revision adding language about side entries.

ARTICLE 315.1 – Scope. Discuss new language regarding the voltages covered by article 315.

ARTICLE 320.23 (A) – Cables run across framing members. Discuss revision of language to framing members opposed to joists.

Wink Electric Class Syllabus
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ARTICLE 322.56 (B) – Taps. Discuss revision dealing with flat cable being marked and not necessarily colored.

ARTICLE 330.112 (A) – 1000 volts or less MC cable. Discuss revision of language in the MC section.

ARTICLE 342.20 (B) – Maximum. Discuss revision of largest size of IMC allowed to be installed.

ARTICLE 344.28 – Reaming and threading. Discuss revision in language regarding PVC coated rigid.

ARTICLE 352.44 (B) – Expansion fittings. Discuss new requirements for expansion joints.

ARTICLE 358.48 – Revision. Discuss revision regarding joining methods.

ARTICLE 358.20 (B) – Maximum. Discuss revision allowing up to 6” EMT to be used.

ARTICLE 404.1 – Scope. Discuss new informational note regarding wall mounted devices.

ARTICLE 404.14 (D) – Snap switch terminations. Discuss new language dealing with 14 awg wire and snap switches.

ARTICLE 404.16 – Reconditioned equipment. Discuss new language prohibiting reconditioning of switches.

ARTICLE 404.30 – Switch enclosures. Discuss new **requirements** for doors with switch mechanisms.

ARTICLE 406.2 – Reconditioned equipment. Discuss relocation from 406.3 (A) and 406.7 to new section 406.2.

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8:00 – 9:00
ARTICLE 406.30 (D) – Receptacle terminations. Discuss new language regarding the limitations of 15 amp branch circuits.

ARTICLE 406.4 (D)(3) – GFCI protection. Discuss revision of language to require listing of products.

ARTICLE 406.4 (D)(8) – GFPE protection. Discuss new language requiring GFPE protection when replacing devices in areas which require it.

ARTICLE 406.6 (D) – Receptacle faceplates. Discuss revision regarding lighting faceplates and what kind of screws are allowable.

ARTICLE 406.9 (C) – Bathtub and shower space. Discuss revision regarding limitations of receptacles around these areas.

ARTICLE 406.12 – TR receptacles. Discuss revision in language attempting to streamline language regarding areas where TR receptacles are required.

ARTICLE 408.4 – Descriptions required. Discuss revision regarding circuit directories.

ARTICLE 408.9 – Replacement panelboards. Discuss revision in requirements for replacement panelboards.

ARTICLE 408.38 – Enclosure. Discuss revision regarding listing of equipment with available arc fault current greater than 10k.

ARTICLE 408.43 – Panelboard orientation. Discuss revision prohibiting panelboards being installed in a face gown position.

ARTICLE 409.60 – Bonding. Discuss reorganization of this article.

ARTICLE 409.70 – Surge protection. Discuss new section requiring surge protection for industrial control panels.

ARTICLE 410.2 – Reconditioned equipment. Discuss revision adding LED drivers and lamps to items that are prohibited from recondition.

ARTICLE 410.10 (F) – Luminaires installed in or under roof decking. Discuss revision requiring 1 ½” space under roof decking.

ARTICLE 410.71 – Disconnecting means for luminaires. Discuss relocation from 410.71 to this section.

ARTICLE 410 PART XVII – Special provisions for germicidal irradiation luminaires. Discuss new part XVII added to the NEC.

ARTICLE 410.184 – GFCI and SPGFCI protection. Discuss revision clarifying when to use these types of devices.

ARTICLE 422 – Appliances. Discuss deletion of sections 422.3, 422.4, 422.15, 422.23, 422.46, 422.50.

ARTICLE 422.16 (B)(2) – Built in dishwashers and compactors. Discuss revision to provisions regarding pass through cords in these installations.

ARTICLE 422.18 – Paddle fans. Discuss revision prohibiting certain kinds of ceiling fan installations.

ARTICLE 424.10 – General – Discuss deletion of special permission.

ARTICLE 424.48 – Installation of cables in walls. Discuss new section allowing heating cables to be installed in walls.

ARTICLE 424.93 (C) – Installation of heating panels in walls. Discuss new section allowing heating panels to be installed in walls.

ARTICLE 425.10 – General. Discuss deletion of special permission.

Wink Electric Class Syllabus
2023 NEC Code Changes Part II
5 hour continuing education class

Saturday 2/11/22 8A-1P, Saturday 3/11/22 8A-1P
Saturday 4/22/22 8A-1P, Tuesday 8/15/22 8A-1P
Saturday 9/23/22 1P-6P, Saturday 11/18/22 1P-6P
Instructor: Clifford Winkel

February location: Fields Sweet School 8540 Root Rd North Ridgeville, Ohio 44039
March location: Jims Electric 39221 Center Ridge Rd North Ridgeville, Ohio 44039
April location: Net Electric 12925 Pearl Rd Strongsville, Ohio 44136
August Location Wink Electric Inc – 34400 Lorain Rd, North Ridgeville, Ohio 44039
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November location: City of Elyria – 1194 Gulf Rd Elyria, Ohio 44035

Page 5/12

9:00 – 10:00
ARTICLE 426.14 – Special permission. Discuss deletion of special permission.

ARTICLE 426.28 – Ground fault protection. Discuss revision recognizing manufacturer's requirements on snow melting equipment.

ARTICLE 427.35 – Scope. Discuss deletion of article 427.35.

ARTICLE 430.1 – Scope. Discuss revision of figure 430.1.

ARTICLE 430.2 – Reconditioned motors. Discuss new section regarding guidance on reconditioning motors.

ARTICLE 440.8 – Single machine and location. Discuss revision to 440.8 prohibiting mini split installation in certain areas.

ARTICLE 440.11 – General – Discuss revision requiring locking of disconnects.

ARTICLE 440.14 – Location. Discuss revision regarding workspace clearance for HVAC equipment.

ARTICLE 445.18 (A) & 445.19 – Disconnecting means and emergency shutdown. Discuss revision allowing disconnection to be behind hinged covers.

ARTICLE 450.2 – Interconnection of transformers. Discuss new section adding guidance for transformer interconnection.

ARTICLE 470.2 – Reconditioned equipment. Discuss new section prohibiting reconditioning of resistors.

ARTICLE 495 – Equipment over 1000 volts AC. Discuss requirements formerly found in 490 are now found in article 495.

ARTICLE 500.4 – Documentation. Discuss revision in documentation requirements by the

AHJ.

ARTICLE 500.5 (D)(1)(A) – Combustible fibers/flyings. Discuss revision definition of combustible fibers.

ARTICLE 500.8 (D)(2) AND (D)(3) – Equipment temperature. Discuss revision in this section to align with the new definition of combustible fibers.

ARTICLE 505.9 (C) CHAPTER 9 TABLE 13 – Equipment suitable for hazardous locations. Discuss new table 13 in Chapter 9 and deletion of table 505.9 (C)(2)(4).

ARTICLE 512 – Cannabis oil equipment. Discuss new article 512 covering this kind of installation area.

ARTICLE 515.10 – Special equipment motor fuel. Discuss language change from gas dispenser to motor fuel dispenser.

ARTICLE 517 – Health care facilities. Discuss revision in definitions of Category 1-4 spaces.

ARTICLE 517.6 – Patient care related equipment. Discuss new language confirming reconditioning requirements in other areas of the code do not apply to patient care equipment.

ARTICLE 517.13 – EGC in patient care spaces. Discuss revision in language regarding installations in these areas.

ARTICLE 517.22 – Demand factors. Discuss new section regarding demand factors in heath care facilities.

ARTICLE 517.30 – Sources of power. Discuss revisions in terminology in this section.

ARTICLE 517 PART V – Diagnostic imaging and treatment equipment. Discuss revision in language from Xray installations to diagnostic imaging and treatment equipment.

10AM – 10:15 BREAK

10:15AM – 11:15AM

Wink Electric Class Syllabus
2023 NEC Code Changes Part II
5 hour continuing education class

Saturday 2/11/22 8A-1P, Saturday 3/11/22 8A-1P
Saturday 4/22/22 8A-1P, Tuesday 8/15/22 8A-1P
Saturday 9/23/22 1P-6P, Saturday 11/18/22 1P-6P
Instructor: Clifford Winkel

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10:15 – 11:15
ARTICLE 518.2 – Casinos and gaming facilities. Discuss revision adding these areas to assembly examples.

ARTICLE 518.4 – Wiring methods. Discuss revision in language including POE cabling.

ARTICLE 518.5 – Supply. Discuss revision reorganizing assembly occupancies.

ARTICLE 547.26 – Physical protection. Discuss new section regarding nonmetallic cables.

ARTICLE 547.44 – Equipotential planes and bonding. Discuss new section clarifying indoor and outdoor locations of these areas.

ARTICLE 550.32 – Service equipment. Discuss revision for disconnect location.

ARTICLE 551.3 – Electrical datum plane. Discuss new section dealing with datum planes at RV areas.

ARTICLE 551.40 (D) – Loss of ground device. Discuss revision eliminating the requirement for reverse polarity devices.

ARTICLE 555.4 – Location of service equipment. Discuss revision modifying 555.4 and distances for docking services.

ARTICLE 555.6 – Load calculations for service and feeder conductors. Discuss relocation from 555.6 to 220.120 for calculations.

ARTICLE 555.14 – Equipotential planes and bonding. Discuss new section regarding installing equipotential planes in marinas and boatyards.

ARTICLE 555.15 – Replacement of equipment. Discuss new section requiring replacement devices to be installed to the new requirements of the NEC.

ARTICLE 555.35 (E) – Leakage current measurement device. Discuss new language requiring these devices to be listed by 1/1/26.

ARTICLE 555.36 (C) – Emergency electrical disconnect. Discuss new requirements mandating the emergency disconnect be located within sight of a marina power outlet.

ARTICLE 555.38 – Luminaires. Discuss new section dealing with luminaires in marinas and dockyards.

ARTICLE 590.4 (F) – Lamp protection. Discuss new revision requiring metal caged temp lighting.

ARTICLE 600.5 (A) – Exception. Discuss new exception relocation of timeclock language.

ARTICLE 600.35 – Retrofit kits. Discuss deletion of section 600.35.

ARTICLE 620.12 (A) – Traveling cables. Discuss new addition of class 2 cables to this section.

ARTICLE 620.22 (A) – Car light receptacles. Discuss revision to specify permissible loads on the car light circuit.

ARTICLE 620.36 – Different systems. Discuss revision specifying which cable types can be run.

ARTICLE 620.51 (A) TYPE EX NO. 2 – Stairway chair lift. Discuss revision determining where stairway chair lifts are allowed.

ARTICLE 625.6 – Listed. Discuss revision determining which EV systems are to be listed.

ARTICLE 625.44 (A) – Portable equipment. Discuss revision adding 60 amp receptacles to this section.

ARTICLE 625.49 – Island mode. Discuss new language dealing with island mode on EV’s.

ARTICLE 630.8 – GFCI for welders. Discuss new section laying out when to install these.

ARTICLE 646.19 – Entrance to and egress from working space. Discuss revision regarding egress doors in modular areas.

ARTICLE 670.1 – Scope. Discuss revision requiring over voltage protection in these environments.

ARTICLE 680 – Swimming pools etc. Discuss reorganization to try to elevate usability of article 680.

ARTICLE 680.5 – GFCI and SPGFCI protection. Discuss revision requirements for these devices in article 680 areas.

ARTICLE 680.9 (A) – Power. Discuss revision clarifying open overhead wiring in raceways.

ARTICLE 680.10 – Electric pool water heaters. Discuss revision including electric pool water installations.

ARTICLE 680.21 (D) – Pool pump motor replacement. Discuss revision requiring GFCI for pumps replacement and reconditioned.

ARTICLE 680.12 – Equipment rooms. Discuss revision requiring drainage.

ARTICLE 680.23 (B)(2)(a) – Forming shell. Discuss revision requiring listing for rigid in certain pool areas.

ARTICLE 680.32 – GFCI and special purpose SPGFCI protection. Discuss revision regarding when to install these devices.

Wink Electric Class Syllabus
2023 NEC Code Changes Part II
5 hour continuing education class

Saturday 2/11/22 8A-1P, Saturday 3/11/22 8A-1P
Saturday 4/22/22 8A-1P, Tuesday 8/15/22 8A-1P
Saturday 9/23/22 1P-6P, Saturday 11/18/22 1P-6P
Instructor: Clifford Winkel

February location: Fields Sweet School 8540 Root Rd North Ridgeville, Ohio 44039
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November location: City of Elyria – 1194 Gulf Rd Elyria, Ohio 44035

11:15 – 12:15

ARTICLE 680.41 (A) – Emergency switch for spas and hot tubs. Discuss revision excluding the need to these installations at single family dwellings.

ARTICLE 680.44 – GFCI and SPGFCI protection. Discuss revision regarding these devices installed in these areas.

ARTICLE 680.54 (C) – Equipotential bonding of splash pads. Discuss new section addressing bonding requirements in these areas.

ARTICLE 690 – Solar photovoltaic systems. Discuss removal of PV output circuit.

ARTICLE 700.2, 701.2, 702.2, AND 708.2 – Reconditioned equipment. Discuss reconditioning of transfer switches being prohibited.

ARTICLE 700.3 (F) – List items 4, 6, 7. Discuss new/revision requiring listing of devices.

ARTICLE 700.5 (D) – Redundant transfer equipment. Discuss revision pertaining to emergency loads supplied by single feeders.

ARTICLE 700.11 (C) – Wiring class 2 powered emergency lighting systems. Discuss new section citing requirements for the separation of class 2 circuits.

ARTICLE 700.12 (C) – Supply duration. Discuss new informational note to reference classification information for EPSS systems.

ARTICLE 700.12 (E) & 701.12 (E) – Stored energy power supply systems. Discuss revision in language from uninterruptible power supplies to stored energy power supply systems.

ARTICLE 700.12 (G) – Microgrid systems. Discuss revision to microgrid system management.

ARTICLE 701.4 (C) – Load management. Discuss revision to load management requirements.

ARTICLE 701.4 (D) – Parallel operation. Discuss new section adding language identifying two different types of parallel operations.

ARTICLE 701.10 – Wiring legally required standby systems. Discuss new section concerning wiring requirements for legally required standby systems.

ARTICLE 701.12 (C) – Supply duration. Discuss new informational note referencing classification information.

ARTICLE 705.11 – Source connections to a service. Discuss revision applying to systems interconnected with new or existing utility services.

ARTICLE 705.13 – EMS systems. Discuss relocation of much of the language from this article to article 750.

ARTICLE 705.20 – Source disconnecting means. Discuss deletion of requirements to lock and/or use tools to open.

ARTICLE 705.30 (F) – Transformers. Discuss new language addressing transformer requirements for interconnected systems.

ARTICLE 705.50 – System operation. Discuss revision discussing operational modes of microgrid systems.

ARTICLE 706.7 – Commissioning and maintenance (energy storage systems). Discuss new section regarding commissioning requirements.

ARTICLE 722 – Cables for power limited circuits. Discuss new article 722 covering general requirements for class 4 circuits.

Wink Electric Class Syllabus
2023 NEC Code Changes Part II
5 hour continuing education class

Saturday 2/11/22 8A-1P, Saturday 3/11/22 8A-1P
Saturday 4/22/22 8A-1P, Tuesday 8/15/22 8A-1P
Saturday 9/23/22 1P-6P, Saturday 11/18/22 1P-6P
Instructor: Clifford Winkel

February location: Fields Sweet School 8540 Root Rd North Ridgeville, Ohio 44039
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ARTICLE 725.144 – Bundling of cables transmitting power and data. Discuss revision removing 4 pair from title section.

ARTICLE 726 – Class 4 power systems. Discuss new article 726 dealing with FMP systems.

ARTICLE 760 – Fire alarm systems. Discuss several section that were revised and reworded in article 760.

ARTICLE 800.179 – Wires and cables. Discuss relocation of hybrid power and comm systems to article 800.

ARTICLE 805.170 – Protectors. Discuss relocation of communications listing to article 800 from 805.

ARTICLE 840.160 – Powering circuits. Discuss relocation of communication cable wiring to article 800.

CHAPTER 9 TABLE 13 – Equipment suitable for hazardous locations. Discuss new table located in chapter 9.

ANNEX A – Discuss new table A.1(b).

ANNEX E – Fire resistance construction. Discuss changes to type IV construction.

Clifford Winkel
5640 Broad Blvd.
North Ridgeville, Ohio 44039
440-346-4125
winkelectric@hotmail.com

BIO

Hello, my name is Cliff Winkel and I am an electrical contractor operating out of North Ridgeville, Ohio. I have been an electrician since 1990 beginning with simple house remodels and rewiring working for various companies. In 1997 I started working for an outfit out of Cleveland, Ohio which dealt with commercial, residential, and industrial applications. In 2000 I applied, tested, passed, and received my Ohio Electrical Contractor's License (#23838) and started my own business, Winkelectric. In 2004 I applied, tested, passed and received my Ohio Electrical Safety Inspector's License (#1862). In 2005 I applied for, and received my Approved Training Agency License (#517). I also am licensed as a fire alarm contractor and am entry level NABCEP certified in photovoltaic installations. I also currently have a NICET level III fire alarm certification. In 2005, 2009 – 2022 I taught OCLIB electrical continuing education classes for electrical contractors (focused on 2005 2008 2011 and 2014/2017/2020 code changes and grounding). From 2000 to current I am continuing work as an electrical contractor. Some of the projects I have been involved in projects including residential buildings, commercial shopping centers, cellular tower land sites, and industrial high voltage maintenance and testing work. I have been registered and operated in numerous municipalities throughout Ohio.

Clifford Winkel

Wink Electric
11/14/22

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: CLIFFORD WINKEL
Organization: WINK ELECTRIC
Address: 5640 BROAD N.RIDGEVILLE OH 44039
E-mail: WINKELECTRIC@HOTMAIL.COM Telephone: 4403464125
Website: WINKELECTRIC.NET
Conference Sponsor (if applicable)______ Conference Email:______

Check here if Course Renewal:______ Prior course number ______ (*i.e. BBS2018-429*)
Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: 2023 NEC CODE CHANGES PART II
Course instructor: CLIFFORD WINKEL
Course description:
CODE CHANGES 2023 REVIEW

Instructional hours per session: 5 Number of Sessions: 1
Course Date(s) and Location:______

Special Content:

Code Administration:______
Existing Buildings:______
Electrical Instruction: X
Plumbing Instruction:______

Conference Course:______
Conference Name:______
Conference location:______

Course to be offered online? YES **On Demand** X **Webinar**______
Course Website: WINKELECTRIC.NET
Detail online course participation confirmation method (*i.e. test, quizlets, participant activity confirmation*):

Course applicable for the following certifications

Residential Certifications Only: ______ Commercial Certifications: X
Administrative Course, All Certifications: ______

Application materials included:

______ Course Outline or Course Learning Objectives
______ Presentation Materials/Slides (not required for roundtable courses)
______ Assessment Materials (for online courses)
______ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

File Attachments for Item:

ER-3 Exploring the Process of 2017 OBC and 2019 RCO (Molnar, David)

All certifications (1 hour)

Staff Notes: Chapter 1 panel discussion with audience participation. Recommend approval.

Committee Recommendation:

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

APPLICATION FOR CONTINUING EDUCATION APPROVAL
COURSE CONDITIONS AND GUIDELINES

The Ohio Board of Building Standards is committed to the ongoing education and professional development of board-certified personnel through the delivery of high-quality, accurate and engaging professional continuing education content. To this end, the Board reviews and approves Continuing Education Courses for building department personnel.

Board approval is granted for course instruction on current codes and standards, including the OBC, OMC, OPC, and RCO, and any other content areas directly related to the responsibilities of the certification for which credit is being requested.

Promotion: Any person or organization promoting an approved course is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, categories 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 may not falsely state BBS approval before approval is granted. Course providers may state that BBS approval is pending.

Application Submission: All Applications and associated materials shall be submitted by email in .pdf format. Instructions for completing the application are attached.

Certificate of Completion: Course providers shall 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.

Any person or organization administering an approved course shall return a completed BBS Course Attendance form by email.

Participants: Participants must attend the complete course as presented by the instructor to receive credit hours approved by the Board. The organization or instructor of online courses shall plan and execute methods to verify the individual's attendance and completion of the course. No partial credit will be given to any participant who failed to complete the entire course as approved.

Board approval: All courses are approved for the calendar year in which application is made. Courses may be renewed so long as the referenced code is in effect, and the CEUs, certification and content remain unchanged. When the referenced code is updated, courses must be updated, and new approvals obtained.

Facility/training area: BBS Course may be delivered in person or online, or both, at the sponsor's option.
Course facilities shall include the following:

In Person Classes:
Sufficient seating capacity
ADA accessible facilities
Appropriate Audio/Visual devices for delivery
Writing surfaces for participants

Online Classes:
Web-accessible
ADA accessible delivery
Tech support available
Live and recorded courses permitted

In-person facilities shall comfortably and safely seat at least the number of attendees present in the room and shall be climate controlled, non-smoking, and sound controlled so that outside noise will not interfere with the training.

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name:______

Organization:______

Address:______

E-mail: dmolnar1@hotmail.com Telephone: 3307140982

Website:______

Conference Sponsor (if applicable)______ Conference Email:______

Check here if Course Renewal:______ Prior course number ______ (*i.e. BBS2018-429*)

Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: Chapter 1 Panel Discussion and Roundtable - Exploring The Process of the 2017 OBC and the 2019 RCO

Course instructor: David Molnar

Course description: Roundtable discussion with a twist - led by an Instructor [MC] interviewing a panel of guest Building Officials from FBOA Topics from the attached outline and the panel on stage as well as relative questions and input from the audience of practical Code experiences. Using various commentaries, guides and handouts available from the Board of Building Standards. GOAL: maximize audience participation

Instructional hours per session: 1 Number of Sessions: 1

Course Date(s) and Location:______

Special Content:

Code Administration: ✓ Conference Course:______

Existing Buildings: ✓ Conference Name:______

Electrical Instruction:______ Conference location:______

Plumbing Instruction:______

Course to be offered online?______ **On Demand**______ **Webinar**______

Course Website:______

Detail online course participation confirmation method (*i.e. test, quizlets, participant activity confirmation*):

______

Course applicable for the following certifications

Residential Certifications Only:______ Commercial Certifications:______

Administrative Course, All Certifications: ✓

Application materials included:

✓ Course Outline or Course Learning Objectives
______ Presentation Materials/Slides (not required for roundtable courses)
______ Assessment Materials (for online courses)
✓ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Instructions for new Continuing Education Approval form

Provider Information

1. Please include all contact information.
2. If course is not part of a conference, leave conference sponsor and email blank.

Course Renewal

1. Indicate if the course is being submitted for renewal. Include prior approval letter and write in prior course number.
2. Certification approval for courses has now changed: all existing courses being renewed will be approved within the new classification system.
    a. Courses previously approved for only residential certifications will be approved for all residential certifications.
    b. Courses previously approved for at least on commercial certification will now be approved for all commercial certifications and all residential certifications.
    c. Courses on required instruction topics, Ohio Ethics, Code Administration and Existing Buildings, will be noted as Administrative Courses and be approved for all certifications.
3. Courses being renewed should skip the New Course information section and are not required to submit outline, agenda, slides or other instructional materials for review. Skip to Special Content, and mark any item that applies to the course.

New Course Information

1. Enter course title, name of instructor, and a brief description of the course content. Learning objectives may be substituted for course description, if desired.
2. Number of instructional hours per session is the length of instructional time.
3. Number of sessions: can be 1 or the number of sessions planned.
4. Course date(s) and location: not necessary at this time, enter if known.

Special Content

1. Indicate if the course will meet instructional time in Code Administration or Existing Buildings.
2. Indicate if the course is a plumbing or electrical course, for ESIAC review and trainee course tracking.
3. If the course is associated with a conference, indicate the conference name and location, as this will allow BBS to coordinate approvals with the conference provider.
4. If the course will be offered online, specify whether it will be on demand or offered as a virtual webinar, or both. Include website where the course will be provided.

Course applicable for the following certifications

This section represents a major change from previous BBS course approval forms.

1. If the course is only for residential certifications, check 'Residential Certifications Only'. The course, if approved, will be approved for all residential certifications.
2. If the course is appropriate for any commercial certifications, check Commercial Certifications. The course, if approved, will be approved for all commercial certification **AND** all residential certifications.
3. If the course is intended to meet required instruction in Code Administration (Chapter 1) or Existing Buildings (commercial or residential) check 'Administrative Course, All Certifications'.

Application Materials Included

This is a checklist for the course submitter's use, to be sure all materials necessary for review are included with the application. All materials should be submitted in .pdf format, along with the application, via email to Michael.Lane@com.ohio.gov or BBS@com.ohio.gov

Chapter 1 Panel Discussion and Roundtable
Exploring The Process of the 2017 OBC and the 2019 RCO

- Section 103 Certified building departments, personnel, and appeals boards
    - Refer to division 4101:7 of the Administrative Code
    - Section 110 Appeals
- Section 104 Duties and responsibilities of building department personnel
    - 104.2.1 Building official.
    - 104.2.2 Plans Examiners
    - 104.2.3 Inspectors
        - Building, Plumbing and Electrical Safety
        - 104.2.3.4 Elective inspectors
            - Mechanical
            - Fire Protection
            - Medical Gas Piping
    - 104.3 Certified boards of building appeals duties and responsibilities.
    - 104.4 Violation of duties
- Section 108 Inspection process
    - 108.1 General:
        - After construction documents have been approved, construction or work may proceed in accordance with the approved documents.
        - Construction or work for which an approval is required shall be subject to inspection. It shall be the duty of the owner or the owner's representative to notify the building department when work is ready for inspection. Access to and means for inspection of such work shall be provided for any inspections that are required by this code. It shall be the duty of the owner or the owner's representative to cause the work to remain accessible and exposed for inspection purposes. Such construction or work shall remain accessible and exposed for inspection purposes until the work has been inspected to verify compliance with the approved construction documents, but failure of the inspectors to inspect the work within four days, exclusive of Saturdays, Sundays, and legal holidays, after the work is ready for inspection, allows the work to proceed.
        - Subsequent work is allowed to proceed only to the point of the next required inspection.
    - 108.2 Required inspections. At the time that the certificate of plan approval is issued, the building official shall provide, to the owner or the owner's representative, a list of all required inspections for each project.:
        - 108.2.1 Lot line markers required
        - 108.2.2 Footing or foundation inspection.
        - 108.2.3 Concrete slab and under-floor inspection.
        - 108.2.4 Lowest floor elevation.
        - 108.2.5 Frame inspection.

- 108.2.6 Lath or gypsum board inspection. Exception: Gypsum board that is not part of a fire-resistive assembly or a shear assembly.
- 108.2.7 Fire-resistant penetrations.
- 108.2.8 Energy efficiency inspections.
- 108.2.9 Building services equipment inspections. mechanical heating and ventilating systems, mechanical exhaust systems, plumbing systems, fire protection systems, and electrical systems.
  - 108.2.9.1 Inspections of elevators. division of industrial compliance pursuant to Chapter 4105 of the Revised Code and as required in Section 3006.1.
  - 108.2.9.2 Inspections of boilers. pursuant to Chapter 4104 of the Revised Code.
- 108.2.10 Other inspections.
  - In addition to the inspections specified above, the building official is authorized to cause to be made or require other inspections of any construction work to be made to ascertain compliance with the provisions of this code.
  - projects of unusual magnitude of construction, - full-time project representation by a registered design professional or inspection agency.
  - Exception: Where the building official requires full-time project inspection, the installation of a fire protection system may be inspected by a person certified under section 3781.105 of the Revised Code. The person shall be certified in the appropriate subfield of fire protection systems being inspected - water-based fire protection systems (formerly automatic sprinkler systems), fire alarm, or special hazards systems design.
- 108.2.11 Special inspections. For special inspections, see section 1704.
- 108.2.12 Inspections, completion. When all of the required successive inspections have been satisfactorily completed and the inspectors have verified compliance with the approved construction documents, the inspectors shall communicate their findings to the building official. The building official, after review of the findings, shall issue the certificate of occupancy or the certificate of completion as described in section 111.
-
- 108.2.12.1 Fire protection system final inspections. Fire protection system final inspections shall be coordinated with the fire official in accordance with Section 901.2.1.2.
- 108.2.13 Industrialized unit inspections. Approved industrialized units and the on-site construction to complete the installation of the industrialized units shall be inspected. Such inspections shall include:
  - Connection to on-site construction, interconnection of modules, connection to utilities. The inspections and conducting of required tests shall not require the destruction or disassembly of any factoryconstructed component authorized by the board.

    - Inspection of the unit for damage resulting from transportation, improper protection of exposed parts from inclement weather or other causes. Damage shall be repaired as required by the building official to comply with the applicable provisions of the rules of the board;
    - Inspection of the unit to determine if it is marked by an insignia furnished by the board; and
    - Inspect the unit to determine if the floor plan, exterior elevations, and exposed details are in conformance with the plans approved by the board.
- 109.1 Adjudication Order
- 109.4 Unsafe Structures

BBS Handouts, Commentaries, Guides and Handouts:

- Commentary – OBC Chapter 1 Administration
- Commentary – RCO Chapter 1 Administration
- 2017 Ohio Building Code (OBC) Building Department Resource Package
- CBO Duties
- Approvals and Inspections Pamphlet
- Building Department Personnel Certification Rules

David Molnar:

Mr. Molnar is the Master Plans Examiner for Richland County and serves as the part-time Chief Building Official for the City of Aurora. He was previously the Chief Building Official for the Medina County Building Department and the City of Canton where he was in charge of the Building Department overseeing the Zoning, Code Enforcement and Building Inspection. Mr. Molnar holds a Bachelor of Architecture from Kent State University and is a licensed Architect in the State of Ohio. He is a member of the International Code Council (ICC), is a Director for the Ohio Building Officials Association (OBOA) and the current President for the Five County Building Officials Association (FBOA). David holds certificates from the Ohio Board of Building Standards and the ICC for Master Plans Examiner, Building Official and Residential Building Official as well as certifications from FEMA for Disaster response.

File Attachments for Item:

ER-4 Exploring the Scope of 2017 OBC and 2019 RCO (Molnar, David)

All certifications (1 hour)

Staff Notes: Chapter 1 panel discussion with audience participation. Recommend approval.

Committee Recommendation:

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

APPLICATION FOR CONTINUING EDUCATION APPROVAL
COURSE CONDITIONS AND GUIDELINES

The Ohio Board of Building Standards is committed to the ongoing education and professional development of board-certified personnel through the delivery of high-quality, accurate and engaging professional continuing education content. To this end, the Board reviews and approves Continuing Education Courses for building department personnel.

Board approval is granted for course instruction on current codes and standards, including the OBC, OMC, OPC, and RCO, and any other content areas directly related to the responsibilities of the certification for which credit is being requested.

Promotion: Any person or organization promoting an approved course is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, categories 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 may not falsely state BBS approval before approval is granted. Course providers may state that BBS approval is pending.

Application Submission: All Applications and associated materials shall be submitted by email in .pdf format. Instructions for completing the application are attached.

Certificate of Completion: Course providers shall 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.

Any person or organization administering an approved course shall return a completed BBS Course Attendance form by email.

Participants: Participants must attend the complete course as presented by the instructor to receive credit hours approved by the Board. The organization or instructor of online courses shall plan and execute methods to verify the individual's attendance and completion of the course. No partial credit will be given to any participant who failed to complete the entire course as approved.

Board approval: All courses are approved for the calendar year in which application is made. Courses may be renewed so long as the referenced code is in effect, and the CEUs, certification and content remain unchanged. When the referenced code is updated, courses must be updated, and new approvals obtained.

Facility/training area: BBS Course may be delivered in person or online, or both, at the sponsor's option.
Course facilities shall include the following:

In Person Classes:	**Online Classes:**
Sufficient seating capacity	Web-accessible
ADA accessible facilities	ADA accessible delivery
Appropriate Audio/Visual devices for delivery	Tech support available
Writing surfaces for participants	Live and recorded courses permitted

In-person facilities shall comfortably and safely seat at least the number of attendees present in the room and shall be climate controlled, non-smoking, and sound controlled so that outside noise will not interfere with the training.

Ohio | **Department of Commerce**

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: ______

Organization: ______

Address: ______

E-mail: dmolnar1@hotmail.com Telephone: 3307140982

Website: ______

Conference Sponsor (if applicable) ______ Conference Email: ______

Check here if Course Renewal: ______ Prior course number ______ (*i.e. BBS2018-429*)

Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: Chapter 1 Panel Discussion and Roundtable - Exploring The Scope of the 2017 OBC and the 2019 RCO

Course instructor: David Molnar

Course description: Roundtable discussion with a twist - led by an Instructor [MC] interviewing a panel of guest Building Officials from FBOA Topics from the attached outline and the panel on stage as well as relative questions and input from the audience of practical Code experiences. Using various commentaries, guides and handouts available from the Board of Building Standards. GOAL: maximize audience participation

Instructional hours per session: 1 Number of Sessions: 1

Course Date(s) and Location: ______

Special Content:

Code Administration: ✓

Existing Buildings: ✓

Electrical Instruction: ______

Plumbing Instruction: ______

Conference Course: ______

Conference Name: ______

Conference location: ______

Course to be offered online? ______ **On Demand** ______ **Webinar** ______

Course Website: ______

Detail online course participation confirmation method (*i.e. test, quizlets, participant activity confirmation*): ______

Course applicable for the following certifications

Residential Certifications Only: ______ Commercial Certifications: ______

Administrative Course, All Certifications: ✓

Application materials included:

✓ Course Outline or Course Learning Objectives
______ Presentation Materials/Slides (not required for roundtable courses)
______ Assessment Materials (for online courses)
✓ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Instructions for new Continuing Education Approval form

Provider Information

1. Please include all contact information.
2. If course is not part of a conference, leave conference sponsor and email blank.

Course Renewal

1. Indicate if the course is being submitted for renewal. Include prior approval letter and write in prior course number.
2. Certification approval for courses has now changed: all existing courses being renewed will be approved within the new classification system.
    a. Courses previously approved for only residential certifications will be approved for all residential certifications.
    b. Courses previously approved for at least on commercial certification will now be approved for all commercial certifications and all residential certifications.
    c. Courses on required instruction topics, Ohio Ethics, Code Administration and Existing Buildings, will be noted as Administrative Courses and be approved for all certifications.
3. Courses being renewed should skip the New Course information section and are not required to submit outline, agenda, slides or other instructional materials for review. Skip to Special Content, and mark any item that applies to the course.

New Course Information

1. Enter course title, name of instructor, and a brief description of the course content. Learning objectives may be substituted for course description, if desired.
2. Number of instructional hours per session is the length of instructional time.
3. Number of sessions: can be 1 or the number of sessions planned.
4. Course date(s) and location: not necessary at this time, enter if known.

Special Content

1. Indicate if the course will meet instructional time in Code Administration or Existing Buildings.
2. Indicate if the course is a plumbing or electrical course, for ESIAC review and trainee course tracking.
3. If the course is associated with a conference, indicate the conference name and location, as this will allow BBS to coordinate approvals with the conference provider.
4. If the course will be offered online, specify whether it will be on demand or offered as a virtual webinar, or both. Include website where the course will be provided.

Course applicable for the following certifications

This section represents a major change from previous BBS course approval forms.

1. If the course is only for residential certifications, check ‘Residential Certifications Only’. The course, if approved, will be approved for all residential certifications.
2. If the course is appropriate for any commercial certifications, check Commercial Certifications. The course, if approved, will be approved for all commercial certification **AND** all residential certifications.
3. If the course is intended to meet required instruction in Code Administration (Chapter 1) or Existing Buildings (commercial or residential) check ‘Administrative Course, All Certifications’.

Application Materials Included

This is a checklist for the course submitter’s use, to be sure all materials necessary for review are included with the application. All materials should be submitted in .pdf format, along with the application, via email to Michael.Lane@com.ohio.gov or BBS@com.ohio.gov

Chapter 1 Panel Discussion and Roundtable

Exploring The Scope of the 2017 OBC and the 2019 RCO

- 101.2 Scope vs 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
- 101.3 Intent
    - *The rules of the board and proceedings shall be liberally construed in order to promote its purpose.*
    - **101.3 Intent.** The purpose of this code is to establish **Uniform Minimum Requirements**
- 102.7 Existing structures.
- 102.8 Temporary Structures.
    - 102.8.1 Conformance.
- 102.10.1 Emergency repairs.
- 102.10.2 Minor repairs.
- 102.11 Building department jurisdictional limitations.
    - 1. Fire. The state fire marshal or fire chief of local jurisdiction.
    - 2. Health. The department of health, or the boards of health of city or general health districts, the division of industrial compliance of the department of commerce, or the departments of building inspection of municipal corporations, townships, or counties shall enforce such provisions relating to sanitary construction.
    - 3. Sewerage and drainage system. In accordance with Section 3781.03 of the Revised Code, the department of the city engineer, in cities having such departments, the boards of health of health districts, or the sewer purveyor
    - 4. Power Generation. Structures on the premises of and directly related to the operation of a generating plant defined as a major utility facility regulated by the power siting board, including the structures associated with generation, transmission, and distribution. As a condition of the power siting board's approval, the building department may be requested to review and inspect these structures for compliance with the rules of the board of building standards. However, the building department has no enforcement authority.
    - 5. State Projects. Certification does not confer any jurisdiction to a certified building department to regulate:
        - 5.1 The construction of buildings by the state of Ohio or on land owned by the state of Ohio – Except Local School Boards funded by Ohio Facilities Commission
        - 5.2 Park districts created pursuant to Chapter 1545. of the Revised Code
        - 5.3 on the premises of, and directly related to the operation of, natural gas liquids fractionation, natural gas cracking, or natural gas processing facilities
        - Note: The lands owned by Miami university in the city of Oxford and Oxford township in Butler County and leased to private individuals or corporations under the land rent provisions of the Act of February 17, 1809, as set forth at 7

        - Ohio laws 184, are subject to local certified building department jurisdiction and are exempt from these provisions.

- 105 Approvals
    - 105.1 Approvals required.
    - 105.2 Validity of approval
    - 105.3 Expiration.
    - 105.4 Extension
    - 105.5 Certificate of plan approval
- 106.1.2 Special provisions.
    - 1. industrialized units or alternative materials, designs and methods of construction or equipment approved by the board
    - 2. public swimming pools – Ohio Department of Health
    - 3. sales, display, storage or manufacture of consumer fireworks, 1.4g or display fireworks, 1.3g – State Fire Marshal
    - 4. identified flood hazard areas – registered surveyor
    - 5. “Request for Participation” form prescribed by the board and provided by the building official to the local fire official annually
    - 6. jails, workhouses, or municipal lockups Ohio department of rehabilitation and corrections.
    - 7. storage or use of hazardous, flammable or combustible liquids or gases connected to and utilized for the operation of building service equipment – fire official for emergency planning purposes
- 106.2.1 Seal requirements. Construction documents shall bear the seal of a registered design professional pursuant to section 3791.04 of the Revised Code. Exceptions: The seal of a registered design professional is not required on construction documents for:
    - Registered Design Professional: Engineer Architect, Landscaped Architect
    - Buildings or structures classified as one-, two-, or three-family dwellings and accessory structures;
    - Energy conservation design for buildings or structures classified as one-, two-, or three-family dwellings;
    - Fire protection system designs submitted under the signature of an individual certified in accordance with section 107.4.4;
    - Installation of replacement devices, equipment or systems that are equivalent in type and design to the replaced devices, equipment or systems; and
    - Alterations, construction or repairs to any buildings or structures subject to sections 3781.06 to 3781.18 and 3791.04 of the Revised Code where the building official determines that the proposed work does not involve the technical design analysis of work affecting public health or general safety in the following areas: means of egress, structural, mechanical, electrical, plumbing, or fire protection.
        - 5.1 For the purpose of this exception, technical design analysis is defined as the development of integrated solutions using analytical methods in accordance with established scientific and engineering principles.

- 106.4 Alternative materials and methods of construction and equipment. For approval of a device, material or assembly that does not conform to the performance requirements in this code, section 114 shall apply.
- 106.5 Alternative engineered design. The design, documentation, inspection, testing and approval of an alternative engineered system shall comply with sections 106.5.1 to 106.5.3 of this rule.
  - Design criteria. An alternative engineered design shall conform to the intent of the provisions of this code and shall provide an equivalent level of quality, strength, effectiveness, fire resistance, durability and safety. Materials, equipment or components shall be designed and installed in accordance with the manufacturer's installation instructions.
  - Submittal. The registered design professional shall indicate on the application that the system is an alternative engineered design. The approval and permanent approval records shall indicate that an alternative engineered design was part of the approved installation. Where special conditions exist, the building official is authorized to require additional construction documents to be prepared by a registered design professional.
  - Technical data. The registered design professional shall submit sufficient technical data to substantiate the proposed alternative engineered design and to prove that the performance meets the intent of this code. Exception: Approval of alternative materials, products, assemblies and methods of construction in accordance with Section 114.3.2.

BBS Handouts, Commentaries, Guides and Handouts:

- Commentary – OBC Chapter 1 Administration
- Commentary – RCO Chapter 1 Administration
- 2017 Ohio Building Code (OBC) Building Department Resource Package
- CBO Duties
- Approvals and Inspections Pamphlet
- Building Department Personnel Certification Rules

David Molnar:

Mr. Molnar is the Master Plans Examiner for Richland County and serves as the part-time Chief Building Official for the City of Aurora. He was previously the Chief Building Official for the Medina County Building Department and the City of Canton where he was in charge of the Building Department overseeing the Zoning, Code Enforcement and Building Inspection. Mr. Molnar holds a Bachelor of Architecture from Kent State University and is a licensed Architect in the State of Ohio. He is a member of the International Code Council (ICC), is a Director for the Ohio Building Officials Association (OBOA) and the current President for the Five County Building Officials Association (FBOA). David holds certificates from the Ohio Board of Building Standards and the ICC for Master Plans Examiner, Building Official and Residential Building Official as well as certifications from FEMA for Disaster response.

File Attachments for Item:

EC-1 2020 National Electric Code (International Association of Electrical Inspectors SW)

All certifications (6 hours)

Ohio | **Department of Commerce**

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Lorenzo Adam
Organization: Southwest Division IAEI
Address: 27 Penbrooke Court, Monroe, Ohio 45050
E-mail: ladam@masonoh.org Telephone: 513-229-8520
Website:
Conference Sponsor (if applicable) Conference Email:

Check here if Course Renewal: Prior course number (*i.e. BBS2018-429*)

Renewals will only be granted for identical content and certifications, within the current code cycle. Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: 2020 National Electrical Code
Course instructor: Various IAEI Instructors (See Attached Bios)
Course description:
Seminar based on the 2020 NEC will cover Electric Calculations, Electrical Services and Overall Important Code Sections

Instructional hours per session: 6 Number of Sessions: 1
Course Date(s) and Location: Receptions Conference Center, Fairfield ,Ohio

Special Content:

Code Administration:
Existing Buildings:
Electrical Instruction: x
Plumbing Instruction:

Conference Course:
Conference Name:
Conference location:

Course to be offered online? **On Demand** **Webinar**
Course Website:
Detail online course participation confirmation method (*i.e. test, quizlets, participant activity confirmation*):

Course applicable for the following certifications

Residential Certifications Only: Commercial Certifications: x
Administrative Course, All Certifications:

Application materials included:

x Course Outline or Course Learning Objectives
x Presentation Materials/Slides (not required for roundtable courses)
Assessment Materials (for online courses)
x Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

Agenda

2020 National Electrical Code
February 4th 2023

Topic: See outlines for more details on these topics.

Instructors: Dewayne Jenkins, Pete Baldauf, Lorenzo Adam, Gaylord Poe

7:30 am to 8:00 am	Registration	
8:00 am to 9:00 am	Electrical Calculations	1.00 h
9:00 am to 9:30 am	Break	
9:30 am to 10:30 am	Electrical Calculations	1.00 h
10:30 am to 10:45 am	Break	
10:45 am to 12:00 m	Electrical Services	1.25 h
12:00 pm to 1:00 pm	Break for lunch	
1:00 pm to 1:45 pm	Electrical Services	0.75 h
1:45 pm to 2:30 pm	2020 NEC	0.75 h
2:30 pm to 2:45 pm	Break	
2:45 pm to 4:00 pm	2020 NEC	1.25 h
4:00 pm	Certificates Distributed	
	Total	6.00 h

Course Outline for Jointly Sponsored Seminar Series
February 4, 2023

Electrical Calculations

Several calculations take place in the NEC, to properly apply certain applications such as conductor voltage drop, ambient conditions, load types and over current protection selection, sizing of conductors and equipment a proper run through the calculations will help contractors, inspectors and plan examiners ease through the permitting process, plan review and inspections.

The code requirements are different from each application. We will be discussing wiring methods and how it affects which facility you are operating under.

- **Definitions Art. 100**
- **Requirements:**
  - **Art. 110**
    - Requirements for Electrical Installation
  - **Art. 220**
    - Branch Circuit, Feeder, and Service Load Calculations
  - **Art. 240**
    - Overcurrent Protection
  - **Art. 310**
    - Conductors for General Wiring
  - **Art. 430**
    - Motors and Motor Circuits
  - **Art. 450**
    - Transformers
  - **Art. 690**
    - PV Systems
  - **Art. 695**
    - Fire Pumps

Electrical Services

This class will address the electrical services that supplies all structures. The class will cover these **articles 230, 240 and 250** as well as the proper application of the codes as they relate to the installation and overcurrent protection of specific equipment, conductors, and services. This article covers service conductors and equipment for control and protection of services and their installation requirements. Parts I through VII in article 240 will provide the general requirements for overcurrent protection and overcurrent protective devices not more than 600 volts, nominal. Part VIII covers overcurrent protection for those portions of supervised industrial installations operating at voltages of not more than 600 volts, nominal. Part IX covers overcurrent protection over 600 volts, nominal. Inspectors, electrical plan examiners, and contractors will obtain the basics steps for determining if plans, projects and/or upgrading projects will comply with the minimum requirements of the Code.

2020 National Electrical Code

This segment of the seminar will cover those articles that are most controversial not only for interpretations but also for their conflict with contractor's perspective and inspector's point of view. At the end, it is the job of the Building Official to the final interpretation of the Code.

- Various important articles will be discussed throughout this topic.
    - **Art. 100, 210, 300, 450, 517, 600, 700.**

- The presentation will focus on:
    - Plan Review Deficiencies
    - Field Deficiencies
    - Code Interpretations

These presentations will be in Power Point format and each participant will be encouraged to discuss and to participate on the subjects presented. Contractors and ESIs will benefit as well as Plans Examiners and Professional Designers by getting firsthand information on these subjects. Both, the Ohio Building Code and the Residential Code of Ohio, in chapters 27 and 33 respectively refers to **2017 NFPA 70** as the standard to comply with electrical installations. Even though the State of Ohio has not adopted the **2020 NFPA 70 version**, the purpose of this class is to let the attendees know of these items in this version of the NEC and not to the enforcement of such version.

INSTRUCTOR QUALIFICATIONS

Lorenzo M. Adam

Lorenzo started his electrical training in 1983. In 1988, he started his own electrical company. In 1996, he obtained the State Electrical Inspector certification. In 1997, he joined the City of Troy as a Building/Electrical Inspector. Currently, he works for the City of Mason. Lorenzo has an Electrical Plans Examiner, Residential Building Official, Building Inspector, Building Official interim certification from the State of Ohio. Lorenzo is currently the secretary/treasurer for the SW Division of IAEI, Ohio Chapter, secretary/treasurer for the Ohio Chapter IAEI and Treasurer and Past President of the Southwestern Ohio Building Officials Association (SWOBOA).

Address: 27 Penbrooke Ct., Monroe, Ohio 45050

Gaylord K. Poe

Gaylord Poe started his longstanding career in the electrical industry in 1969. He earned his Electrical Safety Inspector Certificate (#592) in 1978. He continued to work as an electrician until 1983 when he joined the IBI team as a commercial/industrial field inspector. He was promoted to Commercial Coordinator in 1986, to Assistant Chief Electrical Inspector in 1994, and to Chief Electrical Inspector and President in 2000. He earned his Ohio Electrical Plan Examiner and IAEI Electrical Inspector-Plan Review certificates in 2005. He is the only Ohio ESI certified by the IAEI as a Master Electrical Inspector (2009).

Gaylord is a member of the UL Electrical Council, the NFPA, the Cincinnati Business Development and Permit Center Advisory Committee, the Board of Trustees for the GCEA, the Electrical Trades Advisory Committee for Scarlet Oaks JVS, and is actively involved in course development and training classes for the continuing education programs of the IAEI, IEC, GCEA, and NECA. Gaylord has been involved with the IAEI since the early 1980's. He currently has become the Past-President of the IAEI SW Division, in which he served for 17 years combine.

Address: Suite 125-W, 250 West Court Street, Cincinnati, OH 45202

Caty Robinson

Caty Robinson began her electrical career working as an apprentice in the Dayton, Ohio area. As a member of IBEW Local 82 Caty served a full apprenticeship and worked in the field as a journeyman wireman for Kastle Electric. Caty's Ohio certification #2647 is for ESI (2004) and EPE (2013). Caty joined Inspection Bureau, Inc. (IBI) in 2008 as a commercial Electrical Safety Inspector. Caty currently serves as IBI's Commercial Coordinator and inspects in IBI's commercial territories and Kentucky. Caty is also a member of the IAEI Ohio Chapter SW Division

Address: Suite 125-W, 250 West Court Street, Cincinnati, OH 45202

Peter M. Baldauf

Peter has been in the electrical industry for over 15 years. He began his electrical career working through a trade school in Dayton, Ohio. After graduation, he enrolled in the Associated Builders and Contractors State certified electrical apprenticeship program. Peter attended the program for the full four years and upon completion of the program, he relocated to Tacoma, Washington. In Tacoma, he sat for a State administered test and received State of Washington certification as a journeyman electrician, which is required by the Division of Labor and Industry in that State to perform work as an electrician. Upon his return to the State of Ohio, Peter sat for and was issued a license by the State of Ohio to perform duties associated with the installation and servicing of fire alarm systems. He also applied and sat for the test to become a State Certified Electrical Safety Inspector. He was awarded this Certification in September of 1998. Peter began his career in public service with Montgomery County Building Regulations as an Electrical Inspector in August of 1999. He is currently employed with the City of Vandalia as an Electrical Inspector. Peter also instructs classes for the Master Electrical Contractors Association, Adequate Wiring Committee, and International Association of Electrical Inspectors. He also has certification through the City of Dayton Board of Education as an Adult Education Instructor.

Address: 3600 Shroyer Road, Kettering, OH 45429

Daniel Dewayne Jenkins

Dewayne started his career in the electrical field in 1982 in Dayton, Ohio and several years of experience in the electrical industry both as a contractor and inspector. He served 4 years in an electrical apprenticeship program and has over 8 years in the field as a journeyman electrician and he has 4 years, to his credit, as an electrical estimator and project manager.

Dewayne has been a licensed electrical contractor and a certified electrical safety inspector since 1996. He also holds Ohio certifications as building inspector (1998), electrical plans examiner (2006) and residential building official (2007) and chief building official (2008). He is currently employed by the City of Kettering in the position as an electrical plans examiner, electrical safety inspector and building inspector.

Dewayne is an adjunct lecturer II for Sinclair Community College in the electrical trades for several years. A technical presenter for the Ohio Board of Building Standards (OBBS), International Association of Electrical Inspectors (IAEI), Master Electrical Contractors Association (MECA), Adequate Wiring Committee (AWC) & Greater Cincinnati Electrical Association (GCEA). He has served as President for the Ohio Chapter IAEI (2010). Dewayne has also served as President of the Miami Valley Building Officials Council (2002 & 2003). He currently is the President of the Southwest Division, IAEI and serves on the Electrical Safety Inspector Advisory Committee for the Ohio Board of Building Standards.

Address: 3600 Shroyer Road, Kettering, OH 45429

Jointly Sponsored Seminar Series 2023
Presented by GCEA and Southwest Division IAEI

Facility

The facility is conveniently located in Fairfield, about 1mile west from I-75 off Route 4. Classes are held at the **Receptions 5975 Boymel Drive, Fairfiled, Ohio**. The room occupancy is good for 300 students comfortably with tables and chairs. There are provisions for audio-visual equipment (screen, microphone and speakers). Restrooms are located nearby the room for females and males. Refreshments are served during the class; attendees have access to vending machines as well as water. Duration of the instruction is 6.00 hours. 8:00am – 4:00pm. on February 4th 2023.

Course Materials

Every attendee is responsible for bringing an edition of the NEC. We will use the NEC 2017 and NEC 2020. The instructors will also have on hand the necessary references to answer questions about other codes or standards. Most of the presentations are on a slide-format (Power Point).

Informative Annex D Examples

This informative annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

Selection of Conductors. In the following examples, the results are generally expressed in amperes (A). To select conductor sizes, refer to the 0 through 2000 volt (V) ampacity tables of Article 310 and the rules of 310.15 that pertain to these tables.

Voltage. For uniform application of Articles 210, 215, and 220, a nominal voltage of 120, 120/240, 240, and 208Y/120 V is used in calculating the ampere load on the conductor.

Fractions of an Ampere. Except where the calculations result in a major fraction of an ampere (0.5 or larger), such fractions are permitted to be dropped.

Power Factor. Calculations in the following examples are based, for convenience, on the assumption that all loads have the same power factor (PF).

Ranges. For the calculation of the range loads in these examples, Column C of Table 220.55 has been used. For optional methods, see Columns A and B of Table 220.55. Except where the calculations result in a major fraction of a kilowatt (0.5 or larger), such fractions are permitted to be dropped.

SI Units. For metric conversions, 0.093 m^2 = 1 ft^2 and 0.3048 m = 1 ft.

Example D1(a) One-Family Dwelling

The dwelling has a floor area of 1500 ft^2, exclusive of an unfinished cellar not adaptable for future use, unfinished attic, and open porches. Appliances are a 12-kW range and a 5.5-kW, 240-V dryer. Assume range and dryer kW ratings equivalent to kVA ratings in accordance with 220.54 and 220.55.

Calculated Load *(see 220.40)*

General Lighting Load 1500 ft^2 at 3 VA/ft^2 = 4500 VA

Minimum Number of Branch Circuits Required *[see 210.11(A)]*

General Lighting Load: 4500 VA ÷ 120 V = 38 A

This requires three 15-A, 2-wire or two 20-A, 2-wire circuits.

Small-Appliance Load: Two 2-wire, 20-A circuits *[see 210.11(C)(1)]*

Laundry Load: One 2-wire, 20-A circuit *[see 210.11(C)(2)]*

Bathroom Branch Circuit: One 2-wire, 20-A circuit (no additional load calculation is required for this circuit) *[see 210.11(C)(3)]*

Minimum Size Feeder Required *[see 220.40]*

General Lighting		4,500 VA
Small Appliance		3,000 VA
Laundry		1,500 VA
	Total	9,000 VA
3000 VA at 100%		3,000 VA
9000 VA – 3000 VA = 6000 VA at 35%		2,100 VA
	Net Load	5,100 VA
Range *(see Table 220.55)*		8,000 VA
Dryer Load *(see Table 220.54)*		5,500 VA
Net Calculated Load		18,600 VA

Net Calculated Load for 120/240-V, 3-wire, single-phase service or feeder

18,600 VA ÷ 240 V = 78 A

Sections 230.42(B) and 230.79 require service conductors and disconnecting means rated not less than 100 amperes.

Calculation for Neutral for Feeder and Service

Lighting and Small-Appliance Load		5,100 VA
Range: 8000 VA at 70% *(see 220.61)*		5,600 VA
Dryer: 5500 VA at 70% *(see 220.61)*		3,850 VA
	Total	14,550 VA

Calculated Load for Neutral

14,550 VA ÷ 240 V = 61 A

Example D1(b) One-Family Dwelling

Assume same conditions as Example No. D1(a), plus addition of one 6-A, 230-V, room air-conditioning unit and one 12-A, 115-V, room air-conditioning unit,* one 8-A, 115-V, rated waste disposer, and one 10-A, 120-V, rated dishwasher. See Article 430 for general motors and Article 440, Part VII, for air-conditioning equipment. Motors have nameplate ratings of 115 V and 230 V for use on 120-V and 240-V nominal voltage systems.

*(For feeder neutral, use larger of the two appliances for unbalance.)

From Example D1(a), feeder current is 78 A (3-wire, 240 V).

	Line A	Neutral	Line B
Amperes from Example D1(a)	78	61	78
One 230-V air conditioner	6	—	6
One 115-V air conditioner and 120-V dishwasher	12	12	10
One 115-V disposer	—	8	8
25% of largest motor *(see 430.24)*	3	3	2
Total amperes per conductor	99	84	104

Therefore, the service would be rated 110 A.

Example D2(a) Optional Calculation for One-Family Dwelling, Heating Larger Than Air Conditioning

(see 220.82)

The dwelling has a floor area of 1500 ft², exclusive of an unfinished cellar not adaptable for future use, unfinished attic, and open porches. It has a 12-kW range, a 2.5-kW water heater, a 1.2-kW dishwasher, 9 kW of electric space heating installed in five rooms, a 5-kW clothes dryer, and a 6-A, 230-V, room air-conditioning unit. Assume range, water heater, dishwasher, space heating, and clothes dryer kW ratings equivalent to kVA.

Air Conditioner kVA Calculation

6 A × 230 V ÷ 1000 = 1.38 kVA

This 1.38 kVA [item 1 from 220.82(C)] is less than 40% of 9 kVA of separately controlled electric heat [item 6 from 220.82(C)], so the 1.38 kVA need not be included in the service calculation.

General Load

1500 ft² at 3 VA	4,500 VA
Two 20-A appliance outlet circuits at 1500 VA each	3,000 VA
Laundry circuit	1,500 VA
Range (at nameplate rating)	12,000 VA
Water heater	2,500 VA
Dishwasher	1,200 VA
Clothes dryer	5,000 VA
Total	29,700 VA

Application of Demand Factor *[see 220.82(B)]*

First 10 kVA of general load at 100%	10,000 VA
Remainder of general load at 40% (19.7 kVA × 0.4)	7,880 VA
Total of general load	17,880 VA
9 kVA of heat at 40% (9000 VA × 0.4) =	3,600 VA
Total	21,480 VA

Calculated Load for Service Size

21.48 kVA = 21,480 VA

21,480 VA ÷ 240 V = 90 A

Therefore, the minimum service rating would be 100 A in accordance with 230.42 and 230.79.

Feeder Neutral Load in Accordance with 220.61

1500 ft² at 3 VA	4,500 VA
Three 20-A circuits at 1500 VA	4,500 VA
Total	9,000 VA
3000 VA at 100%	3,000 VA
9000 VA - 3000 VA = 6000 VA at 35%	2,100 VA
Subtotal	5,100 VA
Range: 8 kVA at 70%	5,600 VA
Clothes dryer: 5 kVA at 70%	3,500 VA
Dishwasher	1,200 VA
Total	15,400 VA

Calculated Load for Neutral

15,400 VA ÷ 240 V= 64 A

Example D2(b) Optional Calculation for One-Family Dwelling, Air Conditioning Larger Than Heating

[see 220.82(A) and 220.82(C)]

The dwelling has a floor area of 1500 ft², exclusive of an unfinished cellar not adaptable for future use, unfinished attic, and open porches. It has two 20-A small-appliance circuits, one 20-A laundry circuit, two 4-kW wall-mounted ovens, one 5.1-kW counter-mounted cooking unit, a 4.5-kW water heater, a 1.2-kW dishwasher, a 5-kW combination clothes washer and dryer, six 7-A, 230-V room air-conditioning units, and a 1.5-kW permanently installed bathroom space heater. Assume wall-mounted ovens, counter-mounted cooking unit, water heater, dishwasher, and combination clothes washer and dryer kW ratings equivalent to kVA.

Air Conditioning kVA Calculation

Total amperes = 6 units × 7 A = 42 A

42 A × 240 V ÷ 1000 = 10.08 kVA (assume PF = 1.0)

Load Included at 100%

Air Conditioning: Included below *[see item 1 in 220.82(C)]*

Space Heater: Omit *[see item 5 in 220.82(C)]*

General Load

1500 ft² at 3 VA	4,500 VA
Two 20-A small-appliance circuits at 1500 VA each	3,000 VA
Laundry circuit	1,500 VA
Two ovens	8,000 VA
One cooking unit	5,100 VA
Water heater	4,500 VA
Dishwasher	1,200 VA
Washer/dryer	5,000 VA
Total general load	32,800 VA
First 10 kVA at 100%	10,000 VA
Remainder at 40% (22.8 kVA × 0.4 × 1000)	9,120 VA
Subtotal general load	19,120 VA
Air conditioning	10,080 VA
Total	29,200 VA

Calculated Load for Service

29,200 VA ÷ 240 V = 122 A (service rating)

Feeder Neutral Load, in accordance with 220.61
Assume that the two 4-kVA wall-mounted ovens are supplied by one branch circuit, the 5.1-kVA counter-mounted cooking unit by a separate circuit.

1500 ft^2 at 3 VA	4,500 VA
Three 20-A circuits at 1500 VA	4,500 VA
Subtotal	9,000 VA
3000 VA at 100%	3,000 VA
9000 VA - 3000 VA = 6000 VA at 35%	2,100 VA
Subtotal	5,100 VA

Two 4-kVA ovens plus one 5.1-kVA cooking unit = 13.1 kVA. Table 220.55 permits 55% demand factor or 13.1 kVA × 0.55 = 7.2 kVA feeder capacity.

Subtotal from above	5,100 VA
Ovens and cooking unit: 7200 VA × 70% for neutral load	5,040 VA
Clothes washer/dryer: 5 kVA × 70% for neutral load	3,500 VA
Dishwasher	1,200 VA
Total	14,840 VA

Calculated Load for Neutral
14,840 VA ÷ 240 V = 62

Example D2(c) Optional Calculation for One-Family Dwelling with Heat Pump (Single-Phase, 240/120-Volt Service)

(see 220.82)
The dwelling has a floor area of 2000 ft^2, exclusive of an unfinished cellar not adaptable for future use, unfinished attic, and open porches. It has a 12-kW range, a 4.5-kW water heater, a 1.2-kW dishwasher, a 5-kW clothes dryer, and a 2½-ton (24-A) heat pump with 15 kW of backup heat.

Heat Pump kVA Calculation
24 A × 240 V ÷ 1000 = 5.76 kVA
This 5.76 kVA is less than 15 kVA of the backup heat; therefore, the heat pump load need not be included in the service calculation *[see 220.82(C)]*.

General Load

2000 ft^2 at 3 VA	6,000 VA
Two 20-A appliance outlet circuits at 1500 VA each	3,000 VA
Laundry circuit	1,500 VA
Range (at nameplate rating)	12,000 VA
Water heater	4,500 VA
Dishwasher	1,200 VA
Clothes dryer	5,000 VA
Subtotal general load	33,200 VA
First 10 kVA at 100%	10,000 VA

(continues)

Remainder of general load at 40% (23,200 VA× 0.4)	9,280 VA
Total net general load	19,280 VA

Heat Pump and Supplementary Heat*
240 V × 24 A = 5760 VA

15 kW Electric Heat:

5760 VA + (15,000 VA × 65%) = 5.76 kVA + 9.75 kVA = 15.51 kVA

***If supplementary heat is not on at same time as heat pump, heat pump kVA need not be added to total.**

Totals

Net general load	19,280 VA
Heat pump and supplementary heat	15,510 VA
Total	34,790 VA

Calculated Load for Service

34.79 kVA × 1000 ÷ 240 V= 145 A

Therefore, this dwelling unit would be permitted to be served by a 150-A service.

Example D3 Store Building

A store 50 ft by 60 ft, or 3000 ft^2, has 30 ft of show window. There are a total of 80 duplex receptacles. The service is 120/240 V, single phase 3-wire service. Actual connected lighting load is 8500 VA.

Calculated Load *(see 220.40)*

Noncontinuous Loads
Receptacle Load *(see 220.44)*

80 receptacles at 180 VA	14,400 VA
10,000 VA at 100%	10,000 VA
14,400 VA – 10,000 VA = 4400 at 50%	2,200 VA
Subtotal	12,200 VA

Continuous Loads

General Lighting*	
3000 ft^2 at 3 VA/ft^2	9,000 VA
Show Window Lighting Load	
30 ft at 200 VA/ft *[see 220.14(G)]*	6,000 VA
Outside Sign Circuit *[see 220.14(F)]*	1,200 VA
Subtotal	16,200 VA
Subtotal from noncontinuous	12,200 VA
Total noncontinuous loads + continuous loads =	28,400 VA

*In the example, the actual connected lighting load (8500 VA) is less than the load from Table 220.12, so the minimum lighting load from Table 220.12 is used in the calculation. Had the actual lighting load been greater than the value calculated from Table 220.12, the actual connected lighting load would have been used.

Minimum Number of Branch Circuits Required
General Lighting: Branch circuits need only be installed to supply the actual connected load *[see 210.11(B)]*.

8500 VA × 1.25 = 10,625 VA

10,625 VA ÷ 240 V = 44 A for 3-wire, 120/240 V

The lighting load would be permitted to be served by 2-wire or 3-wire, 15- or 20-A circuits with combined capacity equal to 44 A or greater for 3-wire circuits or 88 A or greater for 2-wire circuits. The feeder capacity as well as the number of branch-circuit positions available for lighting circuits in the panelboard must reflect the full calculated load of 9000 VA × 1.25 = 11,250 VA.

Show Window

6000 VA × 1.25 = 7500 VA

7500 VA ÷ 240 V = 31 A for 3-wire, 120/240 V

The show window lighting is permitted to be served by 2-wire or 3-wire circuits with a capacity equal to 31 A or greater for 3-wire circuits or 62 A or greater for 2-wire circuits.

Receptacles required by 210.62 are assumed to be included in the receptacle load above if these receptacles do not supply the show window lighting load.

Receptacles
Receptacle Load: 14,400 VA ÷ 240 V = 60 A for 3-wire, 120/240 V

The receptacle load would be permitted to be served by 2-wire or 3-wire circuits with a capacity equal to 60 A or greater for 3-wire circuits or 120 A or greater for 2-wire circuits.

Minimum Size Feeder (or Service) Overcurrent Protection
(see 215.3 or 230.90)

Subtotal noncontinuous loads		12,200 VA
Subtotal continuous load at 125% (16,200 VA × 1.25)		20,250 VA
	Total	32,450 VA

32,450 VA ÷ 240 V = 135 A

The next higher standard size is 150 A *(see 240.6)*.

Minimum Size Feeders (or Service Conductors) Required: *[see 215.2, 230.42(A)]*
For 120/240 V, 3-wire system, 32,450 VA ÷ 240 V = 135 A
Service or feeder conductor is 1/0 Cu in accordance with 215.3 and Table 310.15(B)(16) (with 75°C terminations).

Example D3(a) Industrial Feeders in a Common Raceway

An industrial multi-building facility has its service at the rear of its main building, and then provides 480Y/277-volt feeders to additional buildings behind the main building in order to segregate certain processes. The facility supplies its remote buildings through a partially enclosed access corridor that extends from the main switchboard rearward along a path that provides convenient access to services within 15 m (50 ft) of each additional building supplied. Two building feeders share a common raceway for approximately 45 m (150 ft) and run in the access corridor along with process steam and control and communications cabling. The steam raises the ambient temperature around the power raceway to as much as 35°C. At a tee fitting, the individual building feeders then run to each of the two buildings involved. The feeder neutrals are not connected to the equipment grounding conductors in the remote buildings. All distribution equipment terminations are listed as being suitable for 75°C connections. Each of the two buildings has the following loads:

Lighting, 11,600 VA, comprised of electric-discharge luminaires connected at 277 V

Receptacles, 22 125-volt, 20-ampere receptacles on general-purpose branch circuits, supplied by separately derived systems in each of the buildings

1 Air compressor, 460 volt, three phase, 5 hp

1 Grinder, 460 volt, three phase, 1.5 hp

3 Welders, AC transformer type (nameplate: 23 amperes, 480 volts, 60 percent duty cycle)

3 Industrial Process Dryers, 480 volt, three phase,15 kW each (assume continuous use throughout certain shifts)

Determine the overcurrent protection and conductor size for the feeders in the common raceway, assuming the use of XHHW-2 insulation (90°C):

Calculated Load {Note: For reasonable precision, volt-ampere calculations are carried to three significant figures only; where loads are converted to amperes, the results are rounded to the nearest ampere *[see 220.5(B)]*}.

Noncontinuous Loads	
Receptacle Load *(see 220.44)*	
22 receptacles at 180 VA	3,960 VA
Welder Load *[see 630.11(A), Table 630.11(A)]*	
Each welder: 480V × 23A × 0.78 = 8,610 VA	
All 3 welders *[see 630.11(B)]* (demand factors 100%, 100%, 85% respectively)	
8,610 VA + 8,610 VA + 7,320 VA =	24,500 VA
Subtotal, Noncontinuous Loads	**28,500 VA**
Motor Loads *(see 430.24, Table 430.250)*	

(continues)

Air compressor: 7.6 A × 480 V × √3 =		6,310 VA
Grinder: 3 A × 480 V × √3 =		2,490 VA
Largest motor, additional 25%:		1,580 VA
Subtotal, Motor Loads		**10,400 VA**

By using 430.24, the motor loads and the noncontinuous loads can be combined for the remaining calculation.

Subtotal for load calculations, Noncontinuous Loads		**38,900 VA**
Continuous Loads		
General Lighting		11,600 VA
3 Industrial Process Dryers	15 kW each	45,000 VA
Subtotal, Continuous Loads:		**56,600 VA**

Overcurrent protection *(see 215.3)*
The overcurrent protective device must accommodate 125% of the continuous load, plus the noncontinuous load:

Continuous load	56,600 VA
Noncontinuous load	38,900 VA
Subtotal, actual load [actual load in amperes] [99,000 VA ÷ (480V × √3) = 119 A]	**95,500 VA**
(25% of 56,600 VA) (*See 215.3*)	**14,200 VA**
Total VA	**109,700 VA**

Conversion to amperes using three significant figures: 109,700 VA / (480V × √3) = 132 A
Minimum size overcurrent protective device: 132 A
Minimum standard size overcurrent protective device *(see 240.6)*: 150 amperes

Where the overcurrent protective device and its assembly are listed for operation at 100 percent of its rating, a 125 ampere overcurrent protective device would be permitted. However, overcurrent protective device assemblies listed for 100 percent of their rating are typically not available at the 125-ampere rating. *(See 215.3 Exception.)*

Ungrounded Feeder Conductors
The conductors must independently meet requirements for (1) terminations, and (2) conditions of use throughout the raceway run.

Minimum size conductor at the overcurrrent device termination *[see 110.14(C) and 215.2(A)(1), using 75°C ampacity column in Table 310.15(B)(16)]*: 1/0 AWG.

Minimum size conductors in the raceway based on actual load *[see Article 100, Ampacity, and 310.15(B)(3)(a) and correction factors to Table 310.15(B)(16)]*:

95,500 VA / 0.7 / 0.96 = 142,000 VA
[70% = 310.15(B)(3)(a)] & [0.96 = correction factors to Table 310.15(B)(16)]
Conversion to amperes:
142,000 VA / (480V × √3) = 171 A

Note that the neutral conductors are counted as current-carrying conductors *[see 310.15(B)(5)(c)]* in this example because the discharge lighting has substantial nonlinear content. This requires a 2/0 AWG conductor based on the 90°C column of Table 310.15(B)(16). Therefore, the worst case is given by the raceway conditions, and 2/0 AWG conductors must be used. If the utility corridor were at normal temperatures [(30°C (86°F)], and if the lighting at each building were supplied from the local separately derived system (thus requiring no neutrals in the supply feeders), the raceway result (95,500 VA / 0.8 = 119,000 VA; 119,000 VA / (480V × √3) = 143 A, or a 1 AWG conductor @ 90°C) could not be used, because the termination result (1/0 AWG) based on the 75°C column of Table 310.15(B)(16) would become the worst case, requiring the larger conductor.

In every case, the overcurrent protective device shall provide overcurrent protection for the feeder conductors in accordance with their ampacity as provided by this *Code (see 240.4)*. A 90°C 2/0 AWG conductor has a Table 310.15(B)(16) ampacity of 195 amperes. Adjusting for the conditions of use (35°C ambient temperature, 8 current-carrying conductors in the common raceway),

195 amperes × 0.96 × 0.7 = 131 A

The 150-ampere circuit breaker protects the 2/0 AWG feeder conductors, because 240.4(B) permits the use of the next higher standard size overcurrent protective device. Note that the feeder layout precludes the application of 310.15(A)(2) Exception.

Feeder Neutral Conductor *(see 220.61)*

Because 210.11(B) does not apply to these buildings, the load cannot be assumed to be evenly distributed across phases. Therefore the maximum imbalance must be assumed to be the full lighting load in this case, or 11,600 VA. (11,600 VA / 277V = 42 amperes.) The ability of the neutral to return fault current *[see 250.32(B) Exception (2)]* is not a factor in this calculation.

Because the neutral runs between the main switchboard and the building panelboard, likely terminating on a busbar at both locations, and not on overcurrent devices, the effects of continuous loading can be disregarded in evaluating its terminations *[see 215.2(A)(1) Exception No. 2]*. That calculation is (11,600 VA ÷ 277V) = 42 amperes, to be evaluated under the 75°C column of Table 310.15(B)(16). The minimum size of the neutral might seem to be 8 AWG, but that size would not be sufficient to be depended upon in the event of a line-to-neutral short circuit *[see 215.2(A)(1), second paragraph]*. Therefore, since the minimum size equipment grounding conductor for a 150 ampere circuit, as covered in Table 250.122, is 6 AWG, that is the minimum neutral size required for this feeder.

Example D4(a) Multifamily Dwelling

A multifamily dwelling has 40 dwelling units.
Meters are in two banks of 20 each with individual feeders to each dwelling unit.
One-half of the dwelling units are equipped with electric ranges not exceeding 12 kW each. Assume range kW rating equivalent to kVA rating in accordance with 220.55. Other half of ranges are gas ranges.
Area of each dwelling unit is 840 ft^2.
Laundry facilities on premises are available to all tenants. Add no circuit to individual dwelling unit.

Calculated Load for Each Dwelling Unit *(see Article 220)*
General Lighting: 840 ft^2 at 3 VA/ft^2 = 2520 VA
Special Appliance: Electric range *(see 220.55)* = 8000 VA

Minimum Number of Branch Circuits Required for Each Dwelling Unit *[see 210.11(A)]*
General Lighting Load: 2520 VA ÷ 120 V = 21 A or two 15-A, 2-wire circuits; or two 20-A, 2-wire circuits
Small-Appliance Load: Two 2-wire circuits of 12 AWG wire *[see 210.11(C)(1)]*
Range Circuit: 8000 VA ÷ 240 V = 33 A or a circuit of two 8 AWG conductors and one 10 AWG conductor in accordance with 210.19(A)(3)

Minimum Size Feeder Required for Each Dwelling Unit *(see 215.2)*

Calculated Load *(see Article 220)*:	
General Lighting	2,520 VA
Small Appliance (two 20-ampere circuits)	3,000 VA
Subtotal Calculated Load (without ranges)	5,520 VA

Application of Demand Factor *(see Table 220.42)*

First 3000 VA at 100%	3,000 VA
5520 VA - 3000 VA = 2520 VA at 35%	882 VA
Net Calculated Load (without ranges)	3,882 VA
Range Load	8,000 VA
Net Calculated Load (with ranges)	11,882 VA

Size of Each Feeder *(see 215.2)*
For 120/240-V, 3-wire system (without ranges)
Net calculated load of 3882 VA ÷ 240 V = 16 A For 120/240-V, 3-wire system (with ranges)
Net calculated load, 11,882 VA ÷ 240 V = 50 A

Feeder Neutral

Lighting and Small-Appliance Load	3,882 VA
Range Load: 8000 VA at 70% *(see 220.61)*	5,600 VA
(only for apartments with electric range)	5,600 VA
Net Calculated Load (neutral)	9,482 VA

Calculated Load for Neutral

9482 VA ÷ 240 V= 39.5 A

Minimum Size Feeders Required from Service Equipment to Meter Bank (For 20 Dwelling Units — 10 with Ranges)

Total Calculated Load:	
Lighting and Small Appliance	
20 units × 5520 VA	110,400 VA
Application of Demand Factor	
First 3000 VA at 100%	3,000 VA
110,400 VA - 3000 VA = 107,400 VA at 35%	37,590 VA
Net Calculated Load	40,590 VA
Range Load: 10 ranges (not over 12 kVA) *(see Col. C, Table 220.55, 25 kW)*	25,000 VA
Net Calculated Load (with ranges)	65,590 VA

Net calculated load for 120/240-V, 3-wire system,

65,590 VA ÷ 240 V = 273 A

Feeder Neutral

Lighting and Small-Appliance Load	40,590 VA
Range Load: 25,000 VA at 70% *[see 220.61(B)]*	17,500 VA
Calculated Load (neutral)	58,090 VA

Calculated Load for Neutral

58,090 VA ÷ 240 V = 242 A

Further Demand Factor *[220.61(B)]*

200 A at 100%	200 A
242 A - 200 A = 42 A at 70%	29 A
Net Calculated Load (neutral)	229 A

Minimum Size Main Feeders (or Service Conductors) Required (Less House Load) (For 40 Dwelling Units — 20 with Ranges)

Total Calculated Load:	
Lighting and Small-Appliance Load	
40 units × 5520 VA	220,800 VA

Application of Demand Factor *(from Table 220.42)*

First 3000 VA at 100%	3,000 VA
Next 120,000 VA - 3000 VA = 117,000 VA at 35%	40,950 VA
Remainder 220,800 VA - 120,000 VA = 100,800 VA at 25%	25,200 VA
Net Calculated Load	69,150 VA
Range Load: 20 ranges (less than 12 kVA) *(see Col. C, Table 220.55)*	35,000 VA
Net Calculated Load	104,150 VA

For 120/240-V, 3-wire system

Net calculated load of 104,150 VA ÷ 240 V = 434 A

Feeder Neutral

Lighting and Small-Appliance Load	69,150 VA
Range: 35,000 VA at 70% *[see 220.61(B)]*	24,500 VA
Calculated Load (neutral)	93,650 VA

93,650 VA ÷ 240 V = 390 A

Further Demand Factor *[see 220.61(B)*

200 A at 100%	200 A
390 A - 200 A = 190 A at 70%	133 A
Net Calculated Load (neutral)	333 A

[See Table 310.15(B)(16) through Table 310.15(B)(21), and 310.15(B)(2), (B)(3), and (B)(5).]

2020 NEC Study Guide For “Service Grounding Basics”

(This Study Guide was prepared by Gaylord Poe)

Like many code topics, there are numerous NEC rules about the grounding of service installations. As with most of the “complicated” code topics, our problems with these rules begin to disappear as we better understand the basic concepts. Within the numerous NEC rules regarding service grounding, I believe there are three basic concepts that stand out. These concepts apply to all service installations. This study guide will address the three basic concepts. Understand the “Big Three” and the other rules become much easier to understand. *(Note: For the purpose of this study guide the grounded conductor of grounded systems will be referred to as the “neutral”.)*

1. **There’s a difference between “System Grounding” and “Equipment Grounding”.** Don’t let a “misread” of the code rules send you down the wrong path. All service installations require a grounding electrode conductor (GEC) and a grounding electrode system. For a grounded system (where a service conductor is intentionally grounded) the GEC is connected to the grounded conductor. For an ungrounded system (a Delta 3ϕ - 3-wire system is the most common example) the GEC is connected to any metal enclosure that contains service conductors. The big difference is an ungrounded system has no “neutral” to connect the GEC to – everything else stays the same.

2. **Everything that’s metal and contains service conductors shall be bonded.** How do you determine what is defined as “service” and what is not? Easy. Whatever is going to stay “hot” after you turn off the main(s) is “service”. There’s a lot of ways to accomplish the required bonding. For example, on a grounded system anything that’s directly connected to the neutral is considered to be bonded. Examples of enclosures that are bonded by the neutral are: Service switches (the neutral bonding jumper), and CT cabinets or termination boxes or wireways where the neutral is bolted directly to the enclosure. Because of the neutral connection, whatever is bolted to or connected to these enclosures with bonding fittings is bonded too. Anything that is connected to the neutral through an approved connection is considered to be bonded. What are recognized bonding paths? For grounded systems, paths that provide continuity to the neutral conductor using bonding fittings such as bonding-type locknuts, bonding bushings, and threaded hubs. For ungrounded systems, paths that provide continuity between all enclosures using bonding fittings such as bonding-type locknuts, bonding bushings, and threaded hubs. Look at each individual component in the service scheme and imagine a fault within that component. Will all fault current flow through approved bonding paths?

3. **When a neutral is available in the system, the neutral must be run to and bonded to every service disconnecting means.** This rule recognizes that if a fault can be disposed of by using the neutral (as opposed to just enclosures and bonding fittings) then the neutral shall be used for that purpose – even if there is no need for the neutral downstream of the service disconnect. Don’t worry about

multiple disconnects within switchboards, there's a rule covering that. Don't worry about having the neutral bonded more than once either – it's OK on service installations – as a matter of fact, when it's not mandatory it's recommended.

Summary of the "Big Three": The concepts are simple. What we're trying to do here is get rid of a fault quickly before it starts a fire. Service installations often have numerous enclosures containing service conductors located ahead of the main overcurrent device. The main overcurrent device offers no protection for faults in these enclosures. Because of this, a fault in any of these enclosures will continue until it burns clear or burns open or the supply fails. The primary role of the grounding electrode conductor (GEC) during a fault is to keep voltage off of exposed conductive enclosures until the fault clears. *(Note: The GEC only performs this function during a ground fault and even then it will only conduct a very small amount of the fault current.)*

There are two basic kinds of faults encountered ahead of the mains: Line-to-line faults and line-to-ground faults. Direct line-to-line faults are very rare.

Line-to-ground fault, Ungrounded System: A line-to-ground fault on an ungrounded system basically "does nothing" until a second line conductor faults to ground. At that point there is in effect a "short" between the two faulted line conductors with the grounded conductive enclosures serving as the "conductors" between them. The better the bonding path, the lower resistance of the fault path. The lower the resistance of the fault path, the faster the fault will clear.

Line-to-ground fault, Grounded System: Unlike an ungrounded system, a line-to-ground fault on a grounded system instantly causes extreme current flow. Since the system is grounded and the neutral is bonded, a line-to-ground fault is actually a "short" that uses the grounded conductive enclosures between the faulted line conductor and the neutral as "conductors". The better the bonding path, the lower resistance of the fault path. The lower the resistance of the fault path, the faster the fault will clear.

All Faults: Remember, regardless of the type of fault, fault current flows between the fault and the supply. For Services, that supply is the utility transformer. Our job is to make sure that whatever is part of that path is large enough (low resistance) to handle the fault, can do so without failing (main & equipment bonding jumper sizes and connections) and is "tight" enough to eliminate arcs and sparks at all fittings that are conducting the fault for the duration of the fault (bonding fittings).

Example: Let's examine a ground fault on a simple 200A residential service. Suppose the fault is between a line conductor and the service main enclosure: The fault current flows from the utility transformer through the line conductor, through the service enclosure, through the main bonding jumper, through the neutral, and back to the utility transformer. In this example, whatever amount of fault current that is available flows not only though the conductors but also through the enclosure and the main bonding jumper.

On a multiple disconnect grounded service installations this type of fault will use all of the metal enclosures and raceways that are between the fault and wherever the neutral is bonded to work it’s way to the neutral and then on to the supply. The quality of that path depends on the quality of the bonding.

The “bottom line” is “get the fault home” as quick as you can (low resistance path) without any arcing or sparking (from loose or non-bonding type fittings) along the way. Accomplish this and the fault won’t last long enough to cause a fire. It is really that simple.

The NEC rules that are covered in this study guide are:

RE: “**There’s a difference between “System Grounding” and “Equipment Grounding”**
Art. 250.4 (A) & (B), 250.24 (A) & (E), 250.64, 250.50

RE: “**Everything that’s metal and contains service conductors shall be bonded.”**
Art. 250.92 (A) & (B)

RE: “**When a neutral is available in the system, the neutral must be run to and bonded to every service disconnecting means.”**
Art. 250.24 (C), 250.24 (C) – Exception

RE: “**Summary of the “Big Three”**
Art. 250.4 (A) (5), 250.4 (B) (4)

2020 NEC Study Guide For “Services”

(This Study Guide was prepared by Gaylord Poe)

Many questions come to mind when reviewing NEC Article 230. This study guide will address some of the more common code questions that frequently arise concerning service installations for residential and light commercial projects.

1. **What is considered to be “Service”?** In my experience, one of the biggest problems that arise when people (usually “non-technical people” vs. trained electrical professionals) are debating Art. 230 is that often what the parties are arguing as being “Service” is not “Service” at all! So first things first...let’s discuss what “Service” is and what it isn’t.

   a. Art. 100 of the NEC defines **Service** as: “The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.”

   b. Art. 100 of the NEC defines **Service Conductors** as: “The conductors from the service point to the service disconnecting means.”

   c. Art. 100 of the NEC defines **Service Point** as: “The point of connection between the facilities of the serving utility and the premises wiring.”

   You’ll also see in Article 100 that there are definitions for “Service Cable”, “Service Drop”, “Service-Entrance Conductors, Overhead”, “Service-Entrance Conductors, Underground”, “Service-Entrance Conductors, Overhead System”, “Service-Entrance Conductors, Underground System”, “Service Equipment”, and “Service Lateral” and others. Remember that when you are discussing any of these items you are still discussing items that are covered by the term **“Service”**. Only these items are subject to the rules found in Art. 230.

2. **Consider this example -** A small commercial retail strip center is fed underground from the utility and has an 800-amp meter center with an 800-amp main circuit breaker. There are eight individual meters. Seven meters each have a 100-amp circuit breaker supplying a 100-amp feeder run to each tenant space. The eighth meter supplies a 60-amp house panel. In this example, “Service” consists of the underground supply to and including the 800 amp main section in the meter center. That’s it...nothing downstream of this main section is “Service”.

3. **Misinterpretations -** In reviewing the above example, it’s not uncommon to hear comments that the installation failed either in Plan Review or failed during field inspection because: “There are eight services on the building.” Or “The tenant services are not grouped.” Or “There are eight service disconnects.” The reality of the example is there is only one service supplying the building, there are no tenant

"services", there are only tenant feeders, and there is only one service disconnect - the 800-amp main. I've stated many times – "If you're unsure, turn off the main(s). Whatever stays 'hot' is 'Service' whatever 'goes off' is not!"

4. **Number of Services allowed -** This issue probably receives more discussion than any other part of Art. 230 especially when it comes to underground service conductors. The basic rule is that (unless you meet certain conditions permitting additional services) you can only install one service of any given voltage to a building. When the service drop is "in the air" (overhead) the number of services to a building is quite obvious. However because of certain verbiage in 230.2, you can have (figuratively speaking) multiple underground "services" without having to count them as multiple services. 230.2 provides "For the purposes 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." Note some key points in the above quotation. The sentence doesn't deny that this is actually "multiple services" it simply states that it can be considered to be supplying one service. There are other conditions that must be met before you can use this section too. You must have the conditions of 230.40 Exception No. 2 *(the most important part of this exception is that the service disconnecting means must be grouped at one location)* and the underground conductors must be a minimum size *(1/0 AWG)* and all of the underground service conductors must come from the same transformer *(connected together at their supply end)*. In layman's terms, if everything "fits" this NEC rule, you can, for example run six 1/0 AWG underground service conductor sets to six individual meters to six 100-amp service disconnects and have a "600 Amp Service" at a very economical price. Without the rule, you would need one set of underground service conductors (single or multiple in parallel) rated at 600 amps run to a distribution board or box or wireway, and have to deal with the larger conductor(s), splices, taps, labor, etc. When you were all done you would still only have a 600-amp service, just at a much higher cost. All that being said, there are a number of installations that get "red-tagged" because the contractor installed multiple sets of underground service conductors to multiple locations on a building obviously thinking it was OK to do so. That same contractor wouldn't even think of having multiple overhead drops hitting the building in the same manner but assumes it's OK because "it's underground". My advice for when you're considering what is acceptable and what is not regarding this is to mentally change the elevations (from underground to overhead) when you're figuring this out. If it's not OK "in the air" it's probably not OK underground except as provided above in 230.2.

5. **Definition of Building –** One point that needs to be considered first and foremost is this – when the NEC uses the word "building", it is used as the NEC defines "building" in Art. 100. Art. 100 of the NEC contains definitions "essential to the proper application of this Code." That being said, when we use the NEC, we can't

take definitions of words (such as "building") from other codes or standards and use NEC rules with the "foreign" definitions. If a definition of a word is in the NEC, we must use that definition. If a definition of a word is not in the NEC, the definition is often subject to debate. In NEC Art. 100, the definition of building is "A structure that stands alone or that is separated from adjoining structures by fire walls." Note that there are no references to "1-hour rated wall" or "2-hour rated wall" or "3-hour rated wall". There are also no references to masonry walls etc. The key words are: "A structure that stands alone" and "fire walls". A "structure that stands alone" is pretty easy to determine but when we talk about "separated...by fire walls" the water often gets just a little muddy. To complicate the matter, Art. 100 contains no definition of "fire wall". Often someone will want to install a second service to a building and when the inspector says "No" they will come back and say, "We have a 2-hour rated wall." That statement by itself does not mean they have a fire wall. My advice is this: when seeking to define a word not found in Art. 100, the next best place to look is the applicable building code. According to the Ohio Building Code (OBC) the definition of Fire Wall is: "A fire-resistance-rated wall having protected openings, which restricts the spread of fire and extends continuously from the foundation to or through the roof, with sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall." The point is it's going to take more than just additional layers of drywall (for example) to make a wall a fire wall. Structural considerations are also required. My advice is this: If you can't easily make the determination on this matter for the purposes of interpreting 230.2, ask the building department. And, don't ask them for the rating (in hours) of the wall in question. Instead ask them if the project in question is actually <u>two separate buildings</u>...period. If you have two buildings, you have no problem.

6. **Number of Disconnects -** The basic rule that we are taught is the maximum number of service disconnects is six. It's not quite that simple. Art. 230.71 (A) provides a little more detail. The "six disconnect rule" is per service <u>or per each set of service entrance conductors permitted by 230.40 Exceptions.</u> But it goes on to state that there can't be more than six sets of disconnects per service grouped in any one location. Conflicting? Not at all. Confusing? It can be. The exceptions to 230.40 not only permit multiple subsets of service entrance grouped together and fed from one service point but they also permit service entrance conductors to be run to more than one "place" on a building. What 230.71 (A) says is the "six disconnect rule" can be used for <u>each set</u> of service conductors permitted by 230.40 as long as you don't have more than six disconnects grouped in any one location. Also note that if you have another service as permitted by 230.2 (A) through (D), these rules apply separately to that service. For example, you could have 12 disconnects grouped in one electric room if you had a 120/240V service and a 480V service supplying the building and be NEC compliant.

7. **Emergency Disconnects –** NEC 2020 provides a new rule for emergency disconnects for dwelling units. The emergency disconnect shall be installed at a readily accessible outdoor location. At this point in time (December 2022) Ohio has not adopted the 2020NEC for 1, 2, and 3-Family Dwellings. (*Note: There will likely be efforts to exclude or amend this rule upon adoption. This study guide will be updated as necessary. GP*)

8. **Length of Service Conductors permitted in a building –** You'll often hear that there is a "10 foot rule". There is not. 10 foot is often used as a "rule of thumb" by electrical inspectors but it has no basis in code text but plenty of basis in the practical application of the code! When I was much younger, old-timers of the day told me they were told by the old-timers who taught them that the "10 foot rule" came about in the days when all service entrance work was installed in threaded rigid conduit and the inspector would only let you run "one stick of pipe" into a building without a disconnect. I believe that this is a pretty accurate "story" as I have a copy of a memo dated June 11th, 1926, containing minutes of a meeting held in Cincinnati on March 9th 1926 where the phrase "nearest readily accessible" from the (then current) 1925 NEC was defined locally as being 10 feet with "service conduits" being duly noted. The 2020 NEC provides three basic rules in 230.70 (A)(1) for locating the service disconnecting means: it shall be readily accessible, it can outside, or inside nearest the point of entrance (meaning if it is inside it must be installed where the conductors enter the building). It should be noted that in addition to these three basic rules, Art. 230.70 provides additional rules.

Welcome from the Joint Venture Committee

1

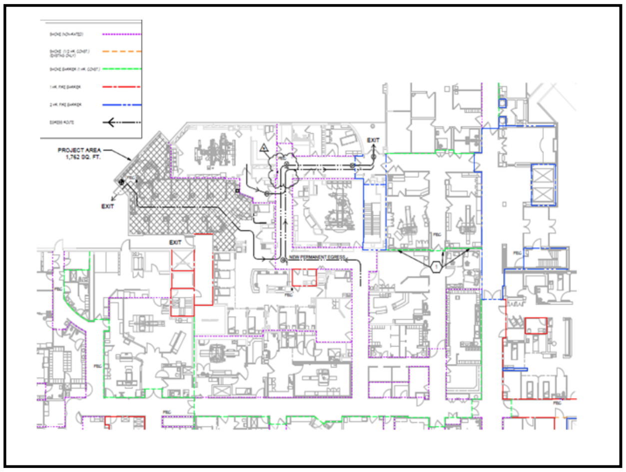
PRESENTED BY LORENZO ADAM & DEWAYNE JENKINS

2

Who is responsible for rated assembly penetrations?

- Typically the installer of the wiring method making the penetration into rated assemblies.
- 3rd party companies
- Read the specifications or approved plans!
- Provide documentation on proposed method, preferably prior to the installation.

3



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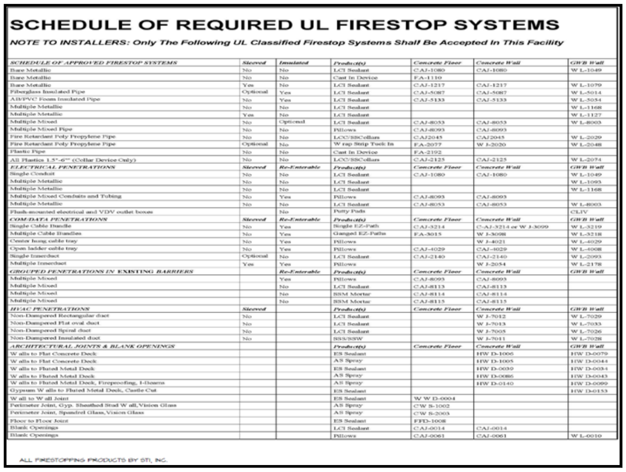

SCHEDULE OF REQUIRED UL FIRESTOP SYSTEMS

NOTE TO INSTALLERS: Only The Following UL Classified Firestop Systems Shall Be Accepted In This Facility

SCHEDULE OF APPROVED FIRESTOP SYSTEMS	*Sleeved*	*Insulated*	*Product(s)*	*Concrete Floor*	*Concrete Wall*	*GWB Wall*
Bare Metallic	No	No	LCI Sealant	CAJ-1080	CAJ-1080	W L-1049
Bare Metallic	No	No	Cast In Device	FA-1110		
Bare Metallic	Yes	No	LCI Sealant	CAJ-1217	CAJ-1217	W L-1079
Fiberglass Insulated Pipe	Optional	Yes	LCI Sealant	CAJ-5087	CAJ-5087	W L-5014
AB/PVC Foam Insulated Pipe	No	Yes	LCI Sealant	CAJ-5133	CAJ-5133	W L-5054
Multiple Metallic	No	No	LCI Sealant			W L-1168
Multiple Metallic	Yes	No	LCI Sealant			W L-1127
Multiple Mixed	No	Optional	LCI Sealant	CAJ-8053	CAJ-8053	W L-8003
Multiple Mixed Pipe	No	No	Pillows	CAJ-8093	CAJ-8093	
Fire Retardant Poly Propylene Pipe	No	No	LCC/SSCollars	CAJ2045	CAJ2045	W L-2029
Fire Retardant Poly Propylene Pipe	Optional	No	W rap Strip Tuck In	FA-2077	W J-2020	W L-2048
Plastic Pipe	No	No	Cast In Device	FA-2192		
All Plastics 1.5"-6"" (Collar Device Only)	No	No	LCC/SSCollars	CAJ-2125	CAJ-2125	W L-2074
ELECTRICAL PENETRATIONS	*Sleeved*	*Re-Enterable*	*Product(s)*	*Concrete Floor*	*Concrete Wall*	*GWB Wall*
Single Conduit	No	No	LCI Sealant	CAJ-1080	CAJ-1080	W L-1049
Multiple Metallic	No	No	LCI Sealant			W L-1093
Multiple Metallic	No	No	LCI Sealant			W L-1168
Multiple Mixed Conduits and Tubing	No	Yes	Pillows	CAJ-8093	CAJ-8093	
Multiple Metallic	No	No	LCI Sealant	CAJ-8053	CAJ-8053	W L-8003
Flush-mounted electrical and VDV outlet boxes		No	Putty Pads			CLIV
COM/DATA PENETRATIONS	*Sleeved*	*Re-Enterable*	*Product(s)*	*Concrete Floor*	*Concrete Wall*	*GWB Wall*
Single Cable Bundle	No	Yes	Single EZ-Path	CAJ-3214	C-AJ-3214 or W J-3099	W L-3219
Multiple Cable Bundles	No	Yes	Ganged EZ-Paths	FA-3015	W J-3098	W L-3218
Center hung cable tray	No	Yes	Pillows		W J-4021	W L-4029
Open ladder cable tray	No	Yes	Pillows	CAJ-4029	CAJ-4029	W L-4008
Single Innerduct	Optional	No	LCI Sealant	CAJ-2140	CAJ-2140	W L-2093
Multiple Innerduct	Yes	Yes	Pillows		W J-2054	W L-2178
GROUPED PENETRATIONS IN EXISTING BARRIERS		*Re-Enterable*	*Product(s)*	*Concrete Floor*	*Concrete Wall*	*GWB Wall*
Multiple Mixed		Yes	Pillows	CAJ-8093	CAJ-8093	
Multiple Mixed		No	LCI Sealant	CAJ-8113	CAJ-8113	
Multiple Mixed		No	SSM Mortar	CAJ-8114	CAJ-8114	
Multiple Mixed		No	SSM Mortar	CAJ-8115	CAJ-8115	
HVAC PENETRATIONS	*Sleeved*		*Product(s)*	*Concrete Floor*	*Concrete Wall*	*GWB Wall*
Non-Dampered Rectangular duct	No		LCI Sealant		W J-7012	W L-7029
Non-Dampered Flat oval duct	No		LCI Sealant		W J-7013	W L-7033
Non-Dampered Spiral duct	No		LCI Sealant		W J-7005	W L-7026
Non-Dampered Insulated duct	No		SSS/SSW		W J-7011	W L-7028
ARCHITECTURAL JOINTS & BLANK OPENINGS			*Product(s)*	*Concrete Floor*	*Concrete Wall*	*GWB Wall*
W alls to Flat Concrete Deck			ES Sealant		HW D-1006	HW D-0079
W alls to Flat Concrete Deck			AS Spray		HW D-1005	HW D-0044
W alls to Fluted Metal Deck			ES Sealant		HW D-0039	HW D-0034
W alls to Fluted Metal Deck			AS Spray		HW D-0086	HW D-0043
W alls to Fluted Metal Deck, Fireproofing, I-Beams			AS Spray		HW D-0140	HW D-0099
Gypsum W alls to Fluted Metal Deck, Castle Cut			ES Sealant			HW D-0153
W all to W all Joint			ES Sealant	W W D-0004		
Perimeter Joint, Gyp. Sheathed Stud W all, Vision Glass			AS Spray	CW S-1002		
Perimeter Joint, Spandrel Glass, Vision Glass			AS Spray	CW S-2003		
Floor to Floor Joint			ES Sealant	FFD-1008		
Blank Openings			LCI Sealant	CAJ-0014	CAJ-0014	
Blank Openings			Pillows	CAJ-0061	CAJ-0061	W L-0010

ALL FIRESTOPPING PRODUCTS BY STI, INC.

5

6


2 HOUR
FIRE BARRIER
OTECT ALL OPENINGS AND PENETRATIONS
rning: Do Not Penetrate Wall without Firestop Permit

7

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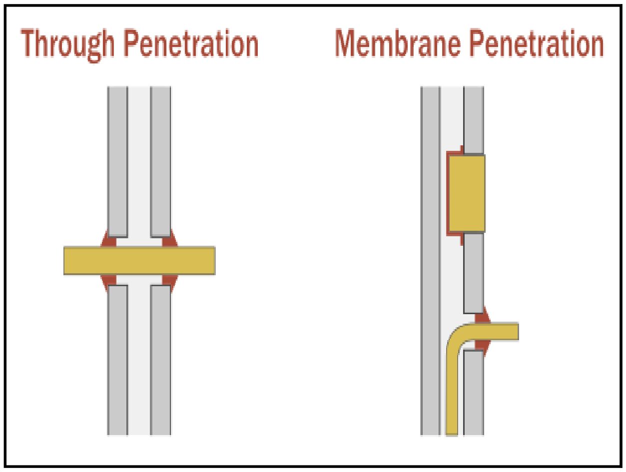
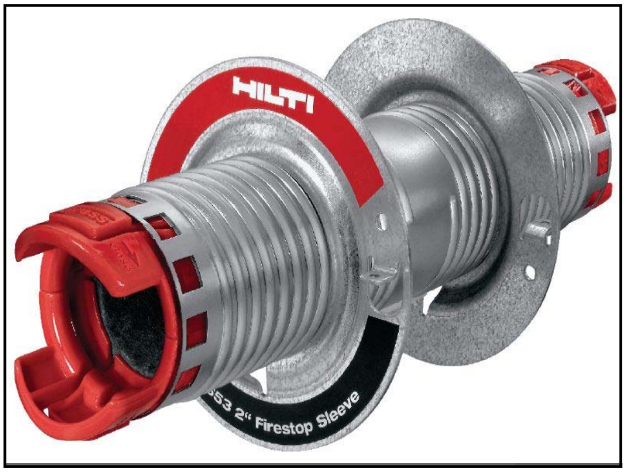
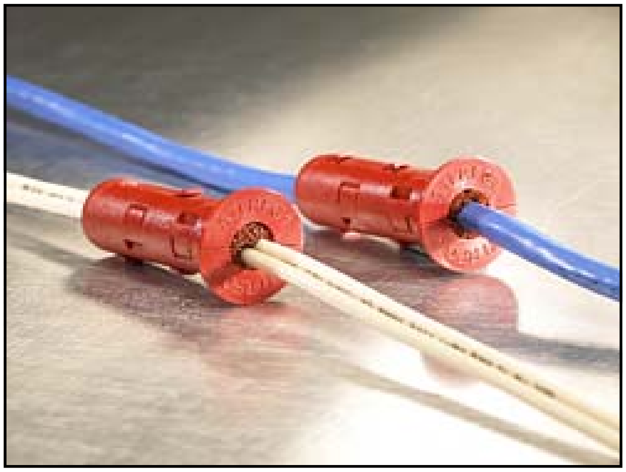

Through Penetration
Membrane Penetration

9


HILTI
S3 2" Firestop Sleeve

10



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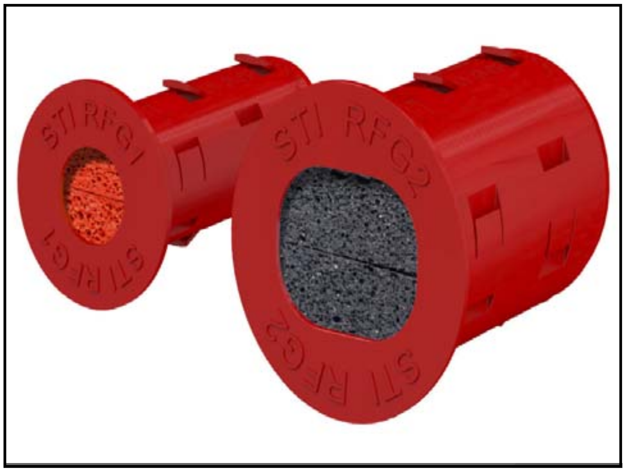
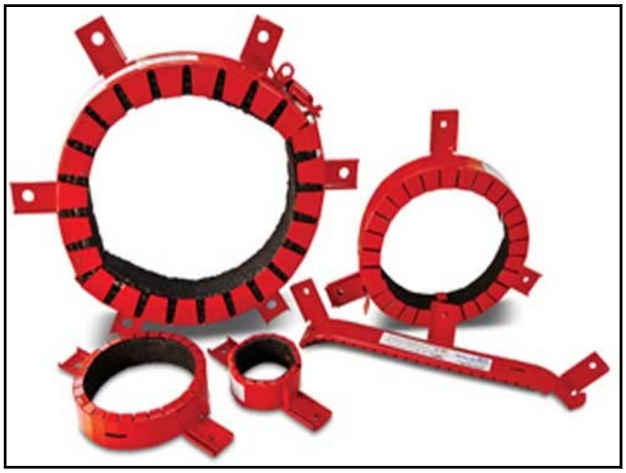

STI RFG1
STI RFG2

12



Penetration Considerations

- UL Fire Resistance Directory
- Proprietary Methods – Hilti, 3M, STI
- Penetration location - floors, walls or ceilings
- Rating and material of assembly
- Size and material making the penetration
- Supporting documentation

How far is service entrance conductors permitted to be ran inside a building?

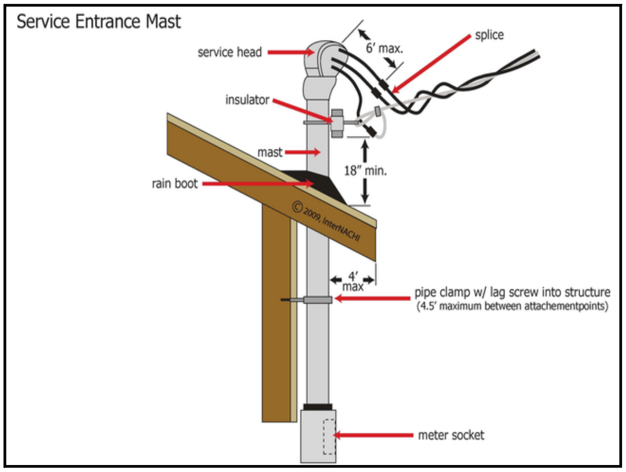
19

20

21

22

23



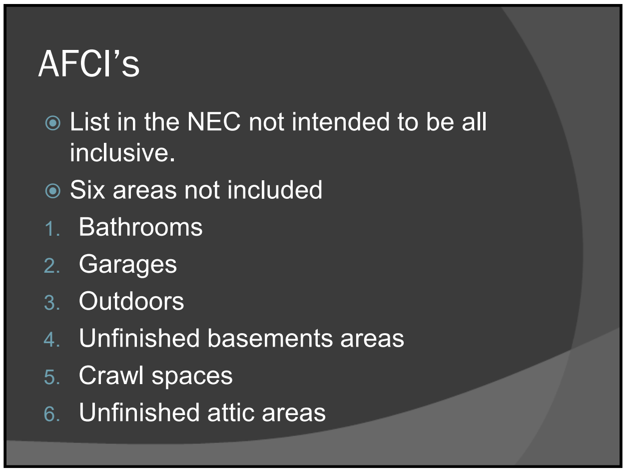
Service Entrance Mast

24

Where are AFCI's required within a dwelling?

210.12(A) AFCI Protection

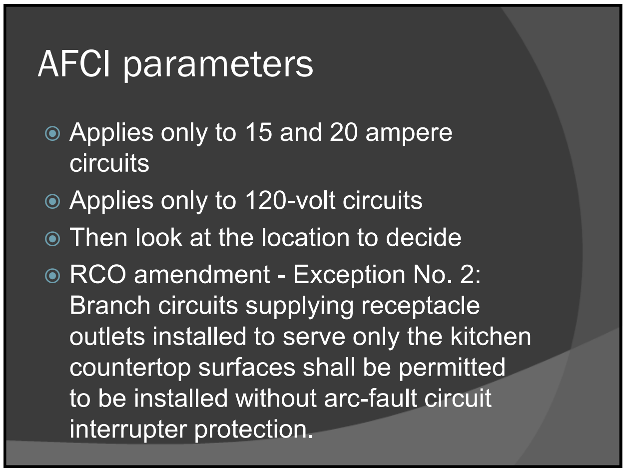
AFCI protection expanded to kitchen and laundry areas



AFCI's

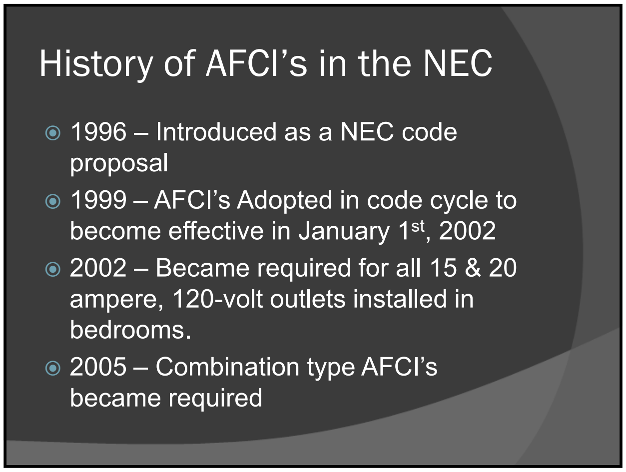
- List in the NEC not intended to be all inclusive.
- Six areas not included

1. Bathrooms
2. Garages
3. Outdoors
4. Unfinished basements areas
5. Crawl spaces
6. Unfinished attic areas



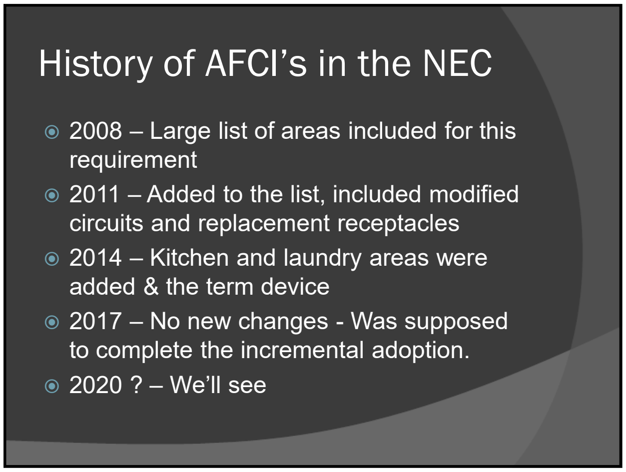
AFCI parameters

- Applies only to 15 and 20 ampere circuits
- Applies only to 120-volt circuits
- Then look at the location to decide
- RCO amendment - Exception No. 2: Branch circuits supplying receptacle outlets installed to serve only the kitchen countertop surfaces shall be permitted to be installed without arc-fault circuit interrupter protection.



History of AFCI's in the NEC

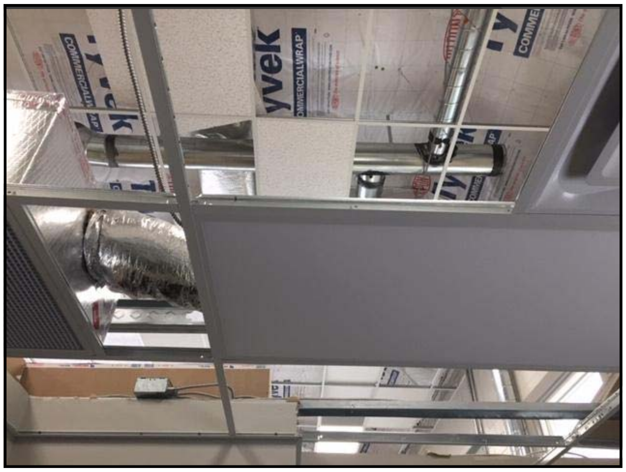
- 1996 – Introduced as a NEC code proposal
- 1999 – AFCI's Adopted in code cycle to become effective in January 1st, 2002
- 2002 – Became required for all 15 & 20 ampere, 120-volt outlets installed in bedrooms.
- 2005 – Combination type AFCI's became required

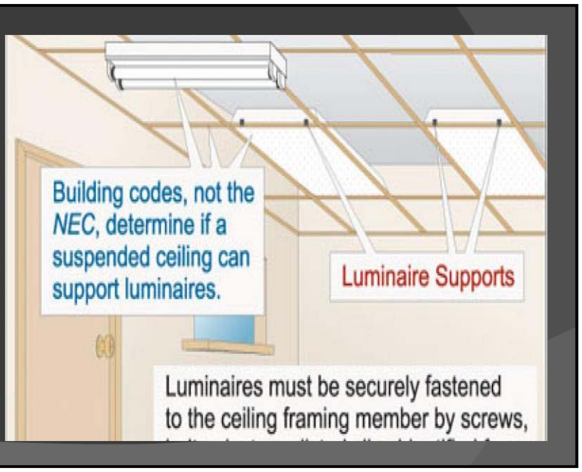


History of AFCI's in the NEC

- 2008 – Large list of areas included for this requirement
- 2011 – Added to the list, included modified circuits and replacement receptacles
- 2014 – Kitchen and laundry areas were added & the term device
- 2017 – No new changes - Was supposed to complete the incremental adoption.
- 2020 ? – We'll see

Are light fixtures required to be fastened to the grid ceiling?





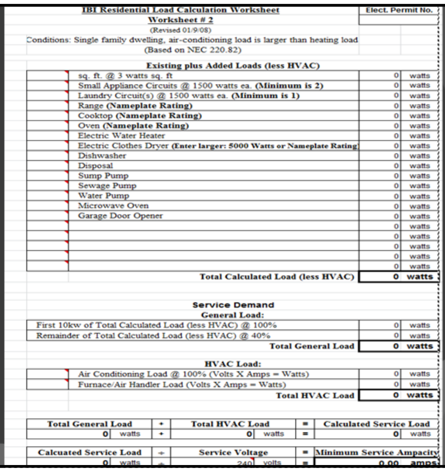
Building codes, not the *NEC*, determine if a suspended ceiling can support luminaires.

Luminaire Supports

Luminaires must be securely fastened to the ceiling framing member by screws,

Is a load calculation required for a new dwelling? Modifications?

- Depends on jurisdictional requirements
- Additions, generators, pool heat pumps, HVAC upgrades



IBI Residential Load Calculation Worksheet

Worksheet # 2

(Revised 01/9/08)

Conditions: Single family dwelling, air-conditioning load is larger than heating load

(Based on NEC 220.82)

Elect. Permit No.

Existing plus Added Loads (less HVAC)

	sq. ft. @ 3 watts sq. ft	0	watts
	Small Appliance Circuits @ 1500 watts ea. **(Minimum is 2)**	0	watts
	Laundry Circuit(s) @ 1500 watts ea. **(Minimum is 1)**	0	watts
	Range **(Nameplate Rating)**	0	watts
	Cooktop **(Nameplate Rating)**	0	watts
	Oven **(Nameplate Rating)**	0	watts
	Electric Water Heater	0	watts
	Electric Clothes Dryer **(Enter larger: 5000 Watts or Nameplate Rating)**	0	watts
	Dishwasher	0	watts
	Disposal	0	watts
	Sump Pump	0	watts
	Sewage Pump	0	watts
	Water Pump	0	watts
	Microwave Oven	0	watts
	Garage Door Opener	0	watts
		0	watts
		0	watts
		0	watts
		0	watts
		0	watts
	Total Calculated Load (less HVAC)	**0**	**watts**

Service Demand

General Load:

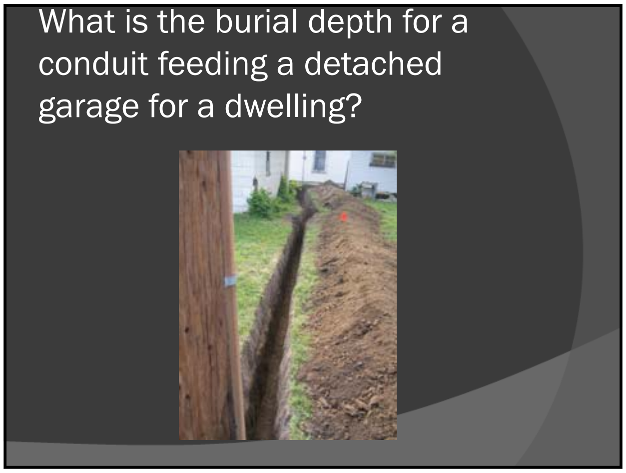
First 10kw of Total Calculated Load (less HVAC) @ 100%	0	watts
Remainder of Total Calculated Load (less HVAC) @ 40%	0	watts
Total General Load	**0**	**watts**

HVAC Load:

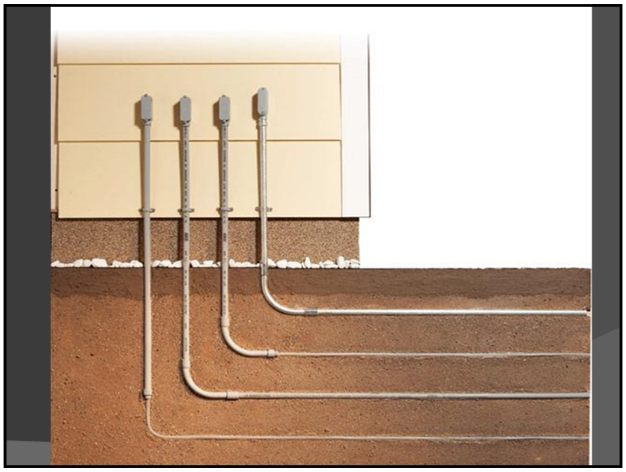
	Air Conditioning Load @ 100% (Volts X Amps = Watts)	0	watts
	Furnace/Air Handler Load (Volts X Amps = Watts)	0	watts
	Total HVAC Load	**0**	**watts**

Total General Load		+	Total HVAC Load		=	Calculated Service Load	
0	watts	+	0	watts	=	0	watts

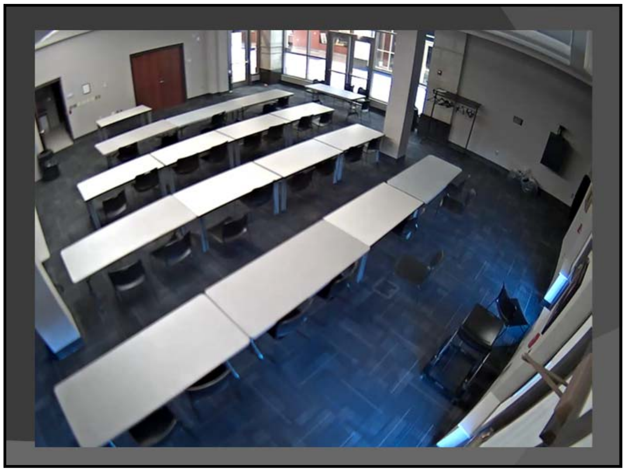
Calcuated Service Load		÷	Service Voltage		=	Minimum Service Ampacity	
0	watts	÷	240	volts	=	0.00	amps

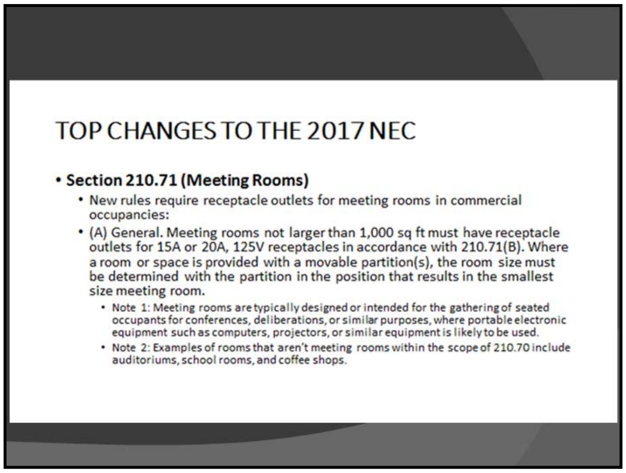


What is the burial depth for a conduit feeding a detached garage for a dwelling?



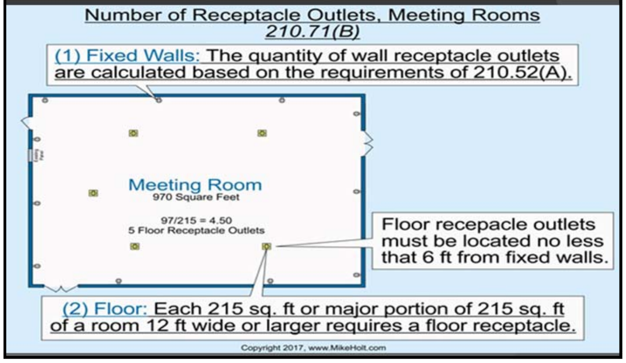
Is all meeting rooms required to have floor receptacles?





TOP CHANGES TO THE 2017 NEC

- **Section 210.71 (Meeting Rooms)**
  - New rules require receptacle outlets for meeting rooms in commercial occupancies:
  - (A) General. Meeting rooms not larger than 1,000 sq ft must have receptacle outlets for 15A or 20A, 125V receptacles in accordance with 210.71(B). Where a room or space is provided with a movable partition(s), the room size must be determined with the partition in the position that results in the smallest size meeting room.
    - Note 1: Meeting rooms are typically designed or intended for the gathering of seated occupants for conferences, deliberations, or similar purposes, where portable electronic equipment such as computers, projectors, or similar equipment is likely to be used.
    - Note 2: Examples of rooms that aren't meeting rooms within the scope of 210.70 include auditoriums, school rooms, and coffee shops.



Number of Receptacle Outlets, Meeting Rooms
210.71(B)

(1) Fixed Walls: The quantity of wall receptacle outlets are calculated based on the requirements of 210.52(A).

Floor recepacle outlets must be located no less that 6 ft from fixed walls.

(2) Floor: Each 215 sq. ft or major portion of 215 sq. ft of a room 12 ft wide or larger requires a floor receptacle.

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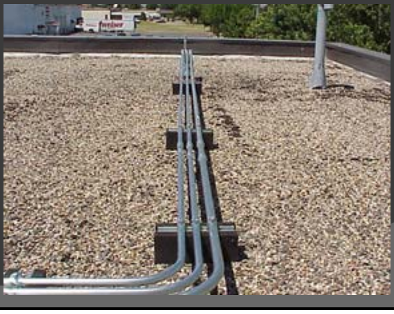
Is it permitted to have multiple circuits feeding a detached garage?

Do conduits installed on a roof top require conductors to be derated?



Does your city still allow fuse panels or FPE panels to remain?

Do I have AFCI protect a furnace in an upstairs closet?

Do I have to GFCI protect crawl space lighting ? Unfinished basements?

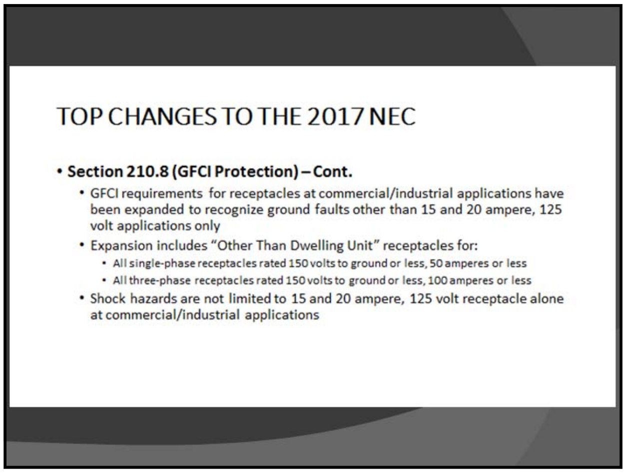
TOP CHANGES TO THE 2017 NEC

- **Section 210.8 (GFCI Protection) – Cont.**
  - GFCI protection for receptacles installed in unfinished basements has been expanded to include non-dwelling unit (commercial/industrial)
  - Revisions to the parent text at 210.8(B) has expanded the receptacles involved to those that are single-phase rated 150 volts to ground or less, 50 amperes or less and three-phase receptacles rated 150 volts to ground or less, 100 amperes or less
  - Similar requirements found at 210.8(A)(5) for dwelling units
  - Same shock hazards exist in an unfinished basement of a commercial building as they do in dwelling units

TOP CHANGES TO THE 2017 NEC

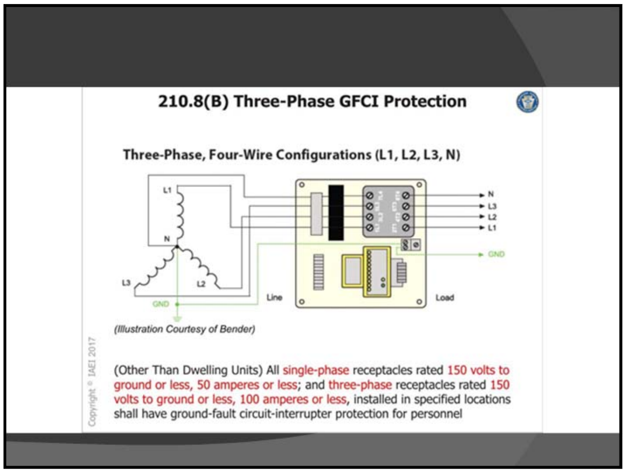
- **Section 210.8 (GFCI Protection) – Cont.**
  - GFCI protection is now required for lighting outlets not exceeding 120 volts in crawl spaces where the space is at or below grade level
  - Applies to all crawl spaces, dwelling unit and non-dwelling units alike
  - This new GFCI requirement for lighting outlets was predicated on a fatality of a worker in a crawl space (broken incandescent light bulb of a keyless lampholder)
  - Numerous open-bulb keyless or pullchain lampholders installed in crawl spaces and are constantly being damaged

Do I have to GFCI protect a 30 amp, 125-250 volt receptacle in a commercial kitchen?



TOP CHANGES TO THE 2017 NEC

- **Section 210.8 (GFCI Protection) – Cont.**
  - GFCI requirements for receptacles at commercial/industrial applications have been expanded to recognize ground faults other than 15 and 20 ampere, 125 volt applications only
  - Expansion includes "Other Than Dwelling Unit" receptacles for:
    - All single-phase receptacles rated 150 volts to ground or less, 50 amperes or less
    - All three-phase receptacles rated 150 volts to ground or less, 100 amperes or less
  - Shock hazards are not limited to 15 and 20 ampere, 125 volt receptacle alone at commercial/industrial applications



210.8(B) Three-Phase GFCI Protection

Three-Phase, Four-Wire Configurations (L1, L2, L3, N)

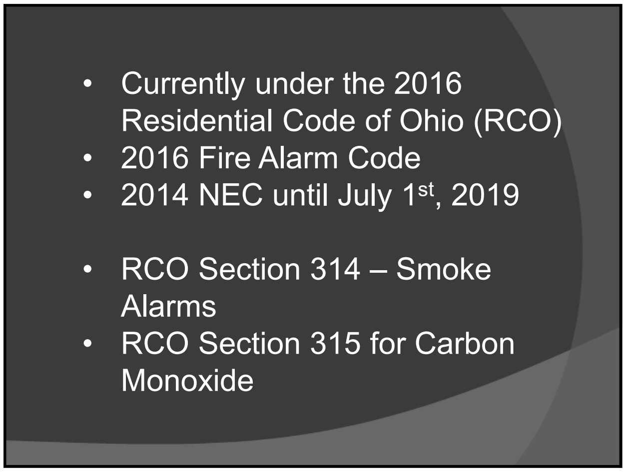
(Illustration Courtesy of Bender)

Copyright © IAEI 2017

(Other Than Dwelling Units) All single-phase receptacles rated 150 volts to ground or less, 50 amperes or less; and three-phase receptacles rated 150 volts to ground or less, 100 amperes or less, installed in specified locations shall have ground-fault circuit-interrupter protection for personnel

Photo Courtesy of Littlefuse

Do I have to install smoke alarms throughout the house when I do a remodel project?



- Currently under the 2016 Residential Code of Ohio (RCO)
- 2016 Fire Alarm Code
- 2014 NEC until July 1st, 2019

- RCO Section 314 – Smoke Alarms
- RCO Section 315 for Carbon Monoxide

Parameters

- Both ionization and photoelectric alarms required on each floor
- Photoelectric required outside bedrooms
- Carbon monoxide required outside bedrooms

Hazardous Locations

- Within 3 feet of bathrooms with tubs or showers
- Within 3 feet of heating vents and return air grills
- Within 3 feet of paddle fans measured from the tips of the blades
- Not permitted within 4 inches of ceilings or walls and not more than 12 inches down from ceiling
- Follow the manufactures installation

Do I have to install a bubble cover under a covered patio canopy?

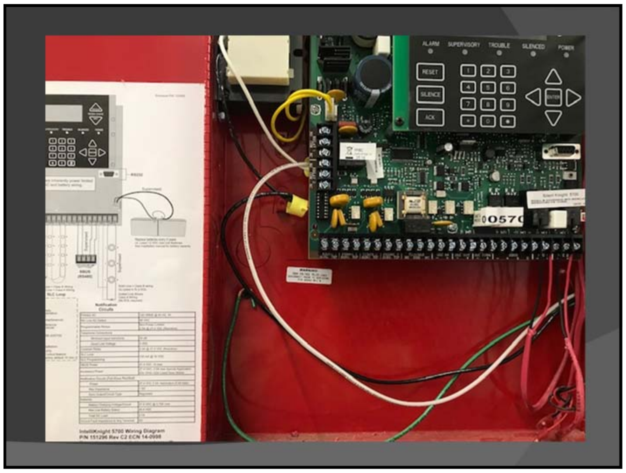
Why is the ground to the transformer the wrong size? I used the table …

Why do I have to install a GFCI protected receptacle for my sump pump in a finished space of the basement?

Why does an inspector fail the installation for support? I have a listed box for a paddle fan and I used the screws that came with the box.


Why did the electrical inspector reject my fire alarm panel installation? I thought the building inspector did those inspections.

73



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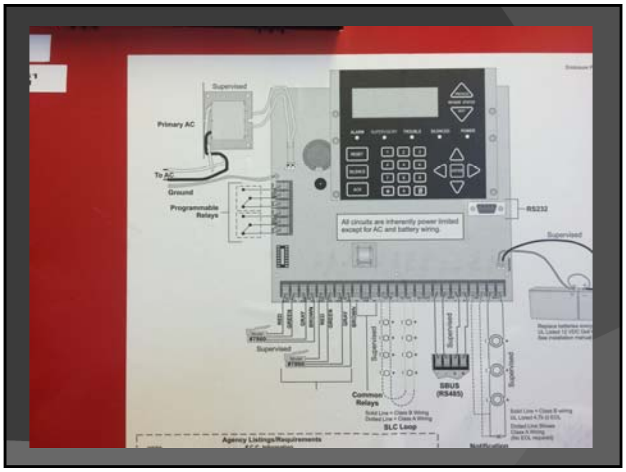

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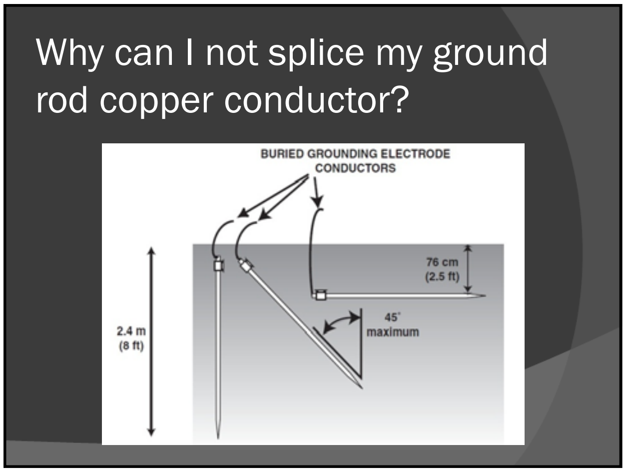

Why can I not splice my ground rod copper conductor?

76

77


Do I need receptacles by my Butler’s pantry?

78

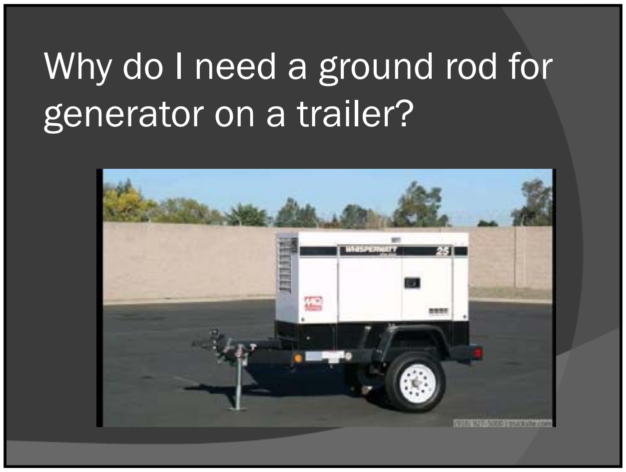
Am I ok running my branch circuit conductors under the joist, using the plate as a running board? After all a 2x6 is a board …

Unfinished Basements and Crawl Spaces

- Two # 6's or larger before you run on the bottom
- Bored or drilled holes
- Running boards

85

86

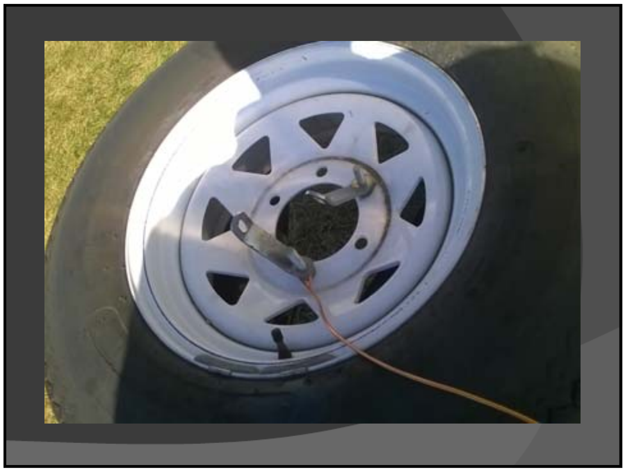


Why do I need a ground rod for generator on a trailer?

87

88

89



90

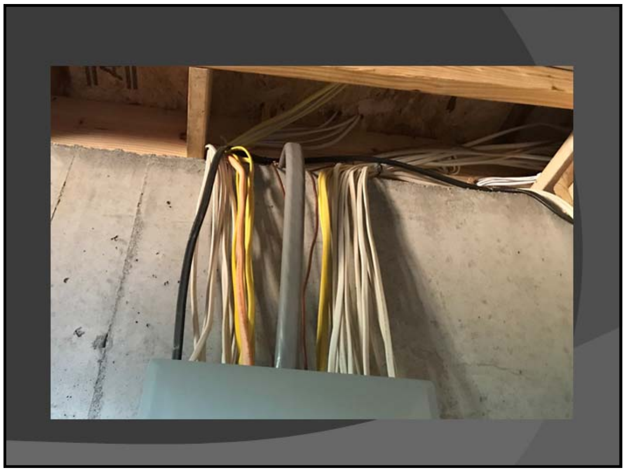
How deep do I have go for my post lamp wires?

91

92

The inspector does not like the way I installed my branch circuit conductors to the panel. Is he or she right?

93



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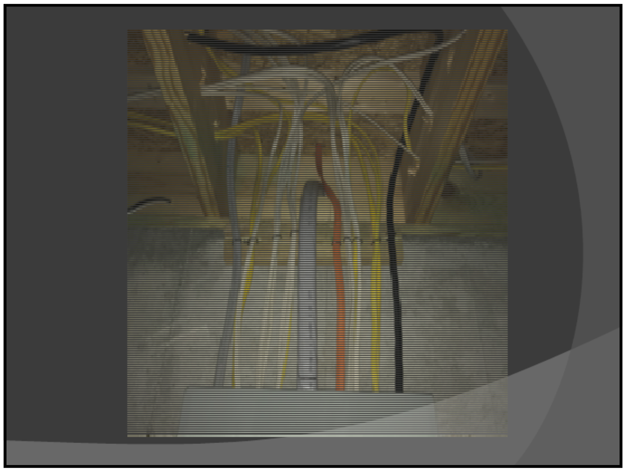
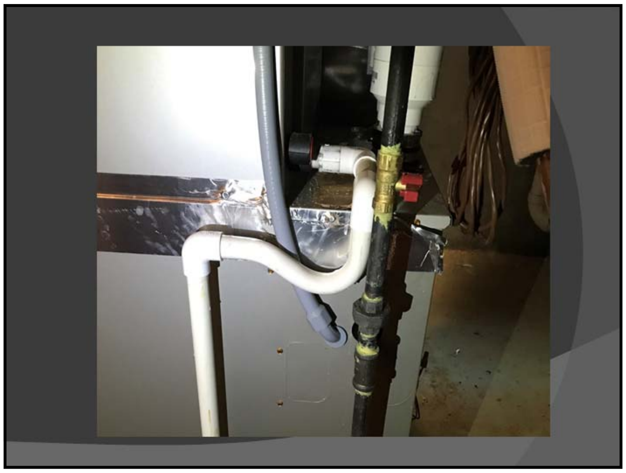


95

What are the rules for installing the branch circuit conductors to a furnace in a box?

96



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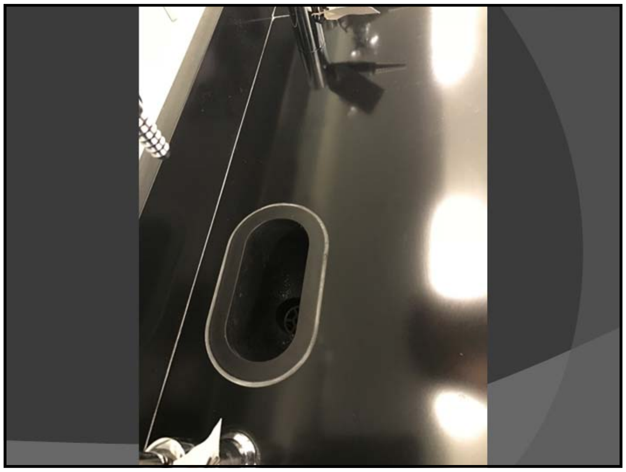
98

Are there any sink size limitations for the installation of GFCI protected receptacles within the 6 feet of such?

99

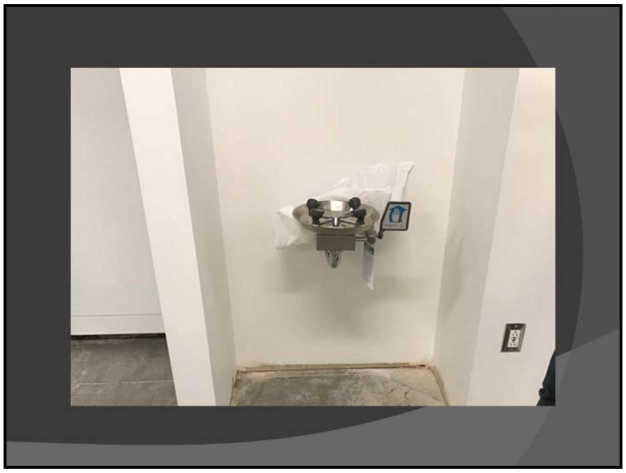
100



101

What are the GFCI protection requirements around an eye washing station?

102



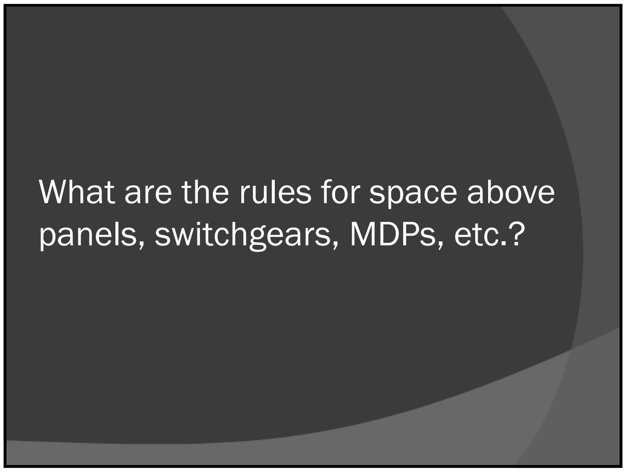
103

What are rules for supporting luminaires whips?

104

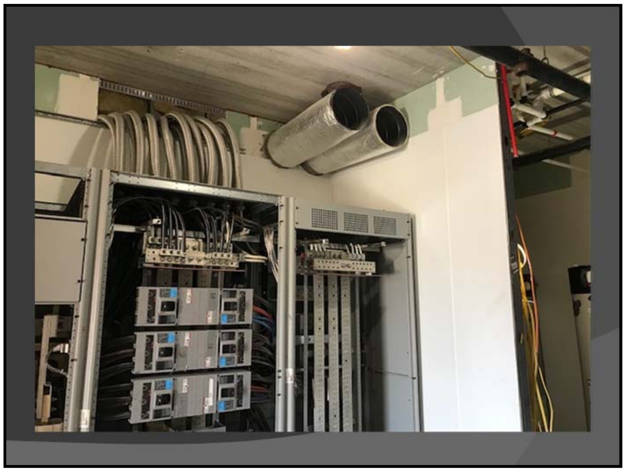
105

106



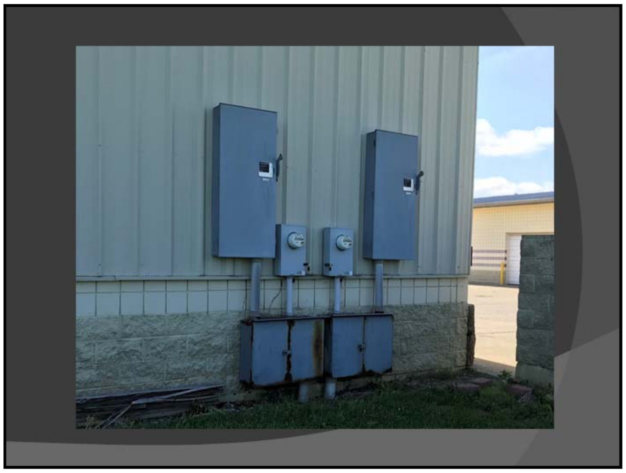
What are the rules for space above panels, switchgears, MDPs, etc.?

107

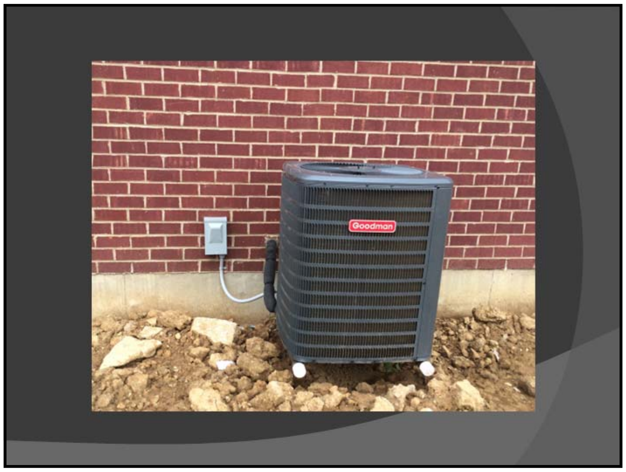


108

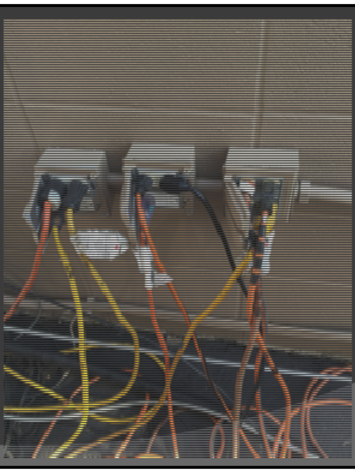
How high can I install my service disconnects?



How low can I install any disconnects?



Do the bubble cover requirements apply to temporary electrical installations?



How close can install a receptacle to a water fountain?

Questions?

Thank you for attending!

See you next year!

File Attachments for Item:

EC-2 Electrical Code Review (IAEI Northwest)

All certifications (twelve sessions of two hours each)

Zachary D Jenkins
BIO/Profile 2022

I currently employed by the Division of Building Inspection, Ottawa County, Ohio as the Building Official, Residential Building Official, Flood Plain Manager, and Building and Electrical Inspector. I am also the President of the North West Ohio Building Officials Association and Vice President of the Ohio Chapter IAEI. In addition to the IAEI, I am a member of the IBEW. I hold my ESI, BI, RBO and CBO certificates.

I am married to my wife Heidi and have 2 kids Zoey and Harrison. I enjoy fishing and hunting.

Ohio | **Department of Commerce**

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Greg Capucini

Organization: IAEI Northwest Division Ohio Chapter

Address: P.O. Box 167667 Oregon Ohio 43616

E-mail: gcapucini@city of sandusky.com Telephone: 419·656·3108

Website: nwohioiaci@ nwohioiaei@yahoo.com

Conference Sponsor (if applicable)______ Conference Email:______

Check here if Course Renewal:______ Prior course number ______ (*i.e. BBS2018-429*)

Renewals will only be granted for identical content and certifications, within the current code cycle. Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: Electrical Code Review

Course instructor: Zach Jenkins

Course description: 2017 NEC updates @ 803 Lime City Road Rossford, Ohio 43460

Instructional hours per session: 2 Number of Sessions: 12

Course Date(s) and Location: 1-10-23 • 2-14-23 • 3-14-23 • 4-11-23 • 5-9-23 • 6-13-23
7-11-23 • 8-8-23 • 9-12-23 • 10-10-23 • 11-14-23 • 12-12-23

Special Content:

Code Administration: ✓

Existing Buildings: ______

Electrical Instruction: ✓

Plumbing Instruction: ______

Conference Course: ______

Conference Name: ______

Conference location: ______

Course to be offered online?______ **On Demand**______ **Webinar**______

Course Website: ______

Detail online course participation confirmation method (*i.e. test, quizlets, participant activity confirmation*):

Course applicable for the following certifications

Residential Certifications Only: ______ Commercial Certifications: ______

Administrative Course, All Certifications: ✓

Application materials included:

✓ Course Outline or Course Learning Objectives

✓ Presentation Materials/Slides (not required for roundtable courses)

______ Assessment Materials (for online courses)

Comming Soon Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

Class Outline Northwest Division Ohio IAEI -Training Agency

2021 OBBS classes held at:
Toledo Electrical JATC 803 Lime City Rd. Rossford, Ohio 43460 on the 2nd Tuesday of each month from 9:30 to 11:30 am. (2 hrs)

All classes will be based on and utilize the 2017 National Electrical Code (NFPA70-17), all participants are encouraged to bring one to classes.

10th 2023

January ~~12th, 2021~~ – Introduction to the 2017 NEC, review code wide changes and the editorial changes made to the NEC based on the NEC Style Manual. Cover Chapter 1 changes to Article 100 Definitions.

14 2023

February ~~9th, 2021~~ – Cover changes to Chapter 1, Article 110 Requirements for Electrical Installations. Review effect of increasing voltage thresholds from 600v or less to 1000v or less, addition of reconditioned equipment to Article 110.3(A), addition of new torqueing requirements for electrical equipment installations in Article 110.14(D),changes to working space clearances in Table 110.26(A)(1).

14th 2023

March ~~9th, 2021 (3/23/2021)~~ – Cover changes to Chapter 2, Article 200 and 210. Review labeling requirements of Article 210.5, expansion of GFCI requirements in Article 210.8(A) and (B), new requirements in Article 210.12(C) for guest rooms and suites of motel/hotels, branch circuit requirements of Article 210.19 thru 210.24, outlet requirements of 210.52 and 210.70.

April 11th 2023

~~April 13th, 2021~~ – Cover changes to Chapter 3, Article 300 and 310. Review requirements for Protection against Physical Damage found in Article 300.4, Burial and cover requirements of Article 300.5 for Underground Installations, Firestopping requirements of article 300.21, requirements for Installations over 1000 volts in Article 110 Part II, Conductor Requirements of Article 310 for parallel installations and derating of conductors.

May ~~11th, 2021~~ 9th 2023 – Cover changes to Chapter 2, Article 220 and 230. Review requirements of Article 220 Calculations for branch circuits, lighting and service load calculations, Article 230 Services Part I General and Part III and IV for Overhead and Underground Installations.

June ~~8th, 2021~~ 13th 2023 – Cover changes to Chapter 2, Article 240 and 250. Review requirements of Article 240 Overcurrent Protection, Part II Tap Rules, new Arc Energy Reduction of Article 240.67, and Article 250 Grounding and Bonding and the grounding electrode system.

July ~~13th, 2021~~ 11th 2023 – Cover changes to Chapter 4, Articles 404 thru 424. Review requirements for Switches per Article 404, Receptacles in Article 406 including the expansion of tamper-resistant receptacles in 406.12, labeling requirements in Article 408.4, Luminaires (fixtures) in Article 410, and Appliance requirements in Article 422 with a link from Article 422.5 to Article 210.8 GFCI Protection.

August ~~10th, 2021~~ 8th 2023 – Cover changes to Chapter 4, Articles 430 thru 490, and Chapter 5. Review requirements for Article 430 Motors and their disconnects per 430 Part IX, Generators Article 445 and their markings per 445.11, Storage Batteries- Article 480 and Article 706 Energy Storage Systems, Article 490 Equipment over 1000 volts, Chapter 5, Articles 500 thru 506 for Hazardous locations, Article 517 Health Care Facilities and their Essential Electrical Systems, Article 590 Temporary Wiring Installations.

September ~~14th, 2021~~ 12th 2023 – Cover changes to Chapter 6, Articles 600 thru 680, Review requirements for Article 600 Signs, article 625 Electric Vehicle Charging, Article 680 Part I, II and III Swimming Pools, Part IV Hot Tubs and Spas, Part V Fountains.

10th 2023

October ~~12th, 2021~~ –Cover changes to Chapter 6, Articles 685 thru 694, Review requirements for Article 685 Integrated Electrical Systems, Article 690 Solar Photovoltaic (PV) Systems, Article 694 Wind Electric Systems, new Article 691 Large-Scale Photovoltaic (PV) Electric Power Production Facility, new Article 712 Direct Current Micro-grids, Review tie-in to Article 685 for alternative energy systems.

14th 2023

November ~~9th, 2021~~ – Cover changes to Article 695 Fire Pumps and Chapter 7 Articles 700 thru 760. Review requirements for Article 700 Emergency Systems, Article 701 and 702 for Standby Systems, Article 708 Critical Operations Power Systems (COPS), Article 760 Fire Alarm Systems and Article 728 Fire-Resistive Cable Systems.

12th 2023

December ~~14th, 2021~~ – Cover changes to Chapter 8 Communications Systems Articles 800 thru 840, Chapter 7, Article 725 Class 1, 2, and 3 Wiring and Power Limited Cables and Article 750 Energy Management Systems.

Analysis of Changes – 2017 *NEC*

Part 2

Training Presentation By:

International Association of Electrical Inspectors

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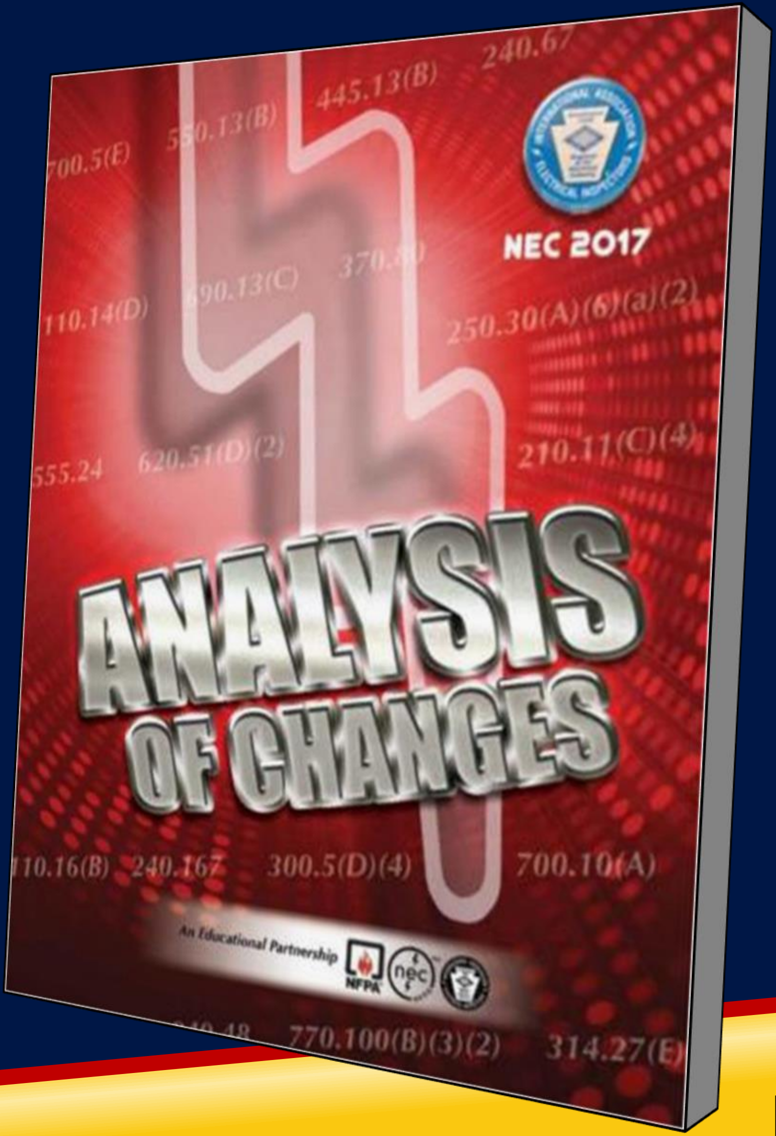
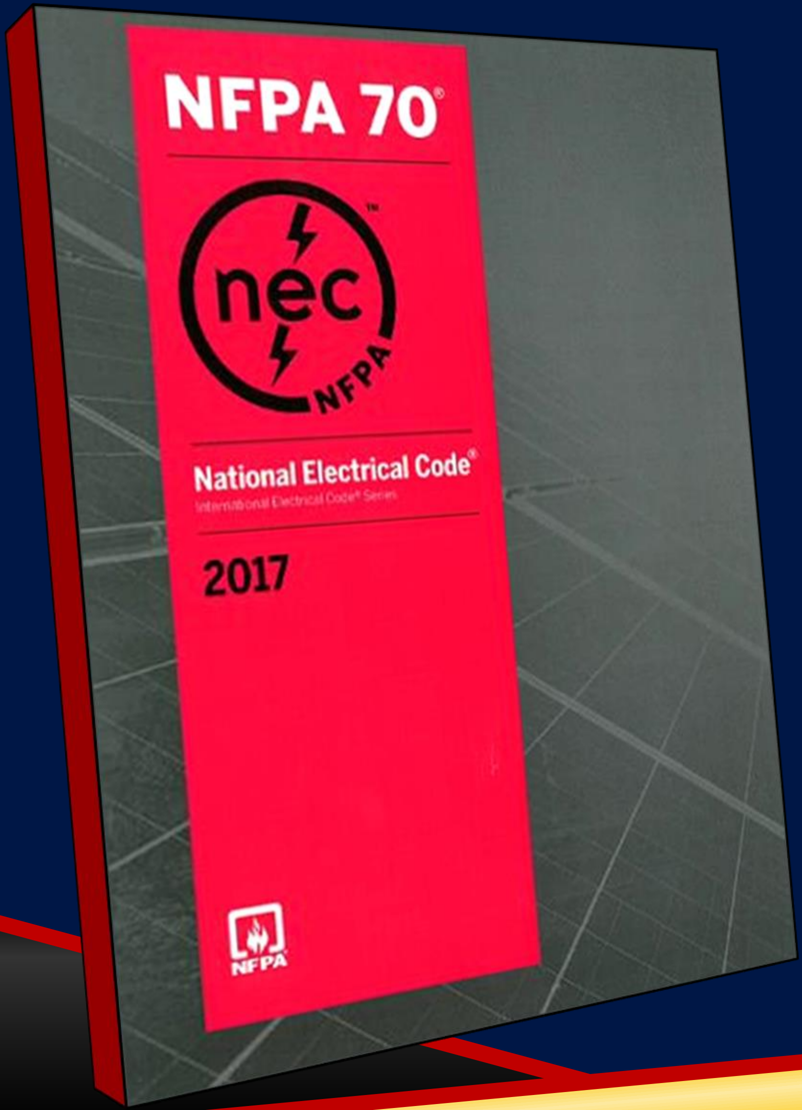


National Electrical Code®



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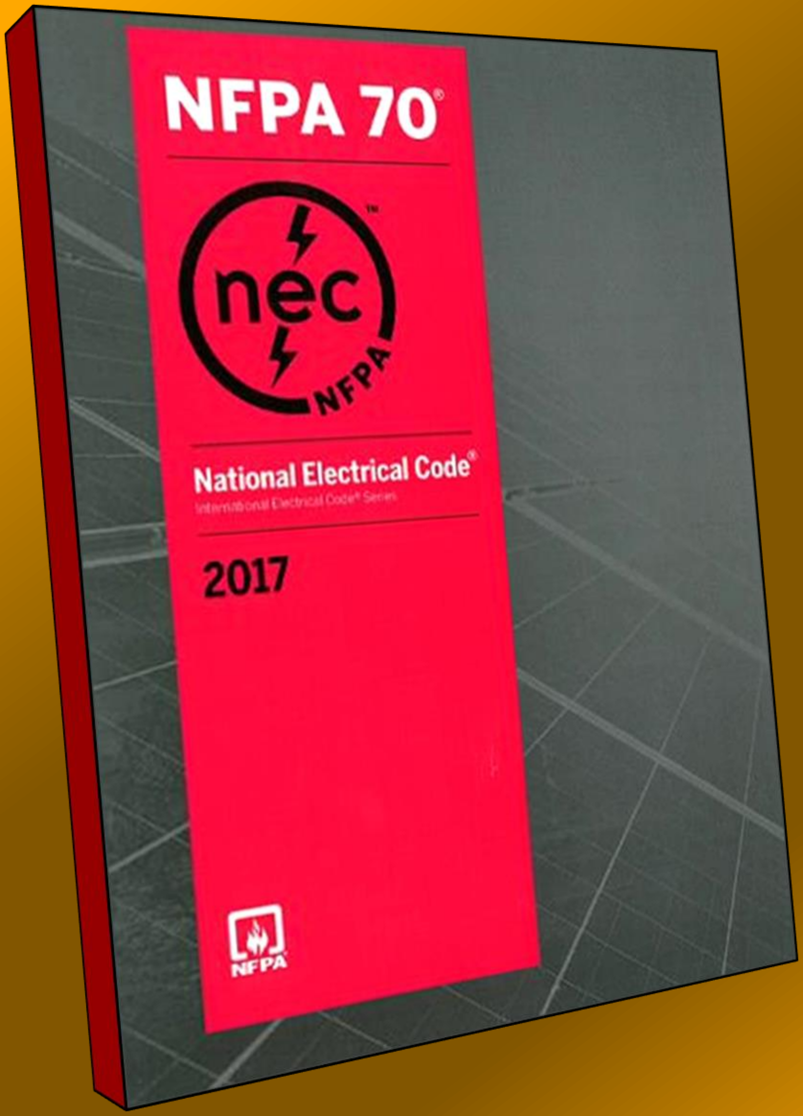
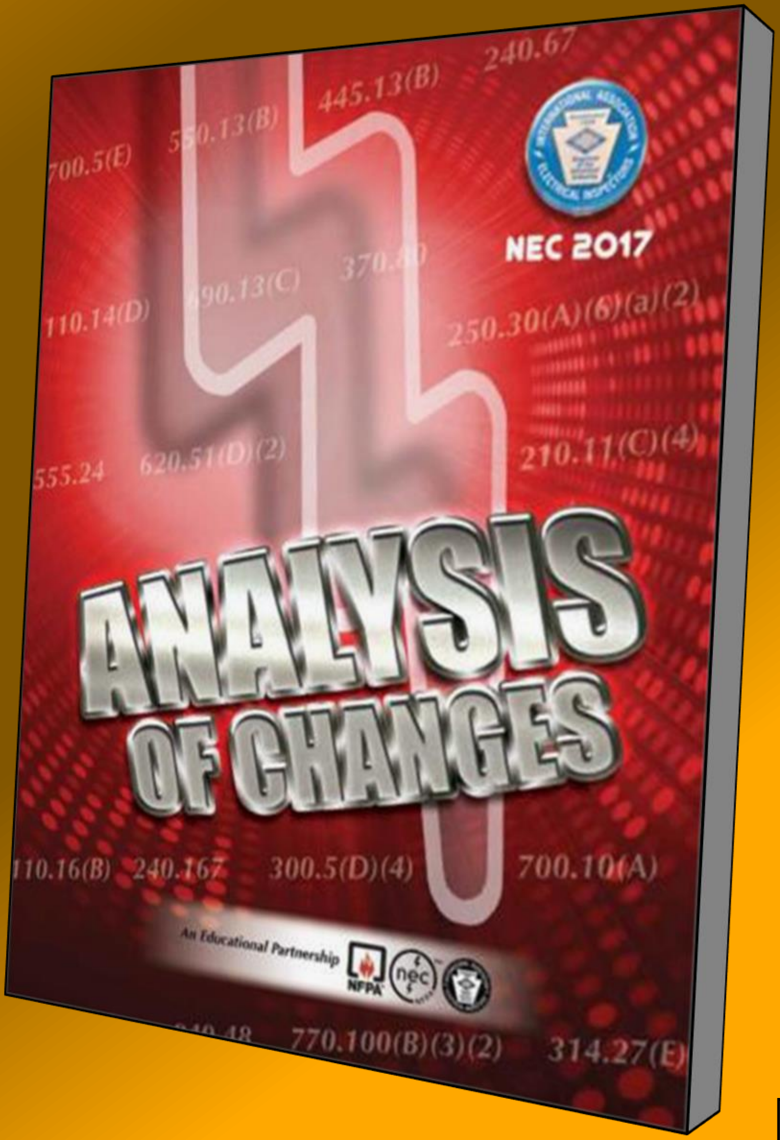
Analysis of Changes-2017 NEC





Analysis of Changes-2017 NEC

INTERNATIONAL ASSOCIATION ELECTRICAL INSPECTORS®

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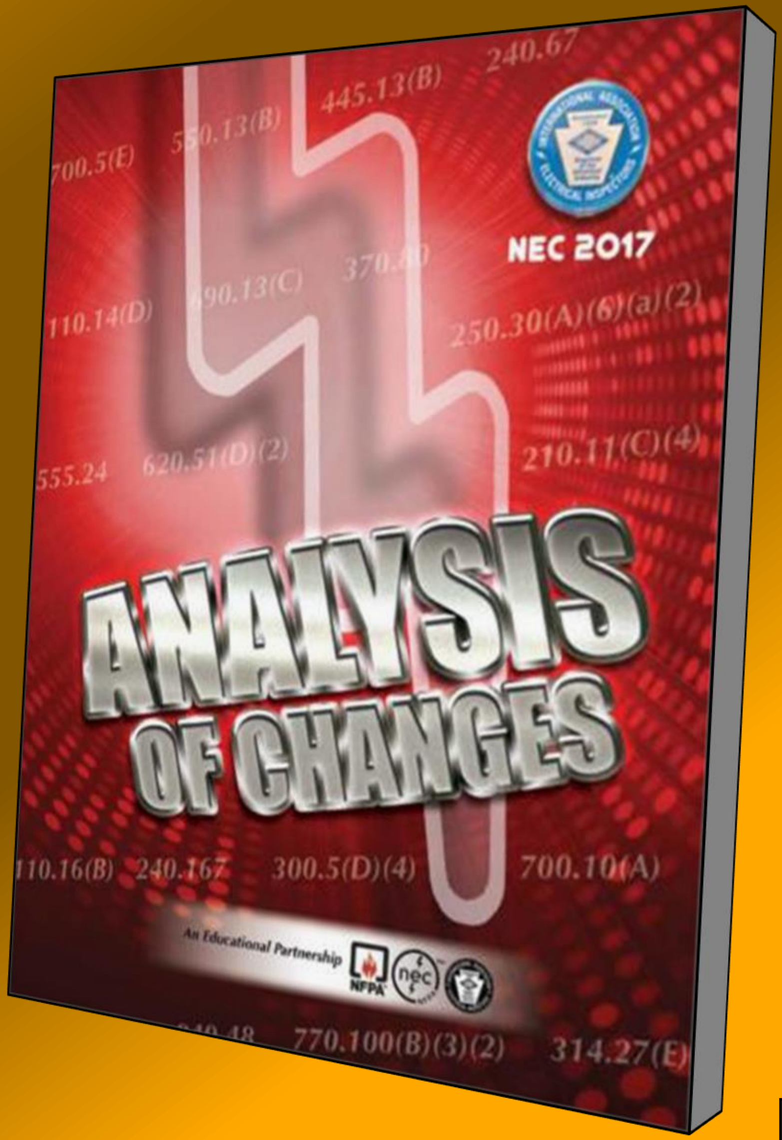
Keystone of the Electrical Industry



Chapter Five
Special Occupancies

500.2 Definitions Moved to Article 100

- Fourteen existing definitions have been **relocated** to Article 100 from 500.2
- Article 500, and in particular 500.2 has been a safe "landing spot" for any definition that applied to more than one hazardous *(classified)* location article rather than locate these multi-article definitions in Article 100 *(as prescribed by the NEC Style Manual)*
- To comply with the *NEC* Style Manual, fourteen definitions that were located at 500.2 have been relocated to Article 100
- Relocated hazardous *(classified)* location definitions will include the term **"[as applied to Hazardous *(Classified)* Locations]**" immediately following the identification of the defined term prior to the actual definition

~~500.2~~ Article 100 - Definitions

Fourteen definitions that resided at 500.2 in previous editions of the *Code* have been relocated to Article 100 of the *NEC*

- **Combustible Dust**
- **Combustible Gas Detection System**
- **Control Drawing**
- **Dust-Ignitionproof**
- **Dusttight**
- **Hermetically Sealed**
- **Nonincendive Circuit**
- **Nonincendive Component**
- **Nonincendive Equipment**
- **Nonincendive Field Wiring**
- **Nonincendive Field Wiring Apparatus**
- **Oil Immersion**
- **Purged and Pressurized**
- **Unclassified Locations**

These relocated hazardous *(classified)* location definitions will include the phrase "[as applied to Hazardous *(Classified)* Locations]" at each of these Article 100 definitions

500.5(A)
~~Classifications of Locations~~ General

- Title of 500.5(A) changed from "Classifications of Locations" to "**General**" as 500.5(A) applies to all of 500.5 *[including 500.5(B), (C), and (D)]*
- Revisions to 500.5(A) clarify that "**refrigerant machinery rooms**" containing ammonia refrigeration may be classified as "**unclassified**" locations based on the use of gas detection and adequate ventilation
- "Adequate ventilation" defined as "continuous or initiated by a detection system at a concentration not exceeding 150 ppm (parts per million)"
- Harmonizes with applicable standards that govern ammonia refrigeration systems *(ANSI/IIAR 2 and ANSI/ASHRAE 15)*

500.5(A) ~~Classifications of Locations~~ General

The title of 500.5(A) was changed to "General" as it applies to all of 500.5

Refrigerant machinery rooms containing ammonia refrigeration may be classified as "unclassified" locations based on the use of gas detection and adequate ventilation *(concentration not exceeding 150 ppm)*

Class I, II, and III Locations and Groups

Substance	**Gas**	**Dust**	**Fibers/Flyings**
Class	Class I [500.5(B)]	Class II [500.5(C)]	Class III [500.5(D)]
Division 1 (Normally Hazardous)	Flammable or combustible concentrations exist under normal operating conditions	Group E, Groups F & G Normally in air in ignitible concentrations	Where they are manufactured
Division 2 (Normally Hazardous)	Confined within closed systems and closed containers	Groups F & G Not normally in air in ignitible quantities	Where they are stored
Groups	A, B, C, and D *NEC* 500.6(A)	E, F, and G *NEC* 500.6(B)	No Groups
NEC Article	501	502	503

Deletion of
Table 500.8(D)(2) Class II Temperatures

- Previous **Table 500.8(D)(2)** Class II Temperatures has been **deleted**

- Previous table is no longer applicable as the **fixed ignition temperature limits** referenced in the table are **no longer used** to evaluate Class II temperature limitations on equipment

- Requirement for maximum surface temperature for Class II dust locations changed from the fixed limits to the **temperature class numbers** during 2002 *NEC* revision cycle

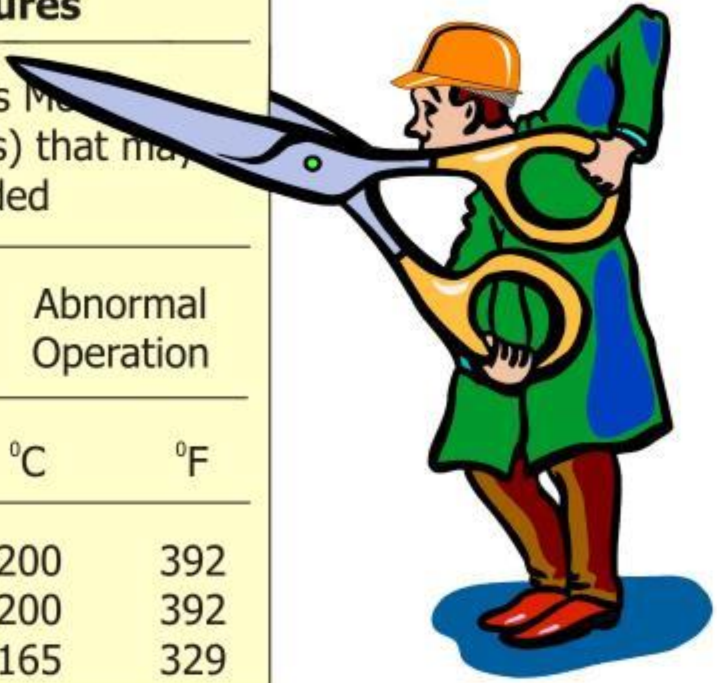
Table 500.8(D)(2) Deleted

Previous Table 500.8(D)(2) has been deleted as the table is no longer applicable

Fixed ignition temperature limits referenced in the table are no longer used to evaluate Class II temperature limitations on equipment

Table 500.8(D)(2) - Class II Temperatures

Class II Group	Equipment Not Subject to Overloading		Equipment (Such as M Power Transformers) that ma be overloaded			
			Normal Operation		Abnormal Operation	
	°C	°F	°C	°F	°C	°F
E	200	392	200	392	200	392
F	200	392	150	302	200	392
G	165	329	120	248	165	329



501.10(B)(1)
Wiring Methods for Class I, Division 2

- **Rigid metal conduit** (RMC) and **intermediate metal conduit** (IMC) with listed threadless fittings as well as **cablebus** added as acceptable wiring methods in Class I, Division 2 locations
- Class I, Division 2 locations are locations in which volatile flammable gases, flammable liquid-produced vapors, or combustible liquid-produced vapors are handled, processed, or used
- Some cables with threadless fittings already permitted to be installed in Class I, Division 2 locations
- Cablebus provides a level of safety equivalent to the other wiring methods permitted for Class I, Division 2 locations *(such as cable tray)*

501.10(B)(1) Class I, Division 2

Rigid metal conduit (RMC) and intermediate metal conduit (IMC) with listed threadless fittings have been added to the allowable wiring methods in a Class I, Division 2 location

Cablebus also added to permitted wiring methods in a Class I, Division 2 location

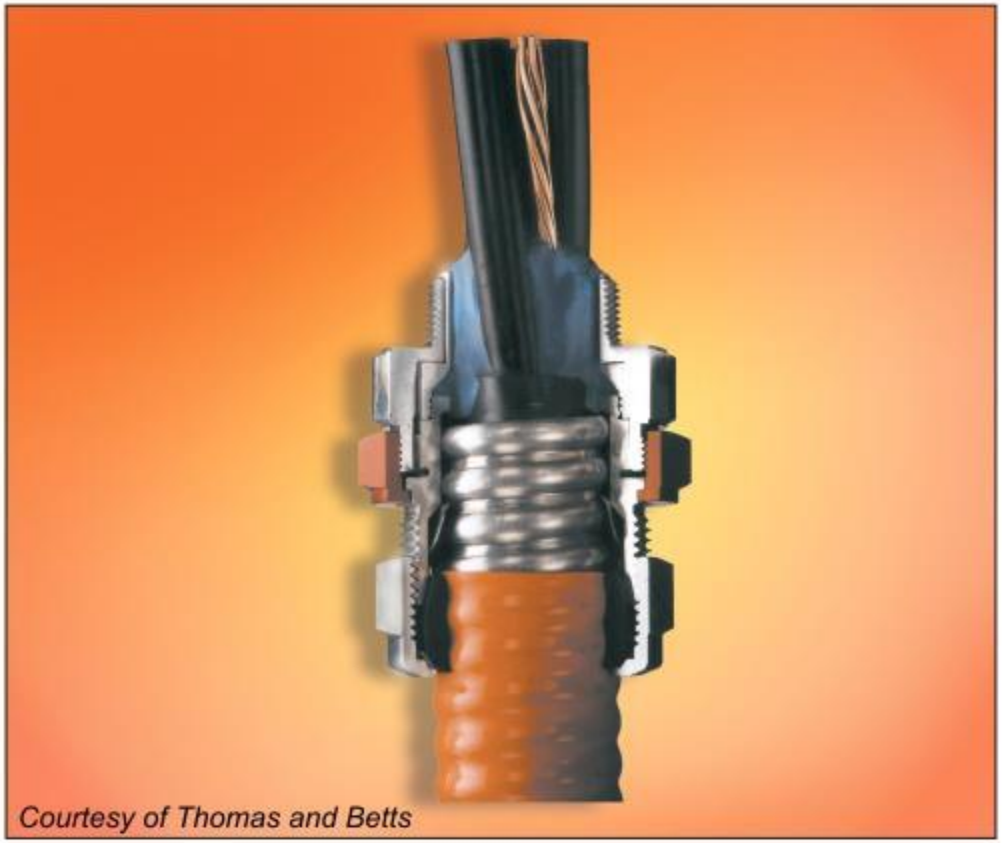
Class I, Division 2 location

501.15(D)(1)
Cable Seals - Class I, Division 1

- Text added to identify the **explosionproof fittings** that can be installed between a cable seal and an enclosure in Class I, Division 1 locations
- Only **explosionproof unions**, **couplings**, **reducers**, **elbows**, and **capped elbows** that are not larger than the trade size of the enclosure entry are permitted between the cable sealing fitting and the enclosure in a Class I, Division 1 location
- Some explosionproof enclosures require seal fittings to be located as much as 450 mm (18 in.) away and are so marked
- This situation lends itself to fittings being installed between the enclosure and a cable seal

501.15(D)(1) Cable Seals - Class I Division 1

Seals for cables entering enclosures shall be installed within 450 mm (18 in.) of the enclosure or as required by the enclosure marking



Courtesy of Thomas and Betts

Only explosionproof unions, couplings, reducers, elbows, and capped elbows that are not larger than the trade size of the enclosure entry are permitted between the sealing fitting and the enclosure

Table 511.3(C) and Table 511.3(D)

- Two new tables added at 511.3 for clarification of area classification of **major** and **minor** commercial repair garages
  - **Table 511.3(C)** Extent of Classified Locations for Major and Minor Repair Garages with Heavier-Than-Air Fuel
  - **Table 511.3(D)** Extent of Classified Locations for Major Repair Garages with Lighter-than-Air Fuel
- Previous requirements of 511.3(C) and (D) were replaced with a new Table 511.3(C) covering **both major and minor repair garages** where **heavier than air** gaseous Class I liquids are transferred or dispensed
- New Table 511.3(D) covers **major repair garages** where vehicles using **lighter than air** gaseous fuels are repaired or stored

Table 511.3(C) and Table 511.3(D) *(cont.)*

- **Major Repair Garage**. A building or portions of a building where major repairs, such as engine overhauls, painting, body and fender work, and repairs that require draining of the motor vehicle fuel tank are performed on motor vehicles, including associated floor space used for offices, parking, or showrooms.
- **Minor Repair Garage**. A building or portions of a building used for lubrication, inspection, and minor automotive maintenance work, such as engine tune-ups, replacement of parts, fluid changes (e.g., oil, antifreeze, transmission fluid, brake fluid, air-conditioning refrigerants), brake system repairs, tire rotation, and similar routine maintenance work, including associated floor space used for offices, parking, or showrooms.
- See 511.2

Table 511.3(C) Extent of Classified Locations for Major and Minor Repair Garages with Heavier-Than-Air Fuel

(Part 1 of 2)

	Class I		
Location	**Division (Group D)**	**Zone (Group IIA)**	**Extent of Classified Locations**
Repair garage, major (where Class I liquids or gaseous fuels are transferred or dispensed*)	1	1	Entire space within any pit, below-grade work area, or subfloor work area that is not ventilated
	2	2	Entire space within any pit, below-grade work area, or subfloor work area that is provided with ventilation of at least 0.3 m^3/min/m^2 (1 ft^3/min/ft^2) of floor area, with suction taken from a point within 300 mm (12 in.) of floor level
	2	2	Up to 450 mm (18 in.) above floor level of the room, except as noted below, for entire floor area
	Unclassified	Unclassified	Up to 450 mm (18 in.) above floor level of the room where room is provided with ventilation of at least 0.3 m^3/min/m^2 (1 ft^3/min/ft^2) of floor area, with suction taken from a point within 300 mm (12 in.) of floor level
	2	2	Within 0.9 m (3 ft) of any fill or dispensing point, extending in all directions
Specific areas adjacent to classified locations	Unclassified	Unclassified	Areas adjacent to classified locations where flammable vapors are not likely to be released, such as stock rooms, switchboard rooms, and other similar locations, where mechanically ventilated at a rate of four or more air changes per hour or designed with positive air pressure or where effectively cut off by walls or partitions

*Includes draining of Class I liquids from vehicles.

Table 511.3(C) Extent of Classified Locations for Major and Minor Repair Garages with Heavier-Than-Air Fuel

(Part 2 of 2)

Location	Class I Division (Group D)	Class I Zone (Group IIA)	Extent of Classified Locations
Repair garage, minor (where Class I liquids or gaseous fuels are transferred or dispensed*)	2	2	Entire space within any pit, below-grade work area, or subfloor work area that is not ventilated
	2	2	Up to 450 mm (18 in.) above floor level, extending 0.9 m (3 ft) horizontally in all directions from opening to any pit, below-grade work area, or subfloor work area that is not ventilated
	Unclassified	Unclassified	Entire space within any pit, below-grade work area, or subfloor work area that is provided with ventilation of at least 0.3 $m^3/min/m^2$ (1 $ft^3/min/ft^2$) of floor area, with suction taken from a point within 300 mm (12 in.) of floor level
Specific areas adjacent to classified locations	Unclassified	Unclassified	Areas adjacent to classified locations where flammable vapors are not likely to be released, such as stock rooms, switchboard rooms, and other similar locations, where mechanically ventilated at a rate of four or more air changes per hour or designed with positive air pressure or where effectively cut off by walls or partitions

*Includes draining of Class I liquids from vehicles.

Table 511.3(D) Extent of Classified Locations for Major Repair Garages with Lighter-Than-Air Fuel

Location	Class I		Extent of Classified Locations
	Division[2]	Zone[3]	
Repair garage, major (where lighter-than-air gaseous fueled[1] vehicles are repaired or stored)	2	2	Within 450 mm (18 in.) of ceiling, except as noted below
	Unclassified	Unclassified	Within 450 mm (18 in.) of ceiling where ventilation of at least 0.3 $m^3/min/m^2$ (1 $ft^3/min/ft^2$) of floor area, with suction taken from a point within 450 mm (18 in.) of the highest point in the ceiling
Specific areas adjacent to classified locations	Unclassified	Unclassified	Areas adjacent to classified locations where flammable vapors are not likely to be released, such as stock rooms, switchboard rooms, and other similar locations, where mechanically ventilated at a rate of four or more air changes per hour or designed with positive air pressure or where effectively cut off by walls or partitions

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[1] Includes fuels such as hydrogen and natural gas, but not LPG.

[2] For hydrogen (lighter than air) Group B, or natural gas Group D.

[3] For hydrogen (lighter than air) Group IIC or IIB+H2, or natural gas Group IIA.


DANGER
NO STEP
BRAKE FLUSH SYSTEM
RTI
FluidPRO

511.8 Underground Wiring - Commercial Garages, Repair and Storage

- New section added to address **acceptable wiring methods** for an underground installation under a commercial repair garage

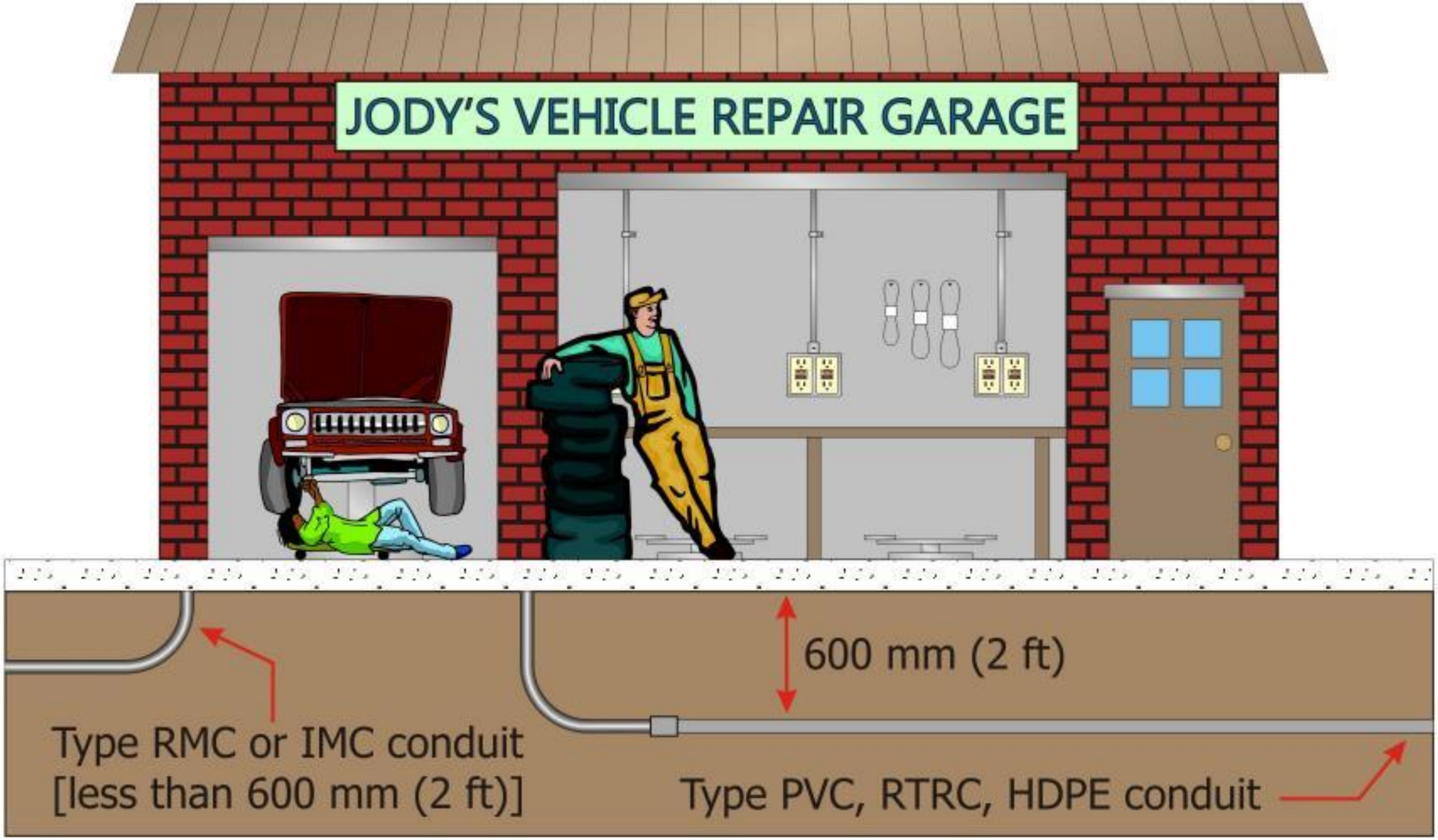
- Underground wiring method for a commercial repair garage to be installed in **threaded rigid metal conduit** (RMC) or **threaded steel intermediate metal conduit** (IMC)

- New exception permits **PVC** conduit, **RTRC** conduit, and high density polyethylene (**HDPE**) conduit to be used where buried under not less than **600 mm (2 ft)** of cover

- Added text patterned after similar underground wiring provisions such as 514.8 and 515.8(A)

511.8 Underground Wiring

Underground wiring method for a commercial repair garage to be installed in threaded RMC conduit or threaded steel IMC conduit



Type PVC, RTRC, and HDPE conduit permitted to be used where buried under not less than 600 mm (2 ft) of cover

514.3(B)(3) Classification of Fuel Storage - Motor Fuel Dispensing Facilities

- New classification information for storage tanks for **compressed natural gas**, **liquefied natural gas**, and **liquefied petroleum gas** fuel storage has been added
- References to other NFPA documents that offer further detail were also added
- Modern storage tanks for these gases are typically full containment type, which has a pre-stressed concrete outer wall and a high-nickel steel inner tank, with extremely efficient insulation between the walls
- New information is extracted material from **NFPA 30A** *(Code for Motor Fuel Dispensing Facilities and Repair Garages)*


NO SMOKING
FLAMMABLE
PROPANE
NORTHWEST

514.8 Ex. No. 2 Underground Wiring - Motor Fuel Dispensing Facilities

- **High density polyethylene (HDPE)** conduit was added to 514.8, Ex. No. 2 as an acceptable wiring method for underground installations for motor fuel dispensing facilities where buried under not less than **600 mm (2 ft)** of cover

- HDPE provides at least the same level of protection and is an equivalent wiring method to PVC or RTRC when installed underground under not less than 600 mm (2 ft) of cover

- HDPE is a nonmetallic flexible raceway manufactured from high density polyethylene for use in underground and innerduct applications

514.8 Ex. No. 2 Underground Wiring

Underground wiring for motor fuel dispensing facilities is required to be installed in threaded RMC or threaded steel IMC

Photos Courtesy of Carlon

High density polyethylene (HDPE) conduit *(along with Type PVC and RTRC conduit)* was added as an acceptable wiring method for underground installations for motor fuel dispensing facilities where buried under not less than 600 mm (2 ft) of cover

514.11 Circuit Disconnects – Motor Fuel Dispensing Facilities

- Emergency shutoff device requirements for a motor fuel dispensing facilities was revised to reflect the requirements of NFPA 30A and for clarity
- Fuel dispensing systems required to be provided with one or more clearly identified emergency shutoff devices or electrical disconnects
- Such devices or disconnects to be installed in approved locations but **not less than 6 m (20 ft) or more than 30 m (100 ft)** from the fuel dispensing devices that they serve
- 514.11 revised to clearly indicate that these minimum and maximum distances hold true at both **attended** and **unattended** motor fuel dispensing facilities

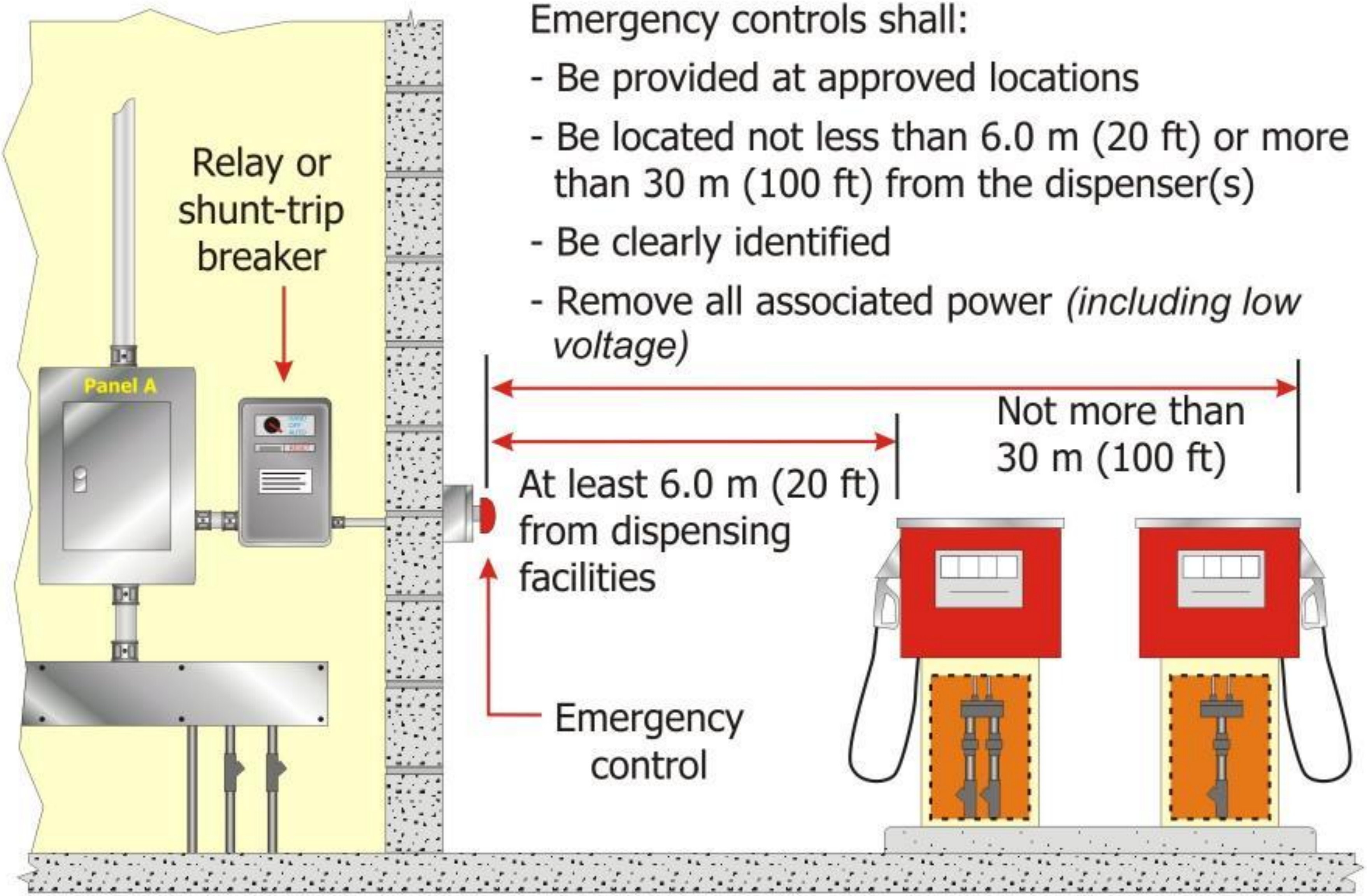
514.11 Circuit Disconnects – Motor Fuel Dispensing Facilities *(cont.)*

- Previous language could be interpreted as requiring emergency controls to be within 30 m (100 ft) of the **closest dispenser of a group** while allowing the other dispensers to be located further than 30 m (100 ft) from emergency control device
- Revised language clearly requires emergency shutoff device not less than 6 m (20 ft) from and not more than 30 m (100 ft) from **any of the fuel dispensing devices that they serve**
- Allows attendant or anyone the ability to quickly shut off all external power to a dispenser at a **safe distance** while having the emergency shutoff devices located within a **reasonable distance** in order to take advantage of these emergency shutoff devices during an emergency situation

514.11 Emergency Controls for Fuel Dispensers

Emergency controls shall:

- Be provided at approved locations
- Be located not less than 6.0 m (20 ft) or more than 30 m (100 ft) from the dispenser(s)
- Be clearly identified
- Remove all associated power *(including low voltage)*



Applies to both Attended and Unattended motor fuel dispensing facilities


EMERGENCY
PUMP
SHUT-OFF
SWITCH
© Jeff Burman


BUC-EE'S
EMERGENCY PUMP SHUT OFF
EMERGENCY PUMP SHUT OFF
BUC-EE'S

Article 516 Entire Article Revised

Spray Application, Dipping, Coating, and Printing Processes Using Flammable or Combustible Materials

- Article 516 was re-arranged and revised to give the article a clearer outline
- Four individual parts were added to the article
  - Part I. General
  - Part II. Open Containers
  - Part III. Spray Application Processes
  - Part IV. Spray Application Operations in Membrane Enclosures
- Requirements now align with **NFPA 33** *(Standard for Spray Application Using Flammable and Combustible Materials)* and **NFPA 34** (*Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids)*

Article 516: Entire Article Revised

Article 516 Spray Application, Dipping, Coating, and Printing Processes Using Flammable or Combustible Materials

Article 516 was extensively revised for clarity and to align with NFPA 33 *Standard for Spray Application Using Flammable and Combustible Materials* and NFPA 34 *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids*

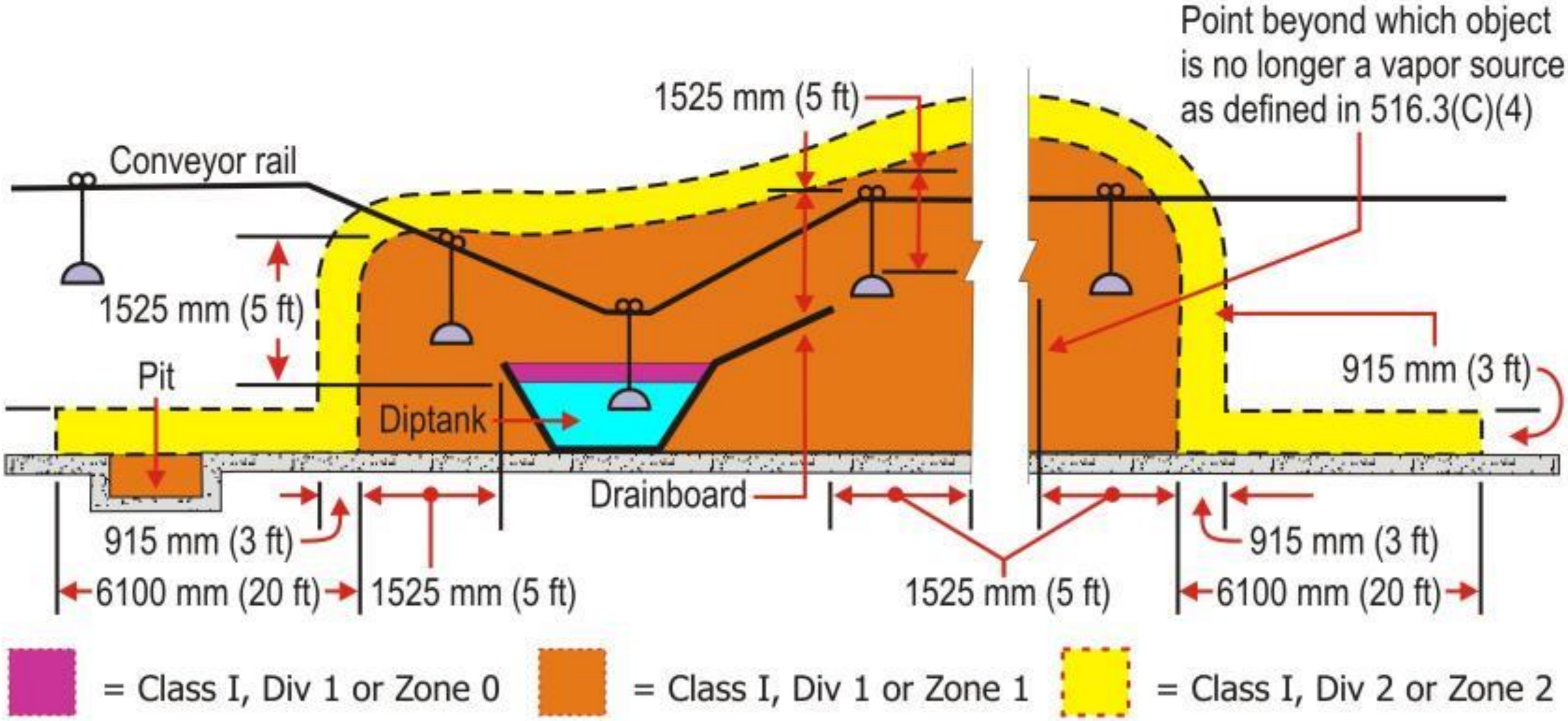


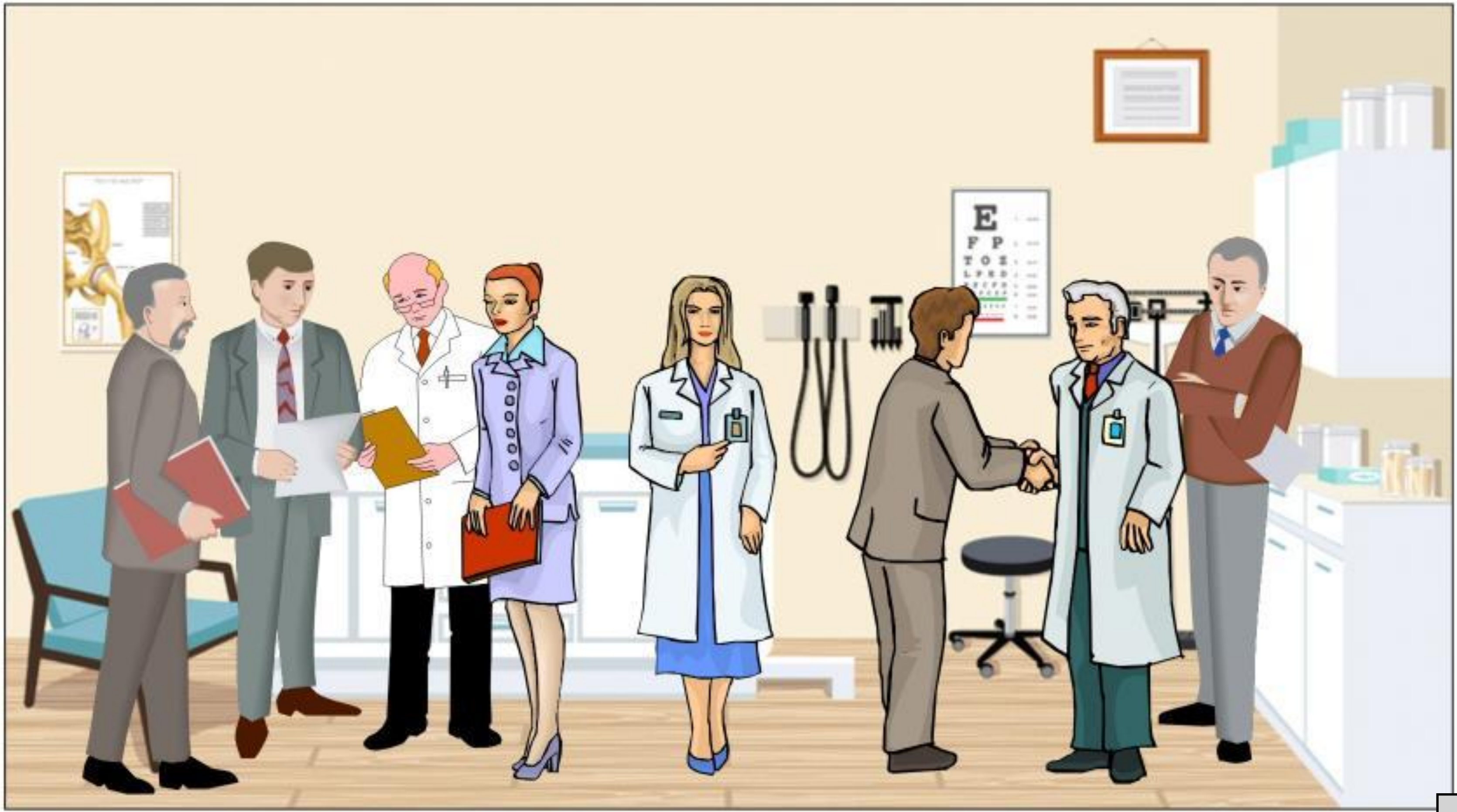
Figure 516.29(a) Electrical Area Classification for Open Dipping and Coating Processes Without Vapor Containment or Ventilation

517.2 Definitions: Governing Body - Health Care Facilities

- New definition for "**Governing Body**" added to Article 517
- Term "governing body" appears at 7 different locations in Article 517
- New definition will be followed by "[99: 3.3.62]" as this is **extracted material from NFPA 99** *(Healthcare Facilities Code)*
- New definition will eliminate some of the confusion that may exist for users of the *Code* when trying to determine who has responsibility for making decisions on certain matters in a health care facility

517.2 Definitions (Health Care Facilities)

Governing Body. The person or persons who have the overall legal responsibility for the operation of a health care facility.



517.2 Definitions: Health Care Facilities

- Definition of "Health Care Facility" was revised to include "**mobile enclosures**"
- Examples of a health care facility that were included in the definition in the previous edition of the *Code* are now found in an informational note below the revised definition
- Revised definition is extracted material from NFPA 99 *(Healthcare Facilities Code)*
- Health care facility is not limited to a traditional "brick and mortar" permanently constructed building
- Health care facility can include a **mobile or portable facility** such as a mobile blood bank or mobile facilities as seen at sporting events

517.2 Definitions (Health Care Facilities)

Health Care Facilities. Buildings, portions of buildings, or mobile enclosures in which human medical, dental, psychiatric, nursing, obstetrical, or surgical care are provided. [99: 3.3.67]

Informational Note: Examples of health care facilities include, but are not limited to, hospitals, nursing homes, limited care facilities, clinics, medical and dental offices, and ambulatory care centers, whether permanent or movable.

517.2 Definitions:
Medical Office (Dental Office)

- To define a well-used term in Article 517, a new definition for "**Medical Office (Dental Office)**" was added at 517.2
- New definition will provide needed clarity when determining health care facility requirements such as branch circuit requirements at patient bed locations
- New definition will make it clear that overnight stays for patients or 24-hour operation facilities do not encompass a medical or dental office

517.2 Definitions:
Medical Office (Dental Office) *(cont.)*

- To define a well-used term in Article 517, a new definition for "**Medical Office (Dental Office)**" was added at 517.2 *(cont.)*
- The use of **sedation or local anesthesia** is involved in minor treatment or procedures under the continuous supervision of a medical or dental professional would be involved at a medical or dental office
- New definition is extracted material from NFPA 99 *(Health Care Facilities Code)*

517.2 Definitions (Health Care Facilities)

Medical Office (Dental Office). A building or part thereof in which the following occur:

(1) Examinations and minor treatments or procedures are performed under the continuous supervision of a medical or dental professional;

(2) Only sedation or local anesthesia is involved and treatment or procedures do not render the patient incapable of self-preservation under emergency conditions; and

(3) Overnight stays for patients or 24-hour operation are not provided. [99: 3.3.98]

517.2 Definitions: Patient Care Space - Health Care Facilities

- Revised definition of “Patient Care Space” will include four NFPA 99 numbered categories for:
  - Basic Care **(Category 3)** Space
  - General Care **(Category 2)** Space
  - Critical Care **(Category 1)** Space
  - Support **(Category 4)** Space
- Bracketed NFPA 99 references were added after each description and informational note
- Informational notes were relocated after each definition with examples of each of the different categories
- Revised definitions and the related informational notes will help clarify the meaning and use of these spaces

517.2 Definitions (Health Care Facilities)

Definition for "**Patient Care Space**" was revised for clarity and to align with definitions in NFPA 99

Basic Care (Category 3) Space:
- Examination or treatment rooms in clinics
- Medical and dental offices
- Nursing homes
- Limited care facilities

General Care (Category 2) Space:
- Inpatient bedrooms
- Dialysis rooms
- In vitro fertilization rooms
- Procedural rooms
- Similar rooms

Critical Care (Category 1) Space:
- Special care unit patient rooms used for critical care
- Intensive care
- Special care treatment rooms
  - Angiography laboratories
  - Cardiac catheterization labs
  - Delivery rooms
  - Operating rooms
  - Post-anesthesia care units
  - Trauma rooms

Support (Category 4) Space:
- Anesthesia work rooms
- Sterile supply
- Laboratories
- Morgues
- Waiting rooms
- Utility rooms
- Lounges

517.16
Use of Isolated Ground Receptacles

- Revisions divided 516.16 into two subdivisions for prohibition of isolated ground receptacles:
  - (A) Inside of a Patient Care Vicinity
  - (B) Outside of a Patient Care Vicinity
- New provisions identify the requirement of ***three*** grounding paths when isolated ground receptacles are required *[metal raceway equipment grounding path, green wire type equipment grounding conductor for the 517.13 "redundant grounding" requirements, and a separate isolated ground equipment grounding conductor to comply with 250.146(D)]*
- Color designation of **green with one of more yellow stripes** required for the isolated ground EGC

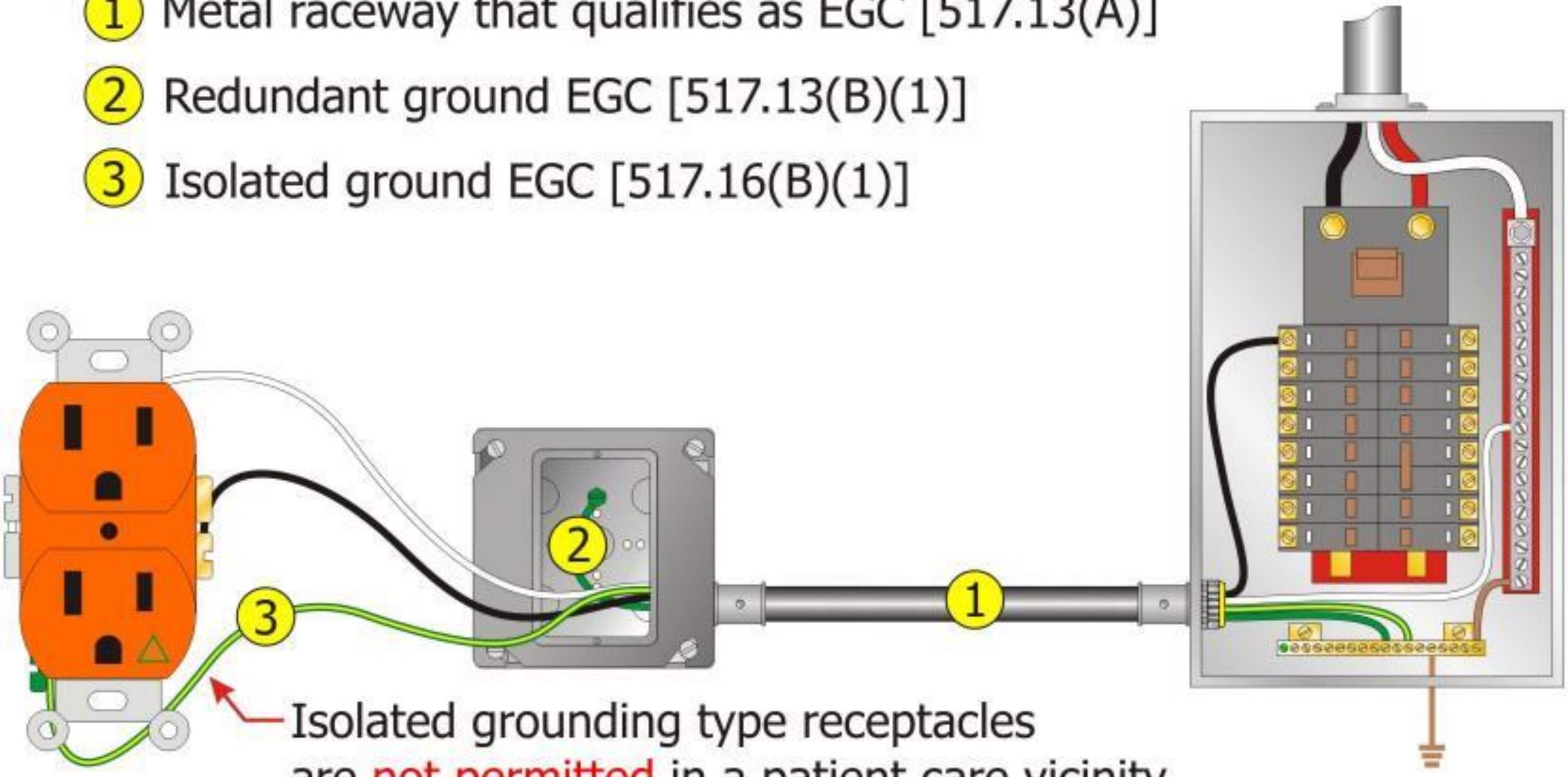
517.16 Use of Isolated Ground Receptacles

New provisions were added to 517.16 pertaining to the proper installation of isolated ground receptacles located outside of a patient care vicinity

① Metal raceway that qualifies as EGC [517.13(A)]

② Redundant ground EGC [517.13(B)(1)]

③ Isolated ground EGC [517.16(B)(1)]



Isolated grounding type receptacles are not permitted in a patient care vicinity

The probation of isolated ground receptacle inside a patient care vicinity are addressed at 517.16(A) and isolated ground receptacles installed outside a patient care vicinity are addressed at 517.16(B)

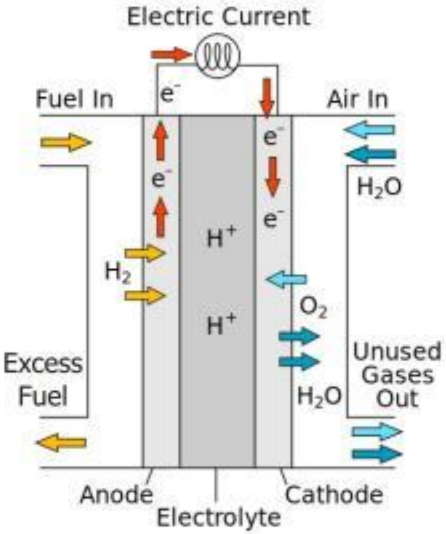
517.30 Types of Power Sources for Essential Electrical System - Health Care Facilities

- Requirements for **two independent sources of power** and an alternate source of power for the essential electrical system for hospitals and other health care facilities were revised and relocated to 517.30
- **Fuel cell systems** will now be permitted to serve as the alternate source for all or part of an essential electrical system as any reference to a battery system has been deleted
- Fuel cells provide a **high level of reliability** and have a proven reliability track record in data centers and other mission critical facilities
- Relocation and revision of "**Sources of Power**" requirements from 517.35 to 517.30 provides a more logical sequence and flow of the text while providing added clarity

517.30(B) Sources of Power
Essential Electrical System (Hospital)

Requirements for two independent sources of power and an alternate source of power for the essential electrical system for hospitals and other health care facilities were revised and relocated to 517.30 *(was 517.35)*

Fuel cell systems will now be permitted to serve as the alternate source for all or part of an essential electrical system



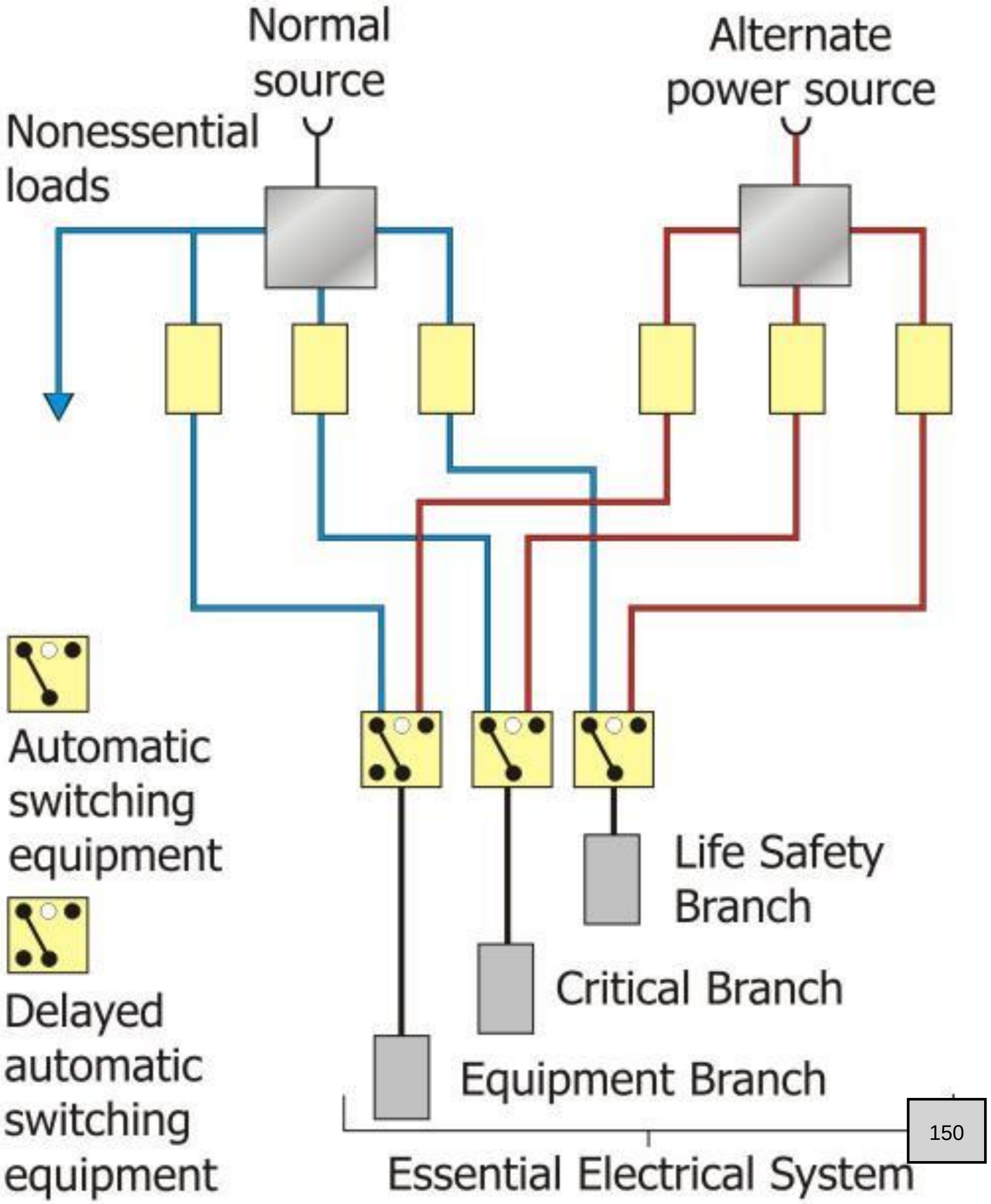


Photo Courtesy of Scott Humphrey

517.34(B) Switching on Critical Branch

- New language was added to specifically allow the **control of task illumination** on the critical branch of the essential electrical system *(switching permitted)*
- Task illumination is the “provision for the minimum lighting required to carry out necessary tasks in the described areas, including safe access to supplies and equipment, and access to exits”
- Critical task illumination lighting is provided in part for the comfort and convenience of the patient
- This lighting should be allowed to be controlled by the patient at his or her own discretion


Hill-Rom

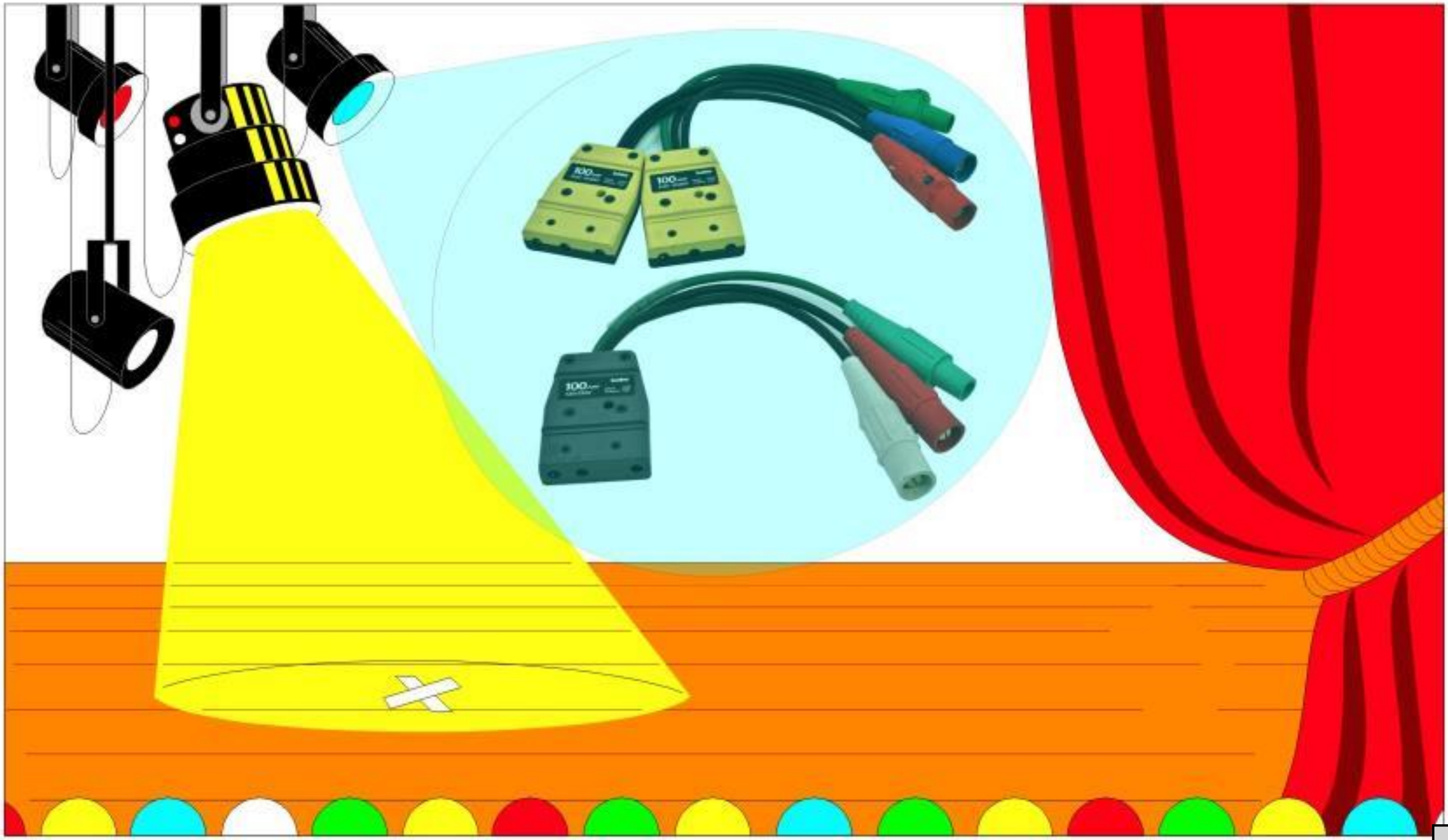
520.2 Definitions: Adapter –

Theaters, Audience Areas of Motion Picture and Television Studios, Performance Areas, and Similar Locations

- A new definition for “**Adapter**” was added to address misapplication of this term in Article 520
- Adapters are often used in these entertainment environments to connect multiple devices together or to a single source
- 520.69, titled “Adapters” details performance of “**two-fers**” and other single- and multiple-circuit outlet devices used as adapters
- Rules for adapters have sometimes been misapplied in the entertainment industry to portable extension cords
- Added definition was needed to correct field misapplication of adapters

520.2 Definitions: Adapter

Adapter. A device used to adapt a circuit from one configuration of an attachment plug or receptacle to another configuration with the same current rating.



520.2 Definitions: Stage Switchboard, Portable

Theaters, Audience Areas of Motion Picture and Television Studios, Performance Areas, and Similar Locations

- A new definition for “**Stage Switchboard, Portable**” was added and the phrase “permanently installed” was added to the existing definition of “Stage Switchboard”
- New definition for a portable stage switchboard clarifies that these devices can only feed stage equipment, while a permanent stage switchboard can feed both stage and non-stage equipment
- Some of the more common terms used for “switchboard” in the entertainment industry are “dimmer rack” or a “relay rack/panel” depending on its function

520.2 Definitions: Stage Switchboard

Stage Switchboard. A permanently installed switchboard, panelboard, or rack containing dimmers or relays with associated overcurrent protective devices, or overcurrent protective devices alone, used primarily to feed stage equipment.

Stage Switchboard, Portable. A portable rack or pack containing dimmers or relays with associated overcurrent protective devices, or overcurrent protective devices alone that are used to feed stage equipment.

525.23(D) GFCI Protection
Carnivals, Circuses, Fairs, and Similar Events

- New requirement for listed, labeled, and **identification for portable use** when said GFCI protection is provided through the use of GFCI receptacles, when the branch circuits supplying these receptacles utilize a **flexible cord**
- Portable GFCIs are plug-in type GFCIs provided with male blades or an integral power-supply cord for connection to a receptacle outlet
- Standard GFCI receptacle used at the end of a flexible cord is common at carnivals, fairs, etc.
- This same type of temporary GFCI installation has resulted in a number of documented fatalities on **construction sites**, which resulted in a comparable restriction at **590.6(A)(2)**


SUGAR SHACK
ELEPHANT EARS
ICE CREAM
ICE COLD DRINKS
CASH ONLY

547.5(F) Separate Equipment Grounding Conductor for Agricultural Buildings

- A separate equipment grounding conductor (EGC) for an underground installation at an agricultural building must be insulated ***(covered conductor removed)***

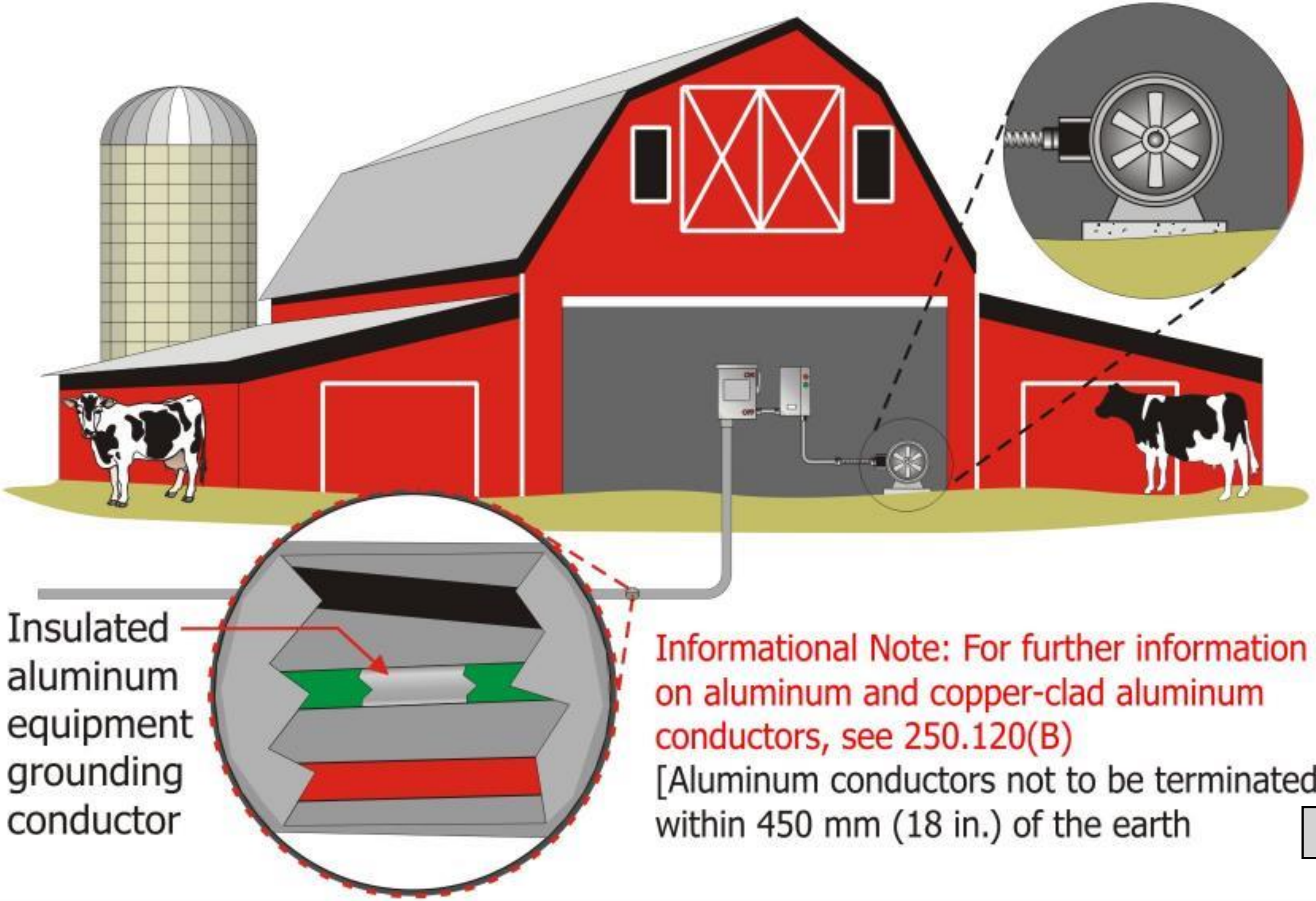
- Further revision removed allowance of a "**covered**" conductor for underground applications at agricultural buildings

- "**Covered conductor**" is defined in Article 100 as "a conductor encased within material of composition or thickness that is *not recognized* by *[the NEC]* as electrical insulation"

- No safety standard, product standard, evaluation or testing of material placed on a conductor so it is considered "covered"

547.5(F) Separate EGC (Agricultural Buildings)

An insulated ~~or covered~~ aluminum or copper equipment grounding conductor is now permitted for underground agricultural building installations



Insulated aluminum equipment grounding conductor

Informational Note: For further information on aluminum and copper-clad aluminum conductors, see 250.120(B)

[Aluminum conductors not to be terminated within 450 mm (18 in.) of the earth

550.2 Definitions: Manufactured Home

- The existing definition for a "**manufactured home**" was revised for consistency with the definition of a "manufactured home" found in **NFPA 501** *(Standard on Manufactured Housing)*
- The last sentence of the definition was **revised to exclude park trailers**
- Park trailer is intended for seasonal use, not intended as a permanent dwelling unit or for commercial uses such as banks, clinics, offices, or similar uses
- Since 1976, the Federal Government *[Department of Housing and Urban Development (HUD)]* has regulated the construction of all manufactured and prefabricated homes

550.2 Definitions: Manufactured Home

- **Manufactured Home.** A structure, transportable in one or more sections, ~~that,~~ which in the traveling mode is 2.4 m (8 ~~body~~ ft) or more in width or 12.2 m (40 ~~body~~ ft) or more in length, or when erected on site, is 29.77 m^2 (320 ft^2) or more ~~and that~~ is built on a permanent chassis and designed to be used as a dwelling with or without a permanent foundation, whether or not connected to the utilities, and includes plumbing, heating, air conditioning, and electrical systems contained ~~when connected~~ therein. The term manufactured home includes any structure that meets all the ~~provisions~~ requirements of this paragraph except the size requirements and with respect to which the manufacturer voluntarily files a certification required by the regulatory agency~~, and except that such term does not include any self-propelled recreational vehicle~~. Calculations used to determine the number of square meters (square feet) in a structure are based on the structure's exterior dimensions~~, measured at the largest horizontal projections when erected on site. These dimensions~~ and include all expandable rooms, cabinets, and other projections containing interior space, but do not include bay windows [501: 1.2.14].
- For the purpose of this *Code* and unless otherwise indicated, the term *mobile home* includes manufactured homes and excludes park trailers defined in 552.4.

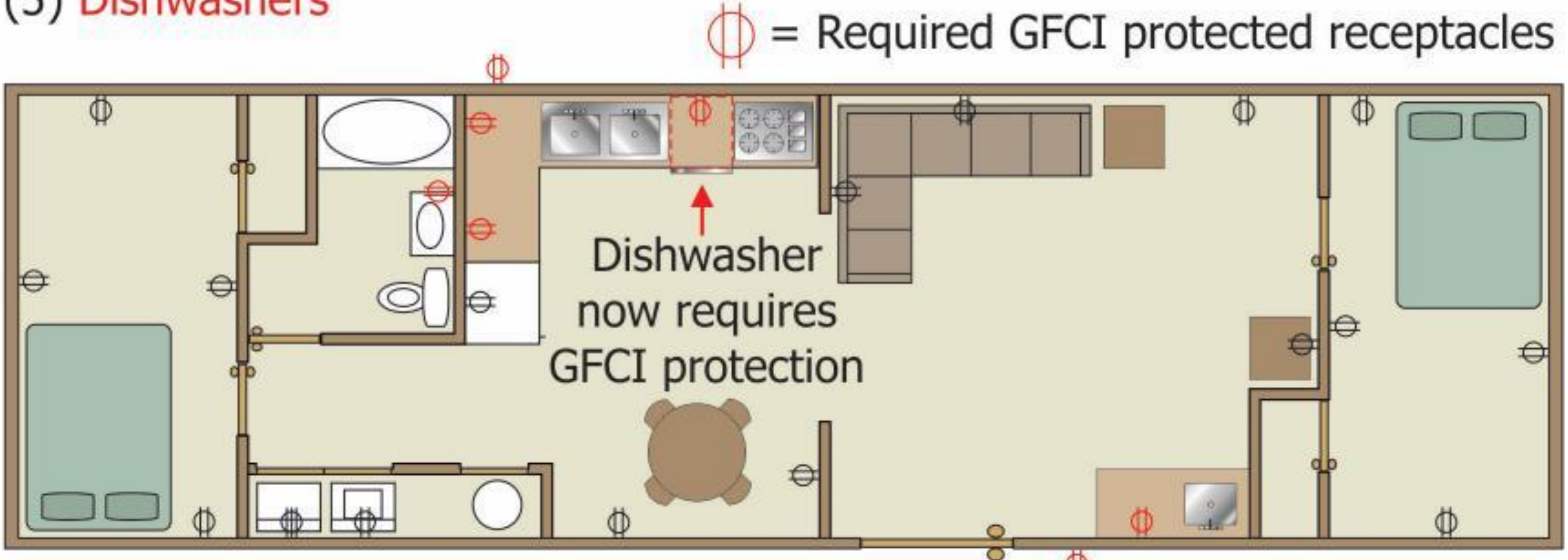
550.13(B) GFCI Protection for Receptacle Outlets at Mobile Homes

- GFCI protection for mobile and manufactured homes was revised to reflect GFCI coverage for all sinks, dishwashers and other locations similarly found at **210.8(A)**
- Clarification was added to the GFCI provisions for **outdoor receptacle outlets** to include all outdoor receptacle outlet including *(but not limited to)* outdoor receptacle outlets located in compartments accessible from outside the unit
- Option of delivering the required GFCI protection through a **feeder** that supplied the branch circuits associated with the receptacle outlets requiring GFCI protection was **removed**
- GFCI requirements for mobile and manufactured homes has not always kept pace with the same GFCI requirements for a conventional dwelling unit

550.13(B) GFCI Protection Required for Mobile and Manufactured Homes

All 125-volt, single-phase, 15- and 20-ampere receptacle outlets installed in the following locations shall be provided with GFCI protection:

(1) Outdoors, including compartments accessible from outside the unit
(2) Bathrooms (including receptacles in luminaires)
(3) Kitchens, where receptacles are installed to serve countertop surfaces
(4) Sinks, where receptacle(s) are installed within 1.8 m (6 ft) of the outside edge of a sink *(any sink)*
(5) Dishwashers



Overhead cut-away view of mobile or manufactured home


HIGHLAND PARK
12

550.25(B) AFCI Protection at Mobile and Manufactured Homes

- AFCI protection at mobile and manufactured homes was revised by eliminating specific list of rooms and areas requiring AFCI protection and simply **requiring compliance with 210.12**
- AFCI protection at mobile and manufactured homes has not keep pace with the expansion of AFCI protection at conventional dwelling units
- Equal AFCI protection is warranted at all dwelling unit locations regardless of the type of dwelling unit involved
- With this reference to **210.12**, any future changes to AFCI protection for conventional dwelling units will have the same effect at mobile and manufactured homes

550.25 AFCI Protection at Mobile and Manufactured Homes

AFCI protection at mobile and manufactured homes was revised by eliminating the specific "laundry list" of rooms and areas requiring AFCI protection at mobile and manufactured homes and simply requiring compliance with 210.12

Red = Outlets requiring AFCI protected branch circuits

Overhead cut-away view of mobile or manufactured home

All 120-volt branch circuits that supply 15- and 20-ampere outlets shall comply with 210.12

551.2 Definitions:
Recreational Vehicle Park

- The definition of "**Recreational Vehicle Park**" was revised to correlate with the same definition in **NFPA 1194** *(Standard for Recreational Vehicle Parks and Campgrounds)*
- NFPA 1194 provides minimum construction requirements for safety and health for occupants using facilities supplied by RV parks
- Changes to this definition were needed to make the definition less specific and limiting and more encompassing such as the definition of "Mobile Home Park" at 550.2
- Revised definition correctly **excludes** locations such as **RV sales lots** and **storage areas for RVs**

551.2 Definition: RV Park

Recreational Vehicle Park. Any parcel or tract of land under the control of any person, organization, or governmental entity wherein two or more RV, recreational park trailer, and/or other camping sites are offered for use by the public or members of an organization for overnight stays.

The definition of "Recreational Vehicle Park" was revised to make the definition consistent with that in NFPA 1194 *(Standard for RV Parks and Campgrounds)*

551.71 Type of Receptacles Provided for RV Parks

- The number of RV sites required to be equipped with **50-ampere**, 125/250-volt receptacles has increased from 20 percent to **40 percent** for all new recreational vehicle sites

- Over 30 percent of new RV production currently are being equipped with 50-ampere power supplies installed

- These percentages will continue to increase year by year

- As the RV industry increases the number of RVs equipped with 50-ampere supply cords, it is important to ensure that RV parks and campgrounds can safely accommodate these power supplies so "cheater cord” adaptors are not a viable option

551.71 Type of Receptacles Provided for RV Parks *(cont.)*

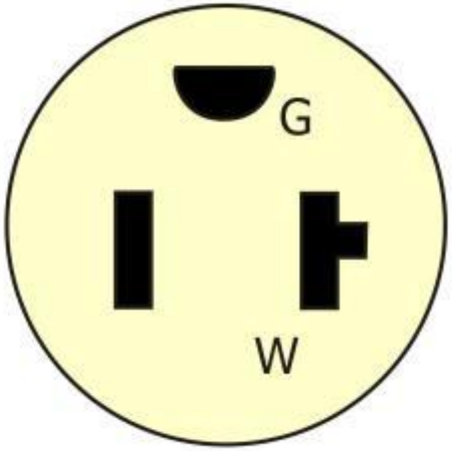
- GFCI devices used in RV site electrical equipment are **not required to be weather or tamper resistant** in accordance with 406.9 and 406.12

- RV site electrical equipment listed for use in RV parks is **NEMA 3R rated**, weather resistant rated equipment and the weather-resistant receptacle requirements of 406.9 are not needed

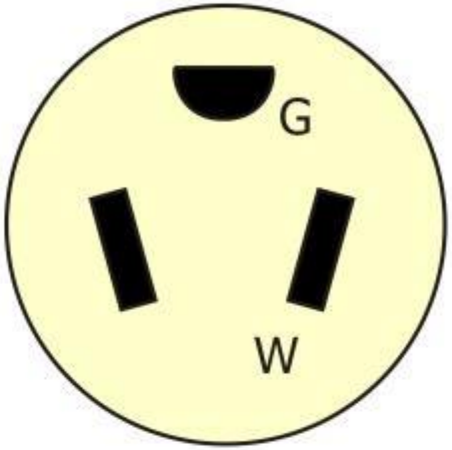
- RV site electric equipment is not for use in a dwelling, so the tamper resistant receptacle requirements of 406.12 is not necessary

551.71 Type Receptacles Provided at RV Parks

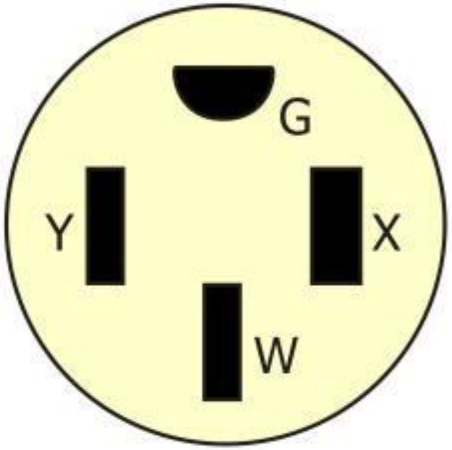
Every RV site (with electrical power provided) must be equipped with a certain number and type of receptacles *[see 551.71(A) through (F)]*



20-A, 125-V,
2-pole, 3-wire,
grounding type



30-A, 125-V,
2-pole, 3-wire,
grounding type



50-A, 125/250-V,
3-pole, 4-wire,
grounding type

551.71 has been broken into six separate first level subdivisions with titles

The number of RV sites required to be equipped with 50-ampere, 125/250-volt receptacles has increased from 20 percent to 40 percent for all new RV sites

GFCI devices used in RV site electrical equipment not required to be weather or tamper resistant in accordance with 406.9 and 406.12

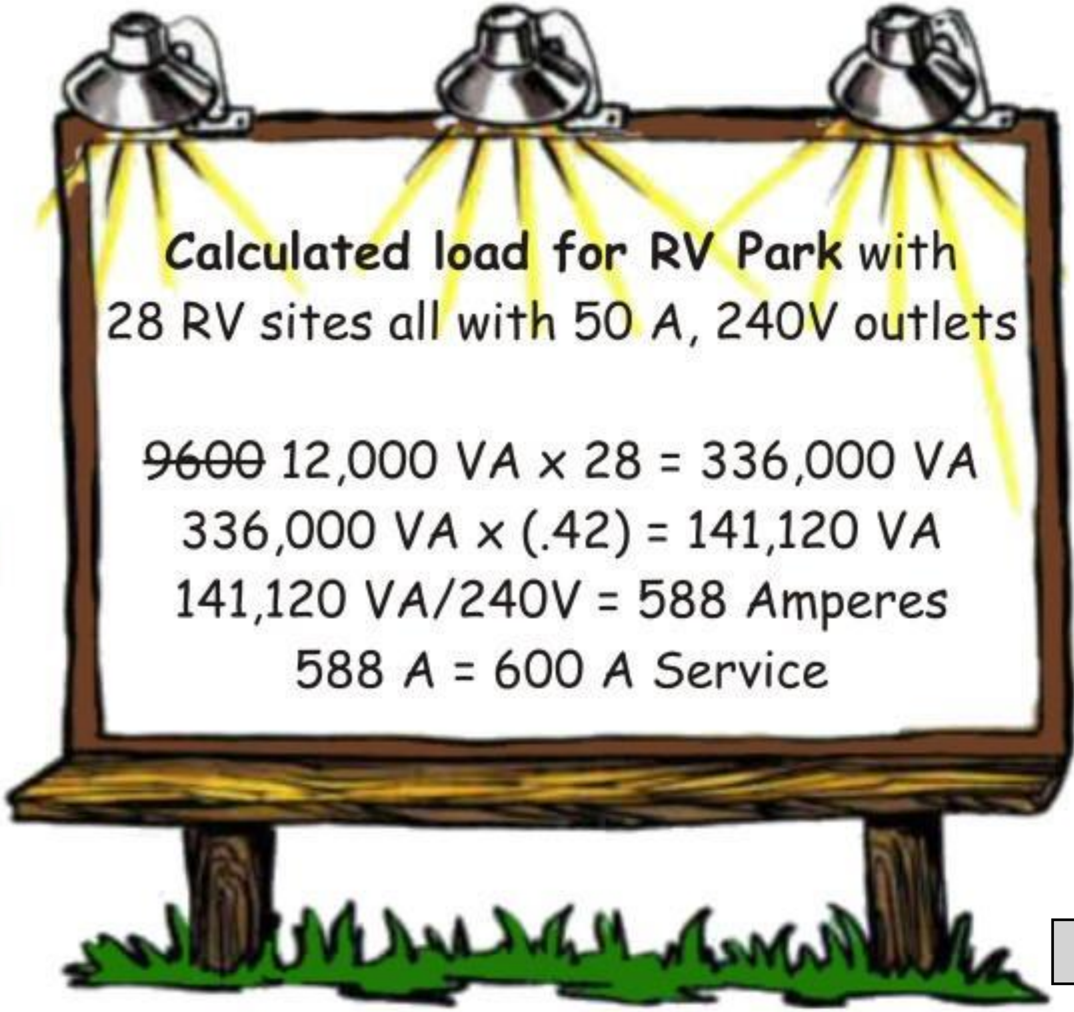

5
5
5

551.73(A) Calculated Load for RV Parks

- Minimum calculated load for RV parks sites equipped with **50-ampere, 208Y/120 or 120/240-volt** supply facilities increased from 9600 volt-amperes to **12,000 volt-amperes** per site
- 9600 VA was based on 40 amperes at 240 volts, 12,000 VA is based on 50 amperes and 240 volts
- As recreational vehicles become larger and demand more electrical power consumption, RV site feeders should be more realistically sized to meet the actual load served
- This change will serve to require larger service or feeder conductors to properly serve the load or fewer RV sites supplied by a service to an RV park

551.73(A) Calculated Load for RV Parks

The calculated load for electrical services and feeders at RV parks shall be calculated on the basis of not less than 12,000 volt-amperes per RV site equipped with 50-ampere, 208Y/120 or 120/240-volt supply facilities.



Calculated load for RV Park with
28 RV sites all with 50 A, 240V outlets

~~9600~~ 12,000 VA x 28 = 336,000 VA
336,000 VA x (.42) = 141,120 VA
141,120 VA/240V = 588 Amperes
588 A = 600 A Service

551.75(B) Grounding Electrode Requirements at RV Parks

- New provisions added to state that power outlets or RV site supply equipment *(other than those used as service equipment)* are **not required to have a grounding electrode established** at RV site pedestals *(electrical equipment)*
- New requirement has to be considered in direct correlation with the revised definitions for a “building” and a “structure” found in Article 100
- A “**Structure**” is now defined as “that which is built or constructed, <u>other than equipment</u>”
- The addition of the phrase “other than equipment” at the end of the definition of “Structure” provides clarification that **structures do not include equipment**

551.75(B) Grounding Electrode Requirements at RV Parks *(cont.)*

- New "structure" definition establishes a difference between a "structures" and "equipment" for the purpose of establishing a grounding electrode system as compared to installing optional or auxiliary electrodes at something like an RV pedestal
- Equipment can be mounted on a structure, but the **equipment itself is not a structure**
- New provisions at 551.75(B) will make it clear that a grounding electrode system will not be required for feeders supplying RV site equipment *(RV pedestal)*
- Previous **informational note that referenced 250.32(A) has been deleted** as this reference implied that the installation of grounding electrode was required at the RV site electrical equipment such as an RV pedestal


31


40

Article 555 Marinas, Boatyards, and Commercial and Noncommerical Docking Facilities

- Title of Article 555 was changed from "Marinas and Boatyards" to "**Marinas, Boatyards, and Commercial and Noncommerical Docking Facilities**"
- Revisions to 555.1 make Article 555 relevant to **dwelling unit docking facilities** as well as commercial docking facilities
- As previously written, the *NEC* rules in Article 555 would not apply to residential boat docking facilities, yet the majority of the rules in Article 555 would be necessary for implication at residential boat docks associated with single-family and multi-family dwelling occupancies
- Article 555 will now apply to all wiring, equipment, and electrical systems installed at boat docking facilities regardless of its location

555.3 GFP at Marinas, Boatyards and Commercial/Noncommercial Docking Facilities

- The **ground-fault protection (GFP)** required for OCPD for marinas, boatyards, and commercial and noncommercial docking facilities cannot exceed **30 mA** *(rather than 100 mA)*
- GFP protection is required in **all supply overcurrent protective devices**, not necessarily in the main OCPD
- The alternative of GFCI protection in each individual branch or feeder was deleted as this 30 mA GFP protection is required in all supply OCPDs
- GFCI protection is still required for 15- and 20-ampere, single-phase, 125-volt receptacles *[see 555.19(B)(1)]*

555.3 Ground-Fault Protection

The ~~main~~ overcurrent protective devices that supply the marina, boatyards, and commercial and noncommercial docking facilities shall have ground fault protection not exceeding 30 mA

GFP protection required for OCPDs for marinas, and now boatyards, and commercial and noncommercial docking facilities as well reduced to a maximum of 30 mA rather than 100 mA

This GFP protection is required on all supply OCPDs *(not necessarily the main OCPD)*

555.19(B)(1)
GFCI Protection for Personnel

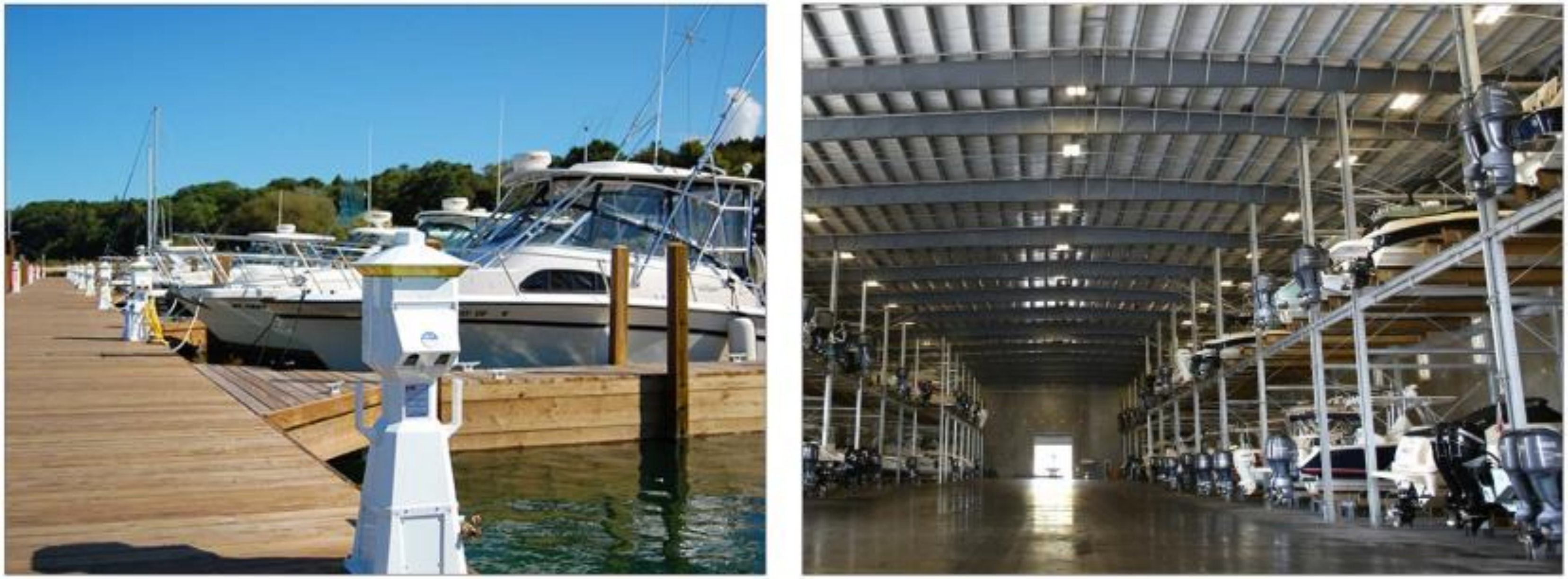
- The term "**where portable electrical hand tools, electrical diagnostic equipment, or portable lighting equipment are to be used**" was deleted
- GFCI protection for personnel will now be required for all 125-volt, single-phase, 15- and 20-ampere receptacles installed outdoors, in boathouses, and in buildings or structures used for storage, maintenance, or repair regardless of the intended use of these receptacles
- Difficult for AHJ to determine which receptacles will employ "portable electrical hand tools, electrical diagnostic equipment, or portable lighting equipment" and which receptacles will not

555.19(B)(1)
GFCI Protection for Personnel *(cont.)*

- The removal of this portable electrical hand tool, etc. conditional language will greatly aid the AHJ to enforce the GFCI requirements at these locations without debate from the installer, builder, or homeowner as to whether or not portable tools, portable lighting and such will be used
- This exact same scenario and deletion of the same condition played out during the 2014 *NEC* revision process at 210.8(B)(8) for non-dwelling unit garages, service bays, and similar areas

555.19(B) GFCI Protection for Personnel

GFCI protection required for all 125-volt, single-phase, 15- and 20-ampere receptacles installed outdoors, in boathouses, and in buildings or structures used for storage, maintenance, or repair regardless of the intended use



The term, "where portable electrical hand tools, electrical diagnostic equipment, or portable lighting equipment are to be used" was deleted

The removal of this portable electrical hand tool, etc. conditional language will aid the AHJ in enforcement of the GFCI requirements at these location

555.24 Signage - Marinas, Boatyards and Commercial/Noncommercial Docking Facilities

- New signage requirement for **precautionary signage** related to electric shock hazard in water around marinas and boatyards
- Gives notice of electrical shock hazard risks to persons using or swimming near a boat dock or marina
- Signage must comply with **110.21(B)(1)** and be clearly visible from all approaches to a marina or boatyard facility
- The signs shall state:

WARNING — POTENTIAL SHOCK HAZARD — ELECTRICAL CURRENTS MAY BE PRESENT IN THE WATER

- Due to stray circulating currents in the water, swimming at marinas and boatyards presents a significant danger of **electric shock drowning (ESD)** to people engaging in aquatic activities

555.24 Signage at Marinas, Boatyards, Etc.

New requirements added for permanent safety signs to be installed to give notice of electrical shock hazard risks to persons using or swimming near a boat dock or marina

WARNING - POTENTIAL SHOCK HAZARD -
ELECTRICAL CURRENTS MAY BE PRESENT IN THE WATER

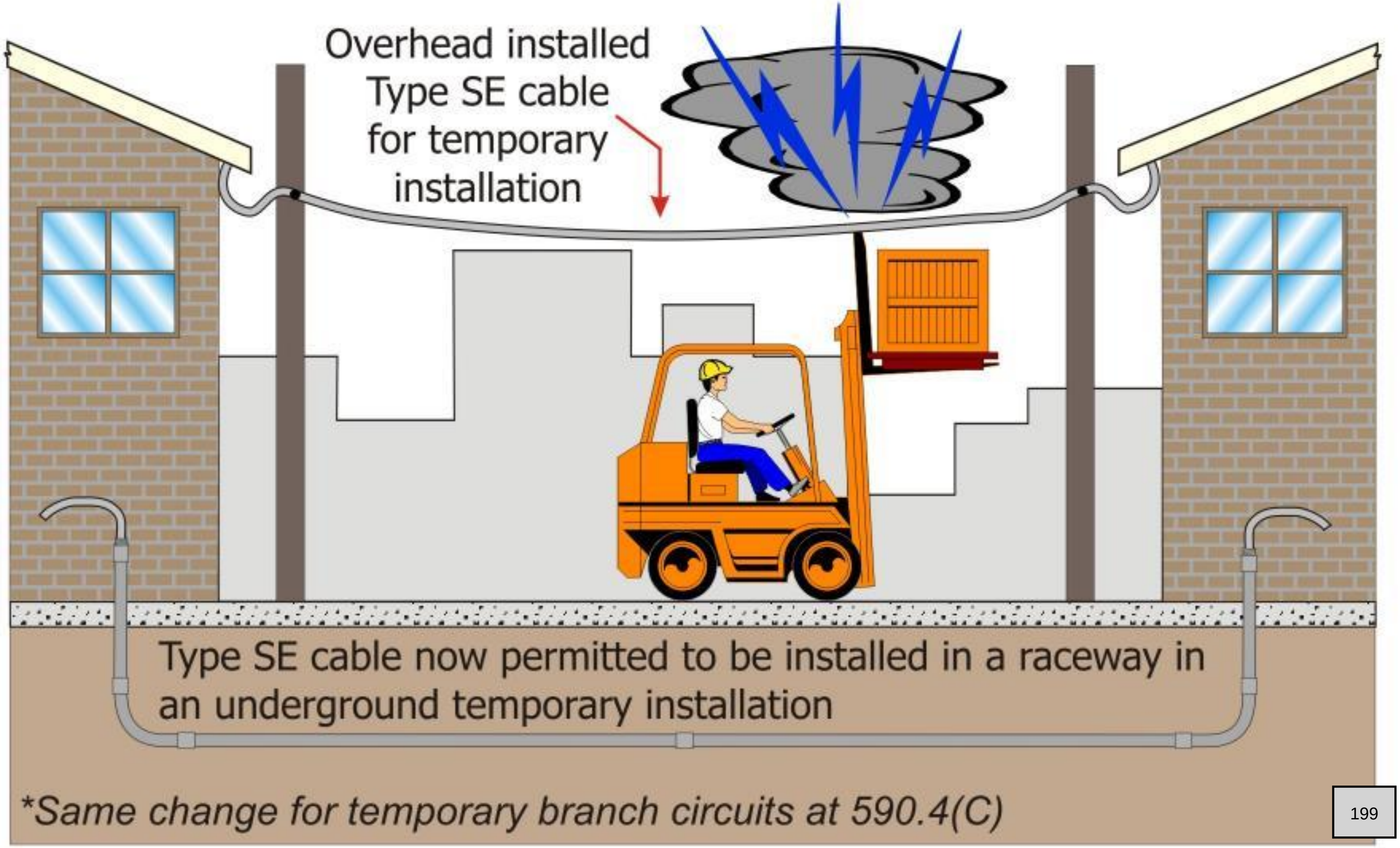
The signs shall be clearly visible from all approaches to a marina or boatyard facility

590.4(B) Feeders for Temporary Installations

- **Type SE cable** has been added to the acceptable cable assembly wiring methods for a temporary installation along with Type NM and Type NMC cable
- Type SE cable is now permitted to be installed in a raceway in a temporary underground installation as well
- 338.12(A)(2) indicates that Type SE cable is not permitted to be installed underground, with or without a raceway
- New provision at 590.4(B)(2) will allow underground installation on a temporary basis while still prohibiting underground use for Type SE cable on a permanent basis
- Same allowance of Type SE cable for temporary installations was installed at **590.4(C)** for **branch circuits**

590.4(B) Feeders (Temporary Installations)

Type SE cable has been added to the acceptable cable assembly wiring methods for a temporary installation along with Type NM and Type NMC cable



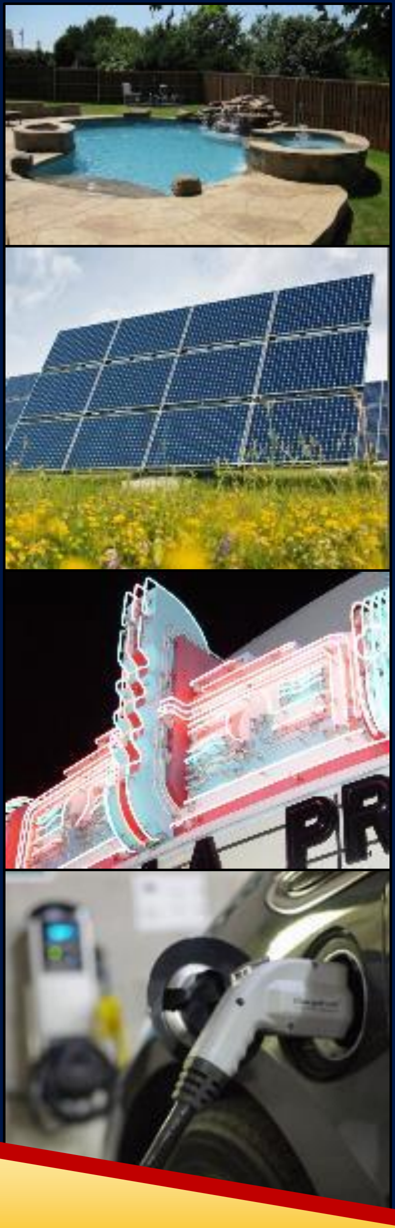
Overhead installed Type SE cable for temporary installation

Type SE cable now permitted to be installed in a raceway in an underground temporary installation

*Same change for temporary branch circuits at 590.4(C)

590.6(A)(1) GFCI - Temporary Installations Receptacle Outlets Not Part of Permanent Wiring

- GFCI protection is permitted in the form of **portable GFCI cord sets in addition to** GFCI protection required for all 125-volt, single-phase, 15-, 20-, and 30-ampere receptacle outlets that are **not a part of the permanent wiring** of the building or structure
- This added language mirrors the added text by **TIA 70-14-6**
- Portable GFCI cord set devices cannot be used as a substitute for protecting temporary wiring, thus protecting the worker on the construction site from damaged supply cables
- If the GFCI protection were permitted at "splitting device" rather than at the source, there would be no GFCI protection for the temporary cable leading to the splitting device where damage often occurs



Chapter Six
Special Equipment

600.4(B)
Marking for Retrofitted Signs

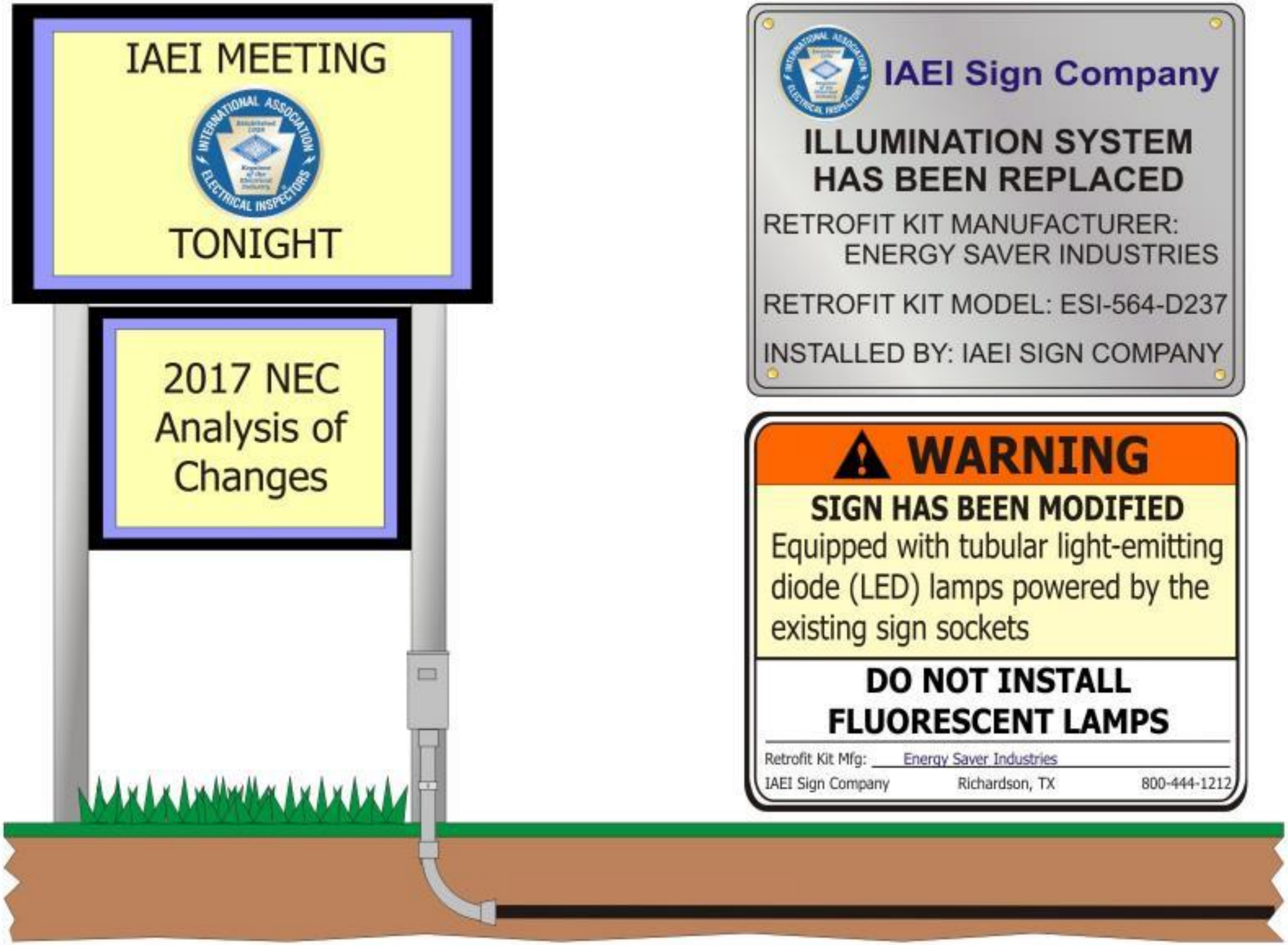
- A new marking requirement was added to indicate that an illumination system has been replaced with a **listed retrofit kit**
- Sign and lighting industries have experienced extensive movement toward the use of “retrofit kits” in an effort to achieve greater energy efficiency in signs and luminaires by replacing the in-place illumination systems with more energy efficient technology such as light emitting diodes (LED)
- Existing electric signs that have been retrofitted need to be marked for the AHJ to inspect the retrofit based on the installation instructions which need to be provided as part of the retrofit kits listing

600.4(B)
Marking for Retrofitted Signs *(cont.)*

- Installer and/or serving company needs to be notified that the sign has a retrofitted lighting system as a safety concern for future maintenance activities involving the sign
- Retrofit will require **additional marking** alerting service personnel that the sign has been modified
- Reference to **110.21(B)** will require label to address the hazard involved with words and/or symbols as required by this *NEC* Chapter One labeling requirement
- New marking requirement for retrofit kits addresses the **location of the required label** as well
- Markings must include the **kit providers** and **installer's name**, **logo**, or **unique identifier**

600.4(B) Marking for Retrofit Kit (Signs)

Retrofitted sign shall be marked that the illumination system has been replaced



IAEI Sign Company

ILLUMINATION SYSTEM HAS BEEN REPLACED

RETROFIT KIT MANUFACTURER: ENERGY SAVER INDUSTRIES

RETROFIT KIT MODEL: ESI-564-D237

INSTALLED BY: IAEI SIGN COMPANY

⚠ WARNING

SIGN HAS BEEN MODIFIED

Equipped with tubular light-emitting diode (LED) lamps powered by the existing sign sockets

DO NOT INSTALL FLUORESCENT LAMPS

Retrofit Kit Mfg: Energy Saver Industries

IAEI Sign Company Richardson, TX 800-444-1212

600.6(A)(1), Ex. No. 2 Disconnects – Energized Conductors Warning Label

- **New exception** added permitting energized conductors ***(with warning label)*** in a Chapter 3 raceway or metal-jacketed cable identified for the location to be run through a sign body or enclosure to a feeder panelboard(s) located within the sign body or enclosure
- **Field-applied permanent warning label** that is visible during servicing is required to be applied to the raceway containing these energized conductors at or near the point of entry into the sign enclosure or sign body complying with **110.21(B)**
- Marking on warning label must include location of the disconnecting means for energized conductor(s) with this disconnecting means being **capable of being locked in the open position** in accordance with **110.25**

600.6(A)(1), Ex. No. 2 Disconnects – Energized Conductors Warning Label *(cont.)*

- The warning label shall state the following:

DANGER - THIS RACEWAY

CONTAINS ENERGIZED CONDUCTORS

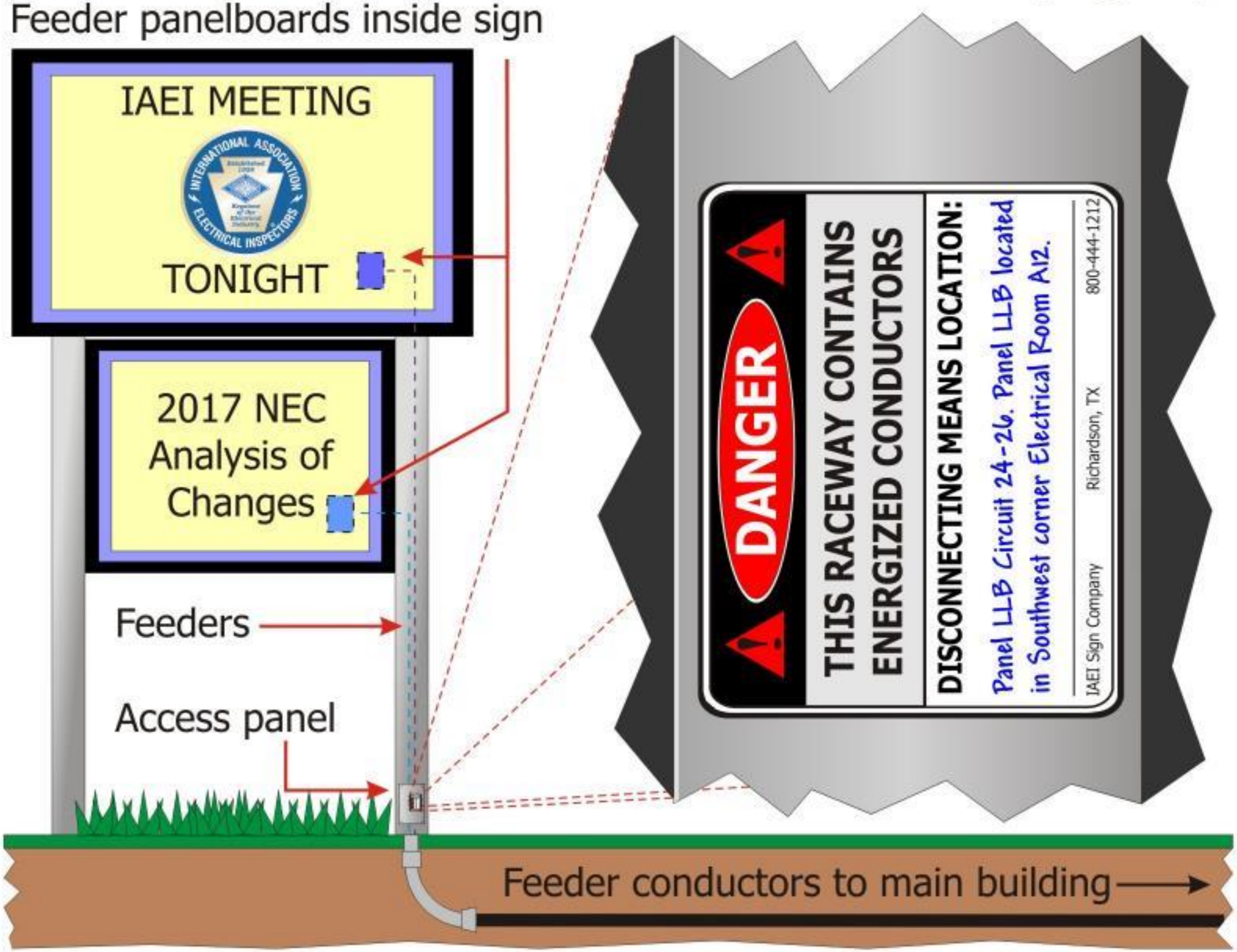
- Electrical safety dictates that these raceways be identified to prevent accidental or deliberate exposure to energized conductors
- Providing a field-applied label with the location of the disconnecting means will contribute to electrical safety for service personnel as well as emergency first responders

600.6(A)(1), Ex. No. 2 Disconnects – Energized Conductors Warning Label *(cont.)*

- The **field-applied permanent warning label** shall:
    - Be applied to the raceway at or near the point of entry into the sign enclosure or sign body
    - Be visible during servicing
    - Comply with 110.21(B)
    - Include the location of the disconnecting means for the energized conductor(s) with the disconnecting means capable of being locked in the open position in accordance with 110.25

600.6(A)(1), Ex. No. 2 Energized Conductors Warning Label - Disconnect Locations (Signs)

Feeder panelboards inside sign



DANGER

THIS RACEWAY CONTAINS ENERGIZED CONDUCTORS

DISCONNECTING MEANS LOCATION:

Panel LLB Circuit 24-26. Panel LLB located in Southwest corner Electrical Room A12.

IAEI Sign Company Richardson, TX 800-444-1212

600.6(A)(1), Ex. No. 2 Energized Conductors Warning Label - Disconnect Locations (Signs)

DANGER

THIS RACEWAY CONTAINS ENERGIZED CONDUCTORS

DISCONNECTING MEANS LOCATION:

Panel LLB Circuit 24-26. Panel LLB located in Southwest corner Electrical Room A12.

IAEI Sign Company Richardson, TX 800-444-1212


THE MIRAGE
TERRY FATOR
VENTRILOQUISM IN CONCERT
THE MIRAGE
CASINO & RESORT
BEATLES LOVE
CAESARS PALACE
THE COSMOPOLITAN
JET


CIRQUE DU SOLEIL
ZARKANA
Aria
Aria
LEMONGRASS
The Thai Restaurant On The Strip
Mandarin
Retail And Self Park
Aria

600.33 ~~LED~~ Class 2 Sign Illumination Systems, Secondary Wiring

- Title changed to "**Class 2 Sign Illumination Systems, Secondary Wiring**" and section was expanded to cover all types of Class 2 lighting systems ***(not just LED lighting systems)***
- LED lighting systems have become an increasingly popular light source over the past decade or so, but LED technology is not the only Class 2 lighting source
- Previous title and content of 600.33 singularly limited rules for use of Class 2 to LED systems, thus leaving other light sources powered by Class 2 sources outside the scope of the section
- 600.33 now references "**low-voltage lighting and equipment connected to a Class 2 power source**" without specifying any particular illumination type such an LED lighting system

600.33 ~~LED~~ Class 2 Sign Illumination Systems, Secondary Wiring *(cont.)*

- 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


IAEI

New Tables Added:
Table 600.33(A)(1) and Table 600.33(A)(2)

- Two new tables added detailing the applications of power limited cable in signs and outline lighting and companion table added detailing Class 2 cable substitutions
    - **Table 600.33(A)(1) Applications of Power Limited Cable in Signs and Outline Lighting**
    - **Table 600.33(A)(2) Class 2 Cable Substitutions**
- Previous language at 600.33(A) gave a reference to Table 725.154 *(Applications of Listed Class 2, Class 3, and PLTC Cables in Buildings)* and required that "listed Class 2 cable that complies with Table 725.154 shall be installed on the load side of the Class 2 power source"

New Tables Added: *(cont.)* Table 600.33(A)(1) and Table 600.33(A)(2)

- Permitted Class 2 cables for electric signs is not readily identifiable in Table 725.154, making it difficult or impossible to determine the permitted cable types for Class 2 sign wiring
- Having new tables located in Article 600 avoid the difficulty and uncertainty of searching a table in Article 725 that does not incorporate a specific reference to types of power limited cable for signs
- New Table 600.33(A)(2) provides the necessary information and directions for ascertaining permitted cable substitutions
- Text revision in 600.33(A) facilitates the use of Class 2 conductors that are acceptable for use in listed electric signs

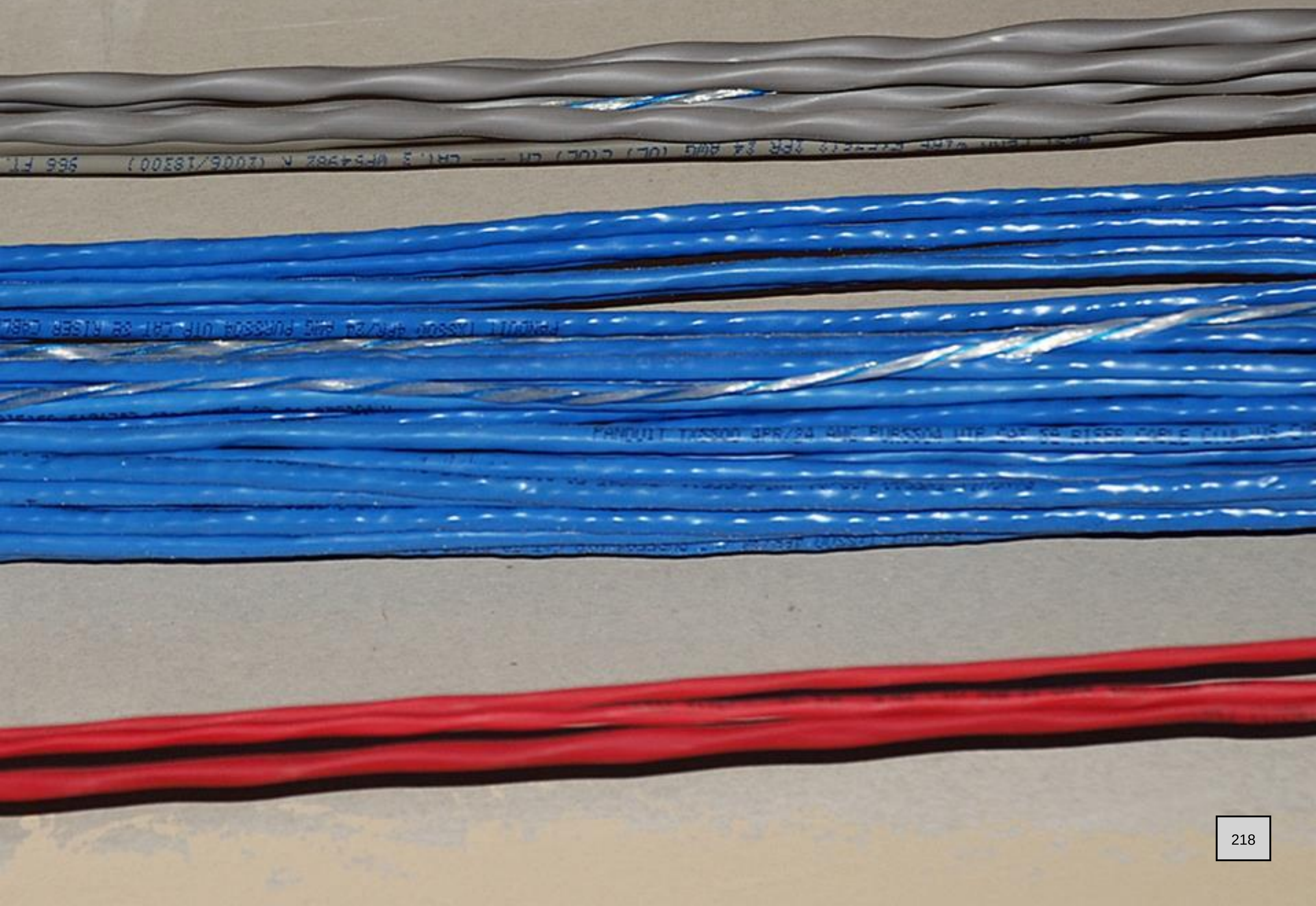


Table 600.33(A)(1) Applications of Power Limited Cable in Signs and Outline Lighting

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.

Reproduction of NEC Table 600.33(A)(1)

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

Reproduction of NEC Table 600.33(A)(2)

600.34 and 600.2
Photovoltaic (PV) Powered Signs

- A new definition for "**Photovoltaic (PV Powered) Sign**" was added to **600.2** and new provisions for PV powered signs were added at **600.34**

- **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.

- This new definition provides the basis for new **600.34** with field wiring rules for installation and electrically safe usage

600.34 and 600.2
Photovoltaic (PV) Powered Signs *(cont.)*

- Sign and PV industry seeing more and more PV powered signs
- New definition provides the basis for new 600.34 with field wiring **rules for installation** and electrically safe usage
- Signs powered by PV system require special installation instructions and new 600.34 will provide these **installation instructions** in addition to application rules of Article 690
- PV powered signs are a special application of PV equipment that is described and covered by **UL 48** *(Standard for Electric Signs)*
- 600.34 **harmonizes** with **Articles 600 and 690** and the end use of PV powered signs constructed in accordance with **UL 48**


CAMPSITES
GROS VENTRE
JENNY LAKE
SIGNAL MTN
COLTER BAY
LIZARD CREEK
FLAGG RANCH


Benedictine Hospital
← Main Entrance
← Administration Bldg.
↑ Medical Arts Bldg.
HealthAlliance
of the Hudson Valley


3F
Tropica
STOP

605.9(C)
Receptacles at Office Furnishings

- Individual office furnishing or groups of interconnected individual office furnishings now cannot contain more than **(13) 15-ampere, 125-volt "receptacles"**
- Receptacle considered up to **two (simplex) receptacles** provided within a single enclosure that are within 0.3 m (1 ft) of each other or **one duplex receptacle**
- The term "receptacle outlets" was changed to "receptacles"
- Moves requirement away from defined term of "receptacle outlet" where "one or more receptacles" can be installed
- New language makes it clear that **(26) individual 15-ampere, 125-volt contact points (receptacles)** is the maximum number of receptacles for this application

605.9(C) Receptacles at Office Furnishings

An individual office furnishing or groups of interconnected individual office furnishings shall not contain more than (13) 15-ampere, 125-volt receptacles

For purposes of this requirement, a receptacle is considered:

(1) Up to two (simplex) receptacles provided within a single enclosure and that are within 0.3 m (1 ft) of each other or...

(2) One duplex receptacle

610.42(B)(3) Brake Coil Taps Deleted - Cranes and Hoists

- **Brake coil taps** for cranes or hoists **without separate overcurrent protection** has been **deleted**
- Break coils are passive devices designed to resist changes in current and store energy in the form of a magnetic field
- Taps to brake coils should follow the same tap rules as every other installation
- With the advent of variable frequency drives and other electronic controls, there is typically a **longer conductor run** between the control cabinet and the brake coil on most newly-installed cranes or hoist
- Risk of fire and more severe damage for new applications goes **beyond the original intent** of the previous *Code* language and warrants elimination of this brake coil provision

620.16 SCCR at Elevator Control Panels

- Elevator control panels required to be marked with its **short-circuit current rating (SCCR)** and shall not be installed where the available short-circuit current exceeds its short-circuit current rating
- Elevator control panels being misapplied in a large number of applications due to an inadequate SCCR for the equipment
- Elevator control panels are often installed without being marked with SCCR
- SCCR determined by its listing process or by an “approved method”
- UL 508A-2013 (Standard for Industrial Control Panels), Supplement SB, is an example of an approved method

620.16 SCCR at Elevator Control Panels

Elevator control panels required to be marked with its short-circuit current rating and shall not be installed where the available short-circuit current exceeds its short-circuit current rating

Short-circuit current rating to be based on listing of assembly or established utilizing an approved method *(such as UL 508A)*

Article 625
Electric Vehicle Charging System

- Article 625 was **reorganized** and **reformatted** with provisions for wireless power transfer equipment being incorporated into the article
- Article 625 has experienced extensive growth and change over the past twenty years since its inception
- Revisions include deletion of requirements pertaining to polarization and noninterchangeability of EV couplers as this is a construction feature evaluated as part of product standard
- New provision added at 625.40 calling for each outlet installed for the purpose of charging electric vehicles to be supplied by an individual branch circuit with no other outlets *(relocation from previous 210.17)*

Article 625
Electric Vehicle Charging System *(cont.)*

- Equipment connection rules were added and/or revised to facilitate provisions for a parallel construction format for portable, stationary, and fixed equipment *(see 625.44)*

- New Part IV titled, "**Wireless Power Transfer Equipment**" was added as well as two new definitions, "**Wireless Power Transfer (WPT)**" and "**Wireless Power Transfer Equipment (WPTE)**" added at 625.2

- See details concerning wireless power transfer equipment at specific changes for Part IV of Article 625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ELECTRIC VEHICLE

625.2 Definitions –
Electric Vehicle Charging Systems

- Two new definitions added:
  - **Wireless Power Transfer (WPT)**
  - **Wireless Power Transfer Equipment (WPTE)**
- New definitions support the new requirements added at **Part IV of Article 625** titled, "Wireless Power Transfer Equipment"
- These definitions derived from terminology as set forth in a **Society of Automotive Engineers (SAE)** standard, **SAE J2954**
- Wireless EV charging offers the advantage of **seamless charging** without having to physically connect the EV to the electrical grid for ease of customer use

625.2 Definitions - EV Charging Systems

Wireless Power Transfer (WPT). The transfer of electrical energy from a power source to an electrical load via electric and magnetic fields or waves by a contactless inductive means between a primary and a secondary device.

Wireless Power Transfer Equipment (WPTE). Equipment consisting of a charger power converter and a primary pad. The two devices are either separate units or contained within one enclosure.

625.10 Electric Vehicle Coupler

- Provisions for **polarization and noninterchangeability** of electric vehicle couplers were **deleted**
- **Design issue** addressed by the listing of the product
- **Electric Vehicle Coupler.** A mating electric vehicle inlet and electric vehicle connector set.
- Noninterchangeability of EV couplers is likewise associated with a given configuration and evaluated as part of the requirements of UL 2251 *(Standard for Safety of Plugs, Receptacles and Couplers for Electric Vehicles)*
- Feature associated with a given configuration and does not lend itself to easy verification or practical enforcement


VOLT


POWER
ERROR
TEST
RESET

Article 625, Part IV - EV Charging System Wireless Power Transfer Equipment

- A new Part IV of Article 625 titled, "**Wireless Power Transfer Equipment**" was added as well as two new definitions, "Wireless Power Transfer (WPT)" and "Wireless Power Transfer Equipment (WPTE)" added at 625.2
- Wireless EV charging creates a connection between a **transmitting pad** on ground level *(such as a garage floor)* and a **receiving pad** integrated on the bottom of the electric vehicle
- New Part IV of Article 625 consist of two sections:
  - **625.101** - requirements for grounding of the non-ferrous metal primary pad base plate *(or listed double-insulation system)*
  - **625.102** - construction requirements

Photo courtesy of Oak Ridge National Laboratory

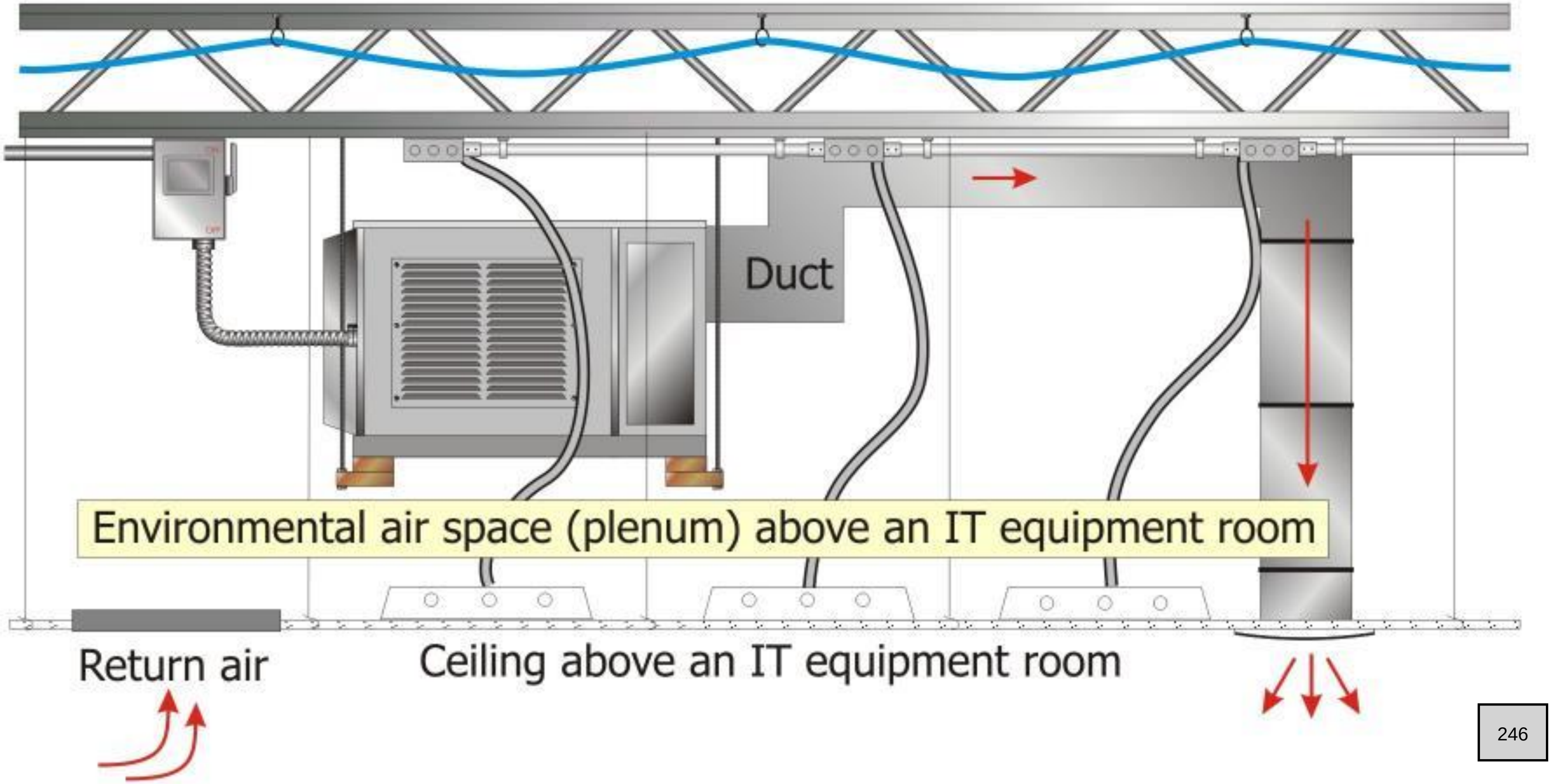
645.3(B) Other Articles (Plenums) – Information Technology (IT) Equipment

- Information pertaining to "Other Articles" and sections applying to wiring and cabling in plenums above an IT equipment room has been reformatted into a **list format** with appropriate titles added at each *Code* reference
- Title changed from "Plenums" to "**Wiring and Cabling in Other Spaces Used for Environmental Air (Plenums)**"
- Correlates with other *Code* language such as **300.22(C)**
- List format improves usability and readability detailing other articles and sections that can be applied to wiring and cabling in plenums above an IT equipment room

645.3(B) Other Articles (Plenums)

Other article and section references applying to wiring and cabling in plenums above an IT equipment rooms has been reformatted into a list format with appropriate titles added at each *Code* reference

The title was changed from "Plenums" to "Wiring and Cabling in Other Spaces Used for Environmental Air (Plenums)"

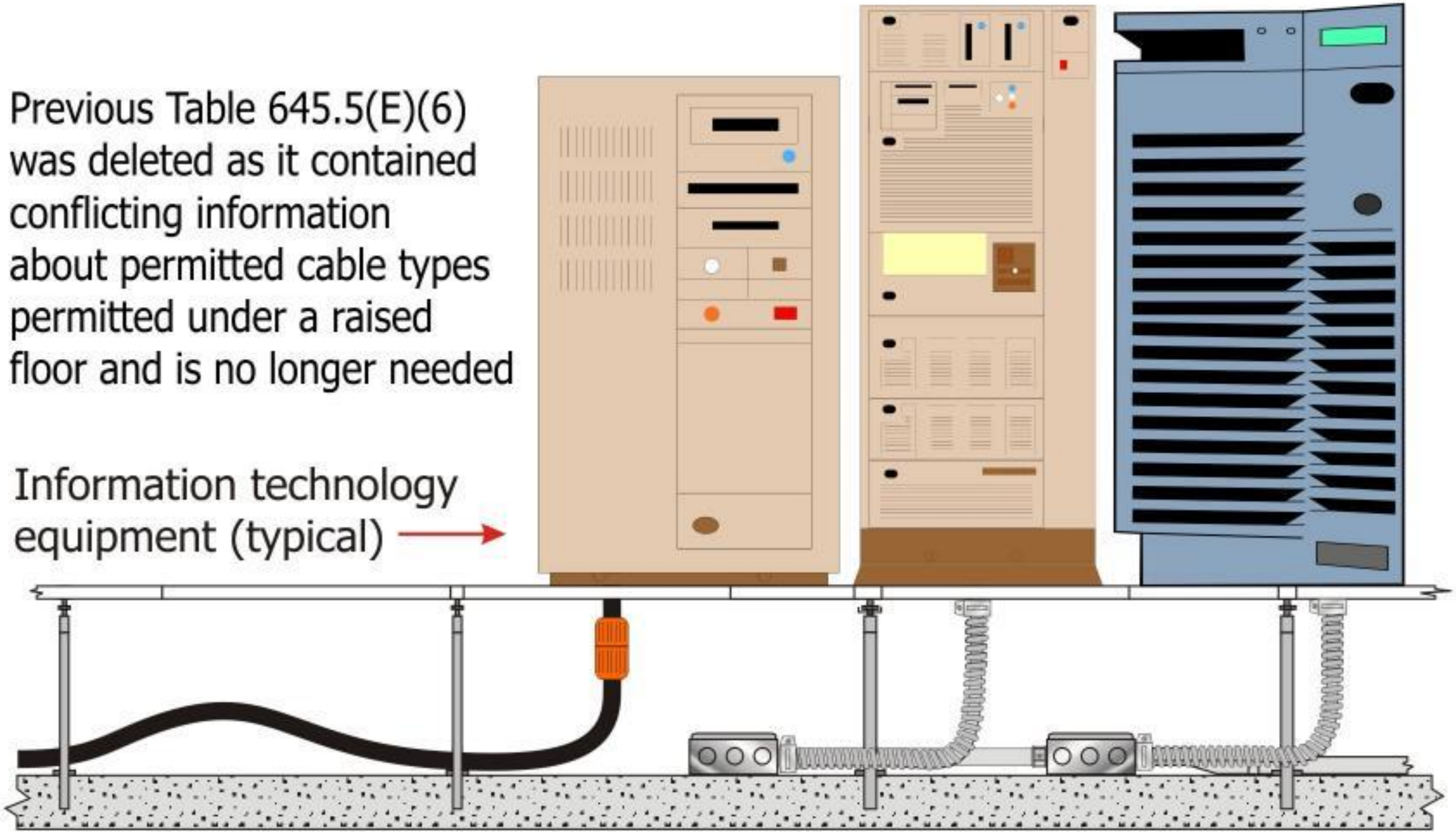


645.5(E) Wiring Under Raised Floors – IT Equipment Rooms

- Requirements for installing wiring methods and cables under a raised floor in an IT equipment room **revised for clarity**
- List format was incorporated for usability
- Previous **Table 645.5(E)(6)** was **deleted** *(no longer needed)*
- New revised text organizes conditions for using the underfloor area for wiring from an **installation requirements standpoint**
  - **645.5(E)(1)** Branch circuit wiring
  - **645.5(E)(2)** Data, cords, interconnection cables and grounding conductors
  - **645.5(E)(3)** Optical fiber cabling

645.5(E) Wiring Under Raised Floors (ITE Rooms)

Requirements for installing wiring methods and cables under a raised floor in an IT equipment room have been revised into a list format for clarity



Previous Table 645.5(E)(6) was deleted as it contained conflicting information about permitted cable types permitted under a raised floor and is no longer needed

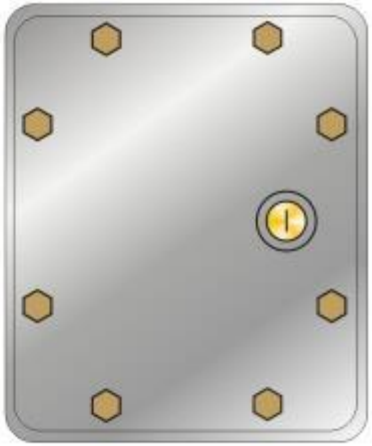
Information technology equipment (typical)

645.18 Surge Protection for Critical Operations Data Systems (IT Equipment)

- New requirement added for **surge protection** for critical operations data systems
- **Critical Operations Data System.** An information technology equipment system that requires continuous operation for reasons of public safety, emergency management, national security, or business continuity.
- **Surge arresters** and **surge-protective devices (SPD)** are typically the devices installed to achieve the desired surge protection and ensure reliable electrical power
- New surge protection requirement in Article 645 correlates with **708.20(D)**

645.18 Surge Protection for Critical Operations Data Systems

Surge protection is now required to be provided for critical operations data systems



Surge arresters

Surge protective devices (SPD)

Article 650 Pipe Organs

- Article 650 covering pipe organs was **revised for clarity**
- Revised by adding **650.2** for three definitions pertaining to Article 650:
  - Electronic Organ
  - Pipe Organ
  - Sounding Apparatus
- New **650.9** added pertaining to protection against accidental contact of the sounding apparatus
- Access to the interior of the sounding apparatus should be limited to qualified personnel

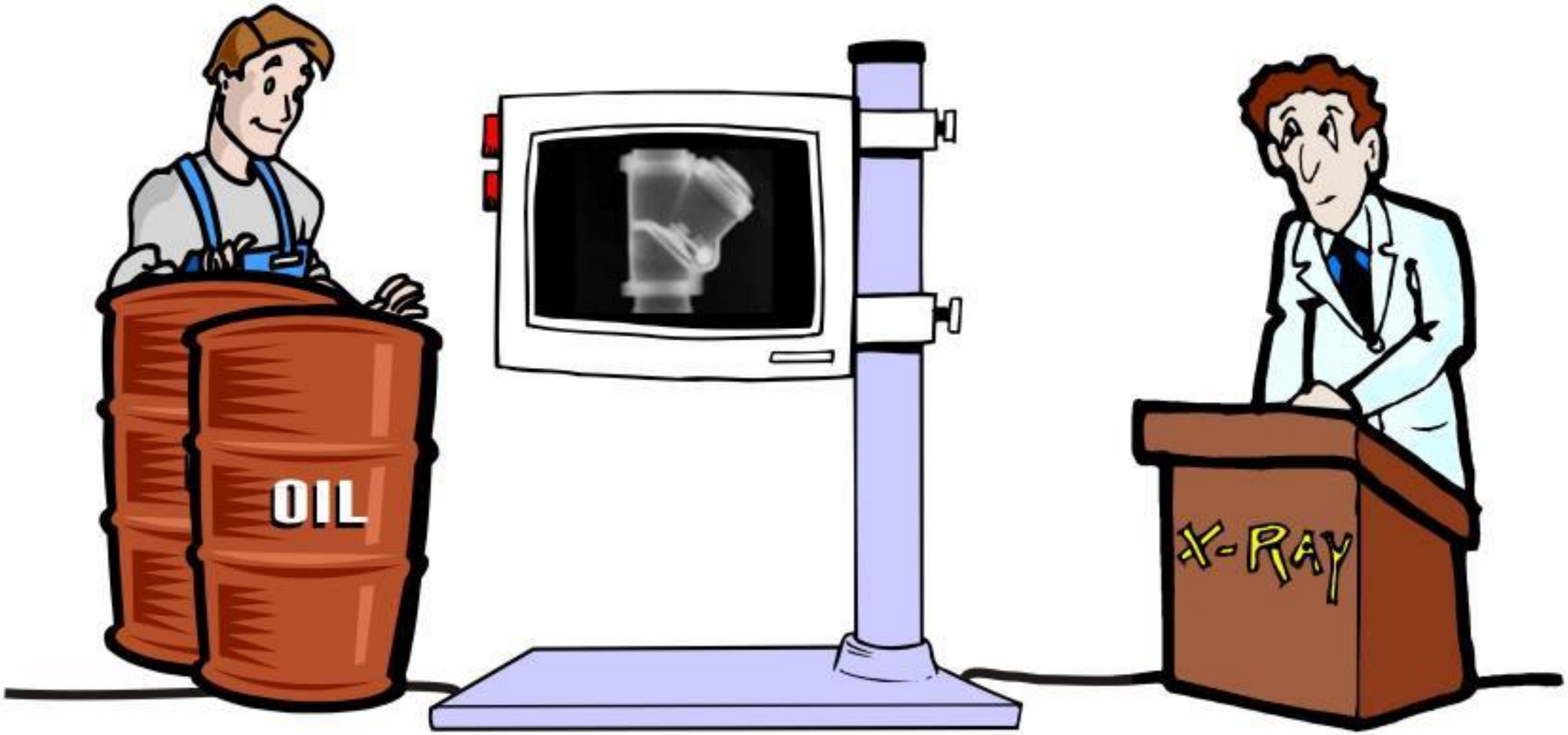

MERRY CHRISTMAS
MERRY CHRISTMAS

660.5 Disconnecting Means – Industrial X-Ray Equipment

- Disconnecting means for industrial-type X-ray equipment required to be located “**within sight**” of the X-ray controls and **readily accessible**
- Ensures proper location of the disconnecting means
- New exception added where disconnecting means would be **impracticable or introduces additional or increased hazards** to persons or property in industrial installations *(with written safety procedures)* where conditions of maintenance and supervision ensure that only qualified persons service the equipment

660.5 Disconnecting Means (X-Ray Equipment)

Disconnecting means for industrial-type X-ray equipment required to be located "within sight" of the X-ray controls and readily accessible



Previous language indicated that the disconnecting means could be placed anywhere (several rooms away) as long as the disconnecting means was "readily accessible" regardless of its location

670.6 Surge Protection for Industrial Machinery

- New requirement added for **surge protection** of industrial machinery with safety interlocking circuits
- Study titled, “Data Assessment for Electrical Surge Protective Devices” showed that **26 percent** of the responders had damage to safety interlocking systems on machines due to electrical surges
- Safety interlocking systems are in place to protect workers from serious injuries and death due to interactions with the machinery
- Protecting workers by protecting the industrial machinery safety interlocking systems from damage due to surges is a step forward in electrical safety

670.6 Surge Protection (Industrial Machinery)

Industrial machinery with safety interlock circuits is now required to have surge protection installed

Photo Courtesy of Eaton

680.2 and Part VIII, Article 680 – Electrically Powered Pool Lift

- New definition for "**Electrically Powered Pool Lift**" along with a new **Part VIII** titled, "**Electrically Powered Pool Lifts**" was added to Article 680
- These lifts allow persons with disabilities to have access to public swimming pools, spas, and hot tubs
- Required components at public aquatic facilities by the **Department of Justice and the Americans with Disabilities Act (ADA)**
- At least two **accessible means of entry** must be provided for each public use and common use swimming pool *(ADA, Section 15.8.2)*

680.2 Definitions - Electrically Powered Pool Lift

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

Art. 680 Part VIII-Electrically Powered Pool Lifts

680.80 General. Electrically powered pool lifts as defined in 680.2 shall comply with Part VIII of Article 680

680.81 Equipment Approval.

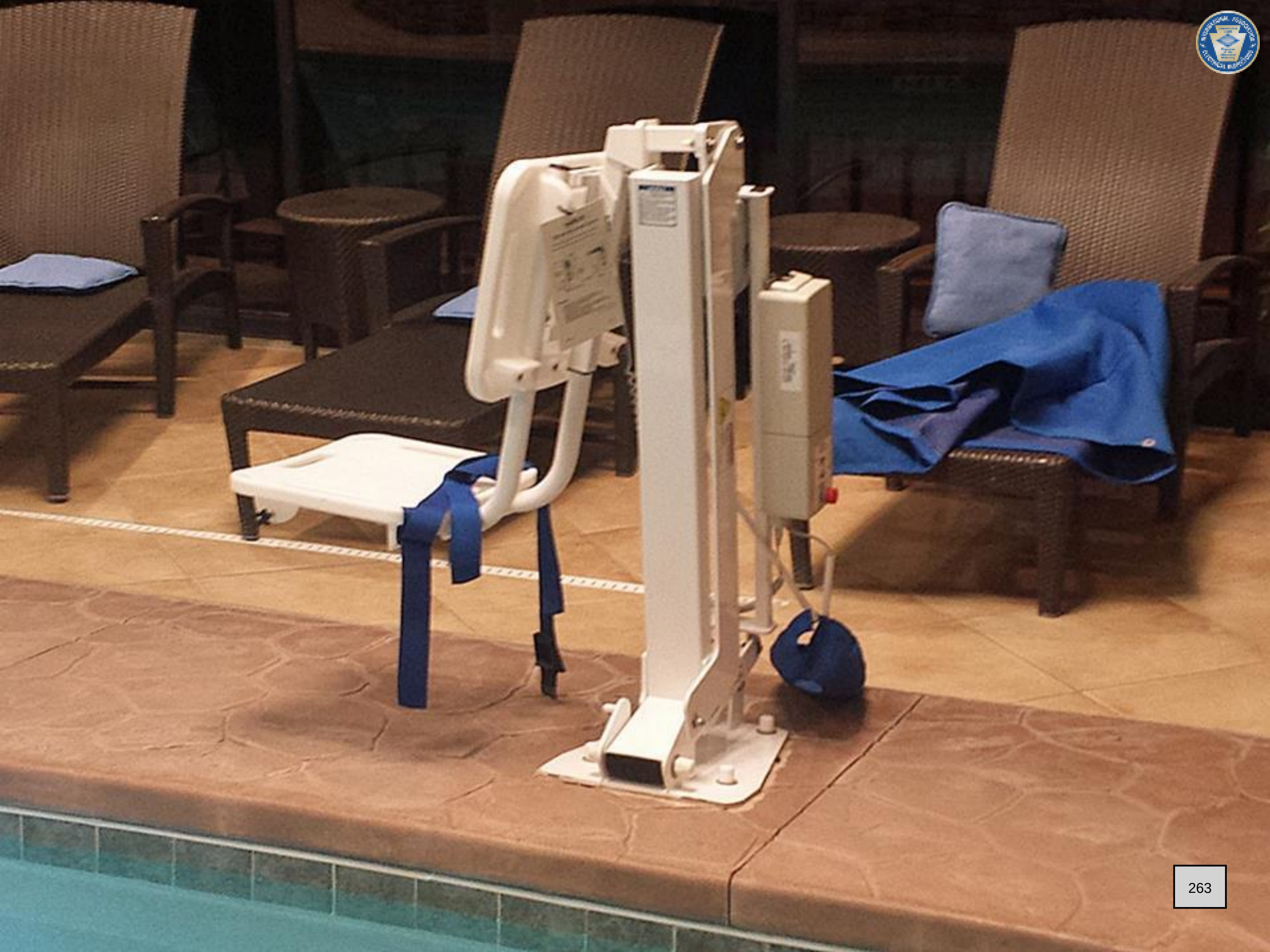
680.82 Protection. (GFCI)

680.83 Bonding.

680.84 Switching Devices.

680.85 Nameplate Marking.

New definition for "Electrically Powered Pool Lift" was added to 680.2 and a new Part VIII titled, "Electrically Powered Pool Lifts" was added to Article 680



680.2 Definitions: Storable Swimming, Wading, or Immersion Pools; or Storable/Portable Spas and Hot Tubs

- Definition clarified with adding the term "**constructed on or above the ground**" before storable/portable "nonmetallic, polymeric or inflatable tubs, spas, or pools regardless of the dimension"

- Clarifies that storable/portable pool, spa, or hot tub with nonmetallic, molded polymeric walls or inflatable fabric walls regardless of dimension is always installed "**on or above the ground**"

- Any pool "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.)" are considered to be a **permanently installed** swimming, wading, immersion, or therapeutic pool


Lay-Z-Spa
Vegas

680.7 Grounding and Bonding Terminals

- New requirements call for grounding and bonding terminals to be **identified for use** in **wet and corrosive environments** and **listed for direct burial** applications as well

- Grounding and bonding terminals at pools, spas, hot tubs, etc. are subjected to **severe environmental conditions** including wet and corrosive conditions

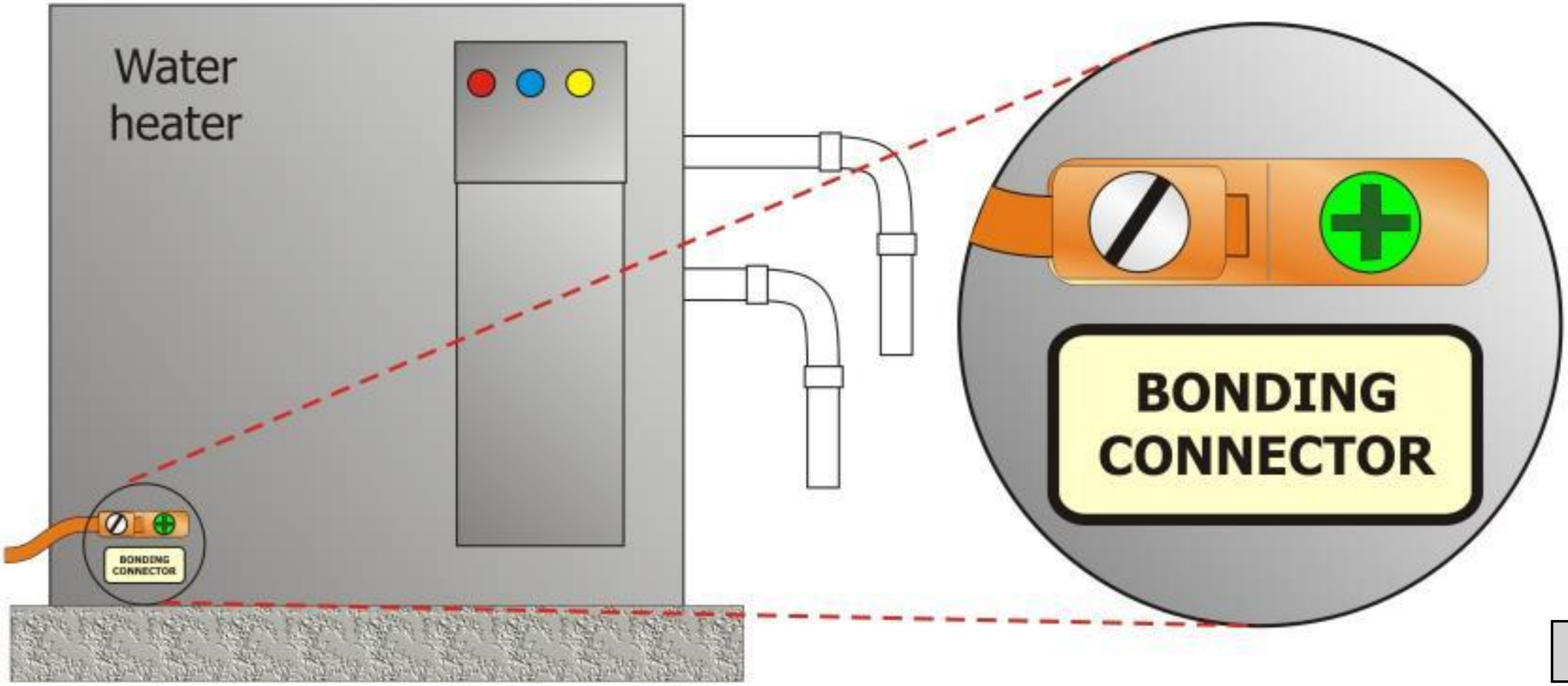
- Field-installed grounding and bonding connections installed in a damp, wet, or corrosive environment will need to be composed of **copper, copper alloy, or stainless steel**

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

Grounding and bonding terminals shall be listed for direct burial use




Bonding Connector.
Connecteur de Raccordement.
Conector de Enlace.
472277

BONDING CONNECTOR

Previous Table 680.10 *(Deleted)* Underground Wiring Burial Depths

- Previous 680.10 *(Underground Wiring Location)* moved to 680.11 and previous **Table 680.10 was deleted**
- The minimum burial depth cover requirements around pools will now be facilitated by **Table 300.5**
- Underground wiring now permitted to be installed in **close proximity** of the pool regardless of its location to the pool and no consideration needs to be given as to whether this wiring is "**necessary to supply pool equipment**" or not
- Revised text will allow service lateral or underground feeder to be routed **within 1.5 m (5 ft)** or close proximity to the pool even though this service or feeder is not "necessary to supply pool equipment"

Table 680.10 Minimum Cover Depths (Deleted)

Previous 680.10 (Underground Wiring Location) moved to 680.11 and previous Table 680.10 Minimum Cover Depths was deleted

Table 680.10 was "kicked out" of the *Code*

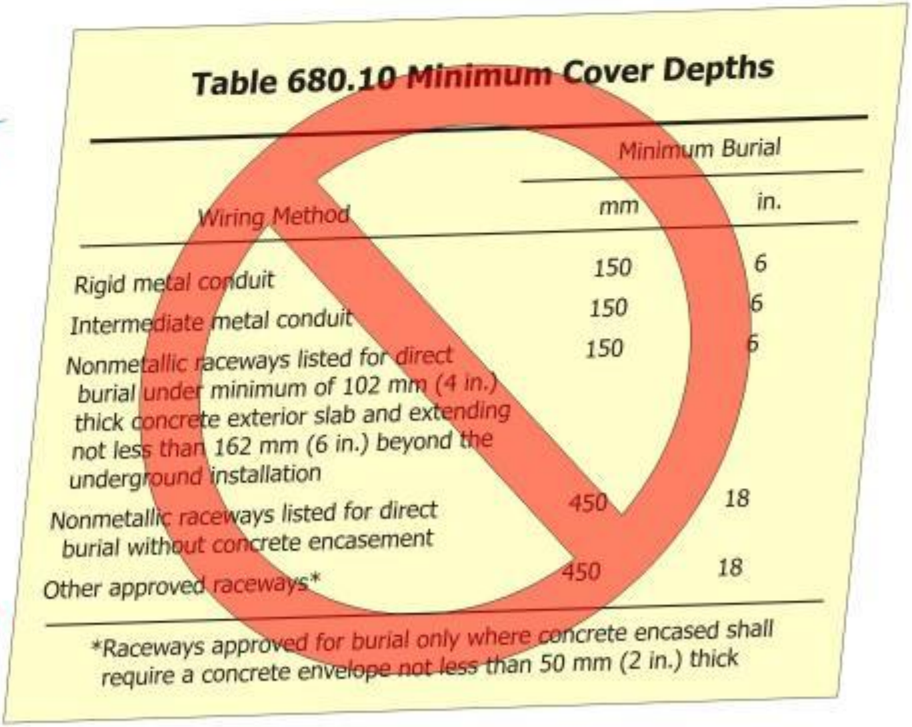


Table 680.10 Minimum Cover Depths

Wiring Method	Minimum Burial	
	mm	in.
Rigid metal conduit	150	6
Intermediate metal conduit	150	6
Nonmetallic raceways listed for direct burial under minimum of 102 mm (4 in.) thick concrete exterior slab and extending not less than 162 mm (6 in.) beyond the underground installation	150	6
Nonmetallic raceways listed for direct burial without concrete encasement	450	18
Other approved raceways*	450	18

*Raceways approved for burial only where concrete encased shall require a concrete envelope not less than 50 mm (2 in.) thick

Table 300.5 burial depth requirements will now apply around swimming pools, spas, hot tubs, fountains, and similar installations


GUNITE
TO
LINE

680.12 Equipment Rooms and Pits and 680.14 Corrosive Environments

- New requirement for **protection against a corrosive environment** for electrical equipment installed in equipment rooms and pits added at **680.12** and **680.14**
- Important to make sure that **proper drainage** is provided to prevent water accumulation at the electrical equipment during normal operation or maintenance
- Electrical equipment should not be installed in areas where the electrical equipment and metal components are going to be subject to a corrosive environment without proper corrosion protection being implemented

680.12 Equipment Rooms and Pits and 680.14 Corrosive Environments *(cont.)*

- Swimming pool and spa equipment is often subject to deteriorating chemicals, especially in rooms or pits
- New provisions added at **680.14** identify 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 as being considered to be a **corrosive environment**
- **Chlorine** and other pool chemicals severely deteriorate electrical connections of conductors, and accelerate rust and deterioration of metal parts of electrical equipment


OUTLET
INLET

Photo Courtesy of Dave Williams, Michigan

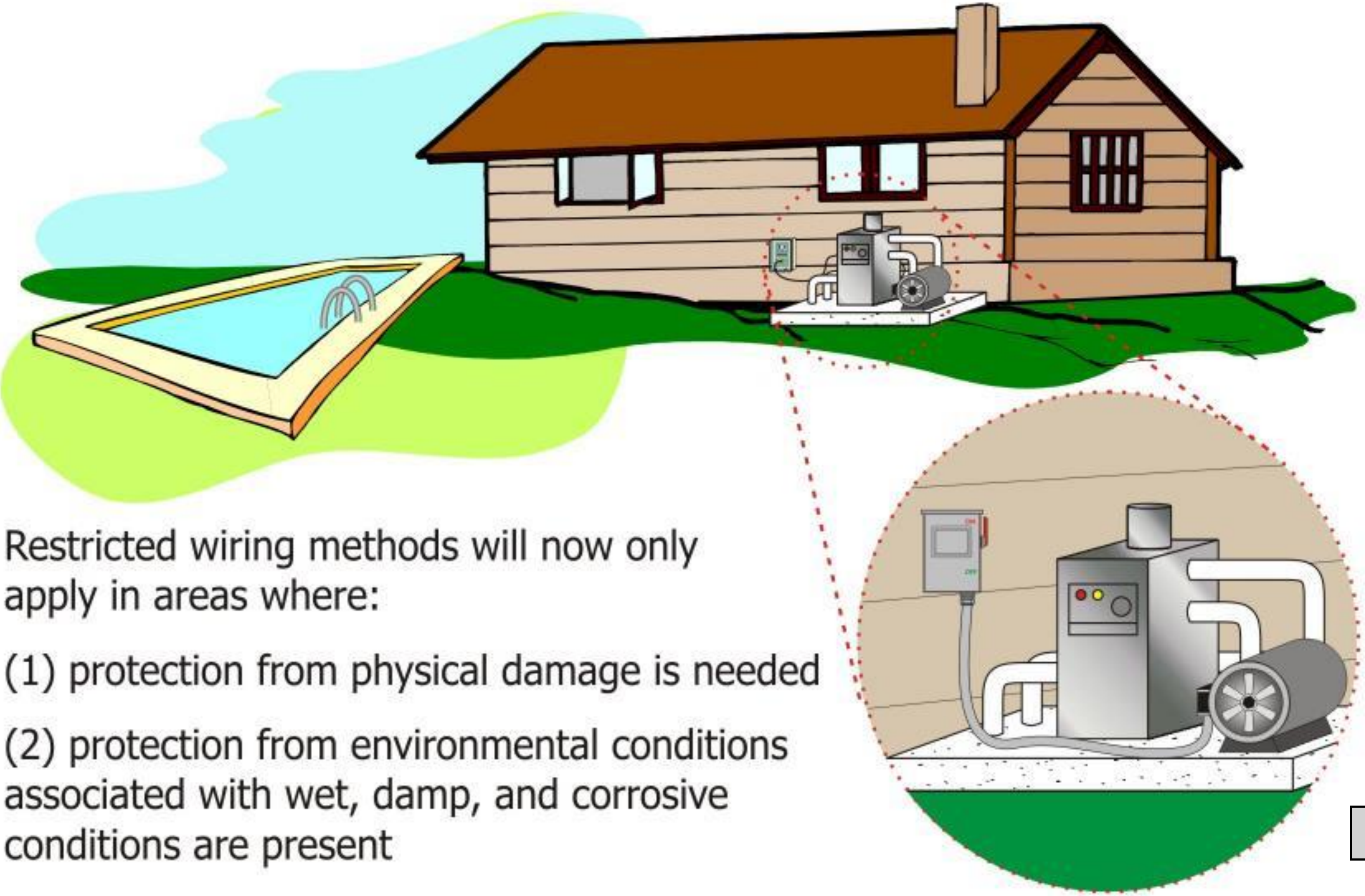
Photo Courtesy of Dave Williams, Michigan

680.21(A) Wiring Methods for Motors – Swimming Pools and Similar Installations

- Restricted wiring methods previously described at 680.21(A) will now only apply in areas where **protection from physical damage** is needed or where **protection from environmental conditions** associated with wet, damp, and corrosive conditions are present
- Where installed in **noncorrosive environments** *(such as in the interior of a dwelling unit)*, branch circuits wiring methods for permanently installed pool pump motors need only comply with requirements of the ***NEC* Chapter 3 wiring methods**
- Distinctions for noncorrosive environments no longer needed as new text added at 680.21(A)(1) now indicates that “where installed in noncorrosive environments, branch circuits shall comply with the general requirements in Chapter 3”

680.21(A) Wiring Methods (Motors)

Where installed in noncorrosive environments, branch circuits wiring methods for permanently installed swimming pool pump motors are to comply with the general requirements of *NEC* Chapter 3 wiring methods



Restricted wiring methods will now only apply in areas where:

(1) protection from physical damage is needed

(2) protection from environmental conditions associated with wet, damp, and corrosive conditions are present

680.22(A)(2) Location of Circulation and Sanitation System Receptacle

- Receptacles that supply power for pool pump motors or other loads directly related to the circulation and sanitation system can now be located not less than **1.83 m (6 ft)** from the inside walls of the pool with the receptacle(s) being of the grounding type and provided with GFCI protection
- Requirement for the pool pump motor receptacle outlet needing to consist of a **single receptacle configuration** was also **eliminated**
- Pool pump motor receptacle outlet need not be located 3.0 m (10 ft) for the inside walls of the pool or be a single receptacle configuration if convenience receptacle outlet can be located not less than 1.83 m (6 ft) from the inside walls of the pool and be of the duplex type configuration

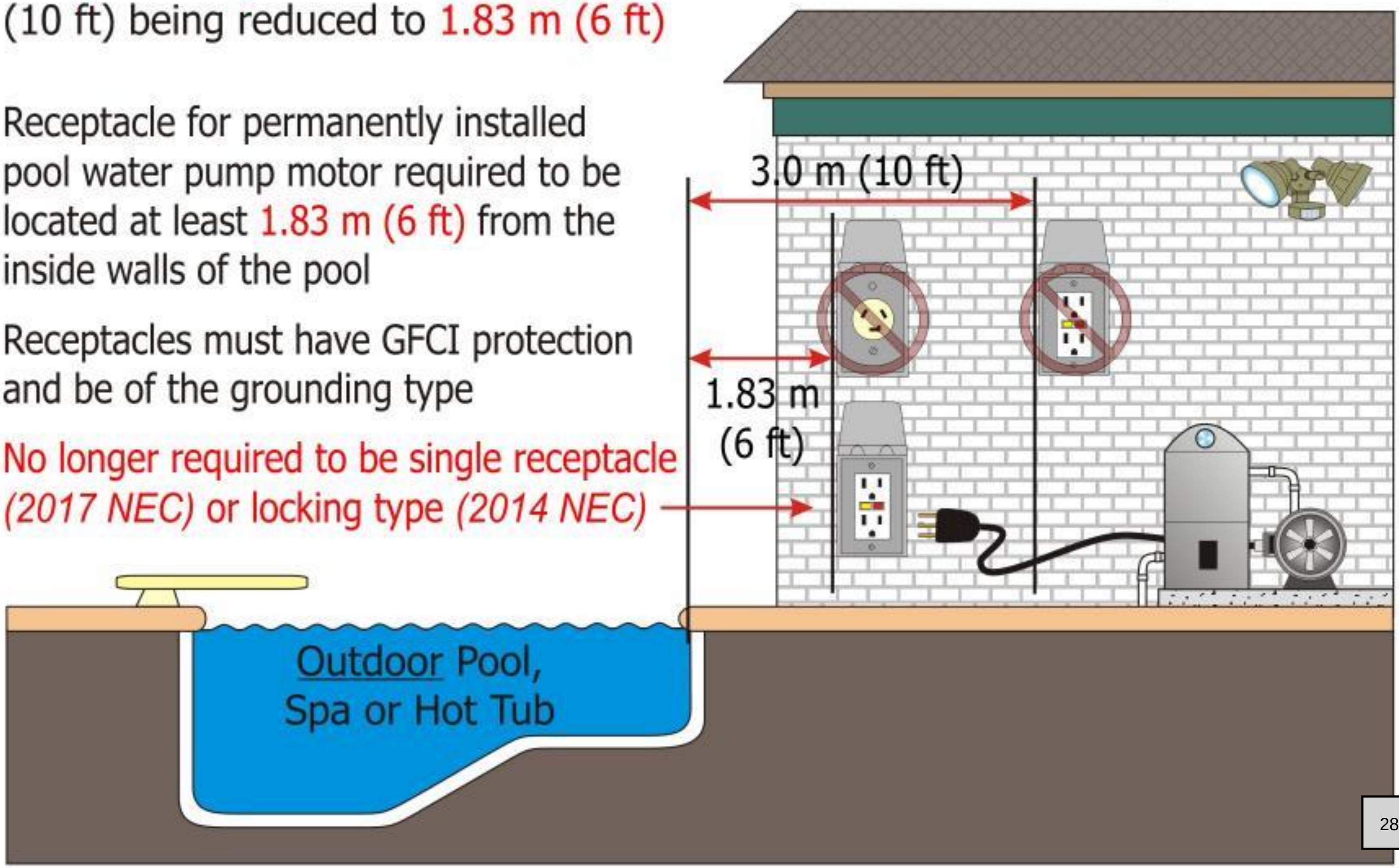
680.22(A)(2) Circulation and Sanitation Receptacle - Location

Requirements for the pool pump motor receptacle were revised with single receptacle requirement removed and minimum distance from the pool of 3.0 m (10 ft) being reduced to 1.83 m (6 ft)

Receptacle for permanently installed pool water pump motor required to be located at least 1.83 m (6 ft) from the inside walls of the pool

Receptacles must have GFCI protection and be of the grounding type

No longer required to be single receptacle *(2017 NEC)* or locking type *(2014 NEC)*



680.22(B)(7) Low-Voltage Gas-Fired Luminaires, Equipment, Etc.

- New provisions added to specifically address **low-voltage gas-fired luminaires, decorative fireplaces, fire pits, and similar equipment**
- With the inclusion of electronic ignitors for these devices, *NEC* regulations were need for this type of equipment
- New provisions for low-voltage gas fire equipment needed with the conversion of gas luminaire technology away from manual ignition and toward the use of low-voltage electronic ignitors

680.22(B)(7) Low-Voltage Gas-Fired Equipment

New requirements added for 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 ignitors 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 a permanently installed pool

680.25 Feeders – Swimming Pools, Fountains, and Similar Installations

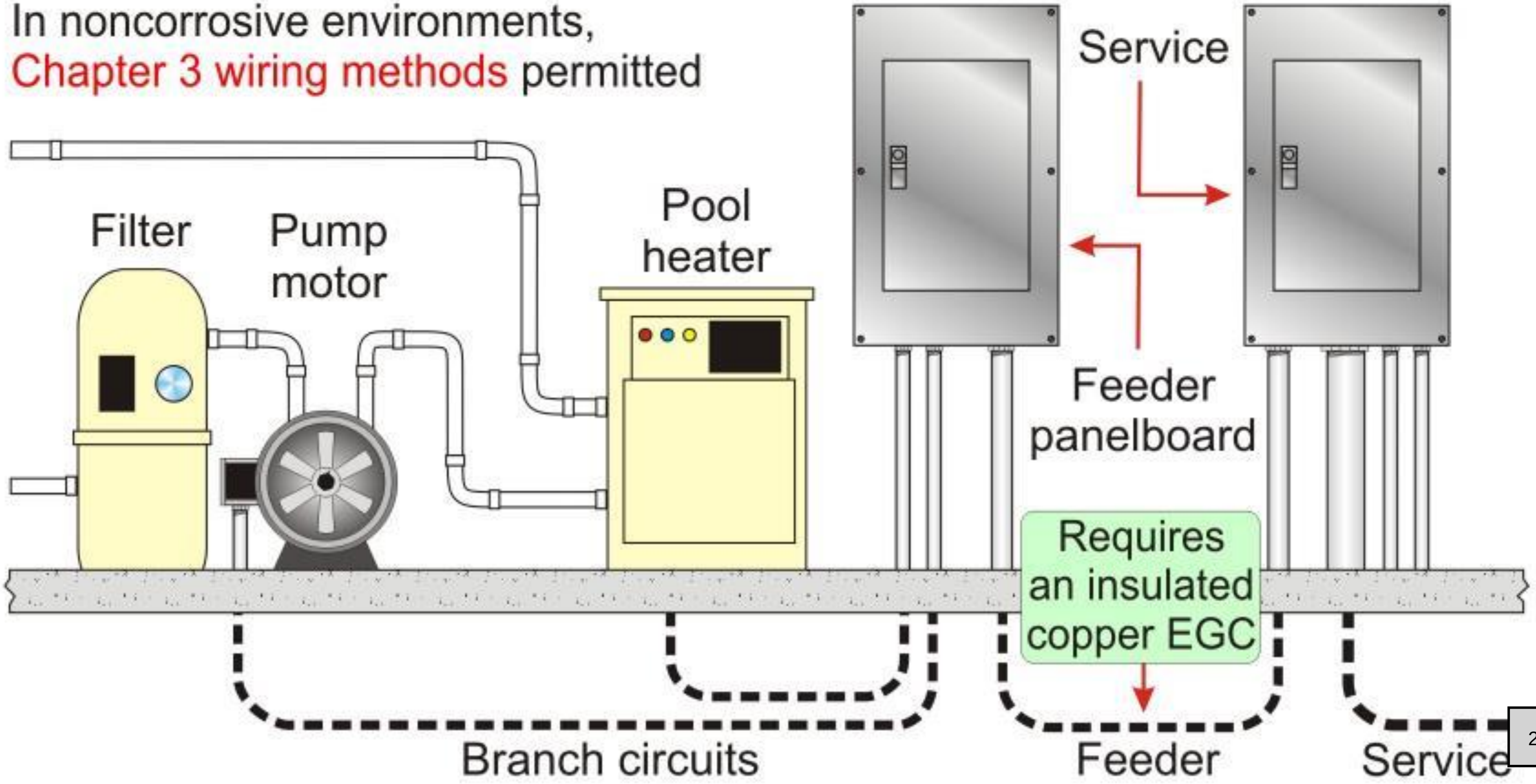
- Previous **680.25(B)** for grounding of swimming pool panelboard feeders was **deleted** in its entirety as grounding provisions for swimming pool panelboard feeders have been incorporated into the revised text at 680.25(A)
- Revised text at **680.25(A)** requires restricted wiring methods **only in areas where harsh conditions** *(physical damage, environmental conditions, corrosive conditions, etc.)* **are present**
- Chapter 3 wiring methods are now otherwise permitted
- Probation of aluminum conduit in the pool area where subject to corrosion was retained

680.25 Feeder to Swimming Pool Panelboard

Previous 680.25(B) for grounding of swimming pool panelboard feeders was deleted as grounding provisions for swimming pool panelboard feeders have been incorporated into the revised text at 680.25(A)

The revised text at 680.25(A) requires restricted wiring methods only in areas where harsh conditions *(physical damage, environmental conditions, corrosive conditions, etc.)* are present

In noncorrosive environments, Chapter 3 wiring methods permitted



680.27(B)(1), Ex. and 680.27(B)(2), Ex. Electrically Operated Pool Covers

- New exceptions added for pool cover motors that would allow motors that are rated to not exceed the low-voltage contact limit to be installed **less than 1.5 m (5 ft)** from the inside walls of the pool and **omit GFCI protection**
- Parent text of 680.27(B)(1) and (B)(2) deals with electrically operated pool cover motors running at nominal voltage
- New designs in pool cover motors are becoming available that are powered by swimming pool transformers and operate at **voltages not exceeding the low-voltage contact limit**
- Added exceptions fashioned from existing text for low-voltage underwater luminaires not requiring grounding at 680.22(B)(6).

680.28 Gas-Fired Water Heater – Swimming Pools, Fountains, and Similar Installations

- New provisions added requiring branch circuits serving **gas-fired swimming pool and spa water heaters** operating at voltages **above the low-voltage contact limit** to be provided with GFCI protection for personnel
- GFCI protection not required for electric water heaters with proper grounding provisions *[see 680.6(3)]* and the listing installation requirement for the use of "**current collectors**"
- Current collectors are not present with a gas-fired swimming pool heater
- 125-volt branch circuit to a gas-fired water heater is susceptible to loss of current and ground-fault condition as much as any other piece of electrical equipment


Pentair Pool Products
MasterTemp 400
Pentair Pool Products
78
SERVICE HEATER
SERVICE SYSTEM
HEATING
SPA ON
POOL ON
HEATER OFF

680.74

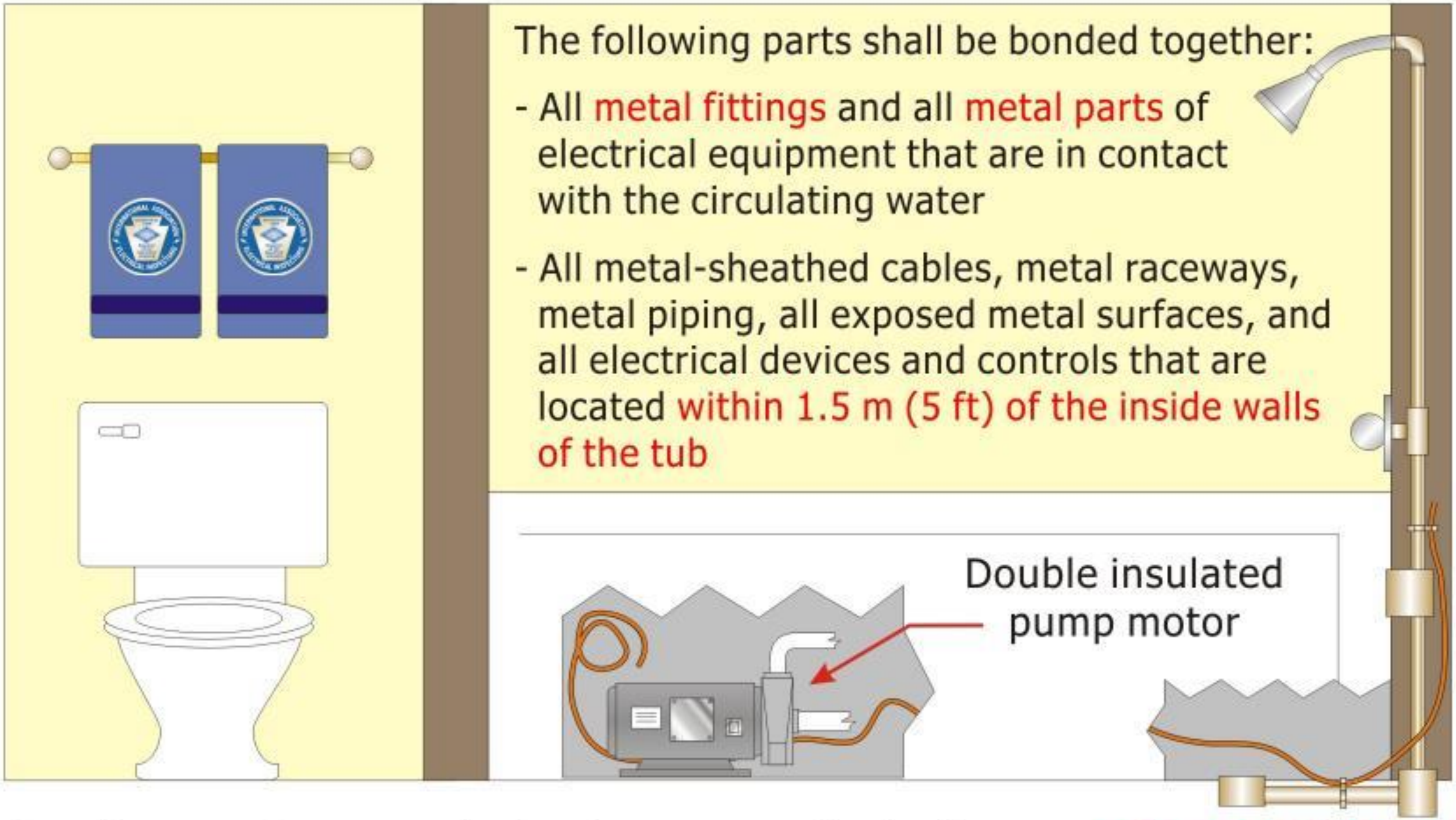
Bonding of Hydromassage Bathtubs

- Bonding requirements for hydromassage bathtubs was reformatted into a **list format**
- New exception added to exempt bonding of "**small conductive surfaces**"
- A list of metallic items located "**within 1.5 m (5 ft) of the inside walls of the tub**" were added to the required items required to be bonded:
  - All metal-sheathed cables, metal raceways, metal piping, and all exposed metal surfaces
  - All electrical devices and controls that are not associated with the hydromassage tub

680.74
Bonding of Hydromassage Bathtubs *(cont.)*

- Besides the metal parts of electrical equipment associated with the tub water circulating system, **all metal fittings within or attached to the tub structure** that are in contact with the circulating water are now required to be bonded together
- New exception added to exempt "**small conductive surfaces not likely to become energized**" from hydromassage bathtub bonding requirements:
  - Isolated air and water jets, supply valve assemblies, and drain fittings not connected to metallic piping
  - Towel bars, mirror frames, and similar nonelectrical equipment not connected to metal framing
- This "small conductive surfaces" exception is very similar to the "exception" in the parent text of 680.26(B)(5)

680.74 Hydromassage Bathtub - Bonding



The following parts shall be bonded together:

- All metal fittings and all metal parts of electrical equipment that are in contact with the circulating water
- All metal-sheathed cables, metal raceways, metal piping, all exposed metal surfaces, and all electrical devices and controls that are located within 1.5 m (5 ft) of the inside walls of the tub

Bonding requirements for hydromassage bathtubs was reformatted into a list format

New exception was added to exempt "small conductive surfaces not likely to become energized" from hydromassage bathtub bonding requirements

682.15 GFCI Protection at Natural and Artificially Made Bodies of Water

- GFCI protection for personnel will now be required for **all** 15- and 20-ampere single-phase, 125-volt through 250-volt receptacles installed outdoors and in or on floating buildings or structures within the electrical datum plane area

- Previous GFCI requirements applied only to those receptacles in areas where used for “storage, maintenance, or repair where portable electric hand tools, electrical diagnostic equipment, or portable lighting equipment” were to be used

- Eliminate the debate in these areas concerning the use of **portable tools, portable lighting and the like** being used or not

690.2 Definitions:
Functional Grounded PV System

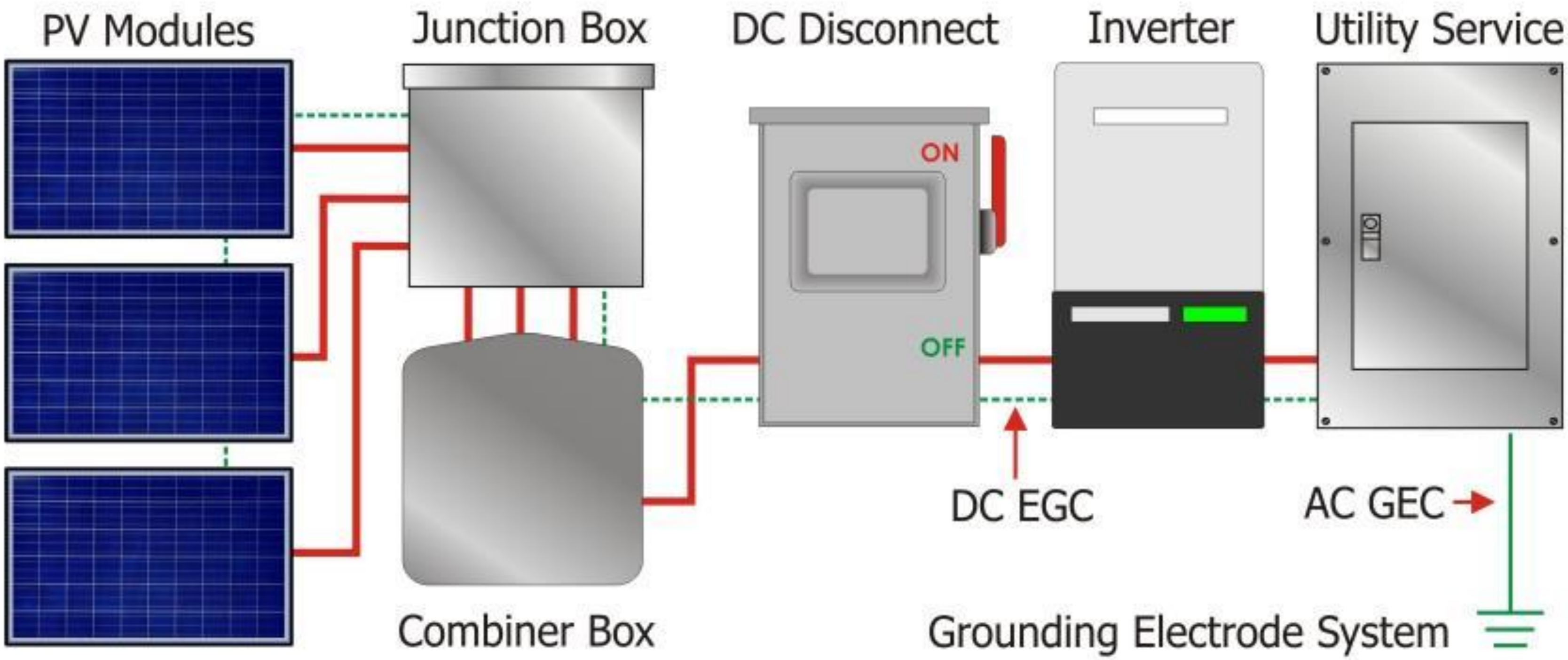
- A new definition for “**Functional Grounded PV System**” was added at 690.2 *(see definition on additional slide)*
- Term used in six different locations throughout Article 690
- New definition needed to clear up confusion over the use of the terms “**functional grounded PV systems**,” “**reference grounded PV systems**” and “**solidly grounded systems**”
- Most PV systems are not solidly grounded; however, the installation requirements are written as if they are
- By clearly delineating “functional grounded PV systems” from solidly-grounded PV systems, the safety requirements for installation become much clearer

690.2 Definitions: Functional Grounded PV System *(cont.)*

- In system grounding, one of the ungrounded circuit *(current-carrying)* conductors is bonded *(connected)* to the equipment grounding system and also to earth *(referred to as reference or* ***functional grounding*** *in most cases)*
- Ungrounded conductor connected to the EGC system and to earth is known as the "**grounded conductor**"
- Connection between the grounded conductor and the EGC system is known as the **system bonding jumper**
- With a non-isolated inverter, the lack of isolation to the grounded ac service conductors requires that the dc PV array be ungrounded for the inverter to work
- While operating, the dc PV array actually becomes referenced to ground through the ac output conductors

690.2 Definition: Functional Grounded PV System

Functional Grounded PV System. A PV system that has an electrical reference to ground that is not solidly grounded.



Informational Note: A functional grounded PV system is often connected to ground through a fuse, circuit breaker, resistance device, non-isolated grounded ac circuit, or electronic means that is part of a listed ground-fault protection system. Conductors in these systems that are normally at ground potential may have voltage to ground during fault conditions.

690.7 Maximum Voltage – Solar Photovoltaic (PV) Systems

- Maximum voltage requirements for PV systems revised for clarity
- Revised 690.7 has only three first level subdivisions now:
  - (A) Photovoltaic Source and Output Circuits
    - *[Previous (A) Maximum Photovoltaic System Voltage and (C) Photovoltaic Source and Output Circuits combined together into one first level subdivision]*
  - (B) DC-To-DC Converter Source and Output Circuits
  - (C) Bipolar Source and Output Circuits
- Provides for a more logical order

690.7 Maximum Voltage – Solar Photovoltaic (PV) Systems *(cont.)*

- Revised requirements of 690.7(A) simplifies the language related to the three methods used to calculate maximum voltage
- New recognized method of determining the maximum voltage for larger PV systems is addressed at 690.7(A)(3) for PV systems of 100 kW or larger
- This method permits a documented and stamped PV system design, using an "**industry standard method**" and provided by a licensed professional electrical engineer for PV systems with a generating capacity of **100 kW or greater**
- Example of "industry standard method" would be SAND 2004-3535, Photovoltaic Array Performance Model published by Sandia National Laboratories

690.7 Maximum Voltage – Solar Photovoltaic (PV) Systems *(cont.)*

- Previous 690.7(B) *(Direct-Current Utilization Circuits)* removed as it referred to the output of PV modules which is not applicable for the output of dc-to-dc converters and these loads that are not under the scope of Article 690
- Previous 690.7(D) *(Circuits over 150 Volts to Ground)* removed as it dealt more with the wiring method
- Previous 690.7(E) (Bipolar Source and Output Circuits) relocated to 690.7(C) and revised to recognize the newly defined functional grounded PV systems
- Removing the solidly grounded system requirements at 690.7(C) addresses the safety issues that a solidly grounded array system present


NEGATI
POSITIVE

690.8(A)(1)
PV Source Circuit Currents

- Second option added for calculating the maximum current for a PV source circuit using an industry standard method provided by a **licensed professional electrical engineer**
- This is in addition to the **125 percent method** permitted by previous editions of the *Code*
- Engineering method would only apply to PV systems with a generating capacity of **100 kW or greater**
- An engineer qualified to design PV systems is capable of making the necessary calculations to develop accurate maximum circuit currents of PV source circuits based on the specifics of an installation location

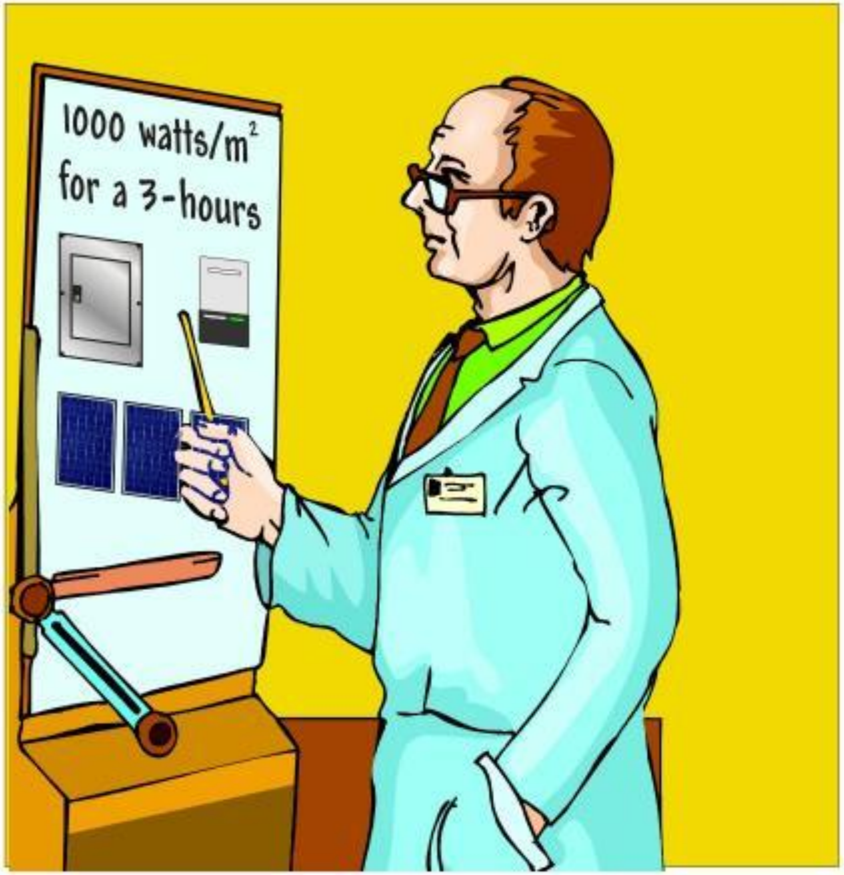
690.8(A)(1)
PV Source Circuit Currents *(cont.)*

- **125 percent calculation method** is **extremely conservative** and based on PV systems without ground-fault protection and capable of operating in short circuit conditions indefinitely
- 125 percent calculation method is fine for small systems as a simple calculation but engineering supervision should be allowed for larger PV systems to use more accurate, less conservative calculations
- Computer software is readily available to engineers that can calculate the actual current generated on PV source circuits based on all the design parameters of a given location
- Added engineering supervision option allows for engineers to calculate the maximum current and apply that current to sizing of PV source circuit conductors

690.8(A)(1) PV Source Circuit Currents

In addition to the 125 percent method permitted by 690.8(A)(1)(1), a second option was added for calculating the maximum current for a PV source circuit using an industry standard method provided by a licensed professional electrical engineer *[690.8(A)(1)(2)]*

Cannot be less than 70 percent of the value calculated using the 125 percent method



Applies to PV systems with a generating capacity of 100 kW or greater

690.11, Exception Arc-Fault Circuit Protection (dc) for PV Systems

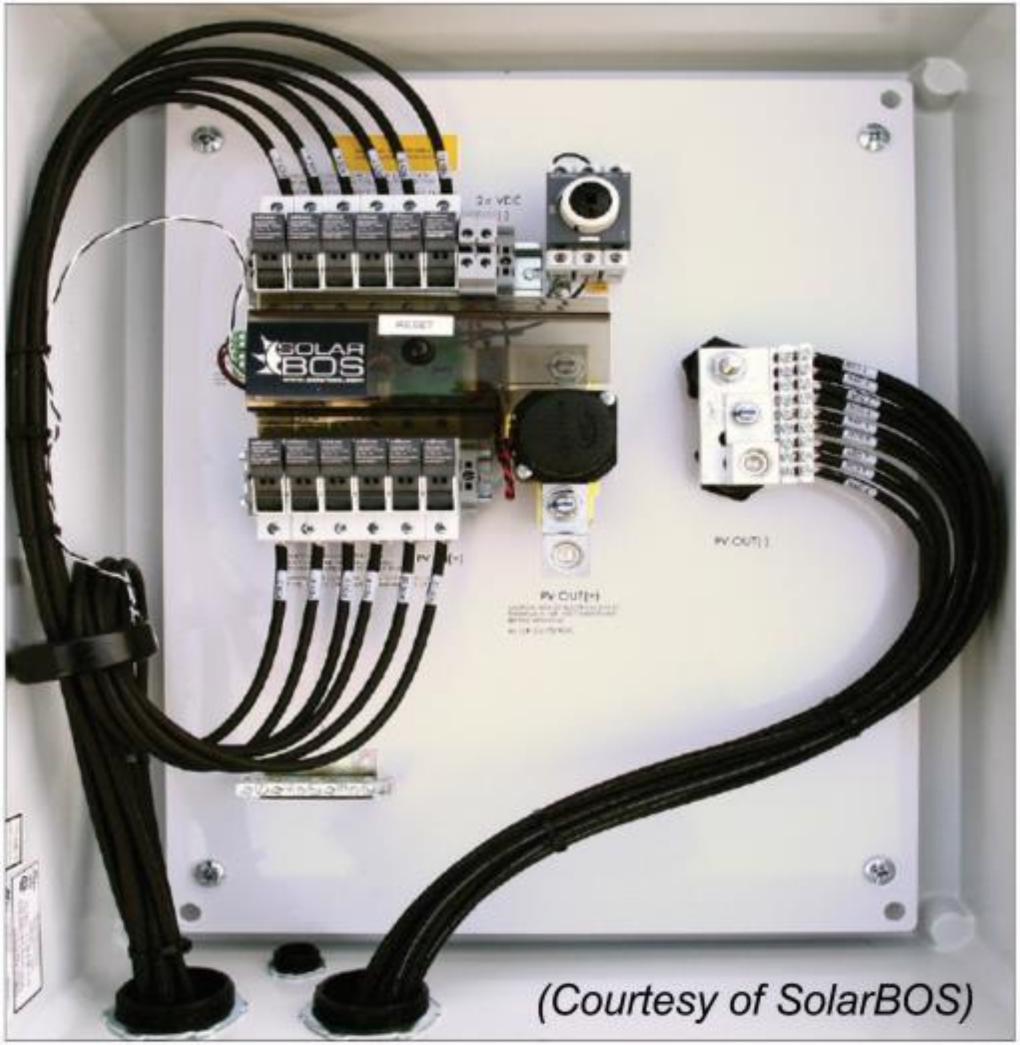
- New exception added for PV systems allowing **PV AFCI protection to be omitted** for PV output circuits and dc-to-dc converter output circuits **not installed on or in buildings** that are direct buried, installed in metallic raceways, or installed in enclosed metallic cable trays
- PV source circuits commonly installed in free air, exposed to environmental hazards and physical damage at the array structure deserve PV AFCI protection
- New exception **does not apply** to PV output circuits and dc-to-dc converter output circuits **installed on or in buildings** such as rooftop-mounted PV systems as these systems are deserving of PV AFCI protection

690.11, Exception Arc-Fault Circuit Protection (dc) for PV Systems *(cont.)*

- Terms “dc source circuits” and “dc output circuits” replaced by “PV system dc circuits,” which includes PV source circuits, dc-dc converter source circuits, PV output circuits, and dc-dc converter output circuits
- Previous language implied that the required PV AFCI protection only applied to PV source and output circuits
- Revision ensures that all dc-dc converter circuits are arc-fault protected

690.11 PV (dc) Arc-Fault Protection

PV AFCI protection requirements and 690.11 received extensive revision and a new exception was added



(Courtesy of SolarBOS)

New exception added for PV systems allowing PV output circuits and dc-to-dc converter output circuits *(not installed on or in buildings)* that are direct buried, installed in metallic raceways, or installed in enclosed metallic cable trays to omit PV AFCI protection

AFCI Combiner, 600 Volt (dc), 12 input circuits with NEMA-4X fiberglass enclosure

690.12 Rapid Shutdown of PV Systems on Buildings

- The requirements for "**Rapid Shutdown**" for PV systems have been revised and divided into four sub-sections
- Revision emphases that the primary existence of the rapid shutdown requirements is to **reduced shock hazard for emergency responders** *(not intended to provide electrical isolation for electrical worker safety as addressed by NFPA 70E and disconnecting means requirements in Part III of Article 690)*
- Revision answers questions regarding the functionality of the PV rapid shutdown device itself
- Controlled rapid shutdown conductors outside the "**array boundary**" must comply with new 690.12(B)(1) *[**305 mm (1 ft)** from the array in all directions]*

690.12 Rapid Shutdown of PV Systems on Buildings *(cont.)*

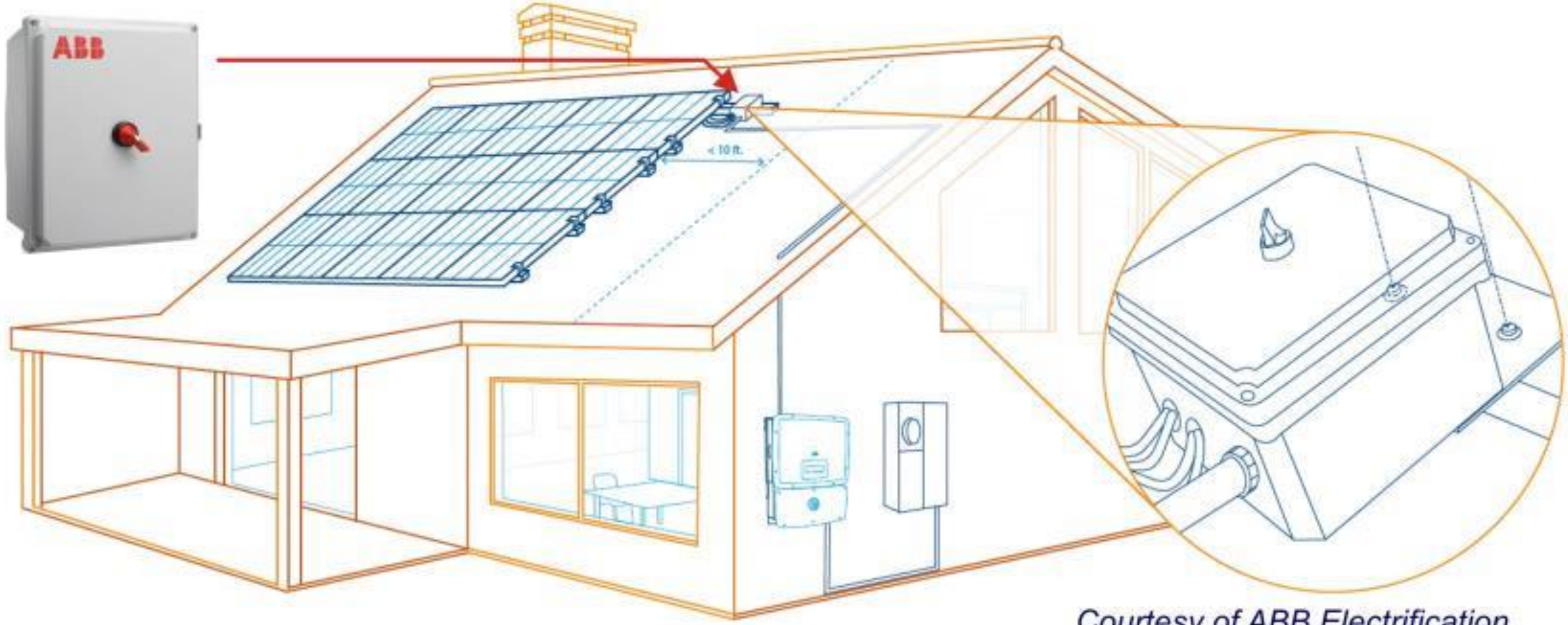
- Controlled conductors located outside the array boundary to be limited to not more than **30 volts** within **30 seconds** of rapid shutdown initiation *(was 10 second initiation in the 2014 NEC)*

- Controlled rapid shutdown conductors located inside the array boundary or not more than 1 m (3 ft) from the point of penetration of the surface of the building are limited to not more than **80 volts** within **30 seconds** of rapid shutdown initiation *(future effective date of January 1, 2019)*

- Rapid shutdown initiator device to be located on the **outside** of the building for **one- and two-family dwellings**

690.12 Rapid Shutdown of PV Systems

The rapid shutdown requirements for PV systems has been revised to emphases the primary existence of the rapid shutdown requirements is to reduced shock hazard for emergency responders and to answer questions regarding the functionality of the PV rapid shutdown device itself



Courtesy of ABB Electrification Products Division (Thomas & Betts)

The structure of 690.12 is now divided into four separate sub-sections titled, 690.12(A) Controlled Conductors, (B) Controlled Limits, (C) Initiation Device, and (D) Equipment

690.13
PV System Disconnecting Means

- New **interrupting rating** and type of disconnect requirements added along with extensive revision to existing requirements
- PV disconnecting means connected to the supply side of a service disconnecting means must be “**listed as suitable for use as service equipment**”
- If a PV system is being directly connected to a servicing utility, important safety aspect that the first disconnecting means be “listed and marked as suitable for service equipment”
- Revision removed the “**nearest the point of entrance**” language and the accompanying exception
- PV disconnecting means must meet the provisions of **690.12** for **rapid shutdown** and full compliance with this rule would satisfy the previous provisions of 690.13(A)

690.13
PV System Disconnecting Means *(cont.)*

- Previous requirement of no PV disconnecting means located in bathrooms moved to **690.4(E)** as it pertains to both equipment and disconnecting means
- **Marking requirement** at **690.13(B)** for marking or identifying of PV disconnecting means has been expanded with marking requirements moved to one location at 690.13(B)
- "***The*** PV system disconnecting means" revised to "***each*** PV disconnecting means" to clearly indicate that it is permissible to have **multiple PV systems** on a building or structure
- Each such system is permitted to have **up to six means of disconnect** as the PV system disconnecting means

690.13
PV System Disconnecting Means *(cont.)*

- New **690.13(E)** requires PV system disconnecting means to have an interrupting and voltage ratings **sufficient for the maximum available short-circuit current ratings** that are available at the terminals of the PV system disconnect

- Important safety aspect to any disconnecting means, including a PV disconnecting means *(see 110.9)*

- New **690.13(F)** added to the PV disconnecting means provisions detailing **three aspects of the PV disconnecting means** including **simultaneous disconnection**

- dc PV system disconnecting means to be marked for use in PV systems or be suitable for **backfeed operation**


PHOTOVOLTAIC SYSTEM SAFETY DC DISCONNECT SWITCH (1 OF 2)
PHOTOVOLTAIC DC POWER SOURCES (3 TYP)
OPERATING CURRENT(MAX-POWER): 43.08 AMPS
OPERATING VOLTAGE(MAX-POWER): 390.6 VOLTS
MAXIMUM SYSTEM VOLTAGE: 600 VOLTS
SHORT CIRCUIT CURRENT: 45.96 AMPS
WARNING - ELECTRIC SHOCK HAZARD DO NOT TOUCH TERMINALS TERMINALS ON BOTH LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OFF POSITION
DANGER / PELIGRO
PHOTOVOLTAIC SYSTEM SAFETY DC DISCONNECT SWITCH (2 OF 2)
PHOTOVOLTAIC DC POWER SOURCES (3 TYP)
OPERATING CURRENT(MAX-POWER): 43.08 AMPS
OPERATING VOLTAGE(MAX-POWER): 390.6 VOLTS
MAXIMUM SYSTEM VOLTAGE: 600 VOLTS
SHORT CIRCUIT CURRENT: 45.96 AMPS
WARNING - ELECTRIC SHOCK HAZARD DO NOT TOUCH TERMINALS TERMINALS ON BOTH LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OFF POSITION
DANGER / PELIGRO
ON
OFF


PHOTOVOLTAIC SYSTEM SAFETY
DC DISCONNECT SWITCH (1 OF 2)
ON
I
PHOTOVOLTAIC DC POWER SOURCES (3 TYP)
OPERATING CURRENT(MAX-POWER): 43.08 AMPS
OPERATING VOLTAGE(MAX-POWER): 390.6 VOLTS
MAXIMUM SYSTEM VOLTAGE: 600 VOLTS
SHORT CIRCUIT CURRENT: 45.96 AMPS
WARNING - ELECTRIC SHOCK HAZARD
DO NOT TOUCH TERMINALS
TERMINALS ON BOTH LINE AND LOAD
SIDES MAY BE ENERGIZED
IN THE OFF POSITION
D
HEAVY DUTY
SAFETY SWITCH
INTERRUPTOR DE
SEGURIDAD DE
SERVICIO PESADO
100 A

690.31(C)(1) Wiring Methods Permitted – Solar Photovoltaic (PV) Systems

- Exception requiring raceways to be used when required by 690.31(A) was removed as long as the wiring remains within the PV array footprint
- Limits exposed conductors to within the array footprint only
- Permits Type USE-2 conductors to be installed in ungrounded as well as grounded systems
- Term "listed and labeled" was replaced with "**listed and identified**" when describing single-conductor PV wire
- New installation requirement and reference to 338.10(B)(4)(b) and 334.30 added to 690.31(C)(1) for PV wiring in a PV array


SHARP
SOLAR MODULE
NT-S5E1U

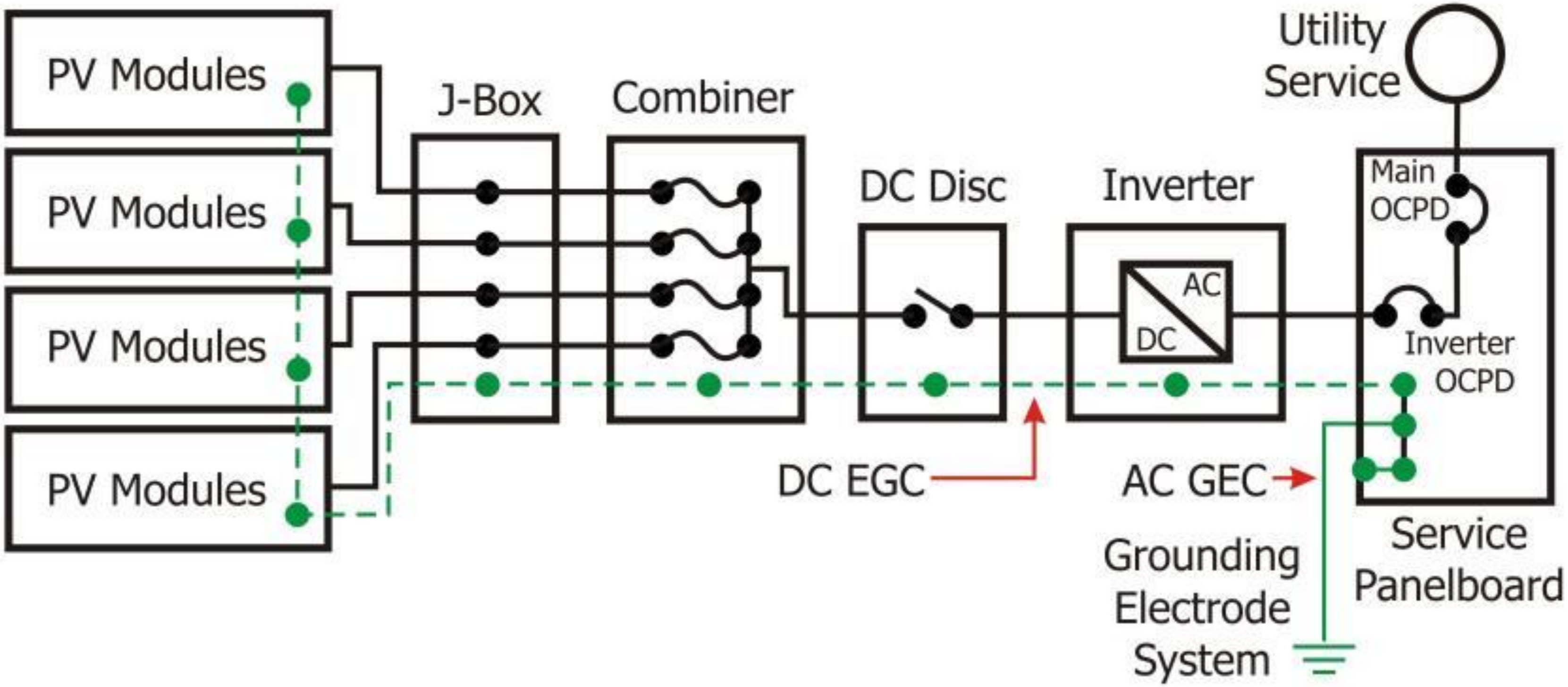

USA WIRE AN
E 800-880-9473 10 AWG XLP (UL) TYPE RHH OR RHW-2 OR USE-2 600V 90C (-40C) OIL RES II

690.35
Ungrounded PV Systems *(Deleted)*

- Requirements for an ungrounded photovoltaic (PV) power system at 690.35 have been **deleted** as these requirements are covered elsewhere in Article 690
- Ungrounded systems are now defined as a "**functional grounded PV system**"
- No longer a need to distinguish between ungrounded systems and what is now defined as a functional grounded PV system *(see new definition at 690.2)*
- Only distinction needed is between a **solidly grounded PV systems** and all other PV systems

690.35 Ungrounded PV System (Deleted)

Provisions for Ungrounded Photovoltaic (PV) Power System have been deleted as the issues and topics previously covered at 690.35 are addressed in other locations within Article 690



Ungrounded PV System
(now referred to as a Functional Grounded PV System)

690.41
System Grounding for PV Systems

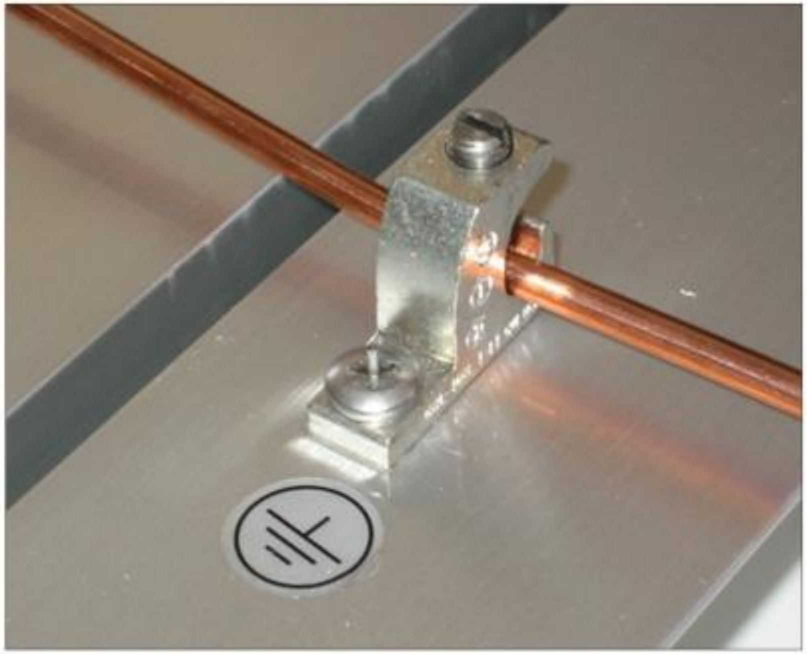
- Requirements for "**System Grounding**" of PV systems revised to properly address the methods by which PV systems are grounded
- Newly defined term "**functional grounded**" addressed at **690.41(A)**
- Previous text of 690.5 *(Ground-Fault Protection)* was moved to **690.41(B)** to better coincide with grounding requirements
- Ground-fault protection is related to system grounding and the issues that system grounding address, better to have GFP grouped with the requirements for system grounding

690.41
System Grounding for PV Systems *(cont.)*

- While the PV ground fault protection function is often a built-in feature of an inverter or charge controller, it may also be built into stand-alone products and other PV system products like PV combiners and dc/dc converters
- This new text will better support the PV ground fault protection functionality in equipment other than inverters and charge controllers

690.41 System Grounding of PV Systems

The requirements for System Grounding of PV systems was revised to properly address the methods by which PV systems are grounded (six configurations)



690.41(A) PV System Grounding Configurations

690.41(B) (GFP) Ground-Fault Protection

The previous text of 690.5 for ground-fault protection of PV systems was moved to 690.41(B) to better coincide with grounding requirements

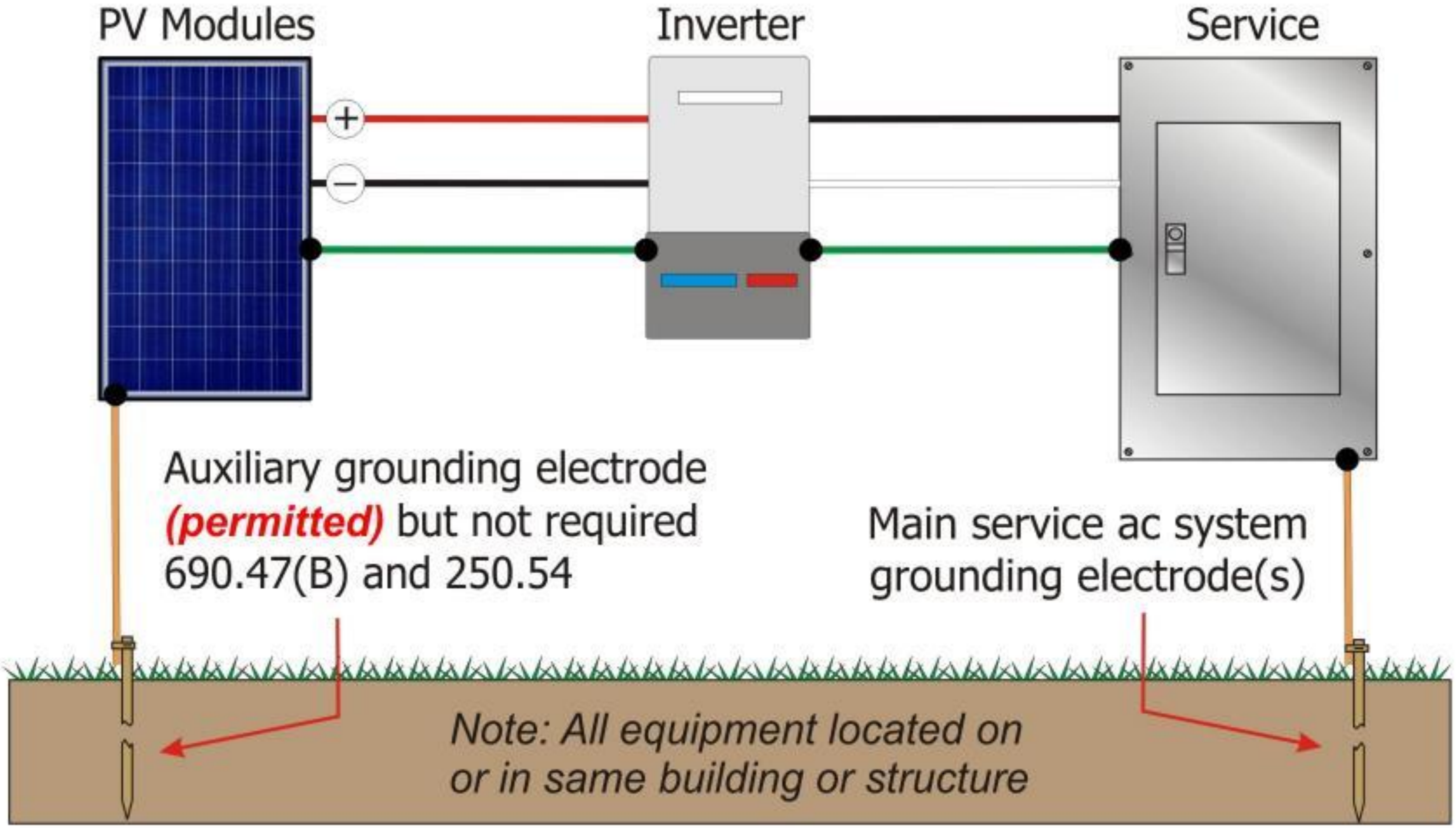
690.47 Grounding Electrode System for PV Systems

- Requirements for the installation of grounding electrodes and grounding electrode conductors for PV systems have been **simplified**, while increasing the safety of PV systems
- 690.47(A) now refers to sections or parts of **Article 250** without repeating the specific grounding electrode rules
- Further simplified to only require a GEC to be attached to solidly grounded PV systems
- Safety provisions of former 690.47(B) reworded and moved to parent text of 690.47(A) while 690.47(B) was deleted
- New ground-mounted PV system will require a new grounding electrode system *(as will a building-mounted system)*, but only if that building did not previously have a GE system

690.47 Grounding Electrode System for PV Systems *(cont.)*

- Text for auxiliary electrodes for PV array grounding has been revised to ***permit*** an auxiliary electrode *(not require one)*
- Auxiliary grounding electrode system helps to minimize the effects of such things as a lightning strike
- Primary purpose of an auxiliary grounding electrode is to maintain the frames of the PV array to as close to local earth voltage potential as possible
- This can also be achieved through a properly installed **equipment grounding conductor** back to an established grounding electrode system for the building or structure

690.47 Grounding Electrode System



The requirements for the installation of a grounding electrode system for PV systems have been revised and simplified

Code language for auxiliary electrodes-for PV array grounding has been revised to *permit* an auxiliary electrode *(not to require one)*

690.56(C) Identification of Power Sources for Buildings with Rapid Shutdown

- Provisions for identifying a PV “**Rapid Shutdown System**” have been extensively revised
- **Two new figures** with illustrated labels have been added to indicate to first responders that rapid-shutdown is provided
  - **Figure 690.56(C)(1)(a)**: Label for PV Systems that Shut Down the Array and the Conductors Leaving the Array
  - **Figure 690.56(C)(1)(b)**: Label for PV Systems that Shut Down the Conductors Leaving the Array Only
- **Detailed roof diagram** required in certain situations showing each different PV system and a “dotted line” around areas that remain energized after rapid shutdown initiated

690.56(C) Identification of Power Sources for Buildings with Rapid Shutdown *(cont.)*

- Rapid shutdown switch to have a **label** located directly on the **rapid shutdown initiator (RSI)** or no more than **1 m (3 ft)** from the rapid shutdown switch that includes the words:

RAPID SHUTDOWN SWITCH FOR SOLAR PV SYSTEM

- Anything that is not touch safe should be labeled as energized
- Revisions direct firefighters and first responders to the **location of the RSI switch** and it clearly identifies what equipment is still live after the system has been shut down
- Allows proper precautions to be taken when responding to an **emergency situation** on a building or structure involving a PV system and a rapid shutdown device

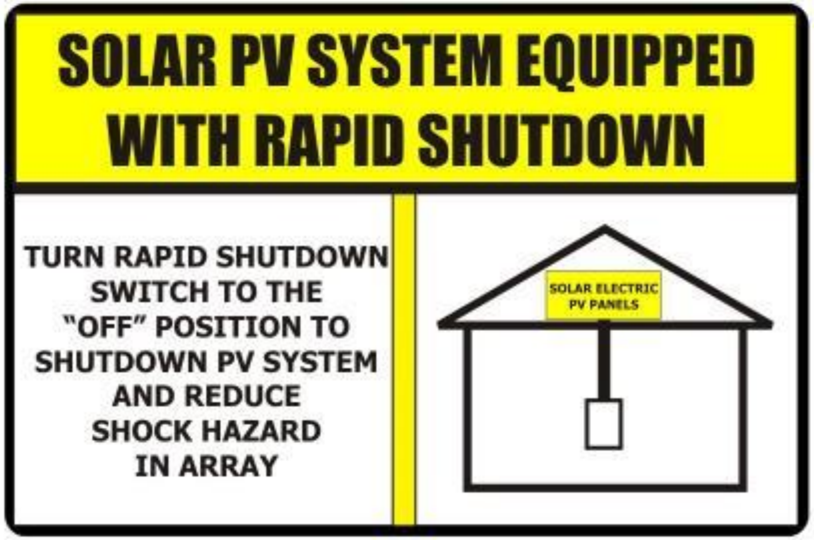
690.56(C) ID of Power Sources Buildings with Rapid Shutdown

Two different labels are required on buildings depending on what type of rapid shutdown system is on the building

Systems with multiple rapid shutdown types will be required to have a detailed directory as simple sign will not be sufficient to clarify the levels of hazard

Plaque or directory required within 1 m (3 ft) of service

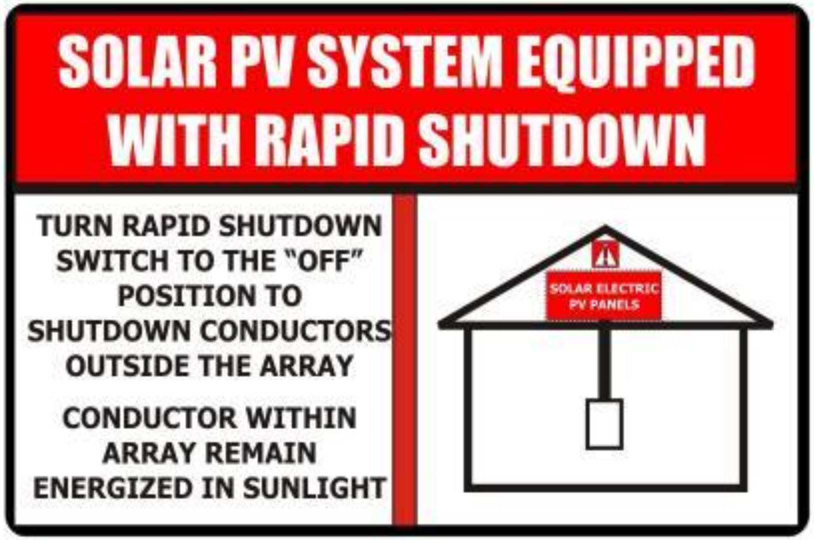
Revision requires any building with a rapid-shutdown PV system to have a plaque to indicate to first responders that rapid-shutdown is provided



SOLAR PV SYSTEM EQUIPPED WITH RAPID SHUTDOWN

TURN RAPID SHUTDOWN SWITCH TO THE "OFF" POSITION TO SHUTDOWN PV SYSTEM AND REDUCE SHOCK HAZARD IN ARRAY

Figure 690.56(C)(1)(a): Label for PV Systems that Shut Down the Array and the Conductors Leaving the Array



SOLAR PV SYSTEM EQUIPPED WITH RAPID SHUTDOWN

TURN RAPID SHUTDOWN SWITCH TO THE "OFF" POSITION TO SHUTDOWN CONDUCTORS OUTSIDE THE ARRAY

CONDUCTOR WITHIN ARRAY REMAIN ENERGIZED IN SUNLIGHT

Figure 690.56(C)(1)(b): Label for PV Systems that Shut Down the Conductors Leaving the Array Only

Figure 690.56(C)(1)(a): Label for PV Systems that Shut Down the Array and the Conductors Leaving the Array

SOLAR PV SYSTEM EQUIPPED WITH RAPID SHUTDOWN

TURN RAPID SHUTDOWN
SWITCH TO THE
“OFF” POSITION TO
SHUTDOWN PV SYSTEM
AND REDUCE
SHOCK HAZARD
IN ARRAY

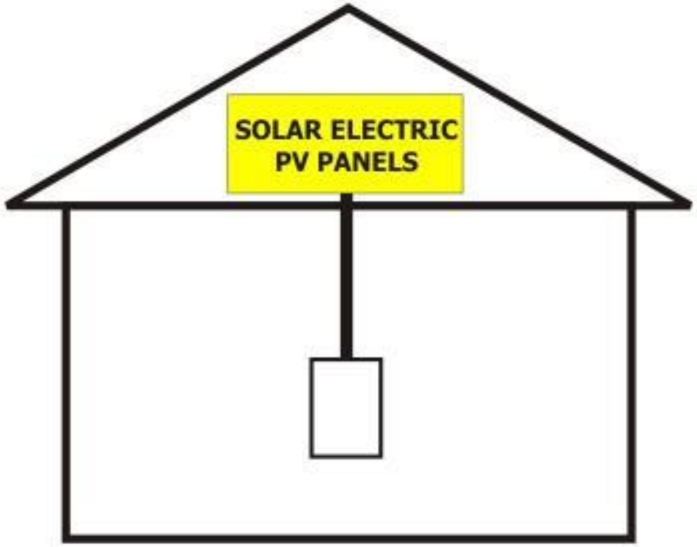
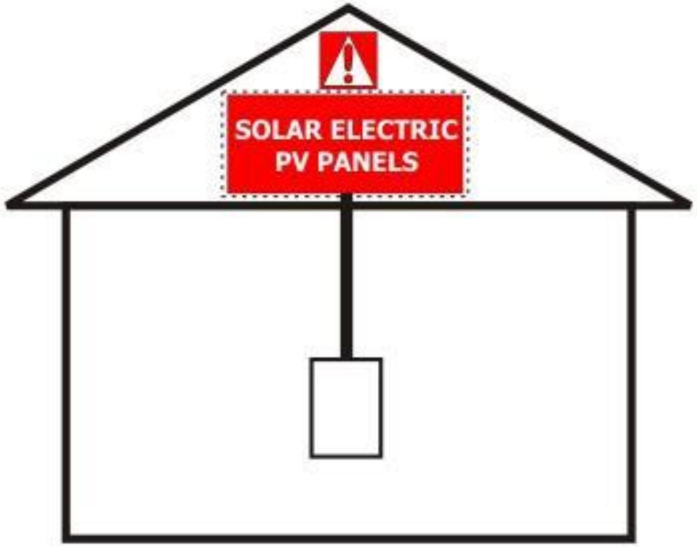


Figure 690.56(C)(1)(b): Label for PV Systems that Shut Down the Conductors Leaving the Array Only

SOLAR PV SYSTEM EQUIPPED WITH RAPID SHUTDOWN

TURN RAPID SHUTDOWN SWITCH TO THE "OFF" POSITION TO SHUTDOWN CONDUCTORS OUTSIDE THE ARRAY

CONDUCTOR WITHIN ARRAY REMAIN ENERGIZED IN SUNLIGHT



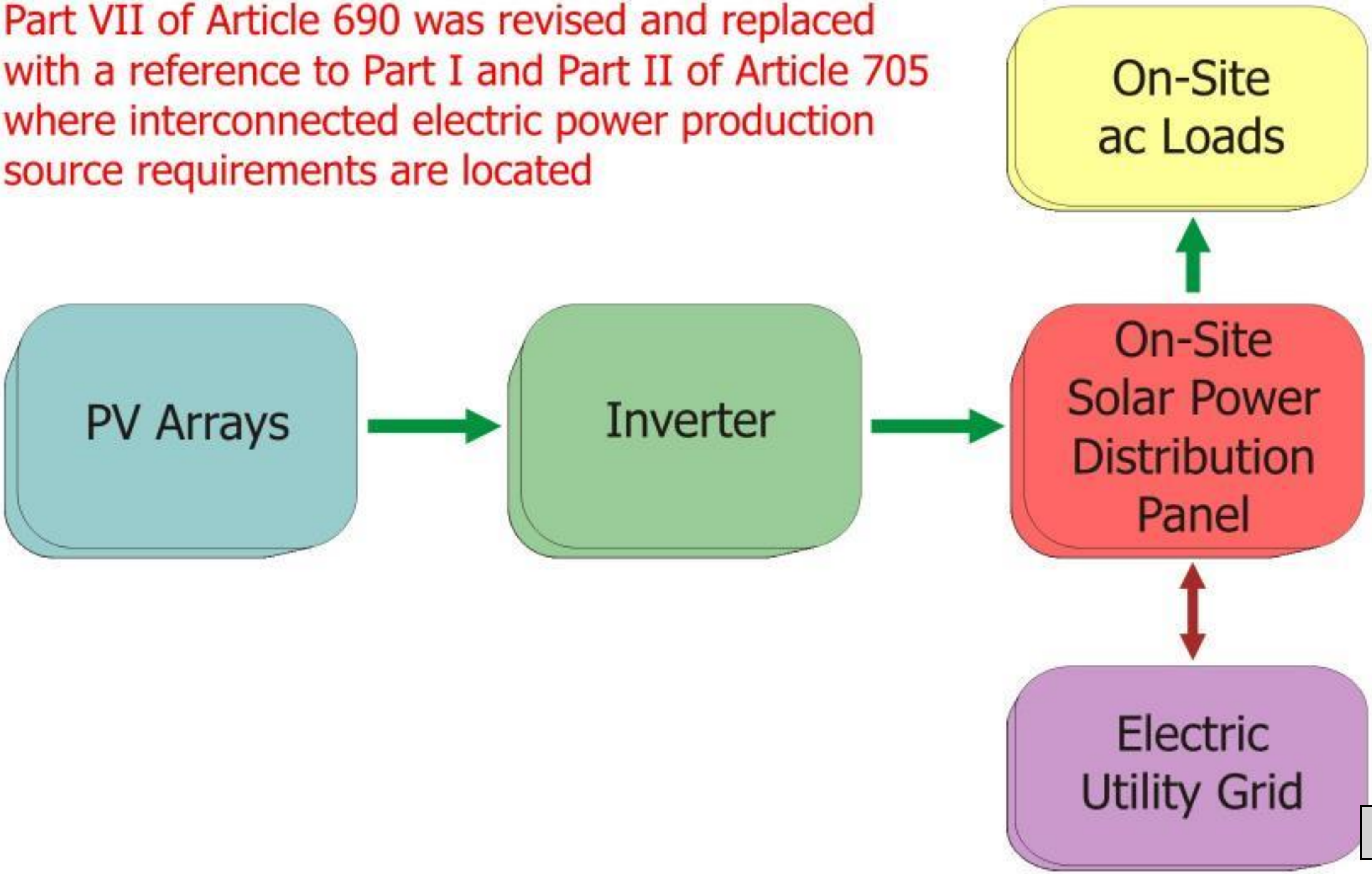
Article 690 Part VII – Connection to Other Sources [Solar Photovoltaic (PV) Systems]

- Part VII of Article 690 was revised and replaced with a reference to **Article 705** where interconnected electric power production source requirements are found
- Part VII of Article 690 is now one simple sentence at **690.59** which states "PV systems connected to other sources shall be installed in accordance with Parts I and II of Article 705"
- Part I of Article 705 covers "General" requirements for interconnected electric power production sources while Part II of Article 705 concerns requirement for **utility-interactive inverters**

Article 690 Part VII Connection to Other Sources

690.59 Connection to Other Sources. PV systems connected to other sources shall be installed in accordance with Parts I and II of Article 705.

Part VII of Article 690 was revised and replaced with a reference to Part I and Part II of Article 705 where interconnected electric power production source requirements are located




SIEMENS
SIEMENS
SIEMENS
IG Plus
IG Plus
ON
OFF

690.71 Energy Storage Systems – PV Systems

- Former provisions of 690.71 for installation of **PV storage battery systems** have been **relocated to Part III Article 706**, leaving one reference to new Article 706 at 690.71
- New Article 706 titled, “Energy Storage System” has been introduced to the 2017 *NEC*
- No need to have identical language in two different articles
- Simpler for 690.71 to refer users of the *Code* to Article 706
- Storage batteries for PV systems accumulate excess energy created by the PV system and store it to be used at night or when there is no other energy input

Article 691 Large-Scale Photovoltaic (PV) Electric Power Production Facility

- New Article 691 for "**Large-Scale Photovoltaic (PV) Electric Power Production Facility**" added to the 2017 *NEC*
- New article covers the installation of large-scale PV electric power production facilities operated for the sole purpose of **providing electric supply to the utility transmission or distribution system** with a generating capacity of **no less than 5,000 kW**
- Typically connected at **medium voltages (4.16kV to 34.5kV)** or even **transmission voltages (69kV or higher)** rather than at 480 volts or lower
- Large-scale PV systems typically connect to grid on the **utility side of the metering system** rather than the customer side

Article 691 Large-Scale Photovoltaic (PV) Electric Power Production Facility *(cont.)*

- These large scale PV systems are typically **accessible only to qualified personnel** rather than to the general public
- Unlike smaller scale PV systems, large-scale PV electric power production facilities are designed and operated similarly to traditional utility power generating plants
- Unqualified individuals must not access the system for their own safety and for protection of the system which is crucial to grid stability
- Access to large-scale PV electric supply stations must be restricted by a **fencing structure** to ensure that systems are adequately protected from the general public
- These large-scale PV systems are difficult if not impossible to fit under the current scope of Article 690

Photo Courtesy of Scott Humphrey

Photo Courtesy of Scott Humphrey

Photo Courtesy of Jim Rogers

695.6(G) Ground-Fault Protection Not Permitted for Fire Pumps

- Revision occurred to clarify that ground-fault protection of equipment is ***not permitted*** for fire pump power circuit(s)
- Fire pumps are required to have an **extra measure of protection** in the event of a fire to allow the fire pump to do its job and try to extinguish the fire
- Fire pumps and their wiring methods should be **sacrificial by nature**
- Previous text indicated that ground-fault protection of equipment shall not be “permitted” for fire pumps
- Some incorrectly interpreted this rule to mean that providing GFP for fire pumps was an option rather than a prohibition

695.6(G) Fire Pumps (GFP Prohibited)

Ground-fault protection of equipment shall not be installed in any fire pump power circuit

Revision changed 695.6(G) from "ground-fault protection of equipment shall not be permitted for fire pumps" to "ground-fault protection of equipment shall not be installed in any fire pump power circuit"

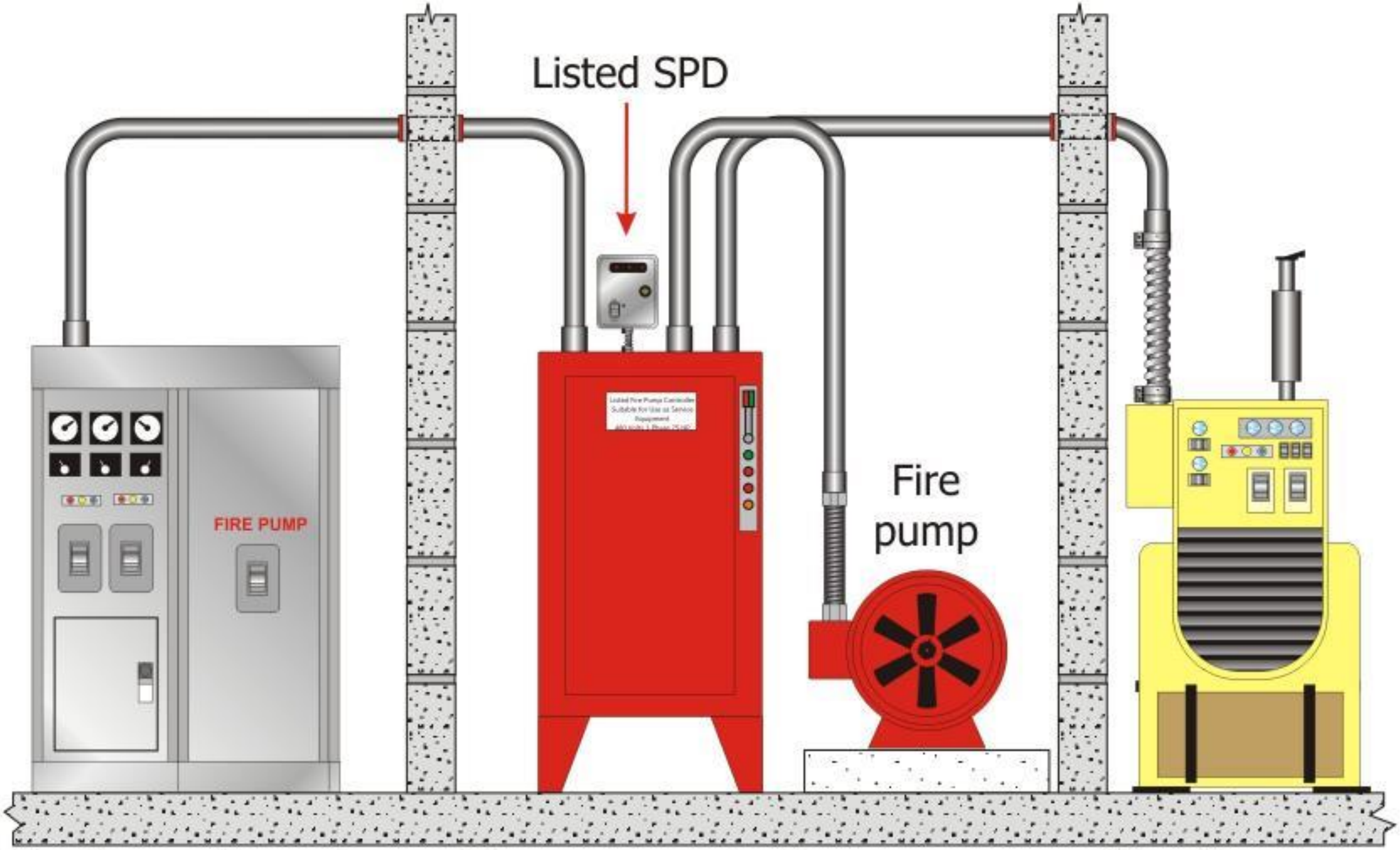
Photo Courtesy of Randy Hunter

695.15 Surge Protection for Fire Pumps

- A listed **surge protection device (SPD)** will now be required to be installed in or on fire pump controllers
- An SPD is necessary to provide protection for the fire pump controller
- The location and type of SPD is a design issue and will remain with the designer and/or installer
- These SPDs for fire pump controllers will be required to be **listed devices** as already required by former 285.5 *(now 285.6)*
- Practical and feasible to protect fire pump installations from damage with a listed SPD

695.15 Surge Protection (Fire Pumps)

A listed surge protection device (SPD) shall be installed in or on the fire pump controller



Chapter Seven
Special Conditions

700.2 and 700.25 Branch Circuit Emergency Lighting Transfer Switch

- New definition for "**Branch Circuit Emergency Lighting Transfer Switch**" along with provisions for same at 700.25 has been added to the 2017 *NEC*
- Added to allow these devices to **transfer emergency lighting loads** supplied by branch circuits rated at not greater than **20 amperes** from the normal branch circuit to an emergency branch circuit
- Accommodates a new class of **transfer switching devices** intended for operation of individual branch circuits in an emergency lighting system

700.2 and 700.25 Branch Circuit Emergency Lighting Transfer Switch *(cont.)*

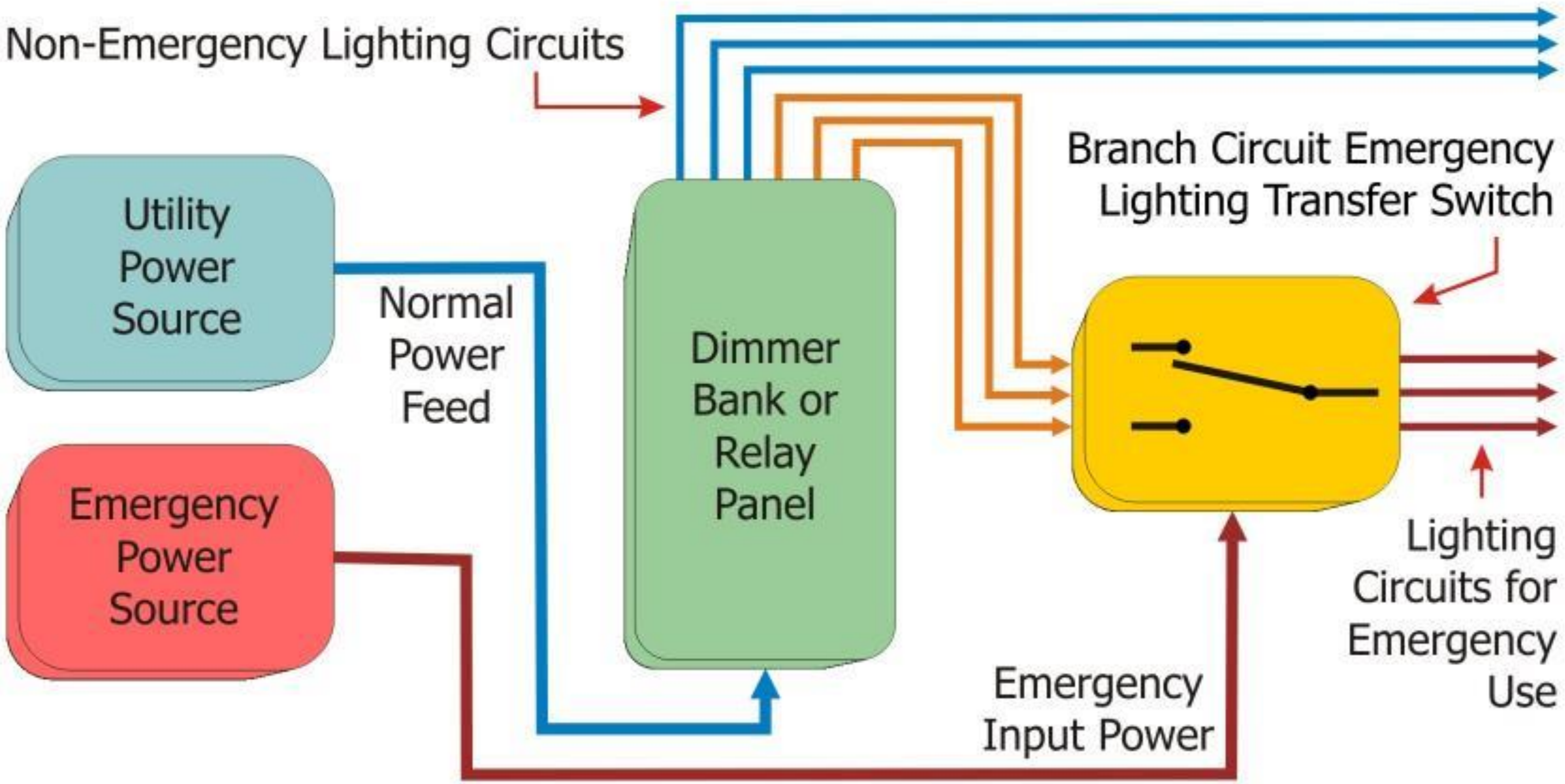
- In some past situations, an **automatic load control relay (ALCR)** has been used to transfer emergency lighting loads from the normal supply to an emergency supply *(even though this is a Code violation of 700.26)*

- ALCRs were never intended for use as general purpose transfer equipment

- ALCRs have not undergone any evaluation as emergency transfer switches

700.2 and 700.25 Branch Circuit Emergency Lighting Transfer Switch

Branch Circuit Emergency Lighting Transfer Switch allowed to be used to transfer emergency lighting loads supplied by branch circuits rated at 20 amperes or less from the normal branch circuit to an emergency branch circuit



Branch Circuit Emergency Lighting Transfer Switch. A device connected on the load side of a branch circuit overcurrent protective device that transfers only emergency lighting loads from the normal supply to an emergency supply.

700.2 and 700.25 Branch Circuit Emergency Lighting Transfer Switch

Branch Circuit Emergency Lighting Transfer Switch allowed to be used to transfer emergency lighting loads supplied by branch circuits rated at 20 amperes or less from the normal branch circuit to an emergency branch circuit

Courtesy of Electronic Theatre Controls, Inc.

Branch Circuit Emergency Lighting Transfer Switch. A device connected on the load side of a branch circuit overcurrent protective device that transfers only emergency lighting loads from the normal supply to an emergency supply.

700.3(F) Temporary Source of Power for Maintenance or Repair of the Alternate Source of Power

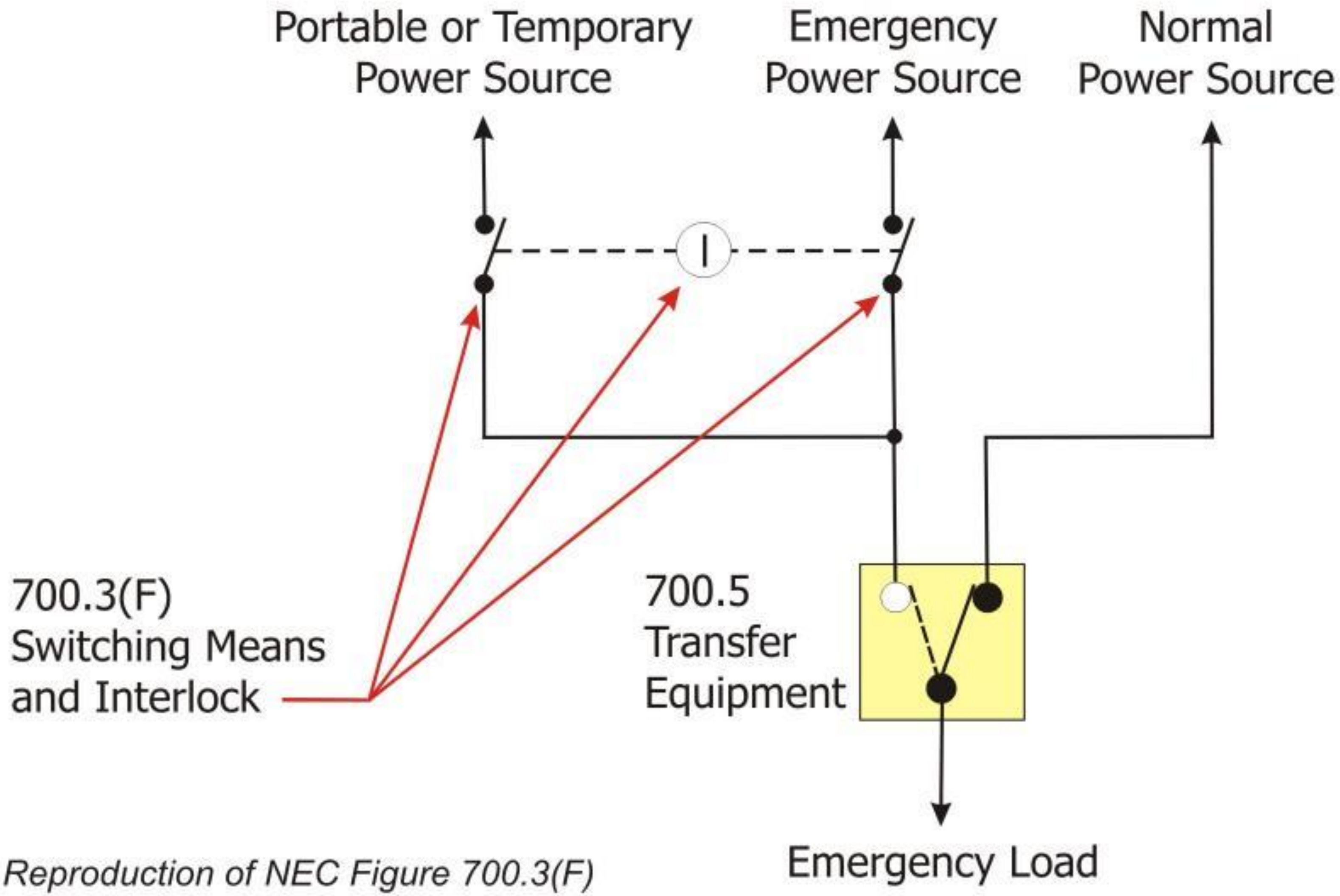
- New provisions added providing performance based requirements for **portable or temporary alternate source of power** to be available whenever a single alternate source of power for emergency system is out of service for **maintenance or repair**
- Permanent switching means must be available for the duration of the maintenance or repair
- New requirement comes with an **exception** with **four conditions**
- New **Figure 700.3(F)** also added to show one possible method to utilize manual switching from the single alternate source of power to the portable or temporary alternate source of power

700.3(F) Temporary Source of Power for Maintenance or Repair of the Alternate Source of Power *(cont.)*

- Previous requirements called for temporary alternate source to be available whenever the emergency generator is out of service for **major maintenance or repair**
- It was difficult to determine what would be considered "**major**" maintenance or repair
- Oil changes are not generally a major maintenance item, but on a large generator, this can take several hours to perform

700.3(F) and Figure 700.3(F)

Temporary Source of Power for Maintenance or Repair of the Alternate Source of Power



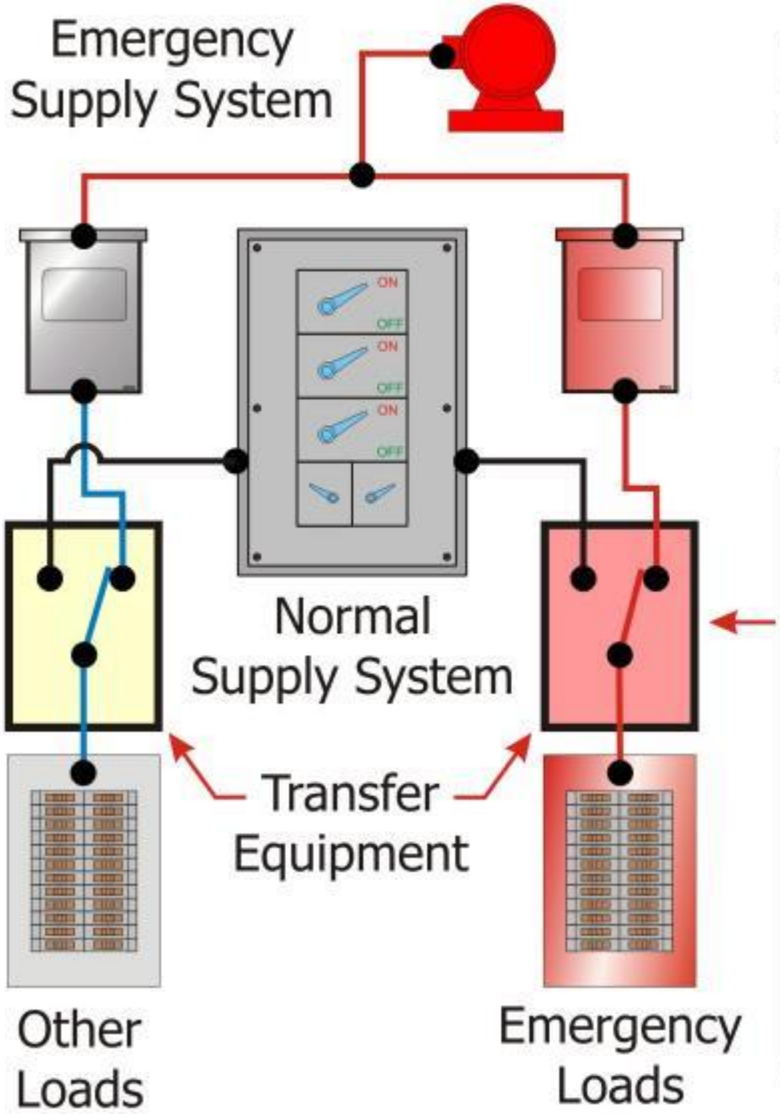
Reproduction of NEC Figure 700.3(F)

700.5(E) Emergency Systems Transfer Equipment Documentation

- New requirements added for **available short-circuit current rating (SCCR) documentation** and **field-marking** at emergency system transfer equipment
- SCCR to be based on the **specific overcurrent protective device type and settings** protecting the transfer equipment
- Additional field marking on the exterior of transfer equipment was deemed necessary as a transfer switch of this nature is typically marked by the manufacturer with several different options resulting in numerous SCCR values
- New field marking of the SCCR value based on the specific type OCPD, ampere rating, and installed settings, which are known factors by the designer and/or installer

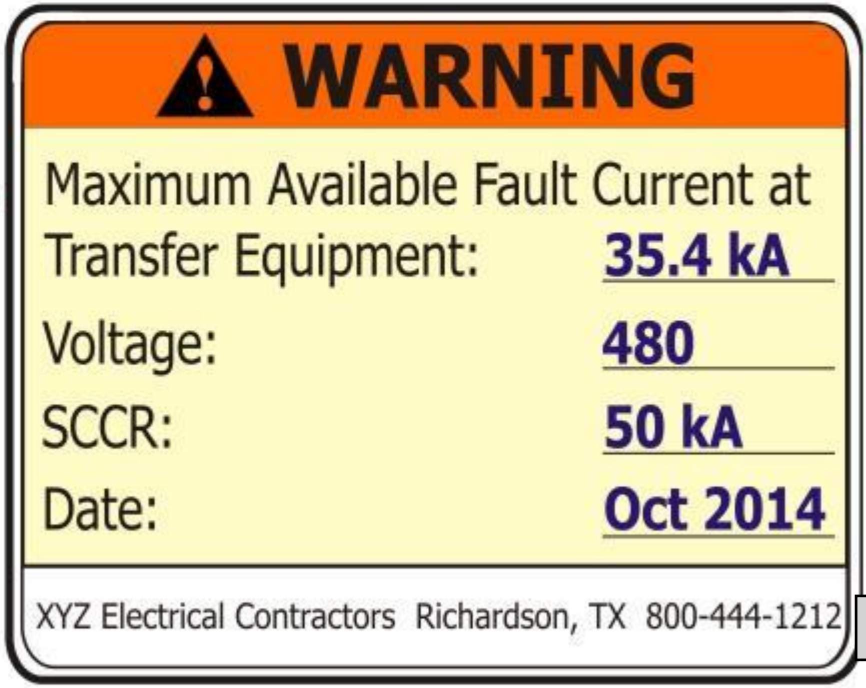
700.5 Documentation of Transfer Equipment

New requirements added for available short-circuit current rating documentation and field-marking at emergency system transfer equipment



Required to be field marked on the exterior of the transfer equipment

SCCR based on the specific overcurrent protective device type and settings protecting the transfer equipment



WARNING

Maximum Available Fault Current at Transfer Equipment: **35.4 kA**

Voltage: **480**

SCCR: **50 kA**

Date: **Oct 2014**

XYZ Electrical Contractors Richardson, TX 800-444-1212


PRIVATE CHECK METER
SS10050
TR


MAINS
PLANT
LOAD

700.10(A)
Identification – Emergency Systems

- Identification for emergency circuits has been expanded to include **cables and raceways not associated with boxes or enclosures**
- Example of this could be a metallic cable system "**daisy chained**" from emergency luminaire to emergency luminaire without installing a junction box between luminaires
- This is in addition to boxes and enclosures associated with emergency system
- New provisions now require exposed emergency circuit or system cable or raceway systems to be **permanently marked** as a component of an emergency circuit or system, at intervals not to exceed **7.6 m (25 ft)** where boxes or enclosures are not encountered

700.10(A)
Identification – Emergency Systems *(cont.)*

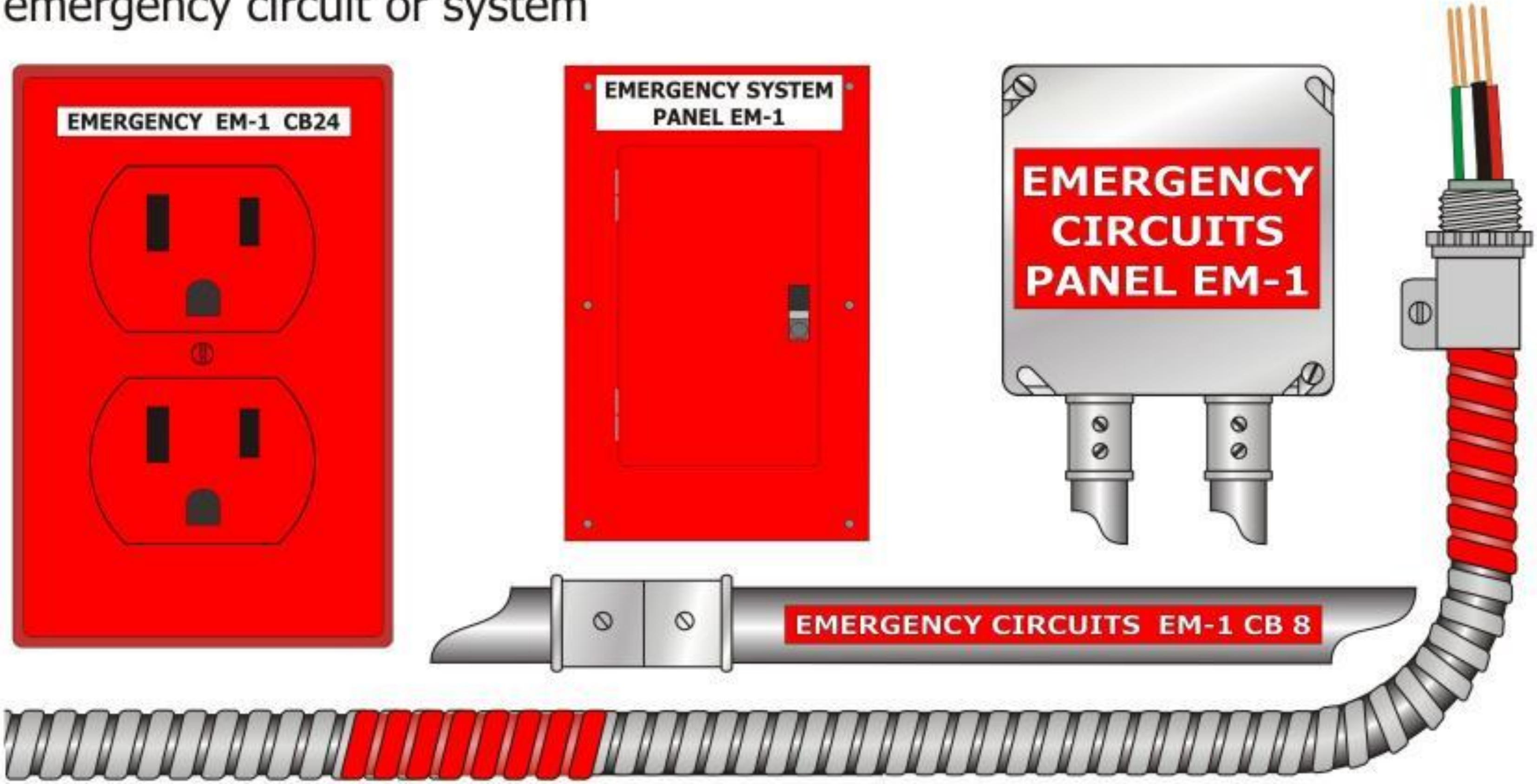
- Identification method could be as simple as **spray painting the cable or raceway** every 7.6 m (25 ft) similar to identification of independent grid wires specific to support of wiring methods above a suspended ceiling as required by 300.11(A)(1) and (A)(2)

- Emergency system **receptacles** now require identification with a "**distinctive color or marking**" on the receptacle cover plates or the receptacle

- The *Code* is not specific as to the means or method to be used to accomplish the receptacle "distinctive color or marking" requirements *(red receptacles and covers, etc.)*

700.10(A) Identification of Emergency Systems

In addition to boxes and enclosures, exposed emergency system cables and raceway systems not associated with boxes or enclosures required to be permanently marked to be readily identified as a component of an emergency circuit or system



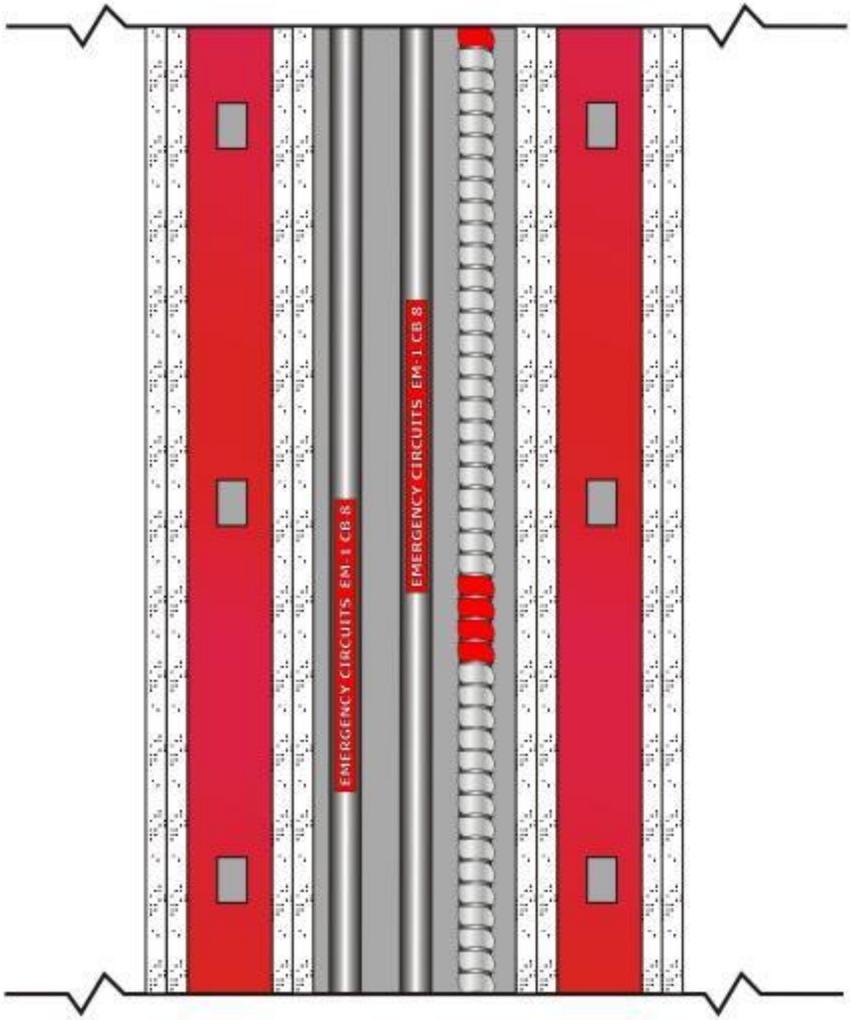
Receptacles supplied from the emergency system now required to be identified by a "distinctive color or marking" on the receptacle cover plates or the receptacle

700.10(D) Fire Protection for Emergency System

- Requirements have been added for **fire protection of emergency system feeders** for:
    - **Health care occupancies** where persons are not capable of self-preservation and
    - **Educational occupancies** with more than 300 occupants
- This is in addition to high-rise buildings and those buildings with large occupancy loads
- Recognizes that schools, learning centers, universities, hospitals, and nursing homes could qualify and the challenges of safe evacuation in the event of fire are similar and just as critical
- This revision/addition had a correlation effect at provisions of **700.12** for **sources of power equipment** to an emergency syste

700.10(D) Fire Protection for Emergency Systems

Occupancy areas requiring fire protection requirements for emergency system feeders was expanded for the 2017 *NEC*



Fire protection provisions for emergency system feeders required for 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

701.6(D) GFP Sensors for Legally Required Standby Systems

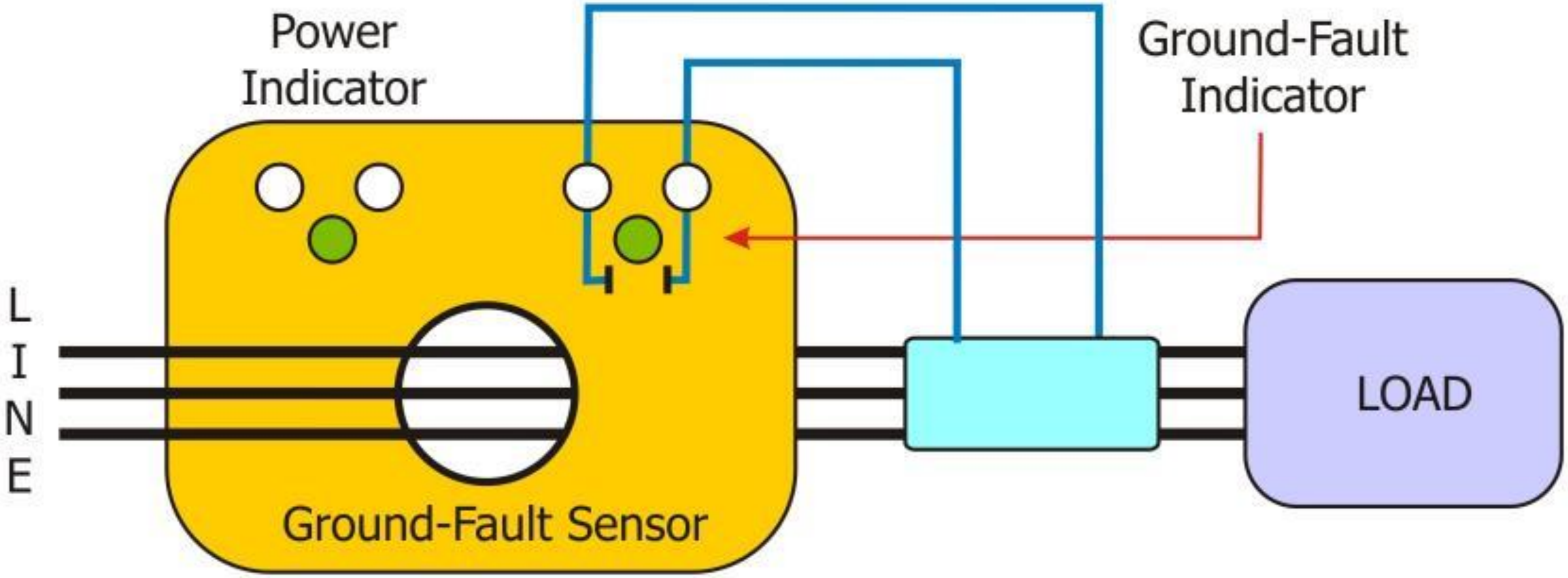
- New text added to allow a **ground-fault sensor** to be located at an **alternate location** for legally required standby systems with **multiple emergency sources** connected to a paralleling bus
- The provisions of 701.6(D) generally calls for ground-fault sensor signal devices to be located **at or ahead of the main system disconnecting means** for the legally required standby source
- A properly installed ground-fault sensor can provide a reliable and cost effective method for sensing ground faults
- New language dealing with systems with **multiple emergency sources connected to a paralleling bus** will help clarify the requirements for installing the ground fault sensor at an alternate location

701.6(D) GFP Sensors for Legally Required Standby Systems *(cont.)*

- For multiple emergency sources, ground fault sensing may be determined by:
  - Zero sequence sensing
  - Differential relaying of the paralleling bus in conjunction with residual ground fault sensing device of the feeders or
  - Other equivalent means
- Same change occurred at **700.6(D)** for **Emergency Systems**

701.6(D) GFP Sensors

The sensor for ground-fault signal devices is generally required to be located at, or ahead of, the main system disconnecting means for the legally required standby source of a legally required standby system



Code language was added at 701.6(D) to allow the ground fault sensor to be located at an alternate location for systems with multiple emergency sources connected to a paralleling bus

702.12(C) Power Inlets for Portable Generators at Optional Standby Systems

- New requirements added for **power inlets used with optional standby generators** to ensure that disconnection of the power inlet **does not occur under load**

- New language requires optional standby equipment containing power inlets **rated 100 amperes or more** for the connection of a generator source to be **listed for the intended use** and be equipped with an **interlocked disconnecting means**

- Not uncommon to find **power inlet boxes** serving as gateway between inside need for electricity and outside supply source

- Disconnecting under load can present a safety hazard if the inlet is not rated for load break or the “intended use”

702.12(C) Power Inlets for Portable Generators at Optional Standby Systems *(cont.)*

- **Two new exceptions** were added omitting power inlet box from being listed for the intended use and being an interlocking disconnecting means:
  - First exception pertains to the power inlet device **rated as a disconnecting means** itself
  - Second exception pertains to **supervised industrial installations** where permanent space is identified for the portable generator to be located within line of sight of the power inlets
- New language intended to either require the power inlet devices used with portable outdoor generators be **load break rated** or be **interlocked with a disconnecting means**


LEVITON PowerSwitch™
MECHANICAL INTERLOCK
100A 3 PHASE Y 120/208VAC
CATALOG NUMBER: 5100MB9W
TYPE 3R, 4X, 12K
IP67
TO RESET: TURN HANDLE TO OFF AND REMOVE PLUG
SEE WARNING BELOW
LOOSEN COVER SCREWS AND OPEN COVER
FOLLOW RESET INSTRUCTIONS ON INSIDE OF COVER
RÉARMEMENT : METTRE L'INTERRUPTEUR
À LA POSITION ARRÊT ET RETIRER LA FICHE
LIRE L'AVERTISSEMENT CI-DESSOUS
DESSERRER LES VIS DU COUVERCLE ET
SUIVRE LES DIRECTIVES DE RÉARM
À L'INTÉRIEUR DU COUVERCLE
PARA REINICIAR : MUEVA LA MA
Y SAQUE LA CLAVIJA
VEA LAS ADVERTENCIAS ABAJ
AFLOJE LOS TORNILLOS DE LA
SIGUIENDO LAS INSTRUCCIONE
PARTE INTERIOR DE LA CUBIER
TRIP
ON
OFF
TURN OFF TO REMOVE PLUG
INSERT PLUG TO TURN SWITCH ON
METTRE L'INTERRUPTEUR EN POSITION ARRET POUR RETIRER LA FICHE
INSEREZ LA FICHE POUR METTRE L'INTERRUPTEUR EN POSITION MARCHE
DESCONECTE PARA QUITAR LA CLAVIJA
INSERTE LA CLAVIJA PARA ENCENDER EL INTERRUPTOR
WARNING
ARC FLASH AND SHOCK HAZARD - MORE THAN ONE SUPPLY DISCONNECT MAY BE REQUIRED TO DE-ENERGIZE EQUIPMENT BEFORE SERVICING.
AVERTISSEMENT
RISQUE D'ARC ELECTRIQUE ET D'ELECTROCUTION - PLUS D'UN INTERRUPTEUR GENERAL PEUVENT ETRE REQUIS POUR METTRE HORS TENSION AVANT L'ENTRETIEN
ADVERTENCIA
EL ARCO ELECTRICO Y PELIGRO DE CHOQUE ELECTRICO - PUEDE REQUERIR DE MAS DE UN INTERRUPTOR PARA DESCONECTA LA ENERGIA DEL EQUIPO ANTES DE HACER MANTENIMIENTO
OVERCURRENT PROTECTED
UL
LISTED 40KF
MANUAL MOTOR CONTROLLER
SUITABLE AS MOTOR DISCONNECT
LR 51334
NOM 057-ANCE
CE
SC39V
MADE IN SWEDEN
99420772

Article 705 Part IV Microgrid Systems
(Interconnected Electric Power Production Sources)

- New Part IV added to Article 705 recognizing **microgrid systems** as an interconnected electric power production source
- Microgrids are an example of one or more **interconnected electric power production source** operating in parallel with a primary source(s) of electricity
- Microgrid systems are modern, localized, small-scale grids, contrary to the traditional, centralized electricity grid
- Microgrids are a way to add resiliency against loss of power in premises wiring systems
- Microgrid systems are sometimes referred to as “**intentionally islanded systems**” and “**stand-alone systems**”

Article 705 Part IV. Microgrid Systems
Interconnected Electric Power Production Sources

A new Part IV was added to Article 705 recognizing "Microgrid Systems" as an interconnected electric power production source

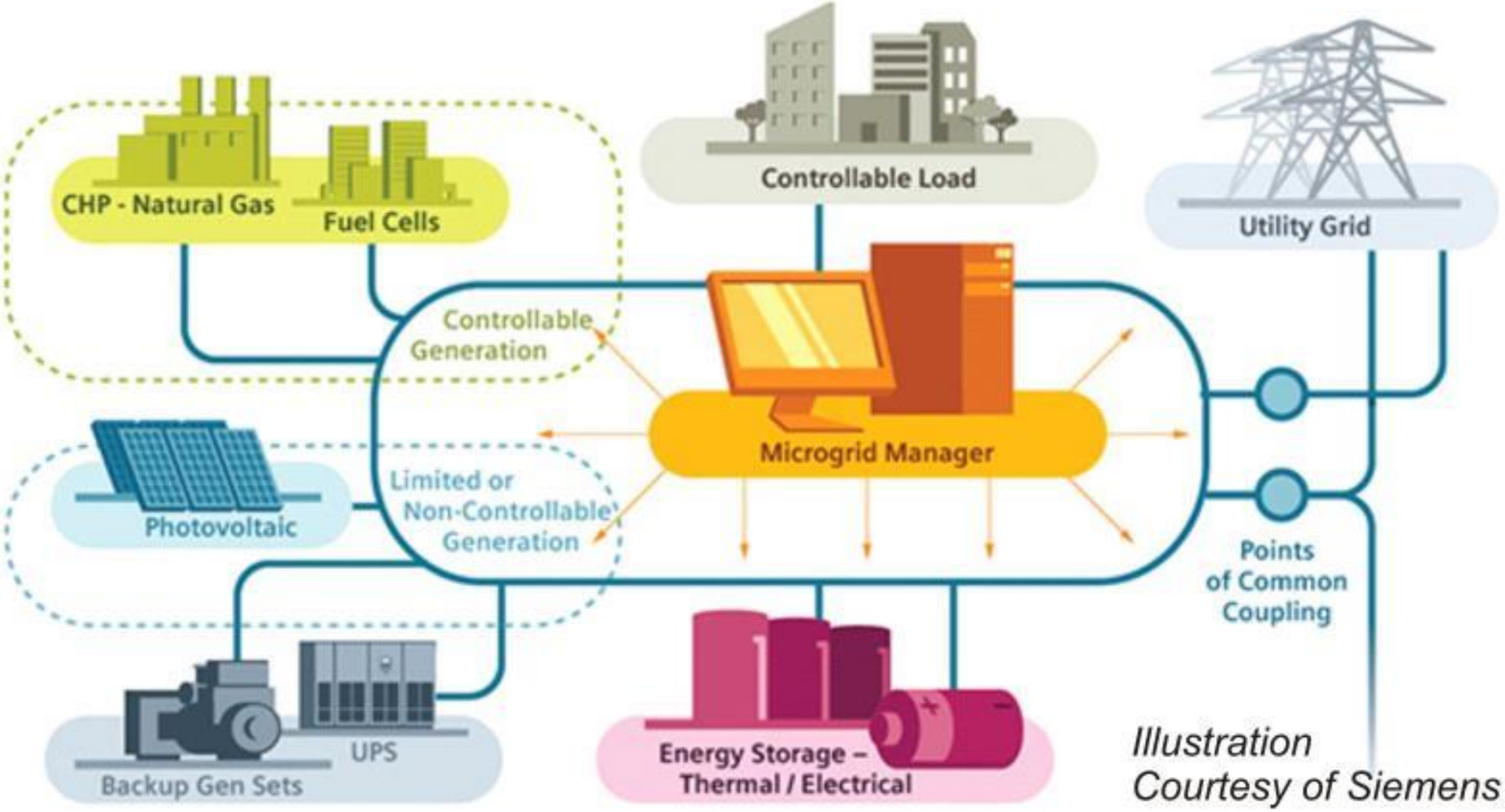


Illustration Courtesy of Siemens

Microgrid systems, sometimes referred to as "intentionally islanded systems" and "stand-alone systems" are a way to add resiliency against loss of power in premises wiring systems

Article 706 Energy Storage Systems

- **New Article** “**Energy Storage Systems**” applies to all permanently installed energy storage systems (ESS) operating at **over 50 volts ac** or **60 volts dc**
- May be **stand-alone** or **interactive** with other electric power production sources
- An ESS is defined as “**one or more components assembled together capable of storing energy for use at a future time**”
- Energy storage involves converting energy from forms that are difficult to store to more conveniently or economically storable forms

Article 706 Energy Storage Systems *(cont.)*

- Energy storage systems (ESS) can consist of the following:
  - Batteries, capacitors, and/or kinetic energy devices *(e.g., flywheels and compressed air)*
  - ac or dc output for utilization
  - Inverters and/or converters to change stored energy into electrical energy
- Energy storage is the capture of energy produced at one time for use at a later time

Illustration Courtesy of A123 Systems

708.10(A)(2) Receptacle Identification for Critical Operations Power Systems (COPS)

- New requirements call for nonlocking-type, 125-volt, 15- and 20-ampere receptacles supplied from the COPS to have an **illuminated face or an indicator light** to indicate that there is power to the receptacle
- This is in addition to the existing requirement for a **distinctive color or marking** so as to be readily identifiable
- New illuminator or indicator light provision provides for ready and continuous ability to identify receptacles that are part of the COPS system
- Alleviate issues arising from remodeling *(such as painting)* and original COPS receptacle cover plate not being re-installed properly on its original COPS receptacle

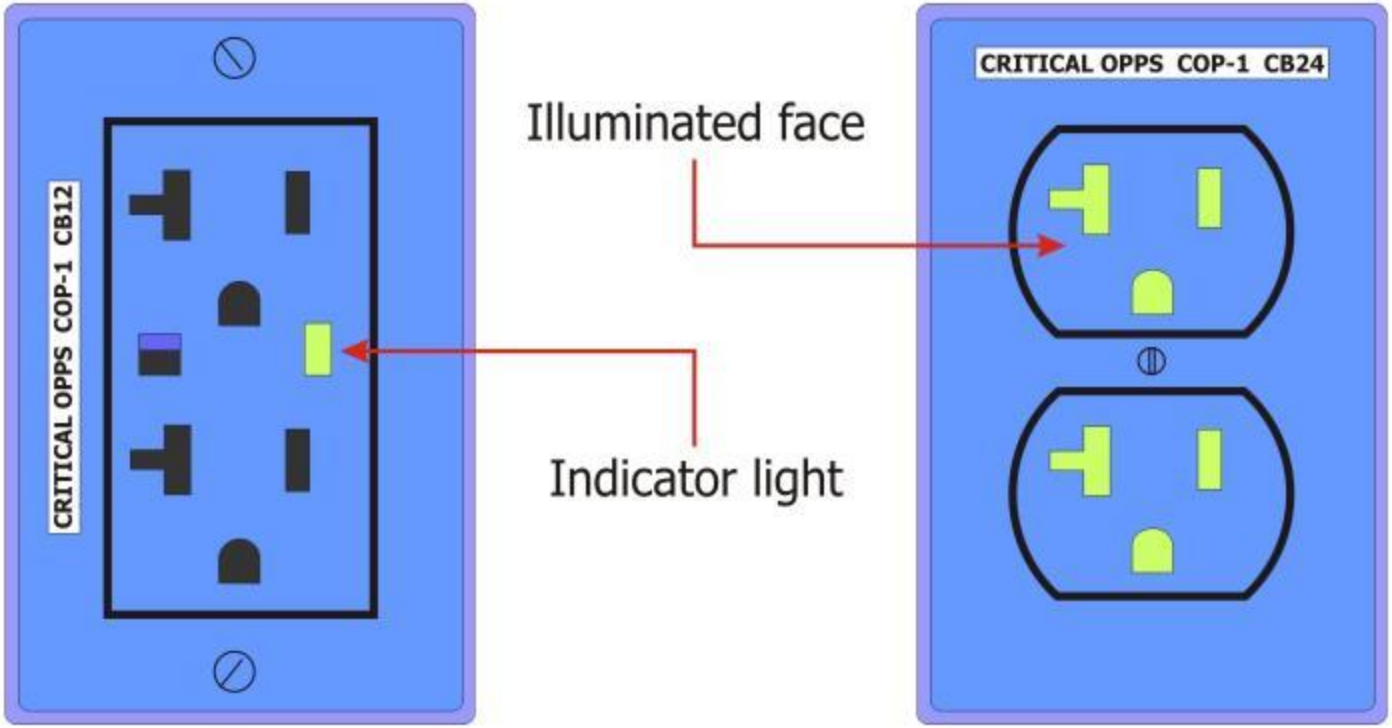
708.10(A)(2) Receptacle Identification for Critical Operations Power Systems (COPS)

- *Continued from previous slide*
- Essential that COPS receptacles have additional identification by either an **indicator light or an illuminated face** so that users of said receptacles knows they are **energized in an emergency** when all other receptacles are not working
- Not uncommon for receptacles from the COPS system to remain dormant until called upon during an emergency situation

708.10(A)(2) Receptacle Identification (COPS)

In a building in which COPS are present with other types of power systems:

The receptacle cover plates or the receptacles themselves supplied from the COPS shall have a distinctive color or marking so as to be readily identifiable



Nonlocking-type, 125-volt, 15- and 20-ampere receptacles supplied from the COPS must have an illuminated face or an indicator light to indicate that there is power to the receptacle

Illuminated Face

Indicator Light

Receptacles courtesy of Pass & Seymour/Legrand

Article 710 Stand-Alone Systems

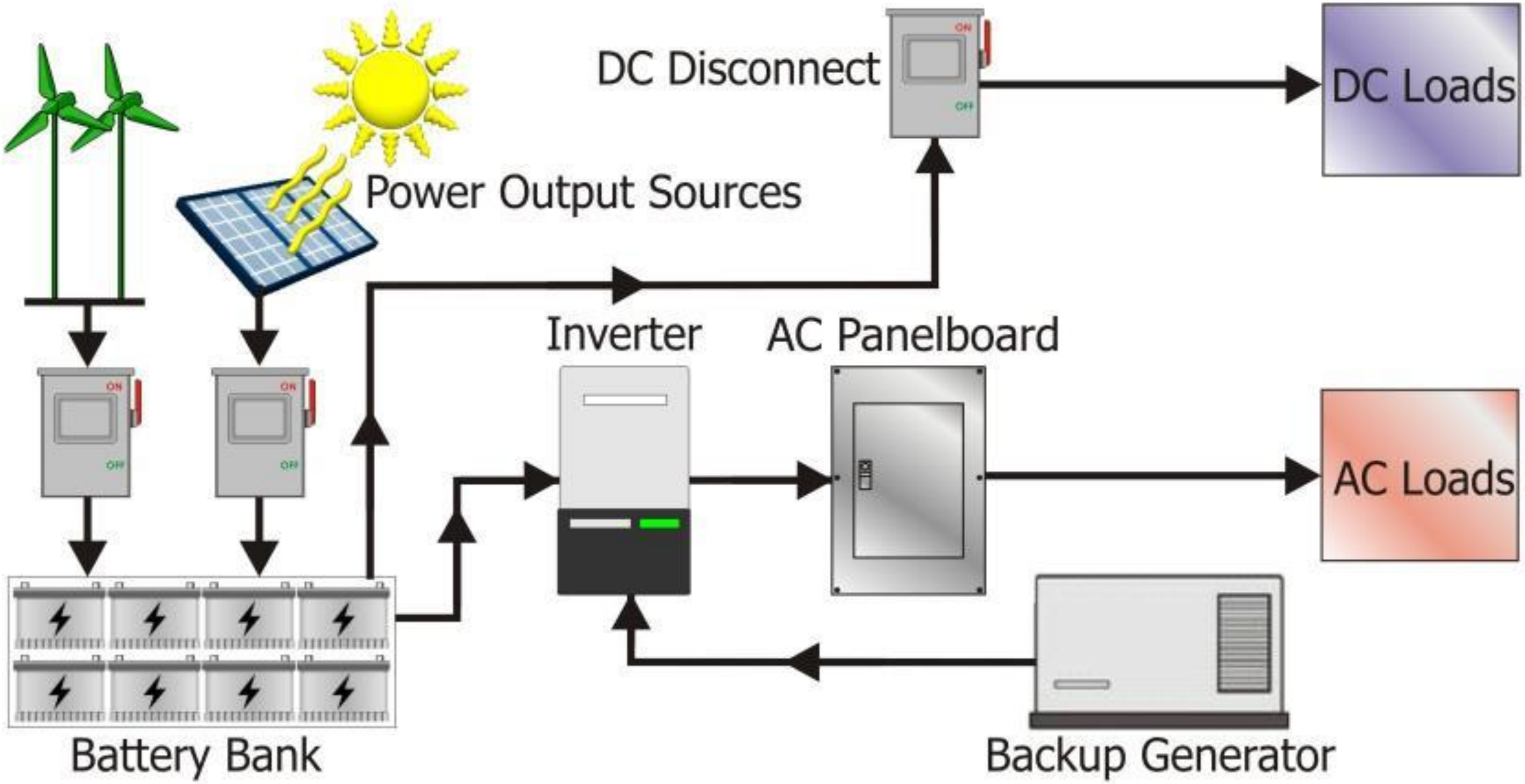
- Requirements of stand-alone systems were brought to one location and **new article** for "**Stand-Alone Systems**" added to address the operating parameters for electric power production sources in a stand-alone mode
- New article covers electric power production sources operating in a stand-alone mode
- Stand-alone power system, sometimes referred to as a remote area power supply, is an **off-the-grid electricity system** for locations not fitted with an electricity distribution system
- Stand-alone power systems will typically include one or more methods of electricity generation, energy storage, and regulation

Article 710 Stand-Alone Systems *(cont.)*

- While these safety requirements existed in Articles 690, 692 and 694, the requirements for a stand-alone system should apply to other power sources such as engine generators
- Stand-alone systems are expected to become more prevalent due to emerging technology in energy storage and local generation

Article 710 Stand-Alone Systems

A new article for "Stand-Alone Systems" was added to address the operating parameters for electric power production sources in a stand-alone mode



Stand-alone power systems typically include one or more methods of electricity generation, energy storage, and regulation

Article 712
Direct Current Microgrids

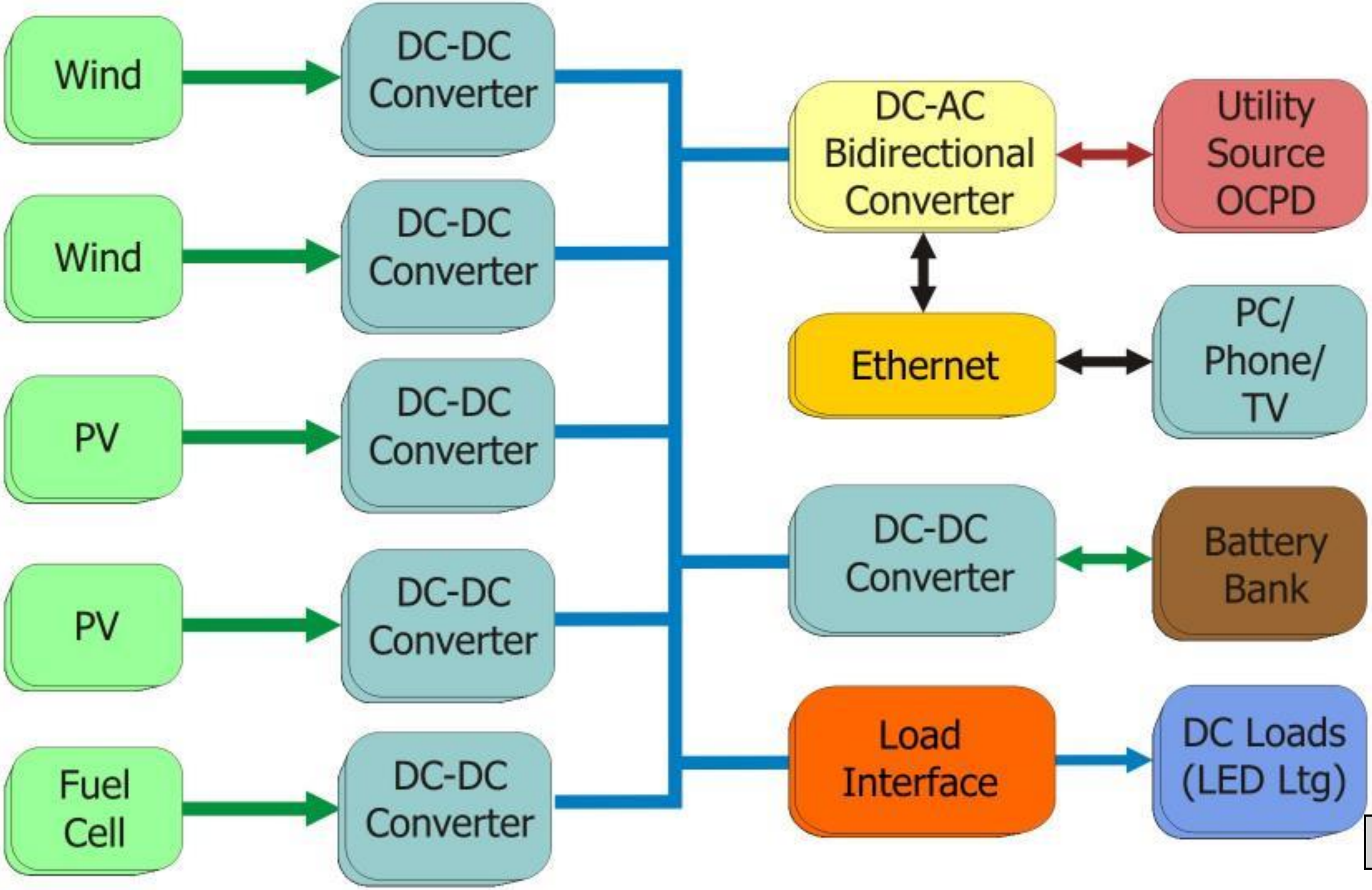
- New Article 712 "**Direct Current Microgrids**" added for power distribution systems consisting of more than one interconnected dc power sources, supplying:
    - dc-dc converters(s)
    - dc loads(s) and/or
    - ac loads(s) powered by dc-ac inverters(s)
- A dc microgrid typically **not directly connected to an ac primary source of electricity**, but some dc microgrids interconnect via one or more dc-ac bi-directional converters or dc–ac inverters
- DC microgrids related to direct utilization of power from dc sources to dc loads such as LED lighting, communications equipment, computers, variable-speed motor drives, etc.

Article 712
Direct Current Microgrids *(cont.)*

- DC microgrids with energy storage offer **inherent resilience and security** from failure of primary power sources
- Need for higher efficiency in **telecom and data centers** has driven these industries to implement dc microgrids in hundreds of data centers around the world
- While the basic requirements for wiring methods, overcurrent protection and grounding are specified in other articles of the *NEC*, they do not cover all of the issues involved when dc multiple sources and dc loads are interconnected
- This is an important first step, and **a place-holder for future requirements** in this rapidly developing arena

Article 712 DC Microgrids

DC Microgrid - A power distribution system consisting of more than one interconnected dc power sources, supplying dc-dc converters(s), dc loads(s), and/or ac loads(s) powered by dc-ac inverters(s).

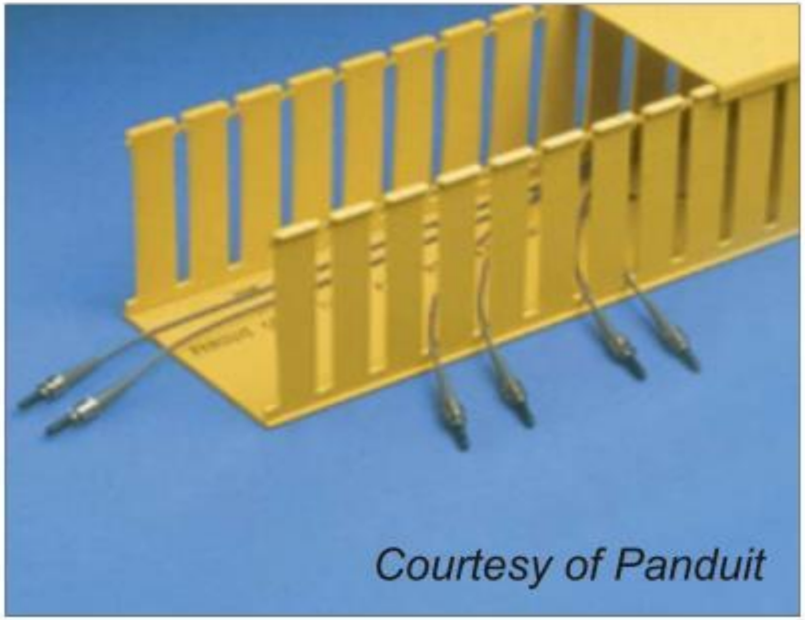


725.3(M) Cable Routing Assemblies and 725.3(N) Communication Raceways

- New requirements added to 725.3 for **cable routing assemblies** and **communications raceways**
- Provide guidance in the selection, listing and installation requirements used for **Class 2, Class 3 and PLTC cables**
- **725.3(M)** provides consistency for **cable routing assemblies** as referenced in Table 800.154(c), 800.182, 800.110(C) and 800.113
- **725.3(N)** provides consistency for **communications raceways** with references to Table 800.154(b), 800.182, 800.113 and 362.24 through 362.56 where requirements applicable to electrical nonmetallic tubing (ENT) apply

725.3(M) Cable Routing Assemblies and 725.3(N) Communications Raceways

New provisions were added to 725.3 (Other Articles) for cable routing assemblies and communications raceways used with Class 2, Class 3 and PLTC cables


Courtesy of Panduit

Cable Routing Assembly

Communications Raceways

New 725.3(M) and (N) will provide guidance in the selection, listing and installation requirements for cable routing assemblies and communication raceways used for Class 2, Class 3 and PLTC cables

725.135(K), (L), and (M) Installation of Type CMUC

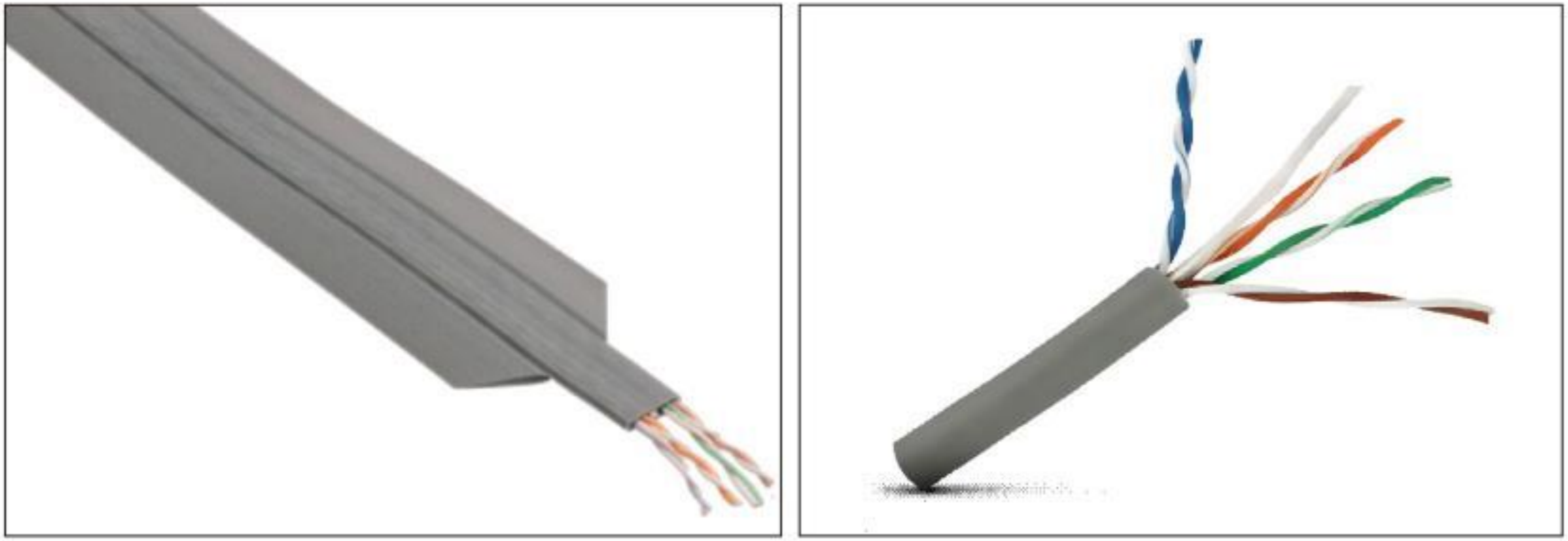
- Type **CMUC undercarpet communication wiring and cables** is now permitted to be installed **under modular flooring, and planks** as well as under carpet
- New *Code* language and Type CMUC applies to one- and two-family dwellings, multifamily dwellings, and other building locations
- Type CMUC is often used in areas that are not easily accessible by traditional cabling methods
- Commercial and retail building owners are rapidly adopting **alternate flooring covering** for use in their facilities in addition to carpet squares, such as modular vinyl planks and tile, laminate and hard wood

725.135(K), (L), and (M) Installation of Type CMUC *(cont.)*

- Type CMUC wire and cable is similar in nature to Type FCC *(flat conductor cable)* addressed at Article 324
- A UL Fact Finding investigation found no additional heating effects caused by the alternate flooring when tested using Type FCC cables
- Type FCC cables carry more power than Type CMUC and the results of the UL fact finding report should be applicable to Type CMUC
- Same change occurred at **800.113(K), (L) and (M)** for the installation of communication wires, cables and raceways, and cable routing assemblies

725.135(K), (L), and (M) Type CMUC Cable

Type CMUC undercarpet communication wiring and cables is permitted to be installed under modular flooring, and planks as well as under carpet



Wiring methods for the installation of Class 2, Class 3, and power-limited tray cables (PLTC) at one- and two-family dwellings, multifamily dwellings, and other building locations is described at 725.135(K), (L), and (M)

This would include CL2P, CL3P, CL2R, CL3R, CL2, CL3, and PLTC cables as well as Type CMUC undercarpet communications wires and cables

725.144 Transmission of Power and Data

(Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits)

- New **725.144** with accompanying **Table 725.144** added to introduce new cable **Type "LP" (Limited Power)** that provides the current limitation due to cable bundling
- Other installation considerations added for **Power over Ethernet (PoE)** type cables
- The **"-LP" cable designation** indicates cable has been evaluated to carry marked current under reasonable worst-case installation scenarios without exceeding the temperature rating of the cable
- These new provisions introduce special cable designs developed that might be used as alternatives to more traditional cables with less restrictions on cable designs and the installations

725.144 Transmission of Power and Data *(cont.)*

(Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits)

- Limited power (LP) cables must be **listed as suitable for carrying power and data circuits** up to a specified current limit for each conductor **without exceeding the temperature rating** of the cable *[see 725.179(I)]*

- Cables must also be marked with the suffix **"-LP"** with the **ampere limit** located immediately following the suffix LP *[example: CL2-LP (1.0A)]*

- New 725.144 and accompanying table added based on **UL Fact Finding Report on Power over Local Area Network Type Cables**

- No conductor (or cable) should be used in such a manner that its operating temperature exceeds its rated maximum temperature

Table 725.144

Table 725.144 Ampacities of Each Conductor in Amperes in 4-Pair Class 2 or Class 3 Data Cables Based on Copper Conductors at an Ambient Temperature of 30°C (86° F) with All Conductors in All Cables Carrying Current, 60°C (140°F), 75°C (167°F), and 90°C (194°F) Rated Cables

AWG	Number of 4-Pair Cables in a Bundle																				
	1			2-7			8-19			20-37			38-61			62-91			92-192		
	Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating		
	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C
26	1	1	1	1	1	1	0.7	0.8	1	0.5	0.6	0.7	0.4	0.5	0.6	0.4	0.5	0.6	NA	NA	NA
24	2	2	2	1	1.4	1.6	0.8	1	1.1	0.6	0.7	0.9	0.5	0.6	0.7	0.4	0.5	0.6	0.3	0.4	0.5
23	2.5	2.5	2.5	1.2	1.5	1.7	0.8	1.1	1.2	0.6	0.8	0.9	0.5	0.7	0.8	0.5	0.7	0.8	0.4	0.5	0.6
22	3	3	3	1.4	1.8	2.1	1	1.2	1.4	0.7	0.9	1.1	0.6	0.8	0.9	0.6	0.8	0.9	0.5	0.6	0.7

Note 1: For bundle sizes over 192 cables, or for conductor sizes smaller than 26 AWG, ampacities shall be permitted to be determined by qualified personnel under engineering supervision.

Note 2: Where only half of the conductors in each cable are carrying current, the values in the table shall be permitted to be increased by a factor of 1.4.

Informational Note: The conductor sizes in data cables in wide-spread use are typically 22–26 AWG.

727.4(5) Ex. to (5)
Uses Permitted for Type ITC-ER Cable

- **New exception** added for **Type ITC-ER cable** to allow transition between cable trays and and utilization equipment or devices for a distance not to exceed **1.8 m (6 ft)** without continuous support where not subject to physical damage
- Same exception exist for power and control tray cable (**Type TC-ER**) at **336.10(7)**
- Cable must be mechanically supported where exiting the cable tray to ensure minimum bending radius is not exceeded
- This will provide consistency between installations practices for Type ITC-ER and Type TC-ER

727.4(5), Ex. to (5) Type ITC-ER Cable

Type ITC cable (without a metallic sheath or armor) that complies with the crush and impact requirements of Type MC cable and is identified for such use with the marking "ITC-ER" shall be permitted to be installed exposed

The cable shall be continuously supported and protected against physical damage using mechanical protection such as dedicated struts, angles, or channels and secured at intervals not exceeding 1.8 m (6 ft)

Instrumentation Tray Cable (Type ITC)

A new exception has been added for Type ITC-ER to allow transition between cable trays and between cable trays and utilization equipment or devices for a distance not to exceed 1.8 m (6 ft) without continuous support where not subject to physical damage

760.176(G) and 760.179(I)
Cable Markings for Fire Alarm Systems

- New **marking requirements** added for temperature ratings and conductor size to be marked on the jacket of **NPLFA** and **PLFA** cables when a temperature rating exceeding **60° C (140 F°)**
- Fire alarm cables must also be marked with **conductor size**
- Temperature rating reference of 60°C (140°F) is consistent with the **product standard listing requirements** for fire alarm cables
- Temperature rating information important when utilizing **“Power over Ethernet” (PoE)** and other technologies where the fire alarm cable pairs carry data and power
- This can be an issue as far as **dissipating generated heat**

760.176(G) and 760.179(I) *(cont.)*
Cable Markings for Fire Alarm Systems

- Current levels on these fire alarm circuits continues to increase *(in some cases as much as 1 ampere)*
- NPLFA and PLFA cables must be marked with the **conductor size** to identify specific size of conductors in the cables so that **determination of maximum current** for fire alarm circuits can be properly evaluated
- In order to design, install, and inspect these systems, **obtainable, detailed information** concerning fire alarm cables is essential

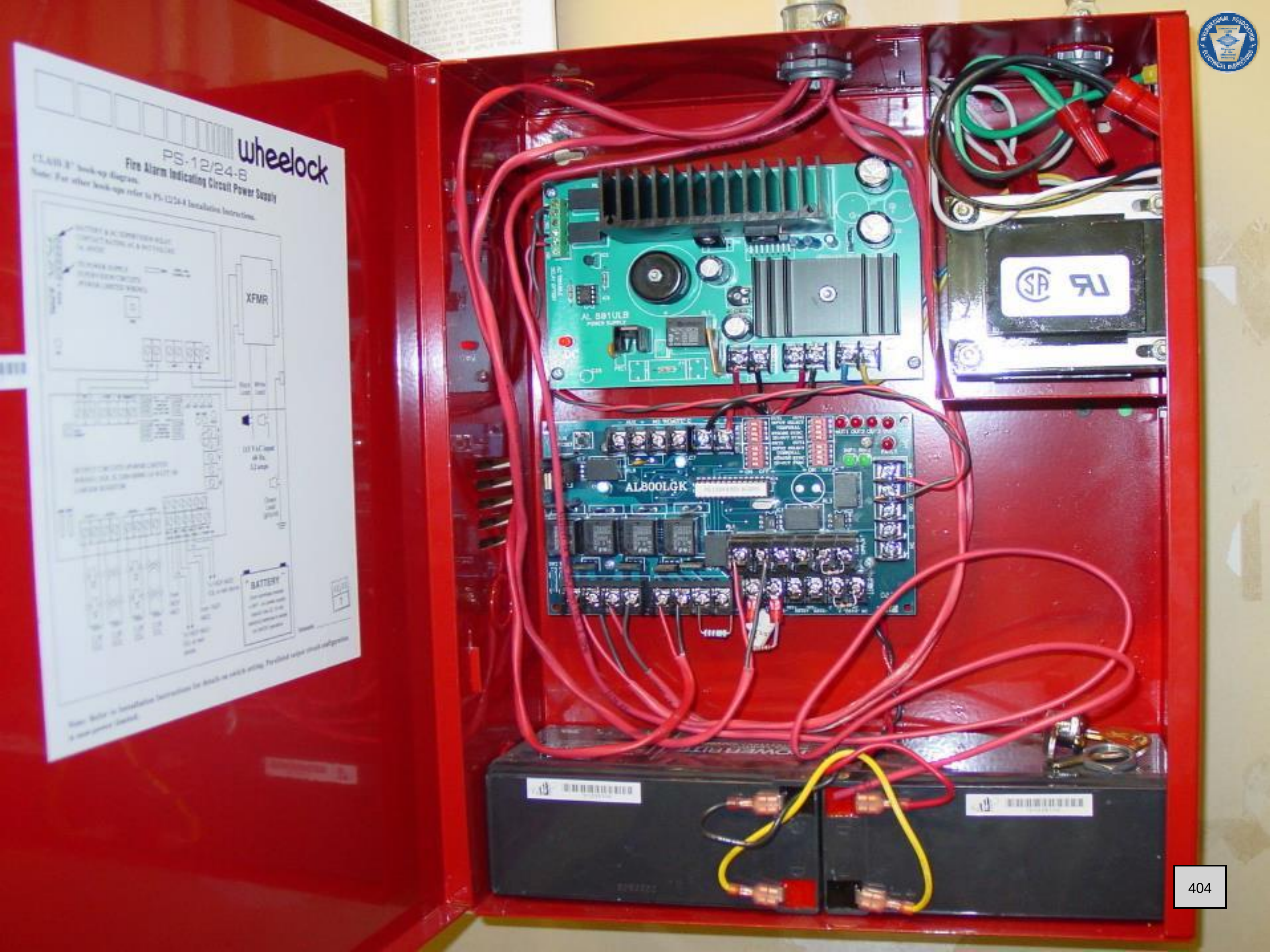
760.176(G) and 760.179(I) Cable Marking

Listing and marking requirements for fire alarms circuits are addressed at 760.176 for NPLFA circuits and 760.179 for PLFA circuits respectfully

Unshielded Non-Plenum Fire Alarm Cable

New marking requirements were added for fire alarm circuits requiring a temperature rating to be marked on the jacket of NPLFA and PLFA cables that have a temperature rating exceeding 60°C (140°F)

The jacket of these cables must now also be marked with the conductor size as well


wheelock
PS-12/24-8
Fire Alarm Indicating Circuit Power Supply
XFMR
BATTERY
AL 881ULB
POWER SUPPLY
AL800LGK

770.44
Overhead (Aerial) Optical Fiber Cables

- New requirements added for **overhead (aerial) optical fiber cables** that **enter a building**

- Previous editions of the *Code* did not contain information pertaining to optical fiber cables installed overhead to a building or structure

- New language structured after same language for overhead *(aerial)* spans located at **800.44** *(Communications Circuits),* **820.44** *(Community Antenna Television and Radio Distribution Systems),* **830.44** *(Network-Powered Broadband Communications Systems),* **840.44** *(Premises-Powered Broadband Communications Systems)*

770.44 *(cont.)*
Overhead (Aerial) Optical Fiber Cables

- Some of the new selected requirements for **overhead (aerial) optical fiber cables** that **enter a building** are as follows:
  - Generally **located below** electric light or power conductors
  - Attachment to cross-arm that carries electric light or power conductors **not permitted**
  - **Climbing space** to comply with **225.14(D)** *[typically 750 mm (30 in.)]*
  - **Minimum separation** of **300 mm (12 in.)** at any point in the span from service drops and sets of overhead service conductors of 0 to 750 volts
  - Vertical clearance of not less than **2.5 m (8 ft)** from all points of **roofs** above which they pass *(with exceptions)*

Overhead Electric Service Drop

Overhead (Aerial) Optical Fiber Cables

770.48 Optical Fiber Cables and Raceways Entering Buildings

- **Point of entrance** for optical fiber cables can now be extended when enclosed in **rigid metal conduit (RMC)** or **intermediate metal conduit (IMC)**
- Optical fiber cables are generally permitted to be installed in building spaces where the length of the cable within the building, measured from its point of entrance, does **not exceed 15 m (50 ft)** and the cable enters the building from the outside and is terminated in an enclosure
- New text allows "**point of entrance**" for optical fiber cable to be extended **anywhere within a building** as long as the entering optical fiber cable is contained in **RMC** or **IMC**
- "**Point of emergence**" becomes the end of said conduit

770.48 Optical Fiber Cables and Raceways Entering Buildings *(cont.)*

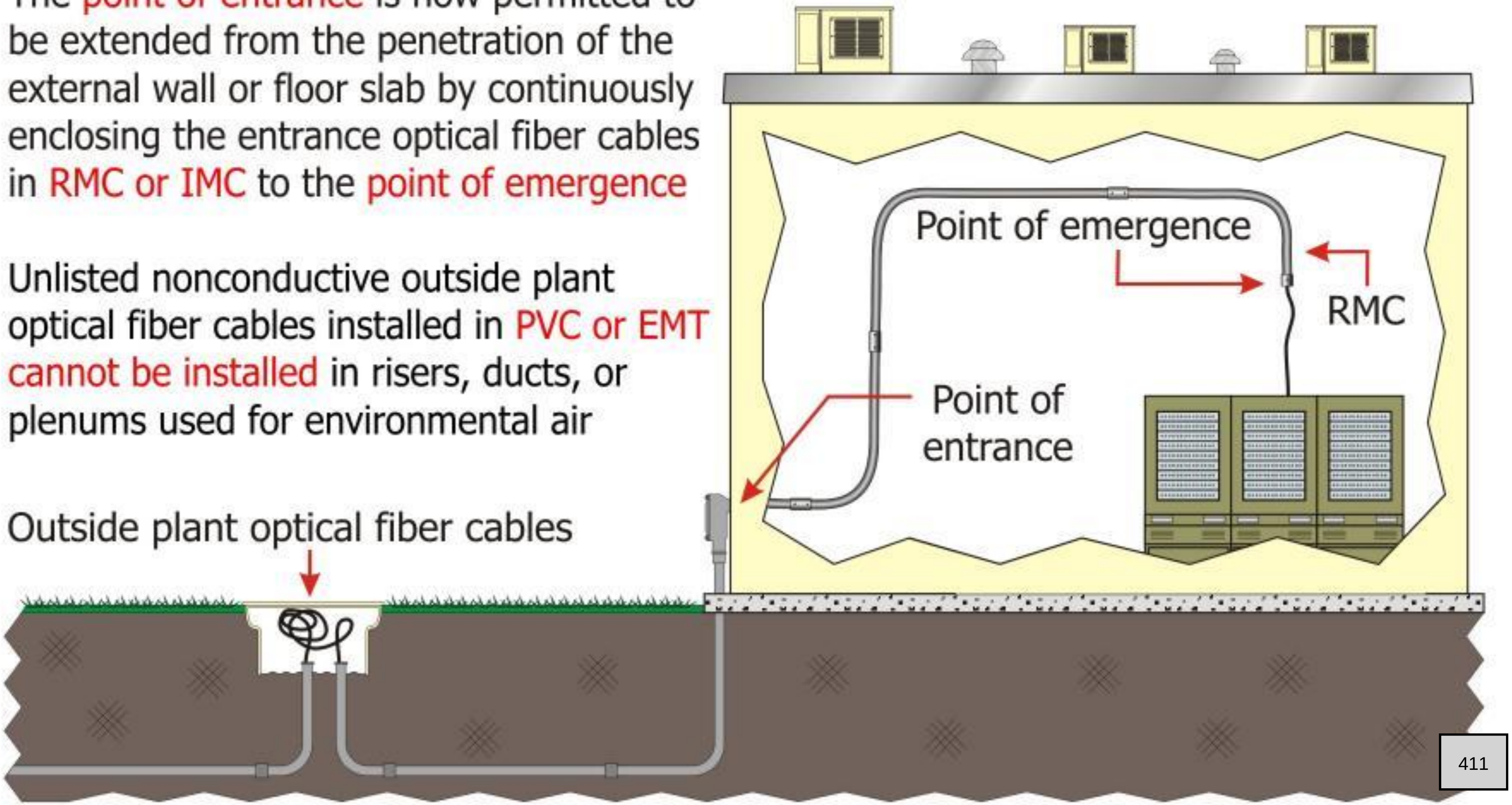
- New language also added at **770.48(B)** to clarify that nonconductive outside plant optical fiber cables installed in **PVC** or **EMT cannot be installed** in risers, ducts and plenums for environmental air, and other places used for **environmental air**
- Provides consistency between requirements of 770.48(A) and (B)
- Same basic change occurred at 800.48 and 820.48
- Title of 770.48 deleted the term “and Raceways” to make Article 770 title consistent with the titles of 800.48 and 820.48

770.48 Optical Fiber Cables Entering Building

Unlisted conductive and nonconductive outside plant optical fiber cables are generally permitted to be installed in building spaces where the length of the cable within the building *(measured from its point of entrance)* does not exceed 15 m (50 ft) and the cable enters the building from the outside and is terminated in an enclosure

The point of entrance is now permitted to be extended from the penetration of the external wall or floor slab by continuously enclosing the entrance optical fiber cables in RMC or IMC to the point of emergence

Unlisted nonconductive outside plant optical fiber cables installed in PVC or EMT cannot be installed in risers, ducts, or plenums used for environmental air

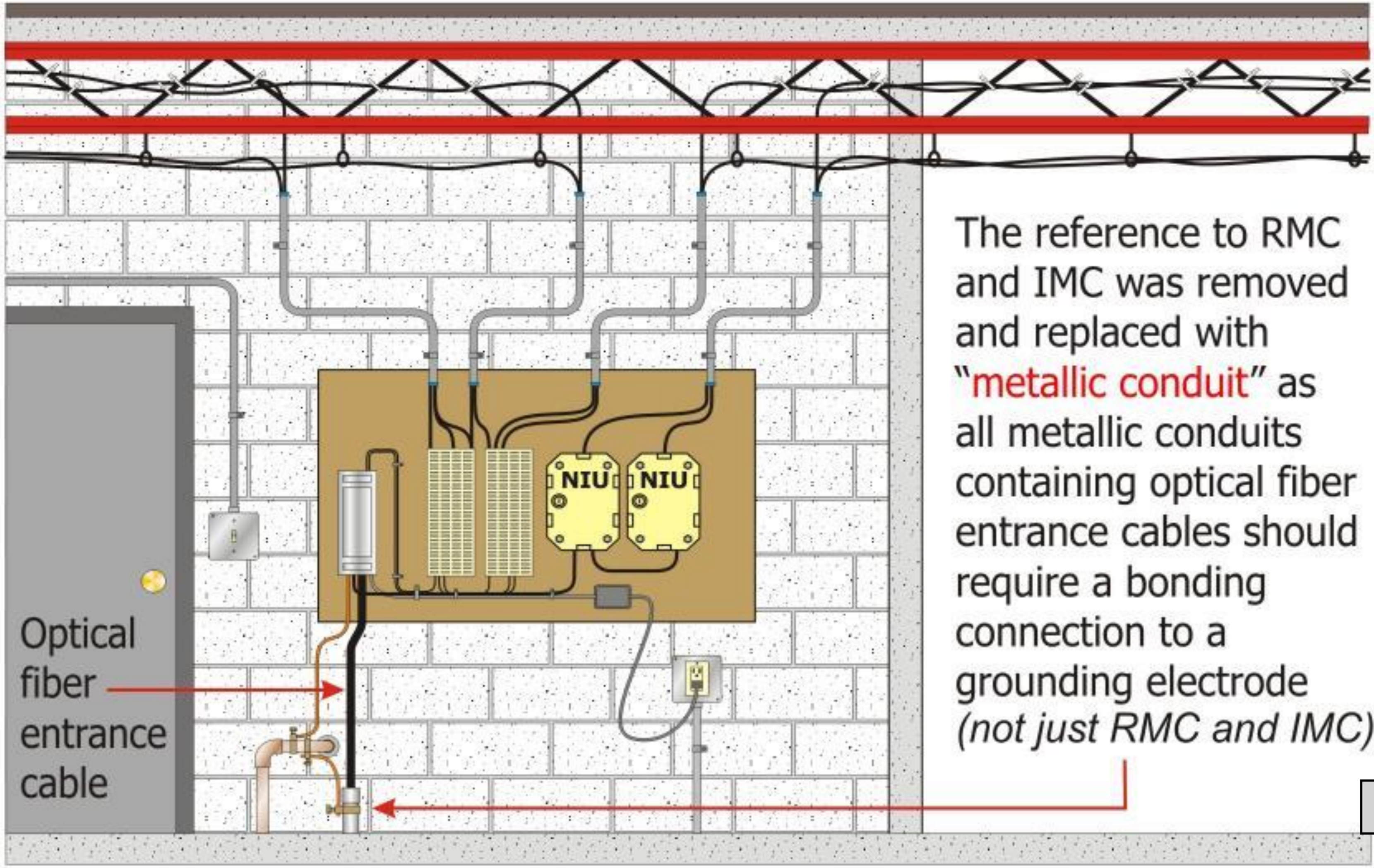


770.49 Metallic Entrance Conduit Grounding for Optical Fiber Cables and Raceways

- **All metallic conduit** *(not just RMC and IMC)* enclosing optical fiber entrance cable must be connected by a **bonding conductor** or **grounding electrode conductor** to a grounding electrode
- As previously written this only applied to rigid metal conduit (RMC) or intermediate metal conduit (IMC)
- Electrical metallic tubing (EMT) should also be grounded and bonded for electrical safety *(see uses permitted)*
- Same change occurred at **800.49** for communications circuits, **820.49** for community antenna television and radio distribution systems, and **830.49** for network-powered broadband communications systems

770.49 Metallic Entrance Conduit Grounding

Metallic conduit containing optical fiber entrance cable shall be connected by a bonding conductor or grounding electrode conductor to a grounding electrode in accordance with 770.100(B)



Optical fiber entrance cable

The reference to RMC and IMC was removed and replaced with "metallic conduit" as all metallic conduits containing optical fiber entrance cables should require a bonding connection to a grounding electrode *(not just RMC and IMC)*

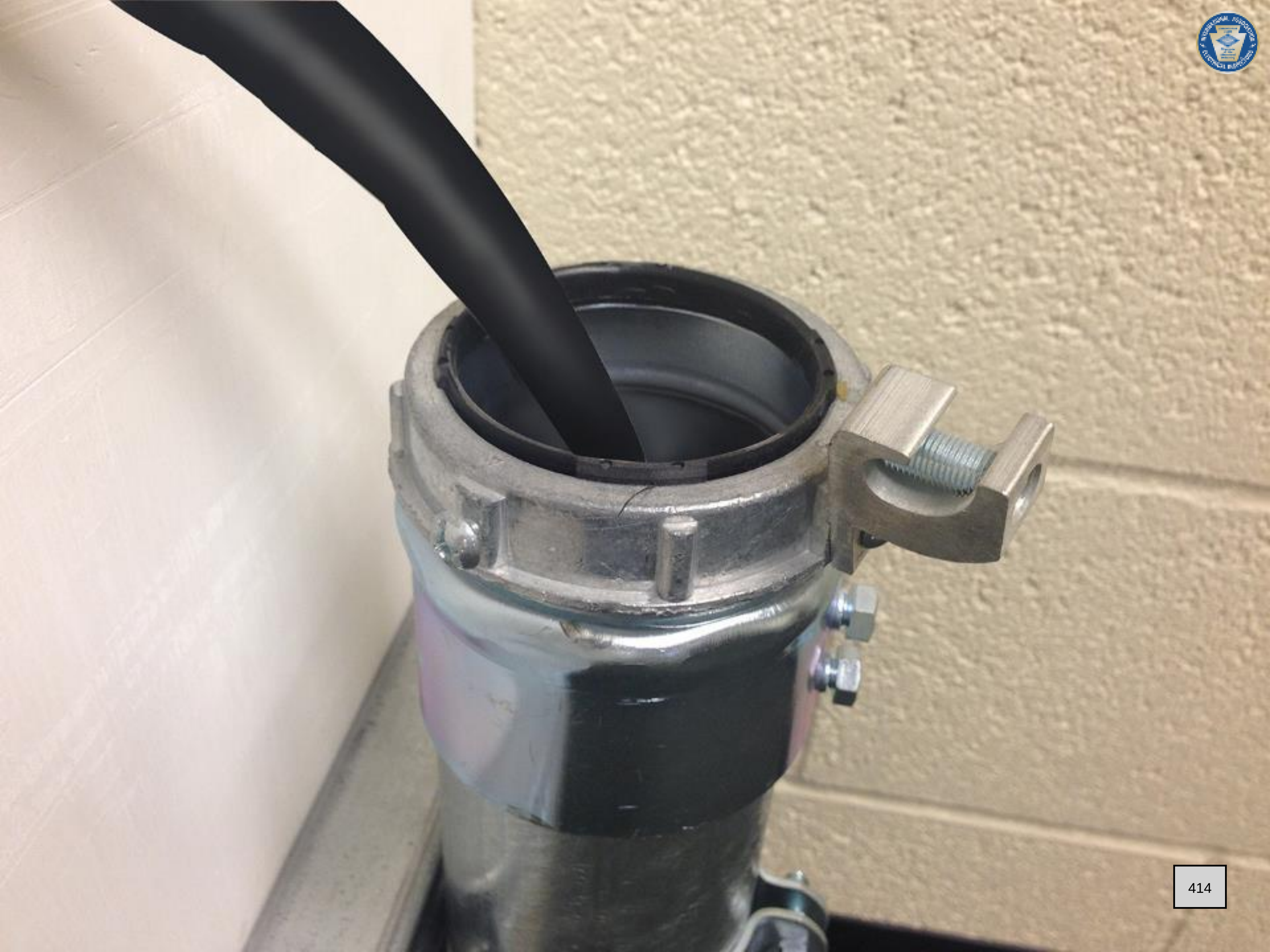


Photo Courtesy of Scott Humphrey

770.100(B)(3)(2) Entrance Cable Bonding and Grounding of Optical Fiber Cables and Raceways

- Revised language added to clarify that **lightning protection system conductors**, *(not just air terminal conductors)*, are **not to be used** as part of the **grounding electrode conductor** or as a **grounding electrode** for optical fiber systems or any communication system in **buildings or structures without intersystem bonding termination or grounding means**
- Term "air terminal conductors (lightning-rod conductors)" was replaced with the broader term "**lightning protection system conductors**"
- Items associated with lightning protections should not be used as a part of the grounding electrode conductor or as a grounding electrode for optical fiber systems or any communication syste

770.100(B)(3)(2) Entrance Cable Bonding and Grounding of Optical Fiber Cables and Raceways

- *Continued from previous slide*
- A lightning protection system is a complete system of rods, cables and groundings designed to intercept a lightning strike and divert it safely to ground (the earth), avoiding structural damage to buildings and other vulnerable objects
- Air terminal conductors are just a part of complete lightning protection system conductors
- Same change occurred at **800.100(B)(3)(2)** for communications circuits, **820.100(B)(3)(2)** for community antenna television and radio distribution systems, and **830.100(B)(3)(2)** for network-powered broadband communications systems

Chapter Eight Communications Systems

810.15 Grounding of Radio and Television Equipment

- Radio and television antennas required to be grounded unless they are located within a **zone of protection** afforded by surrounding taller structures as determined by **"rolling sphere"** theory of lightning protection
- Grounding of masts and metal supporting structures **not required** when antenna and its related supporting mast or structure are within a zone of protection defined by a **46 m (150 ft) radius "rolling sphere"** described in NFPA 780-2014, *Standard for the Installation of Lightning Protection Systems*
- Where sphere is tangent to earth and resting against a strike termination device(s), all space in the vertical plane between the two points of contact and under the sphere is considered to be in the **"rolling sphere" zone of protection**

810.15 Grounding of Radio and Television Equipment *(cont.)*

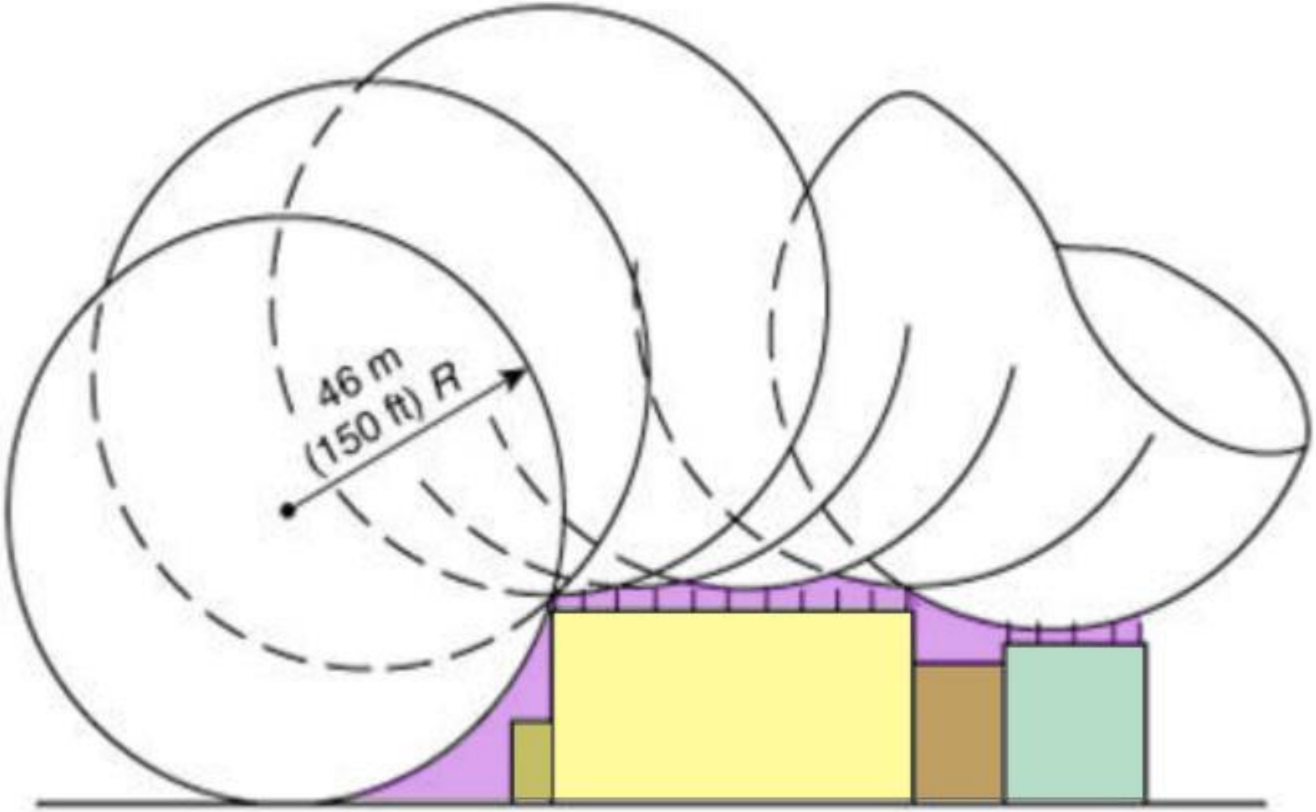
- **All possible placements** of the rolling sphere shall be considered when determining zone of protection using rolling sphere model

- Revision will bring the *Code* up to date with technology surrounding smaller antennas where they are **not likely to be impacted by transient voltages** using the “rolling sphere” model of lightning protection

- Antennas, when installed in protected areas are **highly unlikely to become energized** - no sound reason to require these protected antennas and mast to be grounded per 810.15 and 810.21

810.15 Grounding of Radio and TV Equipment

Masts and metal structures supporting antennas shall be grounded in accordance with 810.21 unless...



Zone of protection as determined by the "Rolling Sphere" method

the antenna and its related supporting mast or structure are within a zone of protection defined by a 46 m (150 ft) radius "rolling sphere"

840.2 Definitions: ~~Optical~~ Network Terminal ~~(ONT)~~ *(Premises-Powered Broadband Communications Systems)*

- Definition of "Optical Network Terminal (ONT)" was revised to "**Network Terminal**"
- This more generic term of "Network Terminal" helps to expand the coverage of Article 840 to recognize **twisted-pair** and **coaxial cable** in addition to **optical fiber** based systems
- Types of **twisted-pair cable** include unshielded twisted-pair (UTP) and shielded twisted-pair (STP)
- The other transmission medium that was recognized was the **coaxial cable system** which can provide a higher transmission rate than twisted-pair

840.2 Definitions: Network Terminal

~~Optical~~ Network Terminal ~~(ONT)~~. A device that converts ~~an optical signal~~ network-provided signals (optical, electrical, or wireless) into component signals, including voice, audio, video, data, wireless, optical, and interactive ~~service electrical~~ services, and is considered ~~to be~~ a network ~~interface equipment~~ device on the premises that is connected to a communications service provider and is powered at the premises.

Revisions occured throughout Article 840 to accommodate twisted pair-based and coaxial cable-based systems in addition to optical fiber-based systems for premises-powered broadband communication systems

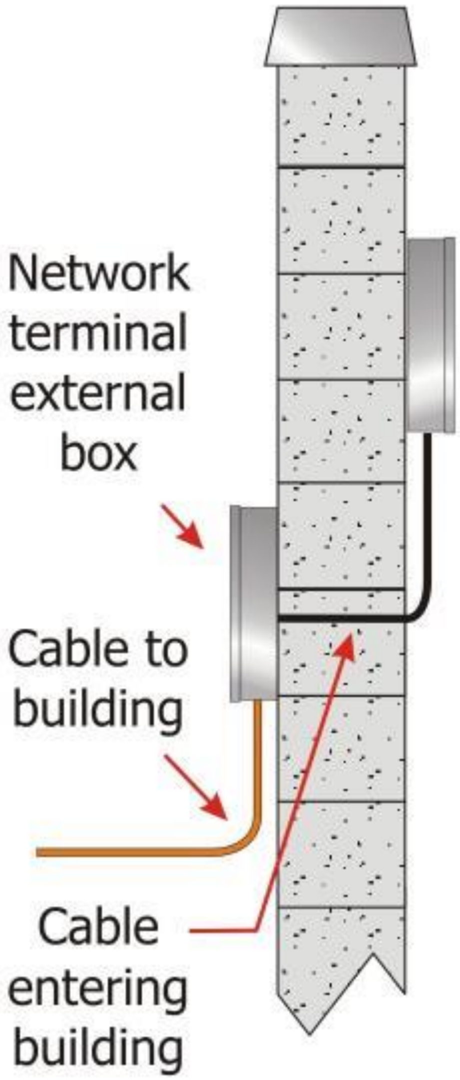
840.48 Unlisted Wires and Cables Entering Buildings *(PPBCS)*

- Three new first level subdivisions which outline specific requirements for unlisted optical fiber cables, communication wires and cables, and coaxial cables were added to 840.48
- Premises-powered broadband communications system *(PPBCS)* wires and cables will now be required to comply with:
  - **770.48** for unlisted **optical fiber cables** entering buildings
  - **800.48** for unlisted communications wires and unlisted multipair **communications cables** entering buildings
  - **820.48** for unlisted **coaxial cables** entering buildings
- Title was changed to "**Unlisted Wires and Cables Entering Buildings**" rather than "Unlisted Cables and Raceways Entering Buildings" as this section deals with **wires and cables**

840.48 Unlisted Wires and Cables Entering Buildings *(PPBCS) (cont.)*

- Articles 770, 800, and 820 each have paragraphs that describe how unlisted communication cables are permitted to be installed where the length of the cable within the building, measured from the point of entrance, **does not exceed 15 m (50 ft)** and the cable enters the building from the outside
- These same rules will now apply to premises-powered broadband communications system wires and cables

840.48 Unlisted Wires and Cables Entering Buildings

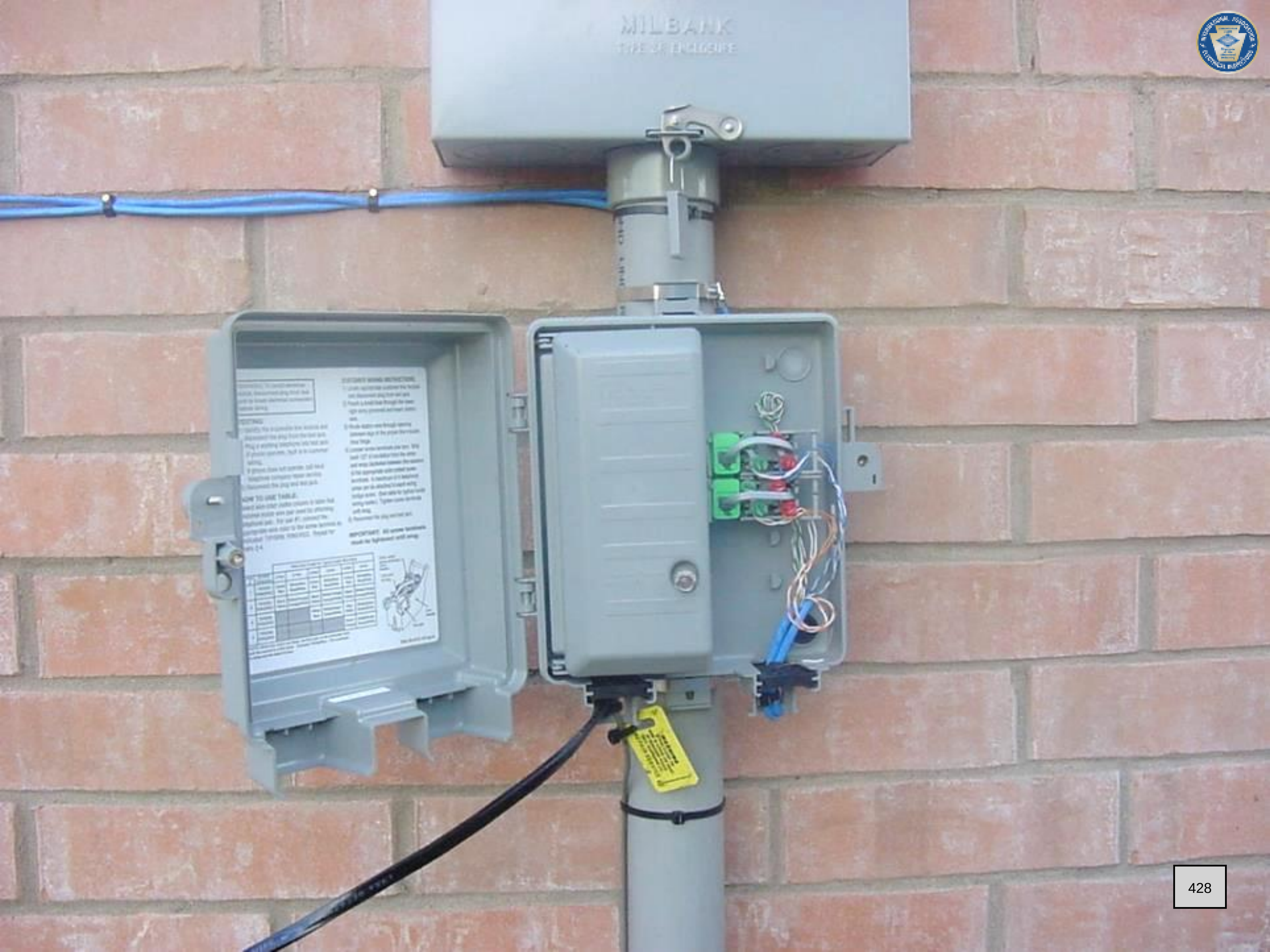


Installations of unlisted premises-powered broadband communication wires and cables entering buildings shall comply with 840.48(A), (B), or (C), as applicable

(A) Optical Fiber Cables - Installations of unlisted optical fiber cables entering buildings shall comply with 770.48

(B) Communications Wires and Cables - Installations of unlisted communications wires and unlisted multipair communications cables entering buildings shall comply with 800.48

(C) Coaxial Cables - Installations of unlisted coaxial cables entering buildings shall comply with 820.48


MILBANK
TYPE 3R ENCLOSURE

840.160 Premises Powering of Communications Equipment over Communications Cables

- New 840.160 *(Powering Circuits)* added with direction to new 725.144 for power delivery circuits that exceed **60 watts** on communications cables
- New requirements give permission for communication cables to carry circuits for powering communications equipment
- Where power supplied over a communications cable is **greater than 60 watts**, communication cables and the power circuit **must comply with new 725.144** where communications cables are used in place of Class 2 and Class 3 cables
- A new type of "**limited-power**" cable has been introduced to simplify the cable choice and installation considerations
- New "LP" cables are marked Type CMP-LP, Type CMR-LP and Type CM-LP

840.160 Powering Circuits

New 840.160 (Powering Circuits) was added under new Part VI (Premises Powering of Communication Equipment over Communication Cables) with direction to new 725.144 for power delivery circuits that exceed 60 watts on communications cables

Ethernet Switch

UPS

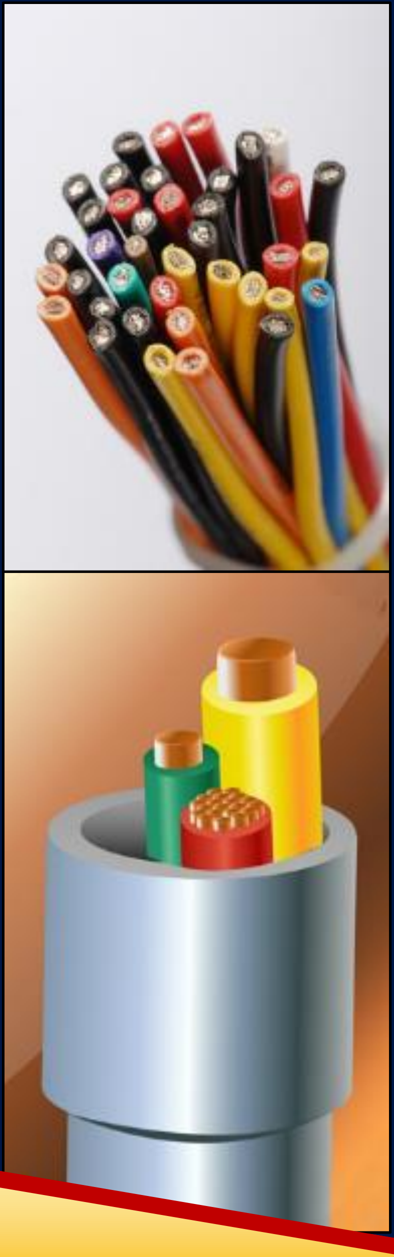
Power Over Ethernet
(PoE) Midspan Hub

Wireless LAN
Access Point

Voice Over
IP Phone

Bluetooth
Access Point

Internet Protocol
(IP) Camera



Chapter Nine
Tables

Chapter 9, Notes to Tables, Note 9

- New language added at Note 9 to specify assemblies of **single insulated conductors** without an overall covering are **not considered a cable** when determining conduit and tubing fill area
- Conduit or tubing fill for the assemblies is to be calculated **based upon the individual conductors**
- Note 9 of the notes to the tables of Chapter 9 directs users of the *Code* to treat multiconductor cables, optical fiber cables, or flexible cords of two or more conductors as a **single conductor** for calculating percentage conduit or tubing fill area
- If cable is an **elliptical-shaped cable** (such as nonmetallic-sheathed cable), cross-sectional area calculation shall be based on using the **major diameter of the ellipse as a circle diameter**

Chapter 9, Notes to Tables, Note 9 *(cont.)*

- Provision for conduit fill for cables is intended to allow the cable wiring methods in Chapter 3 to be considered as a **single entity when calculating conduit fill**
- Industry practice has developed of twisting several single conductors together and placing the assembly on one reel for shipping and installation
- This twisting action does not change the essential nature of the pull or the product or change the conduit fill properties of the individual conductors *(does not make this a cable)*
- This new language will provide clarity to this sometimes misinterpreted cable application

Chapter 9, Notes to Tables, Note 9

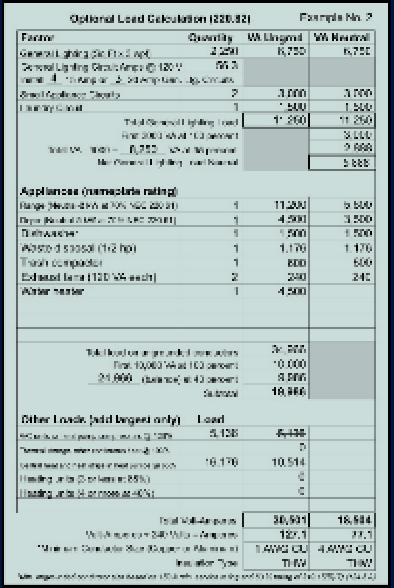
A multiconductor cable, optical fiber cable, or flexible cord of two or more conductors shall be treated as a single conductor for calculating percentage conduit or tubing fill area

For cables that have elliptical cross sections, the cross-sectional area calculation shall be based on using the major diameter of the ellipse as a circle diameter

Assemblies of single insulated conductors without an overall covering shall not be considered a cable when determining conduit or tubing fill area

The conduit or tubing fill for the assemblies shall be calculated based upon the individual conductors

Twisted "assembly" with
(4) individual conductors



Optional Load Calculation (220.82) Example No. 2

Factor	Quantity	VA Ungrnd	VA Neutral
General Lighting ([illegible])	2,250	6,750	6,750
General Lighting Circuit Amps @ 120 V [illegible] 4 15 Amp or 3 20 Amp [illegible] Circuits	56.3		
Small Appliance Circuits	2	3,000	3,000
Laundry Circuit	1	1,500	1,500
Total General Lighting Load		11,250	11,250
First 3000 VA at 100 percent			3,000
Total VA – 3000 = 8,250 VA at 35 percent			2,888
Net General Lighting Load Neutral			5,888
Appliances (nameplate rating)			
Range ([illegible])	1	11,200	[illegible]
Dryer ([illegible])	1	[illegible]	3,500
Dishwasher	1	1,500	1,500
Waste disposal (1/2 hp)	1	1,176	1,176
Trash compactor	1	800	800
Exhaust fans (120 VA each)	2	240	240
Water heater	1	4,500	
Total load on ungrounded conductors		[illegible]	
First 10,000 VA at 100 percent		10,000	
[illegible] (balance) at 40 percent		[illegible]	
Subtotal		[illegible]	
Other Loads (add largest only)	**Load**		
[illegible]	[illegible]	[illegible]	
[illegible]		[illegible]	
[illegible]	[illegible]	[illegible]	
Heating units ([illegible])		[illegible]	
Heating units ([illegible])		[illegible]	
Total Volt-Amperes		[illegible]	[illegible]
[illegible] 240 Volts = Amperes		[illegible]	[illegible]
[illegible] Conductor Size (Copper or Aluminum)		1 AWG CU	4 AWG CU
Insulation Type		THW	THW

[illegible]

Informative Annexes

Informative Annex D – Example D3 Store Building

- Example D3 *(Store Building)* was revised to remove the "**125%**" for continuous loads for calculating the volt-amperes (VA) for the **actual connected lighting loads**
- Factoring a continuous connected lighting load at 125% is **not appropriate in the "Calculated Load" section** of this example
- No such "125%" factor in the 220.12 provision
- Factoring for continuous loads at **125% is covered in the "Minimum Size Feeder *(or Service)* Overcurrent Protection"** as required by 215.3 or 230.90 respectively

Informative Annex D-Example D3 (Store Building)

A store 50 ft by 60 ft, or 3000 ft^2, has 30 ft of show window. There are a total of 80 duplex receptacles. The service is 120/240 V, single phase 3-wire service. Actual connected lighting load is 8500 VA.

Calculated Load *(see 220.40)*

Noncontinuous Loads

Receptacle Load *(see 220.44)*	80 receptacles at 180 VA	14,400 VA
10,000 VA at 100%		10,000 VA
14,400 VA − 10,000 VA = 4400 at 50%		2,200 VA
	Subtotal	12,200 VA

Continuous Loads

General Lighting*	3000 ft^2 at 3 VA/ft^2	9,000 VA
Show Window Lighting Load	30 ft at 200 VA/ft *[see 220.14(G)]*	6,000 VA
Outside Sign Circuit *[see 220.14(F)]*		1,200 VA
	Subtotal	16,200 VA
	Subtotal from noncontinuous	12,200 VA
	Total noncontinuous loads + continuous loads =	28,400 VA

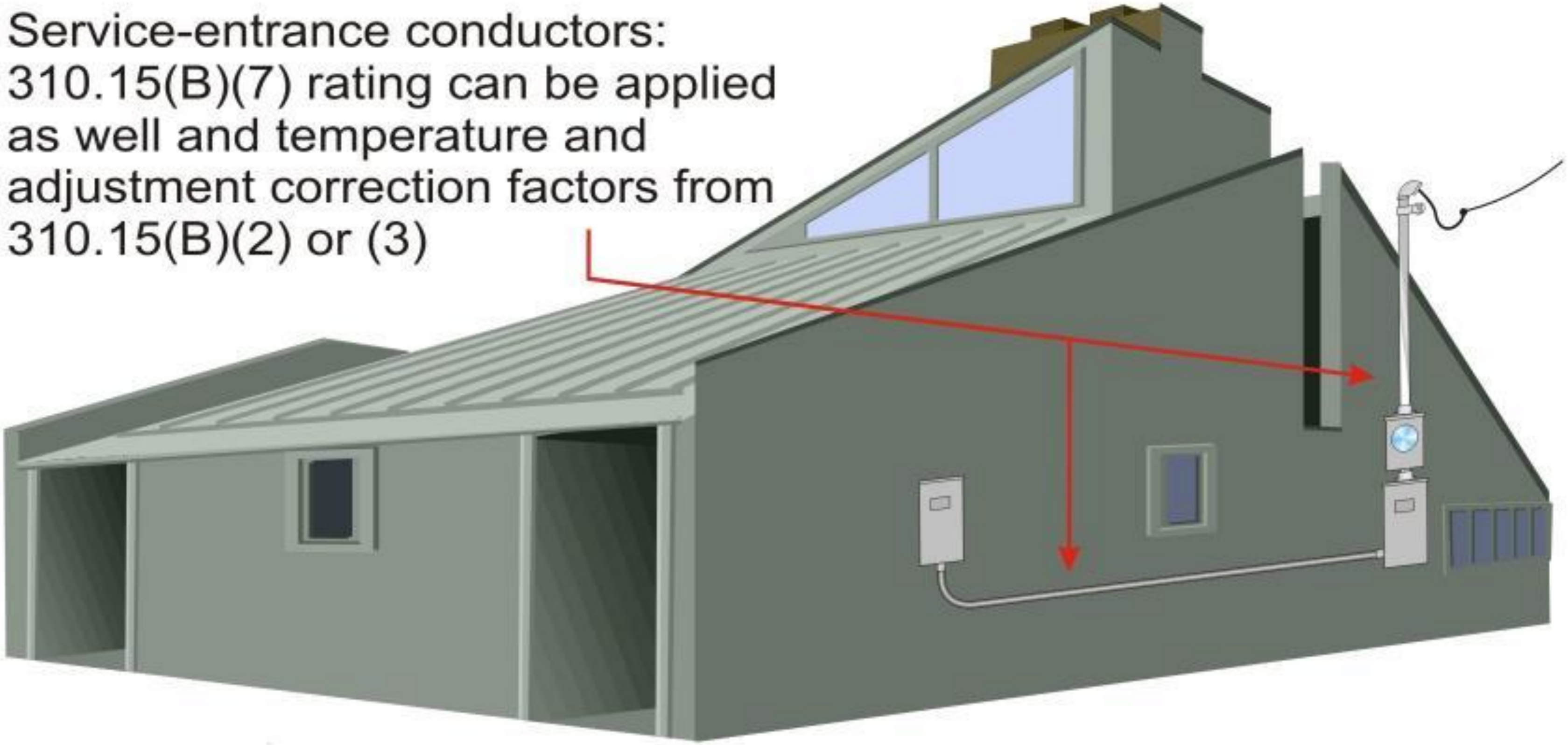
*In the example, ~~125% of~~ the actual connected lighting load (8500 VA ~~× 1.25 = 10,625 VA~~) is less than ~~125% of~~ the load from Table 220.12, so the minimum lighting load from Table 220.12 is used in the calculation. Had the actual lighting load been greater than the value calculated from Table 220.12, ~~125% of~~ the actual connected lighting load would have bee used.

Informative Annex D, Example D7 Sizing of Service Conductors for Dwelling(s)

- Example for "**Sizing of Service Conductors for Dwelling(s)**" revised clarifying the use of **temperature corrections** and **adjustment factors**
- New text added at **310.15(B)(7)** indicates that where correction or adjustment factors are required by **310.15(B)(2) or (3)**, they are **permitted to be applied** to the ampacity associated with the temperature rating of the conductor
- Example D7 now has two examples:
  - "With No Required Adjustment or Correction Factors"
  - "With Required Temperature Correction Factor"
- **Previous Table 310.15(B)(7)** inserted after the example for reference and use

Informative Annex Example D7 [310.15(B)(7)] Sizing of Service Conductors for Dwelling(s)

Example D7 for “Sizing of Service Conductors for Dwelling(s)” has been revised clarifying the use of temperature corrections and adjustment factors along with the 83% adjustment from 310.15(B)(7)



Service-entrance conductors: 310.15(B)(7) rating can be applied as well and temperature and adjustment correction factors from 310.15(B)(2) or (3)

Previous Table 310.15(B)(7) was inserted after Example D7 for reference and use with sizing of dwelling unit service and main feeder conductors

Informative Annex D - Example D7
Sizing of Service Conductors for Dwelling(s)
[Former Table 310.15(B)(7)]

If no temperature correction or ampacity adjustment factors are required, the following table includes conductor sizes calculated using the requirements in 310.15(B)(7). This table is based on 75°C terminations and without any adjustment or correction factors.

	Conductor (AWG or kcmil)	
Service or Feeder Rating (Amperes)	Copper	Aluminum or Copper-Clad Aluminum
100	4	2
110	3	1
125	2	1/0
150	1	2/0
175	1/0	3/0
200	2/0	4/0
225	3/0	250
250	4/0	300
300	250	350
350	350	500
400	400	600

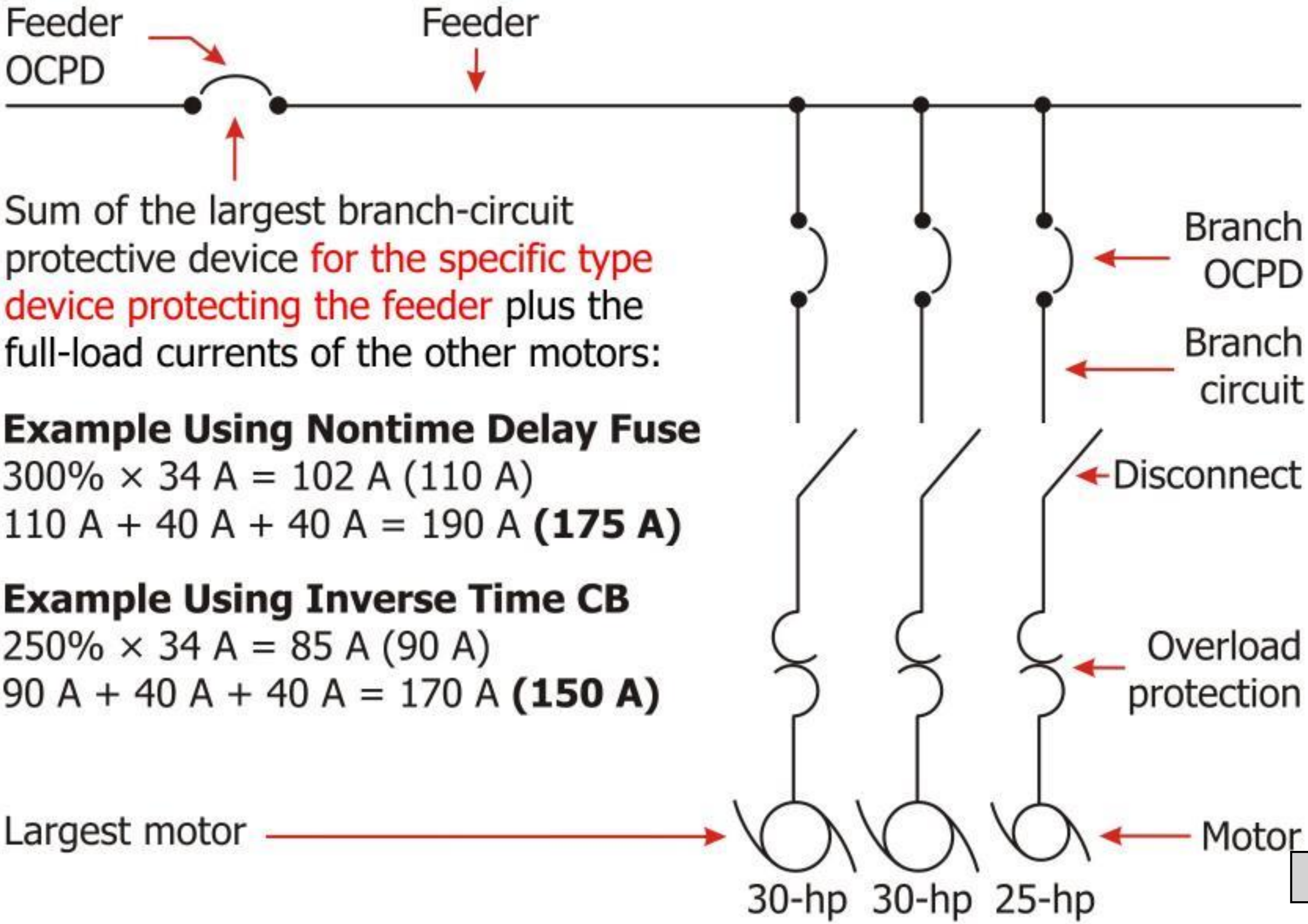
Informative Annex D – Example D8
Motor Feeder Short-Circuit and Ground-Fault

- Example D8 was revised to provide an additional example using different types of protective devices for feeder short-circuit and ground-fault protection
- “Feeder Short-Circuit and Ground-Fault Protection” portion to show:
  - (a) Example using **nontime delay fuse** and
  - (b) Example using **inverse time circuit breaker**
- New phrase "***for the specific device protecting the feeder***" properly corresponds with 430.62(A)

Informative Annex D – Example D8 *(cont.)* Motor Feeder Short-Circuit and Ground-Fault

- Example D8 is based on:
  - One **25-hp**, 460-V, 3-phase, squirrel-cage motor, nameplate full-load current **32 A**, Design B, Service Factor 1.15
  - Two **30-hp**, 460-V, 3-phase, wound-rotor motors, nameplate primary full-load current **38 A**, nameplate secondary full-load current 65 A, 40°C rise.
- The rating of the feeder protective device is based on the sum of the largest branch-circuit protective device **for the specific type of device protecting the feeder**, plus the sum of the full-load currents of the other motors

Informative Annex D - Example D8
Feeder Short-Circuit and Ground-Fault Protection



Sum of the largest branch-circuit protective device for the specific type device protecting the feeder plus the full-load currents of the other motors:

Example Using Nontime Delay Fuse

300% × 34 A = 102 A (110 A)

110 A + 40 A + 40 A = 190 A **(175 A)**

Example Using Inverse Time CB

250% × 34 A = 85 A (90 A)

90 A + 40 A + 40 A = 170 A **(150 A)**

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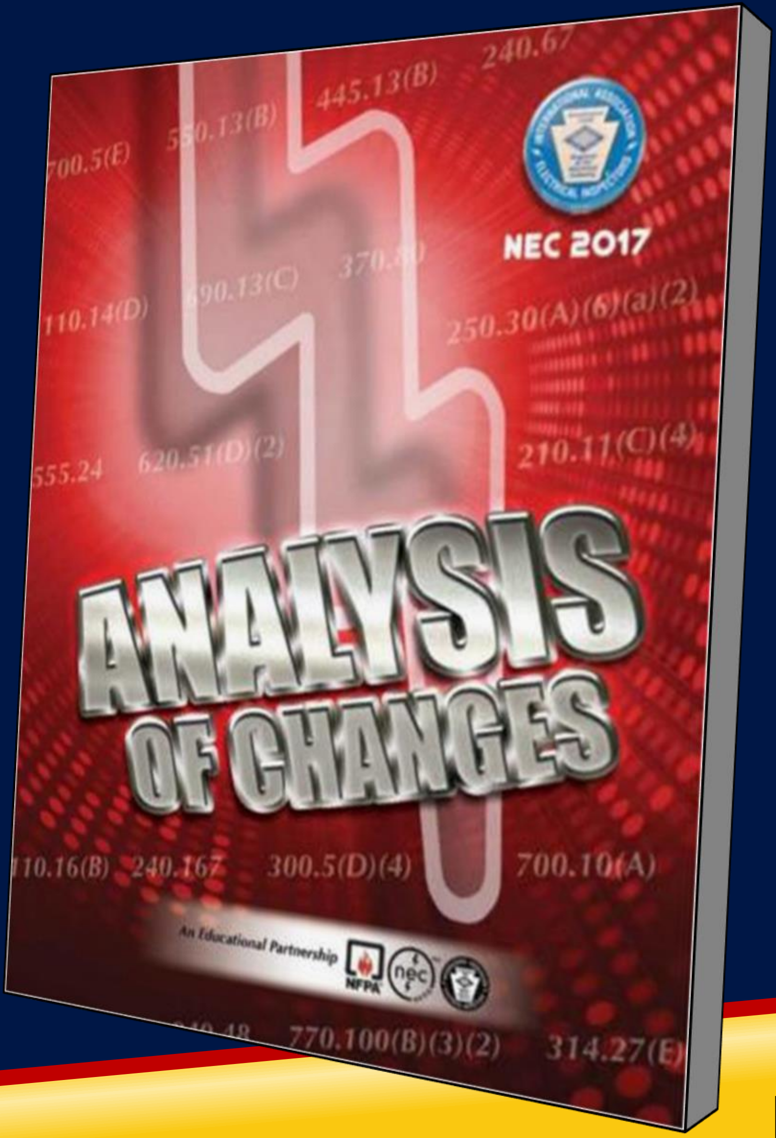

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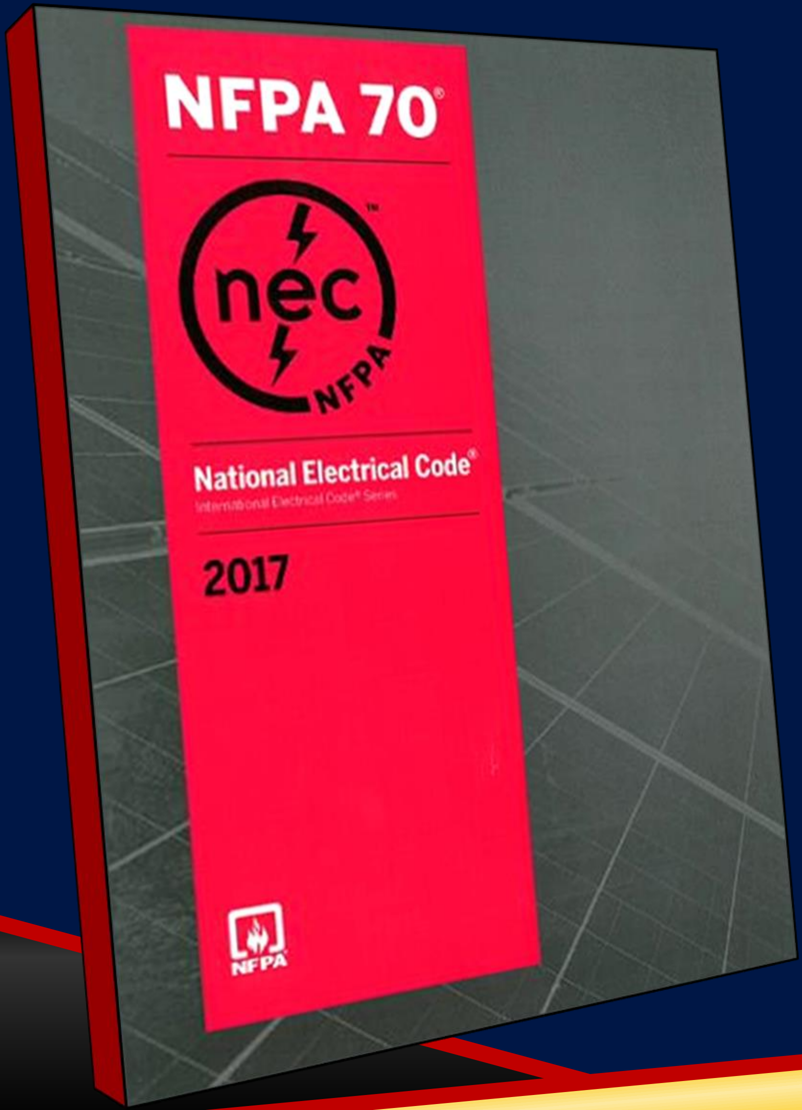
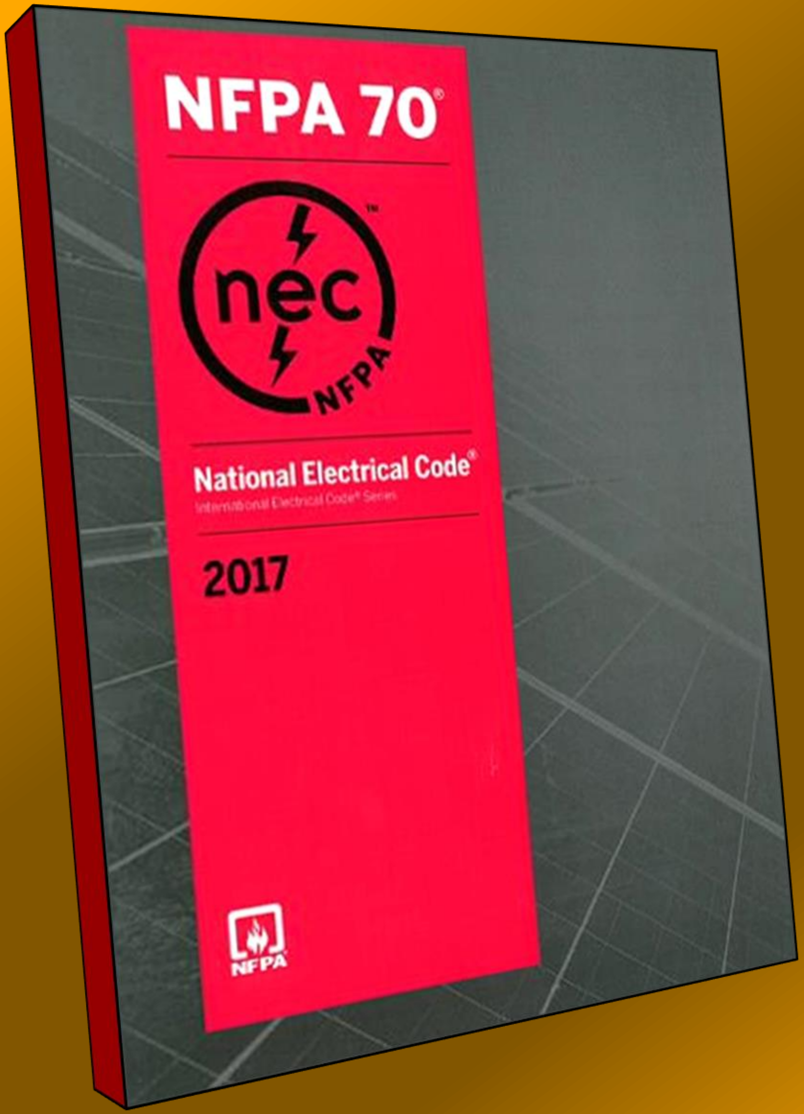
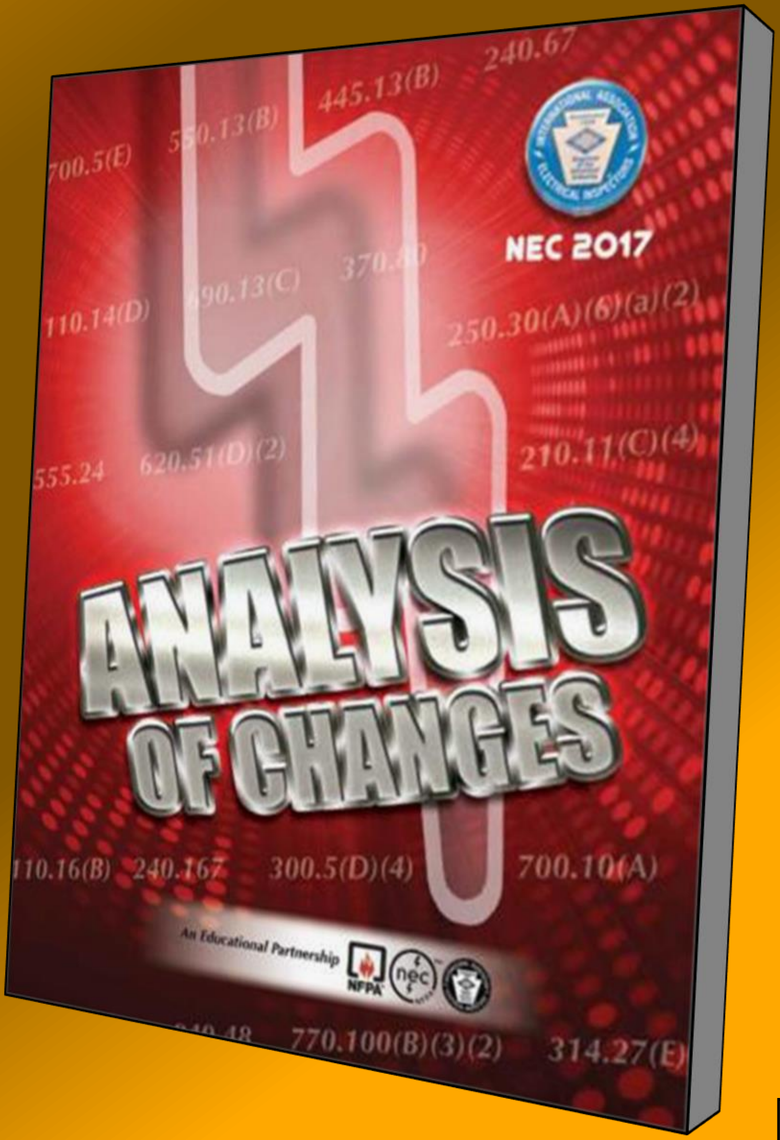


Analysis of Changes-2017 NEC



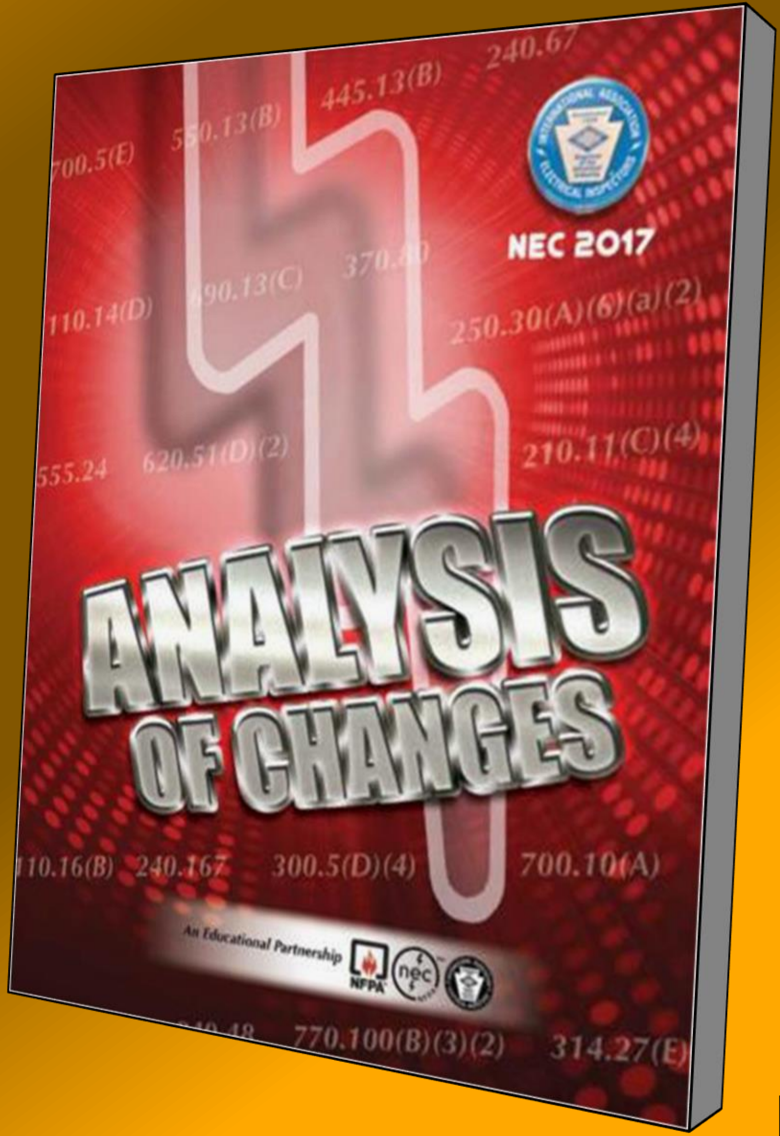


Analysis of Changes-2017 NEC

INTERNATIONAL ASSOCIATION ELECTRICAL INSPECTORS

Established 1928

Keystone of the Electrical Industry



NEC 2017

ANALYSIS OF CHANGES

An Educational Partnership

Code-Wide Changes

Code-Wide Changes

- There were approximately **4,102** public inputs (PI) and **1,513** public comments (PC) submitted for modifications to the 2017 edition of the *NEC*
- **Definitions Relocated to Article 100.** Several existing definitions which appeared in the definitions of a particular article have been relocated to Article 100 as these terms are also found in other articles, not just the article where the previous definition was located
- **Limited Access Working Space.** New requirements added at 110.26(A)(4) concerning working space for equipment located in a space with limited access *(above suspended ceiling, crawl spaces, etc.)*

Code-Wide Changes *(cont.)*

- **Documentation of Available Short-Circuit Current.** There were several new requirements added throughout the *NEC* involving the documentation of the available short-circuit current (fault current) at specific types of equipment, and the date the short-circuit current calculation was performed, with this documentation made available to the AHJ
- **600 Volts to 1000 Volts.** Numerous changes for the voltage threshold continued this *Code* cycle for other articles within the *NEC* increasing the threshold from 600 volts to 1000 volts
- **New Articles.** Five new articles added to the 2017 *NEC*

Code-Wide Changes

Definitions Relocated to Article 100

Limited Access Working Space

600 Volts Threshold to 1000 Volts

Available Short-Circuit Current

Code-Wide Changes: (5) New Articles

Article 425 Fixed Resistance and Electrode Industrial Process Heating Equipment. This article covers fixed industrial process heating employing electric resistance or electrode heating technology (boilers, electrode boilers, duct heaters, strip heaters, immersion heaters, process air heaters, or other approved fixed electric equipment used for industrial process heating).

Article 691 Large-Scale Photovoltaic (PV) Electric Power Production Facility. This article covers the installation of large-scale PV electric power production facilities operated for the sole purpose of providing electric supply to a system operated by a regulated utility for the transfer of electrical energy with a generating capacity of no less than 5,000 kW (generating stations, substations, associated generator, storage battery, transformer, and switchgear areas).

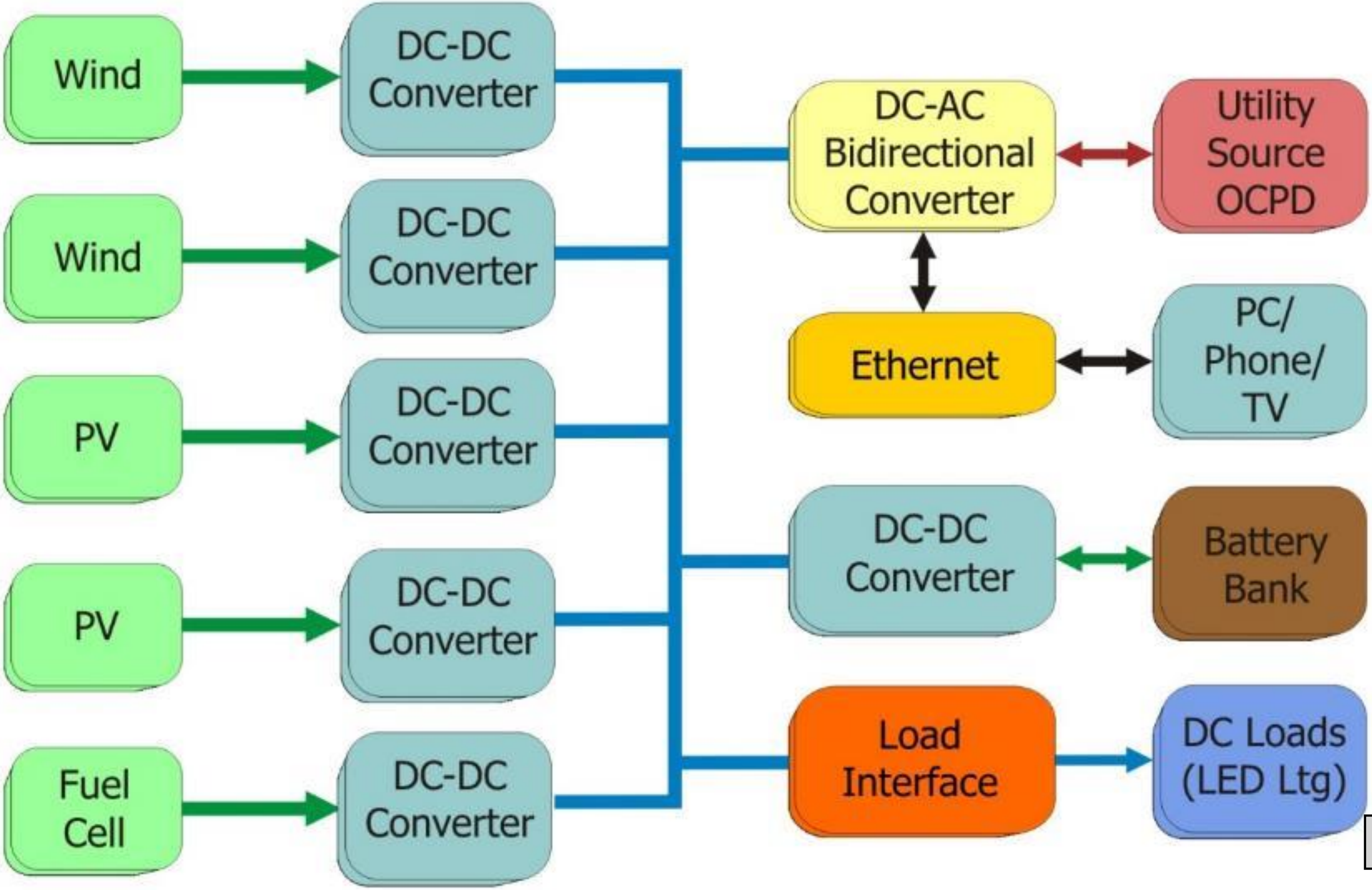
Article 706 Energy Storage Systems. This article applies to all permanently installed energy storage systems (ESS) operating at over 50 volts ac or 60 volts dc that may be stand-alone or interactive with other electric power production sources.

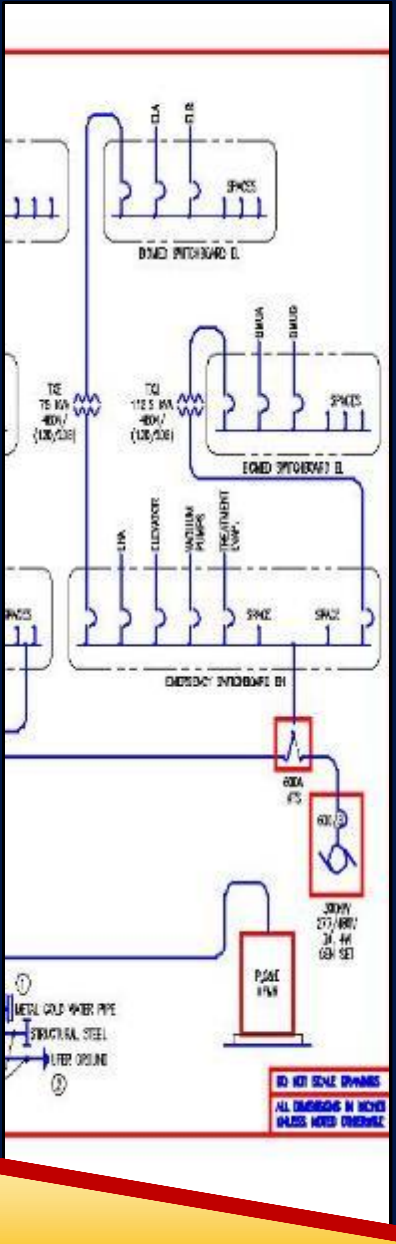
Article 710 Stand-Alone Systems. This article covers electric power production sources operating in stand-alone mode.

Article 712 Direct Current Microgrids (DC Microgrids). This article applies to direct current microgrids, which is a power distribution system consisting of more than one interconnected dc power sources, supplying dc-dc converters(s), dc loads(s), and/or ac loads(s) powered by dc-ac inverters(s).

Article 712 DC Microgrids

DC Microgrid - A power distribution system consisting of more than one interconnected dc power sources, supplying dc-dc converters(s), dc loads(s), and/or ac loads(s) powered by dc-ac inverters(s).





Article 90 Introduction

90.3 Code Arrangement

- Chapters 5 - 7 may supplement or modify the general requirements in Chapters 1 through 7 *(not just Chapters 1 - 4)*
- Revision to 90.3 and Figure 90.3 will now indicate that Chapters 5, 6, and 7 can supplement or modify Chapters 1 through 7
- Rules in these latter chapters to not only modify Chapters 1 through 4 but can modify each other as well
- Figure 90.3 is a “roadmap” of the *NEC*

90.3 Code Arrangement

- Chapter 1 - General
- Chapter 2 - Wiring and Protection
- Chapter 3 - Wiring Methods and Materials
- Chapter 4 - Equipment for General Use

Applies generally to all electrical installations

Supplements or modifies Chapters 1 through 7

- Chapter 5 - Special Occupancies
- Chapter 6 - Special Equipment
- Chapter 7 - Special Conditions

- Chapter 8 - Communication Systems

Chapter 8 is NOT subject to the requirements of Chapters 1 through 7 except where the requirements are specifically referenced in Chapter 8

- Chapter 9 - Tables

Applicable as referenced

- Informative Annexes A through J

Information only - not mandatory

Chapter One
General

Article 100 Definitions: Accessible, Readily *(Readily Accessible)*

- **Accessible, Readily.** 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
- Informational Note: Use of keys is a common practice under controlled or supervised conditions and a common alternative to the ready access requirements under such supervised conditions as provided elsewhere in the *NEC*
- The use of a key is not considered taking an action such as the use of a "tool" to gain ready access
- Crawling under or over something to get to equipment required to be readily accessible is no longer acceptable


April
June
Mesquite
Mesquite
Mesquite
AT&T

Article 100 Definitions: Associated Apparatus

- The definition of "Associated Apparatus" was relocated to Article 100
- **Associated Apparatus *[as applied to Hazardous (Classified) Locations]*.** Apparatus in which the circuits are not necessarily intrinsically safe themselves but that affects the energy in the intrinsically safe circuits and is relied on to maintain intrinsic safety. Such apparatus is one of the following:
  - (1) Electrical apparatus that has an alternative type of protection for use in the appropriate hazardous *(classified)* location
  - (2) Electrical apparatus not so protected that shall not be used within a hazardous *(classified)* location

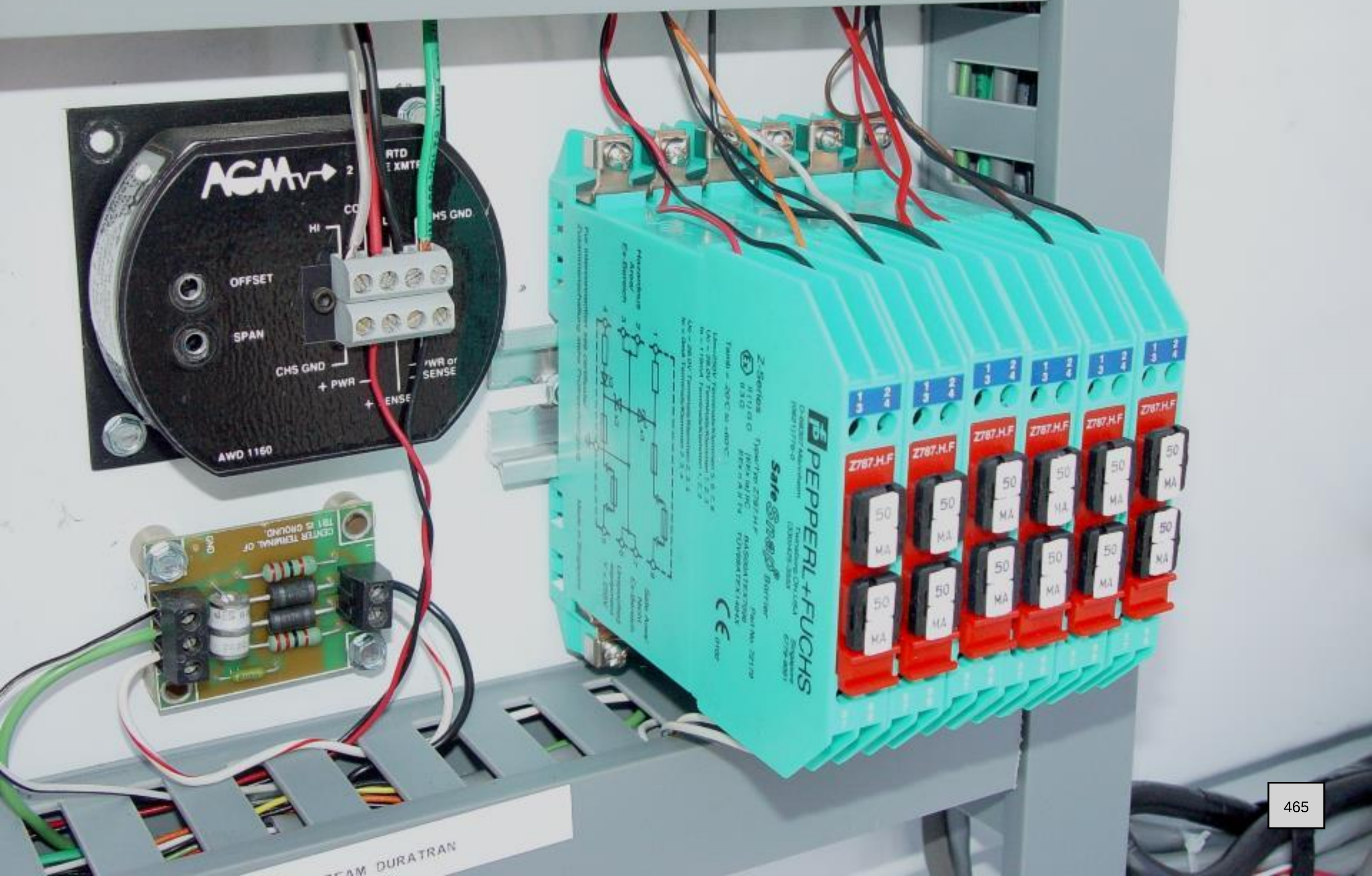
Article 100 Definitions: Associated Apparatus *(cont.)*

- **Informational Note No. 1:** Associated apparatus has identified intrinsically safe connections for intrinsically safe apparatus and also may have connections for nonintrinsically safe apparatus.

- **Informational Note No. 2:** An example of associated apparatus is an intrinsic safety barrier, which is a network designed to limit the energy (voltage and current) available to the protected circuit in the hazardous *(classified)* location, under specified fault conditions.

- This relocation coincides with the relocation of **14 existing definitions** that were located at 500.2 that will now be located in Article 100

Intrinsically safe barriers *(Associated Apparatus)* installed in an IS control panel

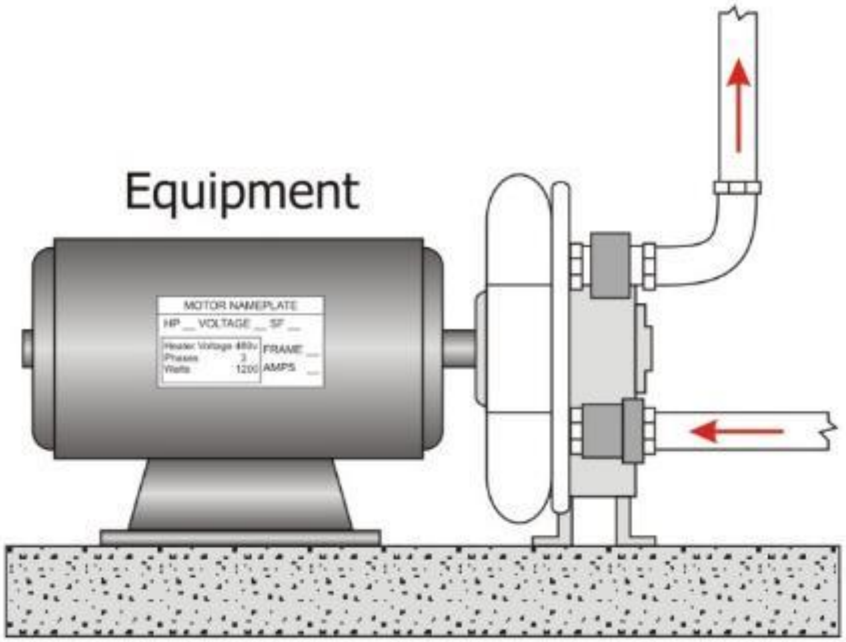


Article 100 Definitions: "Building" and "Structure"

- The related definitions for "**Building**" and "**Structure**" were revised to align with current Building Code terms
- Definition of "**Building**" included unnecessary text that has been removed as it was better suited for the Building Code
- "**Structure**" was defined as that which was built or constructed and could be interpreted as to included equipment
- Including new language "**other than equipment**" to the definition of "**Structure**" will reduce confusion
- Equipment can be mounted on a structure, but the equipment itself is not a "**Structure**"

Article 100 Definitions: Building and Structure

Building



Structure

Building - A structure that stands alone or that is ~~cut off~~ separated from adjoining structures by fire walls ~~with all openings therein protected by approved fire doors~~.

Structure - That which is built or constructed, other than equipment.


HEEDE
SOUTHEAST
SKYTRAK
AMERIMIX


blink
blink
blink
EV
blink

Article 100 Definitions: Coaxial Cable

- **Coaxial Cable.** A cylindrical assembly composed of a conductor centered inside a metallic tube or shield, separated by a dielectric material, and usually covered by an insulating jacket.
- The definition of "**Coaxial Cable**" was relocated to Article 100 to have an application to other articles across the *NEC*
- Definition was previously located at 820.2
- The term "**Coaxial Cable**" appears in Articles 800, 820, 830 and 840
- Definitions of terms that appear in two or more articles are to be located in Article 100 *(NEC Style Manual)*

Coaxial Cable

Article 100 Definitions:
Field Evaluation Body (FEB) and Field Labeled

- Two new terms were added for "**Field Evaluation Body (FEB)**" and "**Field Labeled**"
- **Field evaluations** of electrical products are a recognized process in the electrical community
- In order for the *NEC* to use terms related to a **field evaluation**, these terms need to be defined
- **Field evaluation** is a process whereby products that do not have a certification acceptable to AHJ, owner, or other regulatory body can be evaluated to **applicable product safety standard(s)** for the specific application and location where the product is being utilized
- Definitions are extracted material from **NFPA 790** *(Standard for Competency of Third-Party Field Evaluation Bodies)*

Article 100 Definitions: Field Labeled and Field Evaluation Body (FEB)

Field Evaluation Body (FEB). An organization or part of an organization that performs field evaluations of electrical or other equipment. [NFPA 790, 2012]

Field Labeled (as applied to evaluated products). Equipment or materials to which has been attached a label, symbol, or other identifying mark of an FEB indicating the equipment or materials were evaluated and found to comply with requirements as described in an accompanying field evaluation report.

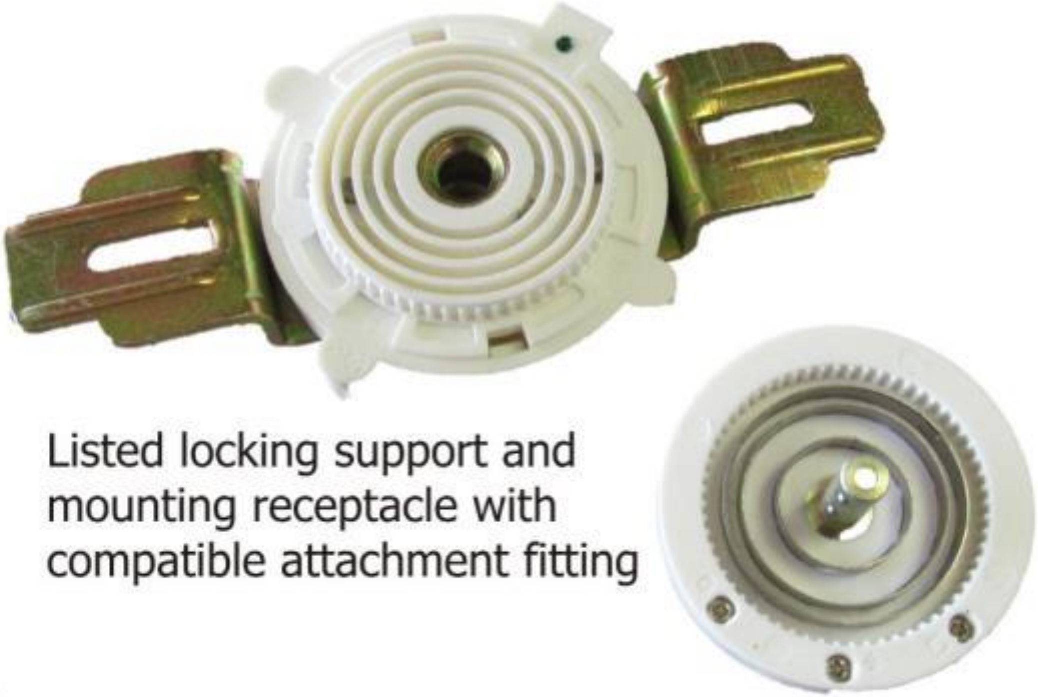
Article 100 Definitions: Receptacle

- The definition of a "**receptacle**" has been revised to recognize mating devices used to install luminaires and ceiling-suspended (paddle) fans

- Definition accommodates electrical utilization equipment employing a means to connect directly to the corresponding contact device *(**other than a traditional attachment plug cap**)*

- Revised definition was necessary to correlate with new **314.27(E)** *(Separable Attachment Fittings)*

Article 100 Definitions: Receptacle



Listed locking support and mounting receptacle with compatible attachment fitting

Courtesy of Safety Quick Lighting and Fans Corp

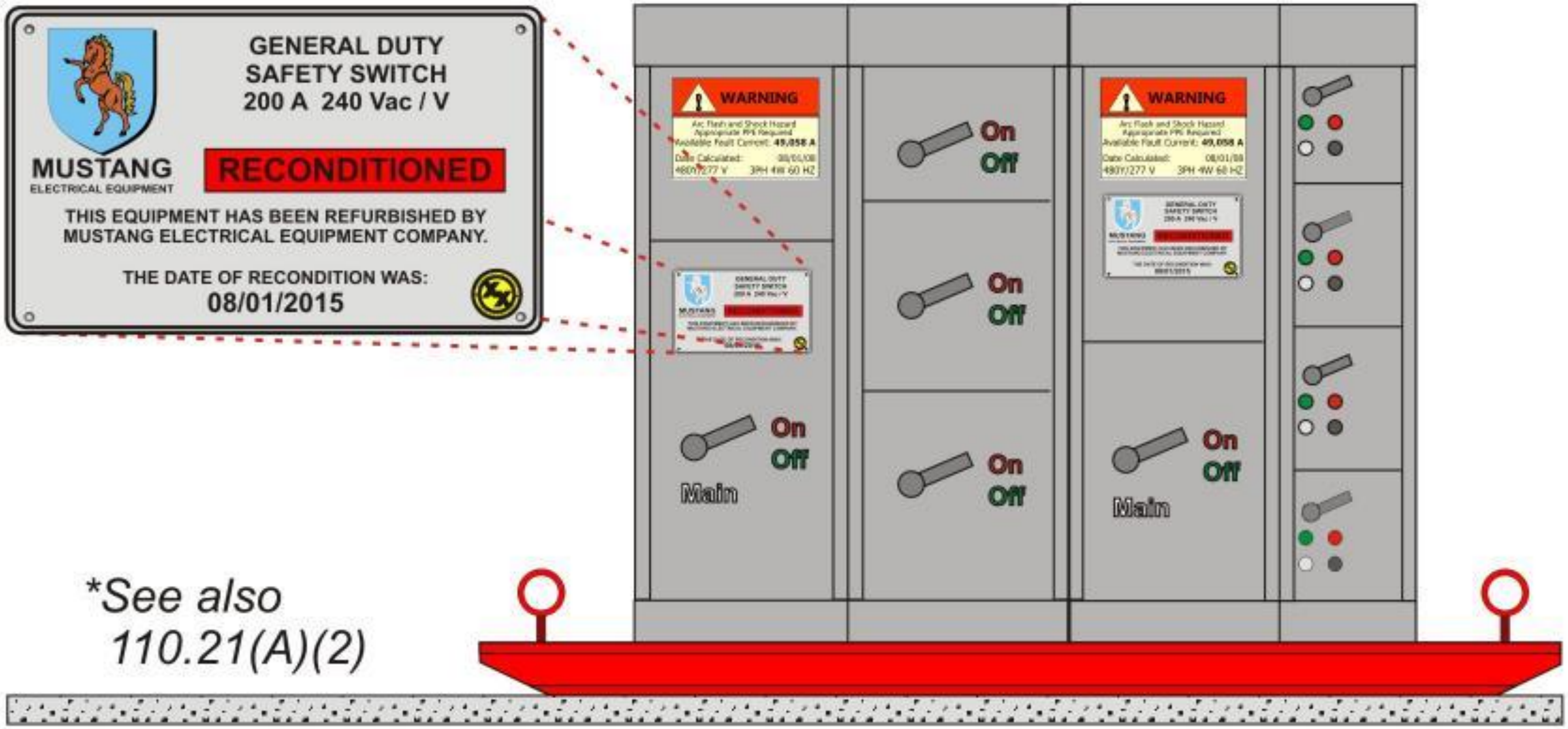
Receptacle. A contact device installed at the outlet for the connection of an attachment plug, or for the direct connection of electrical utilization equipment designed to mate with the corresponding contact device. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is two or more contact devices on the same yoke.

110.3(A)(1), Informational Note No. 1 Examination of Equipment

- New I-Note added indicating equipment may be new, **reconditioned**, **refurbished** or **remanufactured**
- “Examination” judgement was presumed to be reserved for “new” equipment
- Reconditioned, refurbished and remanufactured electrical equipment is now widely used in all types of industry to replace, upgrade or further the life cycle of existing equipment
- In some cases, the existing electrical equipment is no longer being produced or the manufacturer is no longer in business
- New **110.21(A)(2)** provides additional guidance for refurbished, reconditioned, or remanufactured equipment **markings and nameplate requirements**

110.3(A)(1) I-Note No. 1 Examination

In judging equipment, considerations of such things as suitability for installation and use in conformity with the *NEC* shall be part of the evaluation process



*See also
110.21(A)(2)

Informational Note No. 1: Equipment may be new, reconditioned, refurbished, or remanufactured

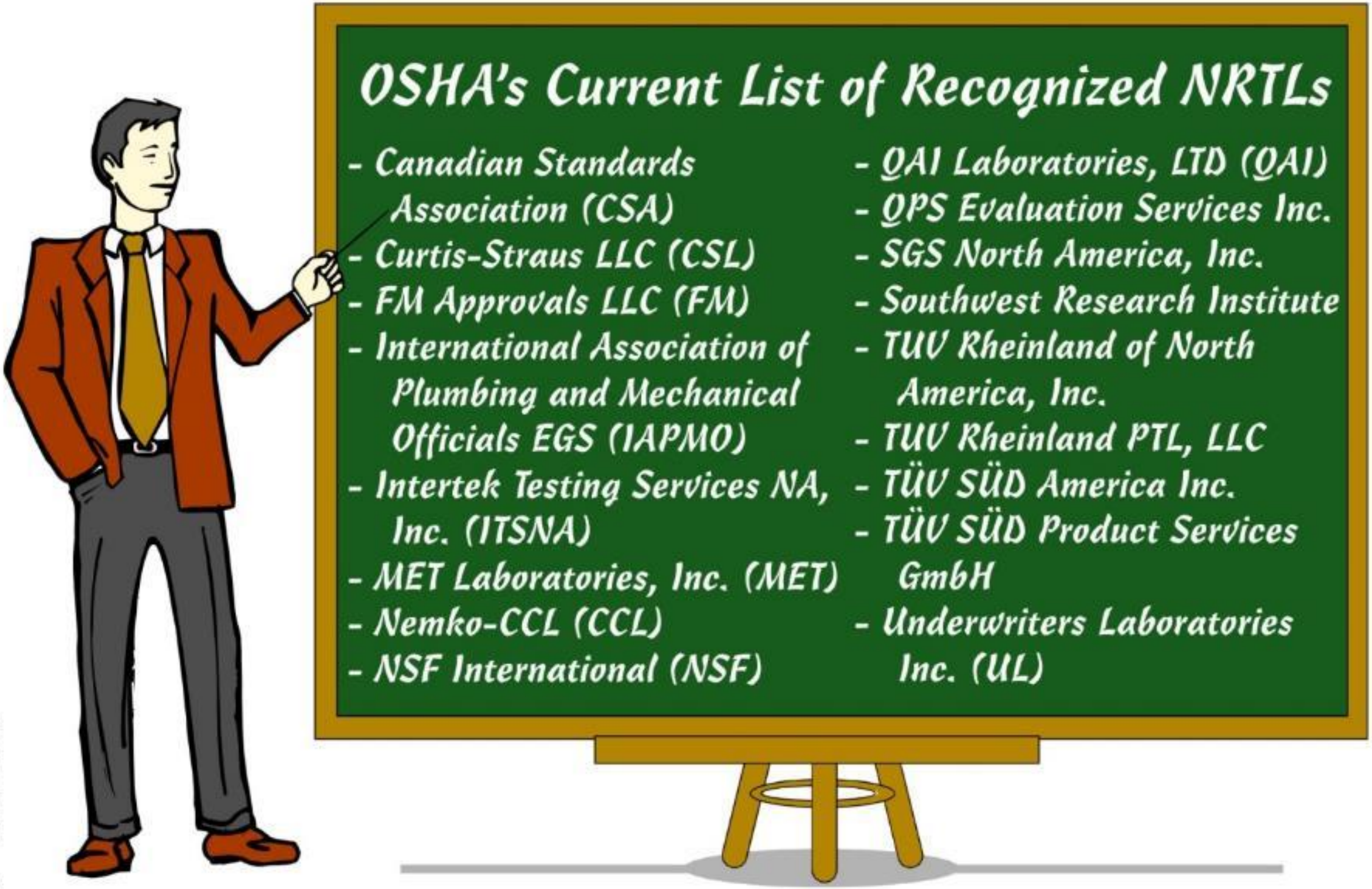
110.3(C) Listing (Product Certification)

- New **110.3(C)** added requiring the listing process be executed by a **qualified third-party electrical testing laboratory** and that the product testing and certification process be in accordance with **appropriate product standards**
- New text and Informational Note provides clarification concerning requirements for **listing (product certification)**
- AHJ depends on listing requirements and product certification as the most common basis for approvals of electrical installations in accordance with the *NEC*
- I-Note points to **OSHA** website which provides a list of **nationally recognized testing laboratories (NRTL)** that meet or exceed OSHA criteria

110.3(C) Listing (Product Certification) *(cont.)*

- **(C) Listing.** Product testing, evaluation, and listing *(product certification)* shall be performed by **recognized qualified electrical testing laboratories** and shall be in accordance with applicable product standards recognized as achieving equivalent and effective safety for equipment installed to comply with this *Code.*
- **Informational Note:** The Occupational Safety and Health Administration ***(OSHA)*** recognizes **qualified electrical testing laboratories** that perform evaluations, testing, and certification of certain products to ensure that they meet the requirements of both the construction and general industry OSHA electrical standards. If the **listing *(product certification)*** is done under a qualified electrical testing laboratory program, this listing mark signifies that the tested and certified product complies with the requirements of one or more appropriate product safety test standards.

110.3(C) Listing and Informational Note



OSHA's Current List of Recognized NRTLs

- Canadian Standards Association (CSA)
- Curtis-Straus LLC (CSL)
- FM Approvals LLC (FM)
- International Association of Plumbing and Mechanical Officials EGS (IAPMO)
- Intertek Testing Services NA, Inc. (ITSNA)
- MET Laboratories, Inc. (MET)
- Nemko-CCL (CCL)
- NSF International (NSF)
- QAI Laboratories, LTD (QAI)
- QPS Evaluation Services Inc.
- SGS North America, Inc.
- Southwest Research Institute
- TUV Rheinland of North America, Inc.
- TUV Rheinland PTL, LLC
- TÜV SÜD America Inc.
- TÜV SÜD Product Services GmbH
- Underwriters Laboratories Inc. (UL)

Product testing, evaluation, and listing to be performed by recognized qualified electrical testing laboratories and must comply with applicable product standards

110.14(D)
Electrical Connections - Installations

- New requirements added for the use of **tightening torque tools** where torqueing is indicated
- Previous I-Note at parent text of 110.14 has been deleted and replaced with enforceable *Code* text at **new 110.14(D)**
- Tightening torque tools now required where torqueing is specified on the equipment or in **manufacturer installation instructions**
- Where a tightening torque is indicated as a numeric value on equipment or in manufacturer installation instructions, **calibrated torque tool shall be used to achieve the indicated torque value** *(unless manufacturer installation instructions provide for an* ***alternative method*** *of achieving the required torque)*

110.14(D) Electrical Connection Torque Tools

Where a tightening torque is indicated as a numeric value on equipment or in installation instructions provided by the manufacturer, a calibrated torque tool is generally required to be used to achieve the indicated torque value

110.16(B)
Service Equipment Arc-Flash Hazard Warning

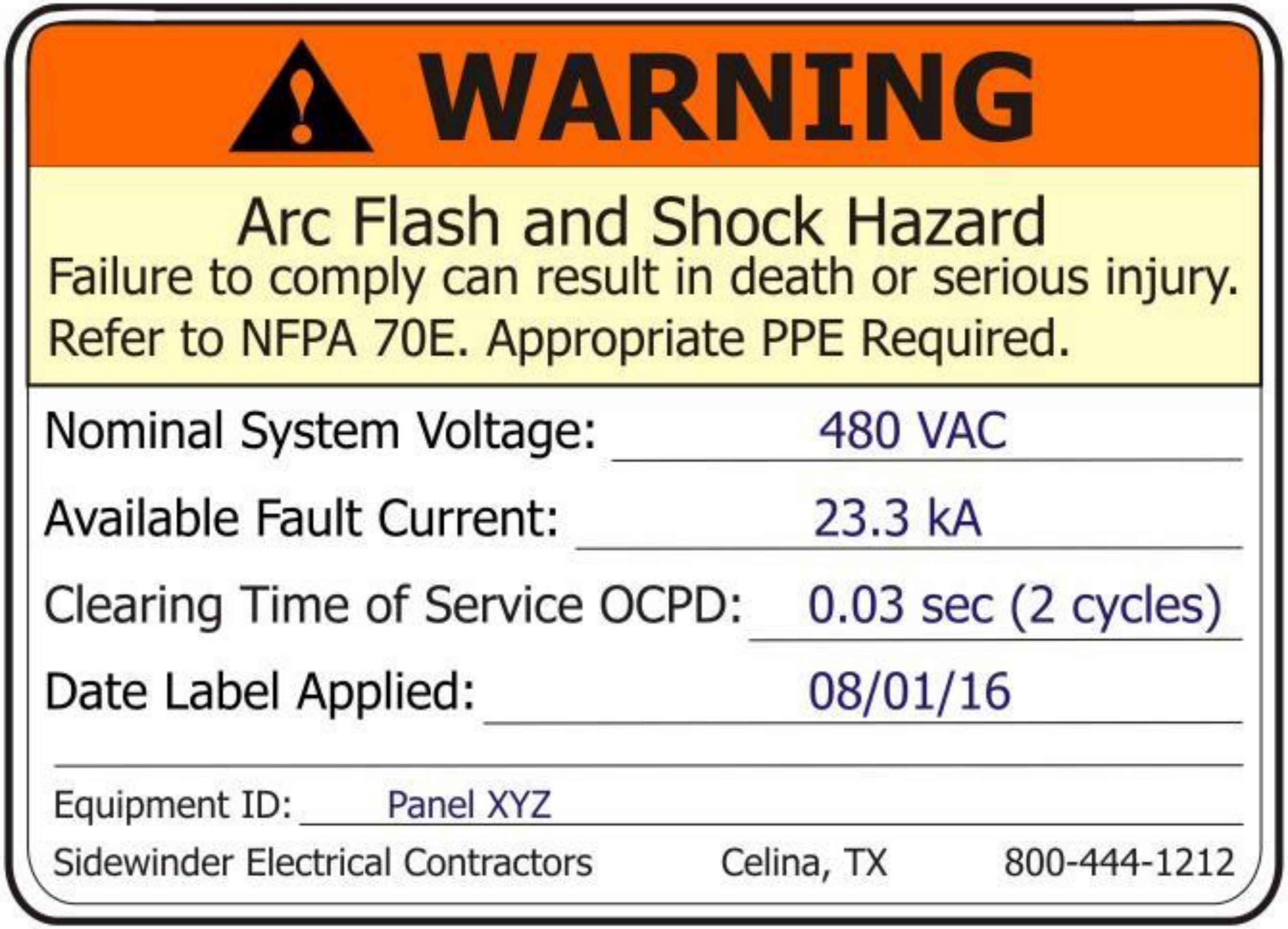
- New **110.16(B)** was added requiring **non-dwelling unit service equipment** rated **1200 amperes or more** to be labeled with the normal system voltage, available fault current, clearing times, and date the label was applied
- Basic arc-flash warning label of 110.16 expanded to require additional information for non-dwelling unit service equipment
- Information needed to determine such things as the incident energy, minimum arc rating of clothing and personal protective equipment (PPE), and working distance from NFPA 70E
- Date the label was applied is necessary as the posted available fault current will fluctuate and can be affected by events beyond the control of the property owner

110.16(B) *(cont.)*
Service Equipment Arc-Flash Hazard Warning

- Non-dwelling unit service equipment rated 1200 amperes or more required be permanently field or factory labeled with:
  - Normal system voltage
  - Available fault current
  - Clearing times
  - Date the label was applied
- Exception: Service equipment labeling shall not be required if an arc-flash label is applied in accordance with acceptable industry practice *(see NFPA 70E 2015 Standard for Electrical Safety in the Workplace)*
- **Note: The following slides illustrate what this label could look like**

110.16(B) Arc-Flash Hazard Warning Label

In other than dwelling units, in addition to the requirements in 110.16(A), a permanent label shall be field or factory applied to service equipment rated 1200 amperes or more



WARNING

Arc Flash and Shock Hazard

Failure to comply can result in death or serious injury.

Refer to NFPA 70E. Appropriate PPE Required.

Nominal System Voltage: 480 VAC

Available Fault Current: 23.3 kA

Clearing Time of Service OCPD: 0.03 sec (2 cycles)

Date Label Applied: 08/01/16

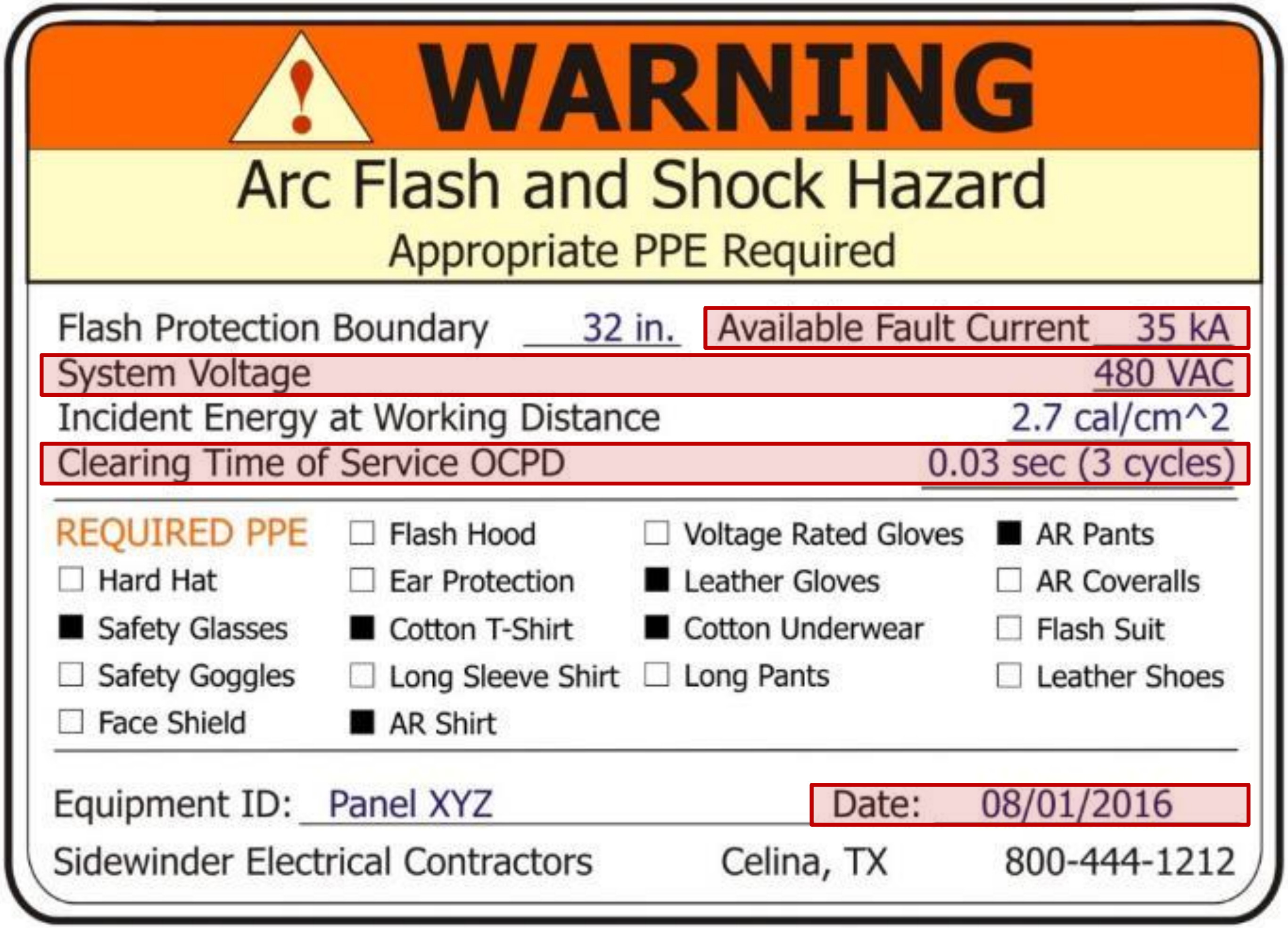
Equipment ID: Panel XYZ

Sidewinder Electrical Contractors Celina, TX 800-444-1212

Exception: Label not required if arc flash label is applied in accordance with "acceptable industry practice" (NFPA 70E)

110.16(B) Arc-Flash Hazard Warning Label

In other than dwelling units, in addition to the requirements in 110.16(A), a permanent label shall be field or factory applied to service equipment rated 1200 amperes or more



WARNING

Arc Flash and Shock Hazard

Appropriate PPE Required

Flash Protection Boundary 32 in.
Available Fault Current 35 kA
System Voltage 480 VAC
Incident Energy at Working Distance 2.7 cal/cm^2
Clearing Time of Service OCPD 0.03 sec (3 cycles)

REQUIRED PPE

☐ Hard Hat
■ Safety Glasses
☐ Safety Goggles
☐ Face Shield

☐ Flash Hood
☐ Ear Protection
■ Cotton T-Shirt
☐ Long Sleeve Shirt
■ AR Shirt

☐ Voltage Rated Gloves
■ Leather Gloves
■ Cotton Underwear
☐ Long Pants

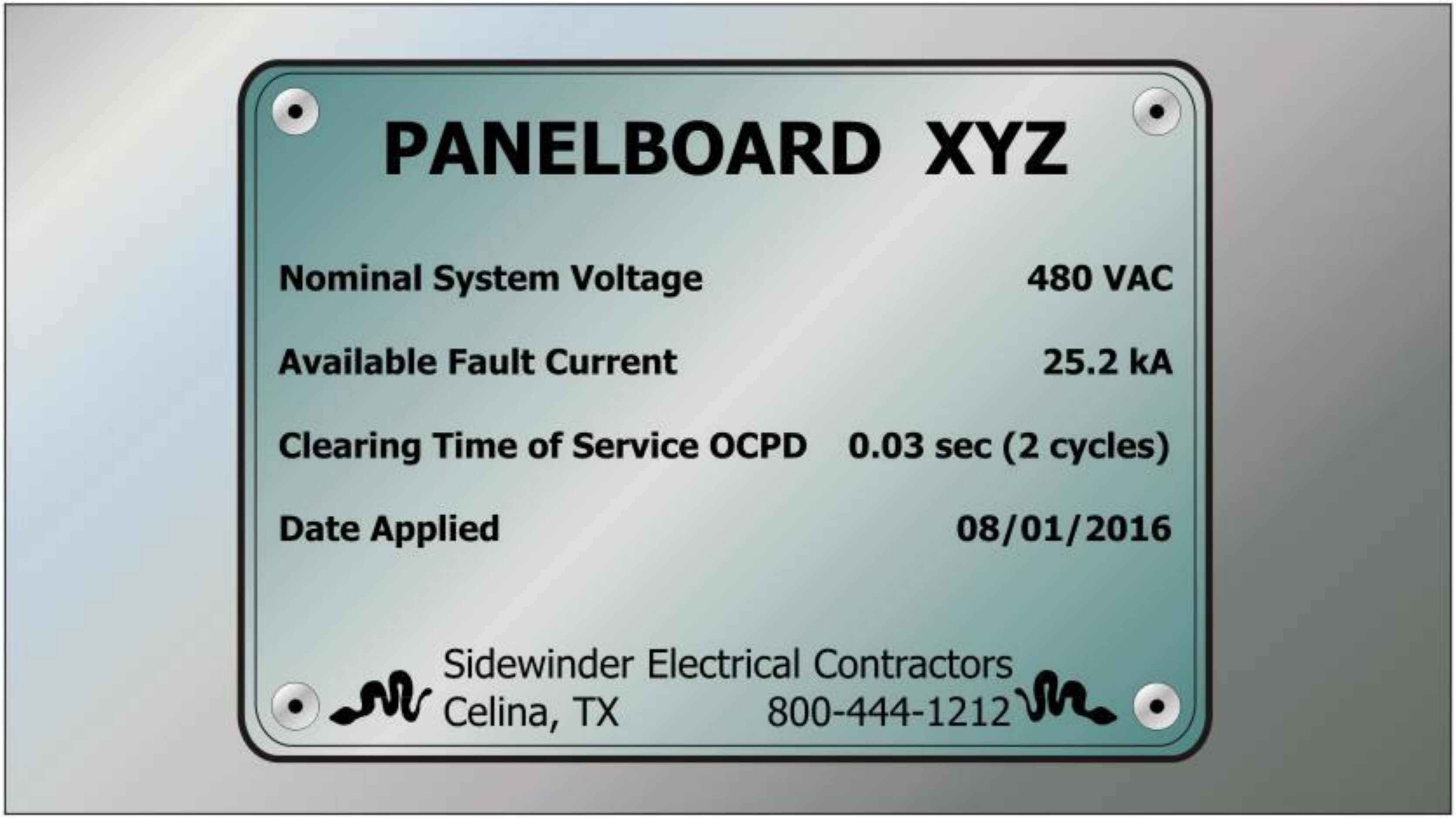
■ AR Pants
☐ AR Coveralls
☐ Flash Suit
☐ Leather Shoes

Equipment ID: Panel XYZ
Date: 08/01/2016
Sidewinder Electrical Contractors Celina, TX 800-444-1212

Exception: Label not required if arc flash label is applied in accordance with "acceptable industry practice" (NFPA 70E)

110.16(B) Arc-Flash Hazard Warning Label

In other than dwelling units, in addition to the requirements in 110.16(A), a permanent label shall be field or factory applied to service equipment rated 1200 amperes or more



PANELBOARD XYZ

Nominal System Voltage	**480 VAC**
Available Fault Current	**25.2 kA**
Clearing Time of Service OCPD	**0.03 sec (2 cycles)**
Date Applied	**08/01/2016**

Sidewinder Electrical Contractors
Celina, TX 800-444-1212

Exception: Label not required if arc flash label is applied in accordance with “acceptable industry practice” (NFPA 70E)

SQUARE D®

GENERAL DUTY SAFETY SWITCH
INTERRUPTOR DE SEGURIDAD DE SERVICIO GENERAL
200 A
240 Vac / V~

⚠ DANGER / PELIGRO

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH
PELIGRO DE DESCARGA ELÉCTRICA, EXPLOSIÓN O DESTELLO POR ARQUEO

• Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.	• Utilice equipo de protección personal (EPP) apropiado y siga las prácticas de seguridad eléctrica establecidas por su Compañía (consulte la norma NFPA 70E).
• This equipment must only be installed and serviced by qualified electrical personnel.	• Solamente el personal eléctrico especializado deberá instalar y prestar servicio de mantenimiento a este equipo.
• Never operate energized switch with door open. Keep door fastened.	• Nunca haga funcionar el interruptor con la puerta abierta cuando esté energizado. Mantenga la puerta asegurada.
• Turn off switch before removing or installing fuses or making load side connections.	• Desenergice el interruptor antes de extraer o instalar fusibles o de hacer conexiones en el lado de carga.
• Always use a properly rated voltage sensing device at all line and load fuse clips to confirm switch is off.	• Siempre utilice un dispositivo de tensión nominal adecuado en los clips para fusibles de los lados de carga y línea para confirmar la desenergización del interruptor.
• Turn off power supplying switch before doing any other work on or inside switch.	• Desenergice el interruptor antes de realizar cualquier otro trabajo en el interruptor.
• Do not use renewable link fuses in fused switches.	• No utilice fusibles de cinta renovables en los interruptores de fusible.
Failure to follow these instructions will result in death or serious injury.	**El incumplimiento de estas precauciones podrá causar la muerte o lesiones serias.**
To lock out switch, place padlock hasp through hole in lockplate and above handle.	Para bloquear el interruptor, la aldaba del candado debe pasar por el agujero en la placa de inmovilización y por encima de la manija.

40275-957-02

SERVICE DISCONNECT

110.21(A)(2) Equipment Markings - Reconditioned Equipment

- New **110.21(A)(2)** added to require **refurbished, reconditioned, or remanufactured equipment** to be marked with the **name, trademark, and other descriptive marking** of the organization responsible for reconditioning the electrical equipment
- New rules added to provide **traceability** and other additional information to manufacturers, owners, installers, and AHJs related to reconditioned equipment
- The **date of the reconditioning** must also be established on the nameplate or marking
- AHJ should never rely solely on equipment's original listing as basis of approval of reconditioned electrical equipment

110.21(A)(2) Equipment Markings - Reconditioned Equipment *(cont.)*

- **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. Reconditioned equipment shall be identified as "reconditioned" and approval of the reconditioned equipment shall not be based solely on the equipment's original listing.
- ***Exception:*** *In industrial occupancies, where conditions of maintenance and supervision ensure that only qualified persons service the equipment, the markings indicated in 110.21(A)(2) shall not be required.*
- **Informational Note:** Industry standards are available for application of reconditioned and refurbished equipment. Normal servicing of equipment that remains within a facility should not be considered reconditioning or refurbishing.

110.21(A)(2) Reconditioned Equipment

MUSTANG
ELECTRICAL EQUIPMENT

GENERAL DUTY
SAFETY SWITCH
200 A 240 Vac / V

RECONDITIONED

THIS EQUIPMENT HAS BEEN REFURBISHED BY
MUSTANG ELECTRICAL EQUIPMENT COMPANY.

THE DATE OF RECONDITION WAS:
08/01/2015

Typical marking requirements for reconditioned electrical equipment in accordance with 110.21(A)(2)

110.26(A)(4)
Limited Access Working Space

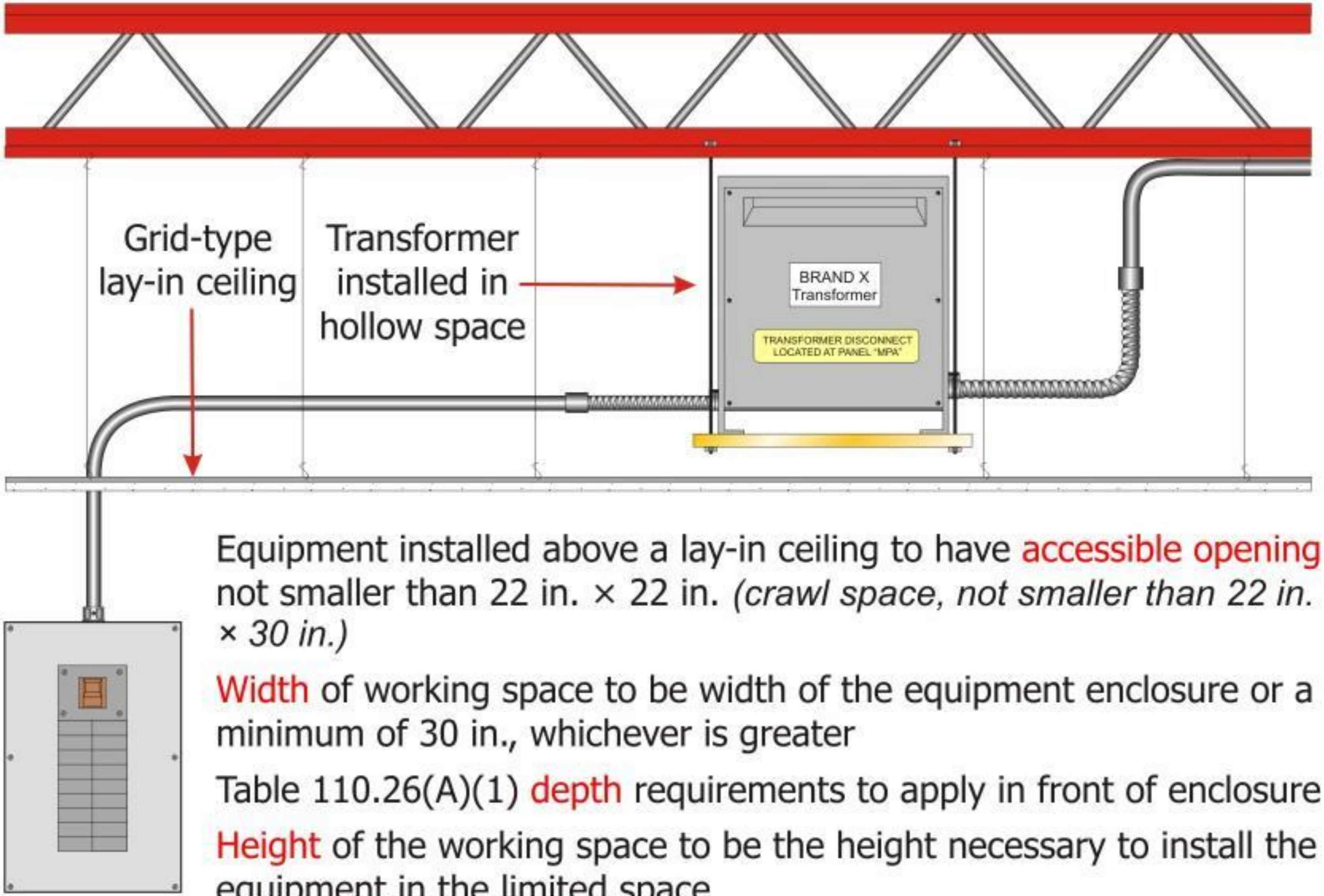
- New requirements added in Article 110 concerning working space for equipment located in a space with **limited access** *(above suspended ceiling, crawl spaces, etc.)*
- Previous 424.66(B) limited access working space requirements was relocated to **110.26(A)(4)** to **broaden this requirement** to more than just duct heaters
- Limited access working space requirements at **crawl spaces** were added to this requirement as well
- Strict compliance with 110.26(A)(1), (A)(2) and (A)(3) in ceiling spaces and crawl spaces is not feasible and in some cases, not possible

110.26(A)(4)
Limited Access Working Space *(cont.)*

- The *NEC* Correlating Committee appointed a ***Working Space Task Group*** to review requirements for working space of electrical equipment that is often installed in spaces with **limited access** such as transformers, motors, air-handling equipment, etc.

- Working space requirements for equipment *(with limited access or not)* that are **likely to require examination, adjustment, servicing, or maintenance while energized** are general requirements for all electrical equipment

110.26(A)(4) Limited Access Working Space



Equipment installed above a lay-in ceiling to have accessible opening not smaller than 22 in. × 22 in. *(crawl space, not smaller than 22 in. × 30 in.)*

Width of working space to be width of the equipment enclosure or a minimum of 30 in., whichever is greater

Table 110.26(A)(1) depth requirements to apply in front of enclosure

Height of the working space to be the height necessary to install the equipment in the limited space

Horizontal ceiling structural member/access panel permitted in spac

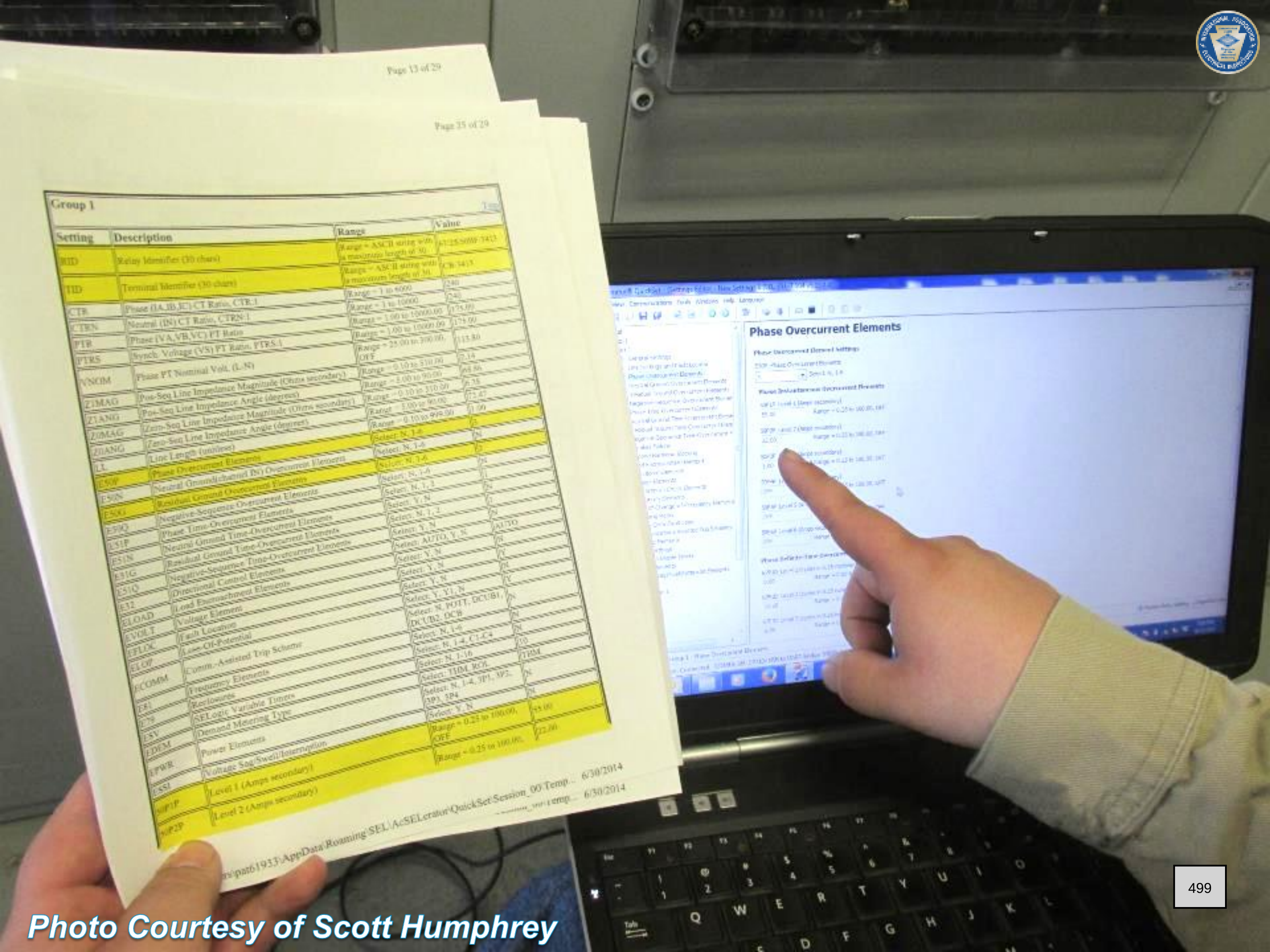
110.26(A)(4) Limited Access required above a lay-in suspended ceiling

110.26(A)(4) Limited Access required in crawl spaces

110.41(A) and (B) Inspections and Tests - Pre-energization and Operating Tests/Reports

- New requirements added at **110.41** for **pre-energization testing** and **reporting** of electrical equipment (over 1000 volts) upon request by the AHJ
- Being located in Article 110, this will apply to all equipment rated over 1000 volts regardless of its location
- Ensures that these electrical systems perform to their design specifications and a record verifying the proper settings and test data would be available to the AHJ, installers, operators, testers, and maintainers after the equipment is put into service
- Similar to 225.56 for outdoor feeders and branch circuits greater than 1000 volts

Photo Courtesy of Shermco Industries



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Group 1

Top

Setting	Description	Range	Value
RID	Relay Identifier (30 chars)	Range = ASCII string with a maximum length of 30	67/25/50BF 3413
TID	Terminal Identifier (30 chars)	Range = ASCII string with a maximum length of 30	CB 3413
CTR	Phase (IA,IB,IC) CT Ratio, CTR:1	Range = 1 to 6000	240
CTRN	Neutral (IN) CT Ratio, CTRN:1	Range = 1 to 10000	240
PTR	Phase (VA,VB,VC) PT Ratio	Range = 1.00 to 10000.00	175.00
PTRS	Synch. Voltage (VS) PT Ratio, PTRS:1	Range = 1.00 to 10000.00	175.00
VNOM	Phase PT Nominal Volt. (L-N)	Range = 25.00 to 300.00, OFF	113.80
Z1MAG	Pos-Seq Line Impedance Magnitude (Ohms secondary)	Range = 0.10 to 510.00	2.14
Z1ANG	Pos-Seq Line Impedance Angle (degrees)	Range = 5.00 to 90.00	68.86
Z0MAG	Zero-Seq Line Impedance Magnitude (Ohms secondary)	Range = 0.10 to 510.00	6.35
Z0ANG	Zero-Seq Line Impedance Angle (degrees)	Range = 5.00 to 90.00	72.47
LL	Line Length (unitless)	Range = 0.10 to 999.00	1.00
E50P	Phase Overcurrent Elements	Select: N, 1-6	2
E50N	Neutral Ground(channel IN) Overcurrent Elements	Select: N, 1-6	N
E50G	Residual Ground Overcurrent Elements	Select: N, 1-6	2
E50Q	Negative-Sequence Overcurrent Elements	Select: N, 1-6	N
E51P	Phase Time-Overcurrent Elements	Select: N, 1, 3	1
E51N	Neutral Ground Time-Overcurrent Elements	Select: Y, N	N
E51G	Residual Ground Time-Overcurrent Elements	Select: N, 1, 2	1
E51Q	Negative-Sequence Time-Overcurrent Elements	Select: Y, N	N
E32	Directional Control Elements	Select: AUTO, Y, N	AUTO
ELOAD	Load Encroachment Elements	Select: Y, N	N
EVOLT	Voltage Element	Select: Y, N	Y
EFLOC	Fault Location	Select: Y, N	N
ELOP	Loss-Of-Potential	Select: Y, Y1, N	Y
ECOMM	Comm.-Assisted Trip Scheme	Select: N, POTT, DCUB1, DCUB2, DCB	N
E81	Frequency Elements	Select: N, 1-6	N
E79	Reclosures	Select: N, 1-4, C1-C4	N
ESV	SELogic Variable Timers	Select: N, 1-16	10
EDEM	Demand Metering Type	Select: THM, ROL	THM
EPWR	Power Elements	Select: N, 1-4, 3P1, 3P2, 3P3, 3P4	N
ESSI	Voltage Sag/Swell/Interruption	Select: Y, N	N
50P1P	Level 1 (Amps secondary)	Range = 0.25 to 100.00, OFF	55.00
50P2P	Level 2 (Amps secondary)	Range = 0.25 to 100.00,	22.00

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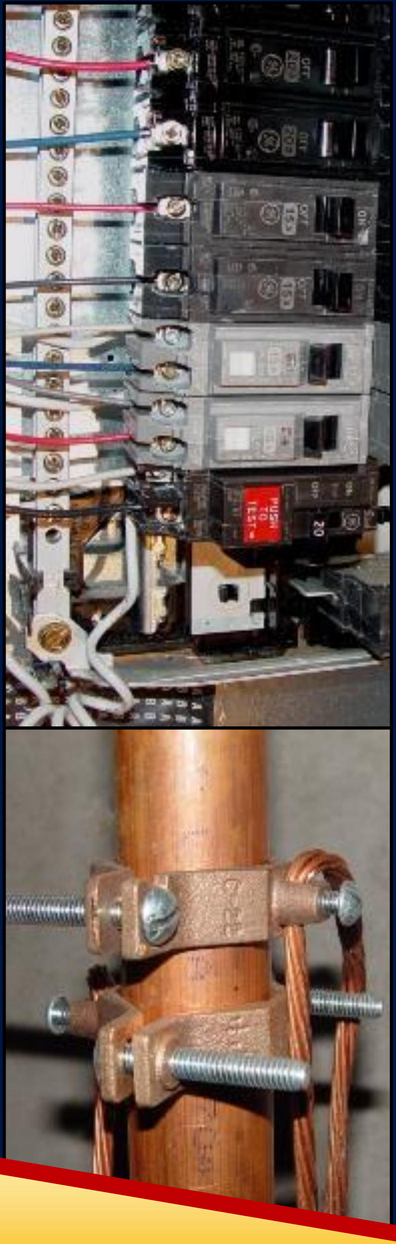
...Temp... 6/30/2014

Phase Overcurrent Elements

Photo Courtesy of Scott Humphrey



Chapter Two Wiring and Protection

210.5(C)(1), Exception
Identification of Ungrounded Conductors

- New exception added for **relief from identifying** each ungrounded conductor for **existing installations** where a voltage system(s) already exists and a different voltage system is being added

- Numerous existing and older systems exist that are supplied by more than one nominal voltage system installed prior to the adoption of the 2005 *NEC [when 210.5(C) was first mandated]*

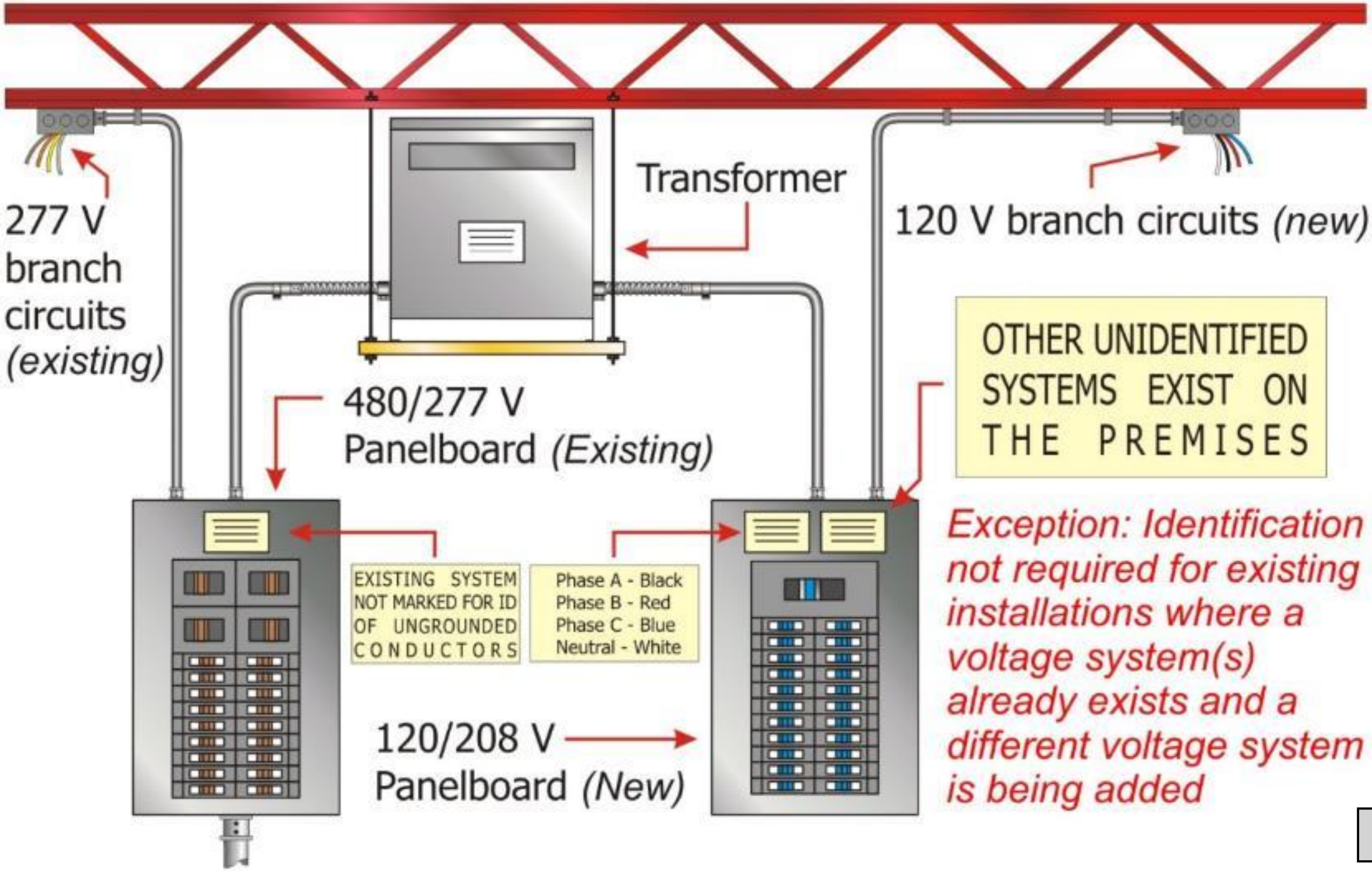
- A new requirement was also added concerning the **durability** and makeup of the labels involved

210.5(C)(1), Exception
Identification of Ungrounded Conductors *(cont.)*

- New exception also included labeling requirements for these older existing unidentified installations requiring a label at each voltage system distribution equipment point
- Must identify that **only the newer added voltage system(s)** have been marked or identified at each termination, connection, and splice point
- The new system label(s) will be required to include the words "**Other Unidentified Systems Exist on the Premises**"
- Labels required by 210.5(C)(1)(b) to be "**sufficiently durable**" and able to withstand the environment in which it is installed

210.5(C)(1), Ex. ID of Ungrounded Conductors

Where premises wiring systems have more than one nominal voltage system, each ungrounded branch circuit conductor shall be identified by phase or line and system at all termination, connection, and splice points



277 V branch circuits *(existing)*

Transformer

120 V branch circuits *(new)*

480/277 V Panelboard *(Existing)*

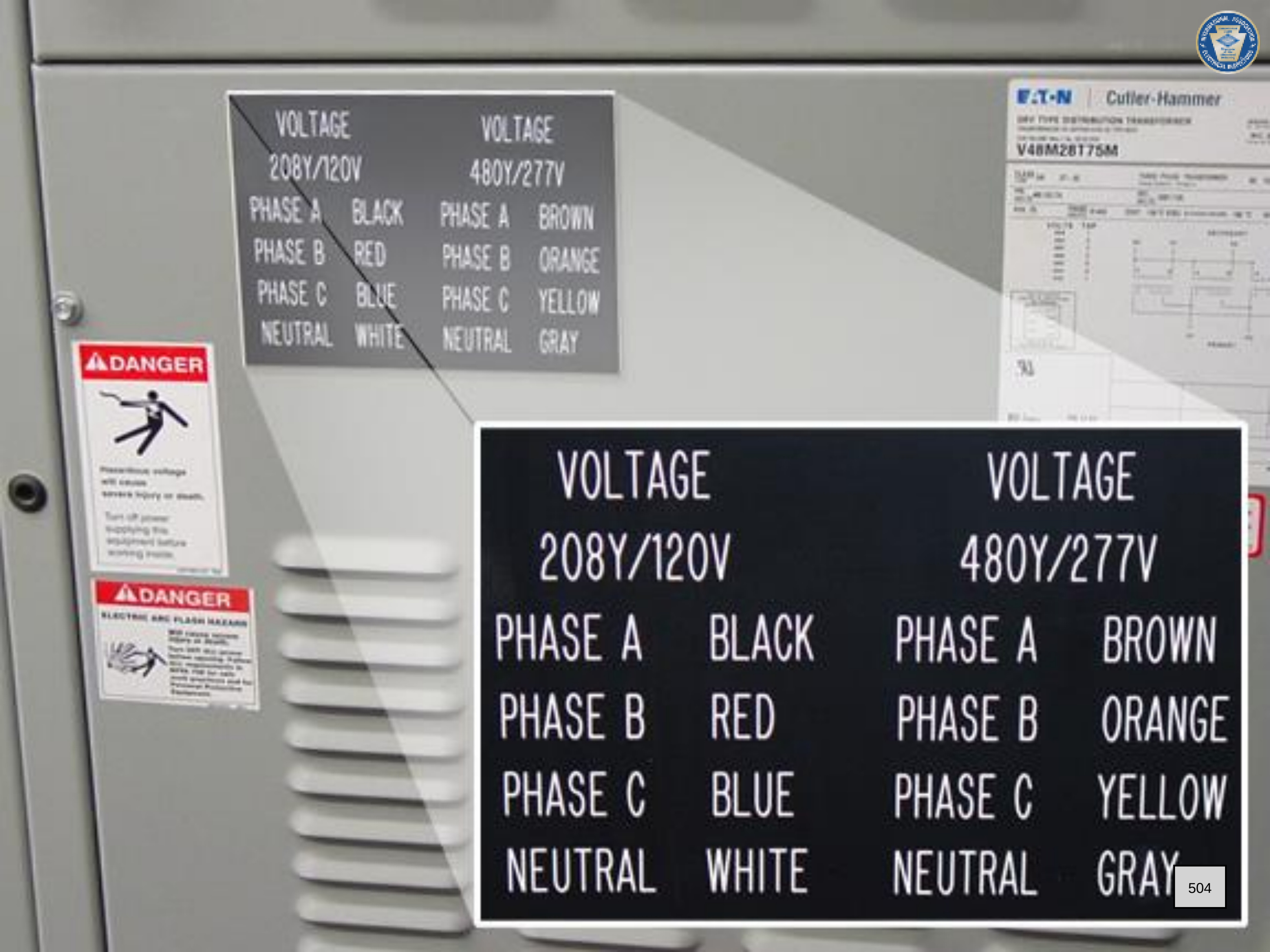
OTHER UNIDENTIFIED SYSTEMS EXIST ON THE PREMISES

EXISTING SYSTEM NOT MARKED FOR ID OF UNGROUNDED CONDUCTORS

Phase A - Black
Phase B - Red
Phase C - Blue
Neutral - White

120/208 V Panelboard *(New)*

Exception: Identification not required for existing installations where a voltage system(s) already exists and a different voltage system is being added



VOLTAGE 208Y/120V		VOLTAGE 480Y/277V	
PHASE A	BLACK	PHASE A	BROWN
PHASE B	RED	PHASE B	ORANGE
PHASE C	BLUE	PHASE C	YELLOW
NEUTRAL	WHITE	NEUTRAL	GRAY

210.8 GFCI Protection - Measurements

- New language added to clarify how measurements are to be determined for GFCI receptacle *(added at parent text of 210.8)*
- Measurements from receptacles to objects *(such as a sink)* that would qualify for GFCI protection should be measured as the "**shortest path**" a cord of an appliance connected to a receptacle would take **without piercing a floor, wall, ceiling, or fixed barrier, or passing through a door, doorway, or window**
- Similar to existing text at **680.22(A)(5)** for receptacle measurements around permanently installed swimming pools

210.8
GFCI Protection - Measurements *(cont.)*

- Eliminates the need for GFCI protection for receptacles installed inside a cabinet *(under a sink)* as the measurement to the sink would constitute "**penetrating a cabinet door**" in order to achieve this measurement
- Compliments revisions at **210.8(A)(7)** *(dwelling units)* and **210.8(B)(5)** *(non-dwelling units)*

210.8 Measurements for GFCI Protection

GFCI protection shall be provided as required in 210.8(A) through (E) and installed in a readily accessible location

Note: This illustration could be an office break room or a dwelling unit kitchen

When determining distance from receptacles, distance shall be measured as the “shortest path” the cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, or fixed barrier, or passin through a door, doorway, or window

210.8(A)(7)
GFCI Protection at Dwelling Unit Sinks

- Dwelling unit sink measurements revised for determining which receptacles require GFCI protection

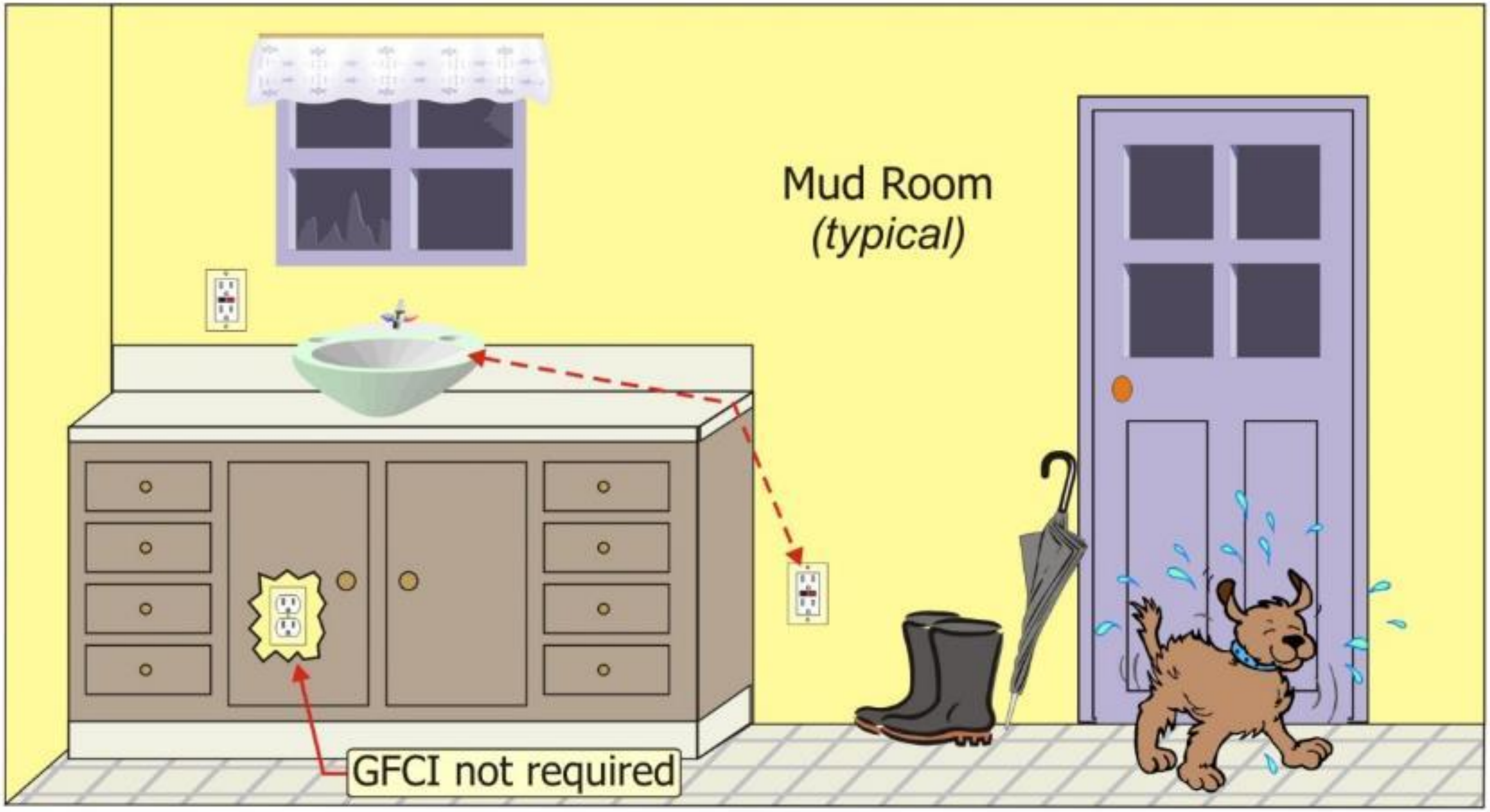
- All 125-volt, single-phase, 15- and 20-ampere receptacles installed within 1.8 m (6 ft) of the “**top inside edge of the bowl**” of any dwelling unit sink *(including the kitchen sink)* require GFCI protection without the measurement piercing a floor, wall, ceiling, or fixed barrier, or passing through a door, doorway, or window

- Revision makes it clear that the measurement from the receptacle to the sink ends or begins at the “**top inside edge of the bowl**” of the sink rather than the “outside edge” of the sink *(outside edge of a sink is three dimensional)*

210.8(A)(7) *(cont.)*
GFCI Protection at Dwelling Unit Sinks

- This revision, along with addition to parent text of 210.8 will eliminate the necessity for GFCI protection for receptacles installed inside a cabinet *(such as a receptacle for the garbage disposer)* as the measurement to the sink would constitute "penetrating a cabinet door" in order to achieve this required 1.8 m (6 ft) measurement
- This same revision occurred at **210.8(B)(5)** for GFCI protection and measurements at a **non-dwelling unit sink**

210.8(A)(7) GFCI Protection at Sinks



GFCI required for all 125-volt, single-phase, 15- and 20-ampere receptacles installed within 1.8 m (6 ft) from the top inside edge of a dwelling unit sink *(laundry, utility, mud room, kitchen, wet bar, etc.)* without the measurement piercing a floor, wall, ceiling, or fixed barrier, or passing through a door, doorway, or window

Note: Same requirement at 210.8(B)(5) for non-dwelling unit sinks

210.8(B)
GFCI Protection at Other Than Dwelling Units

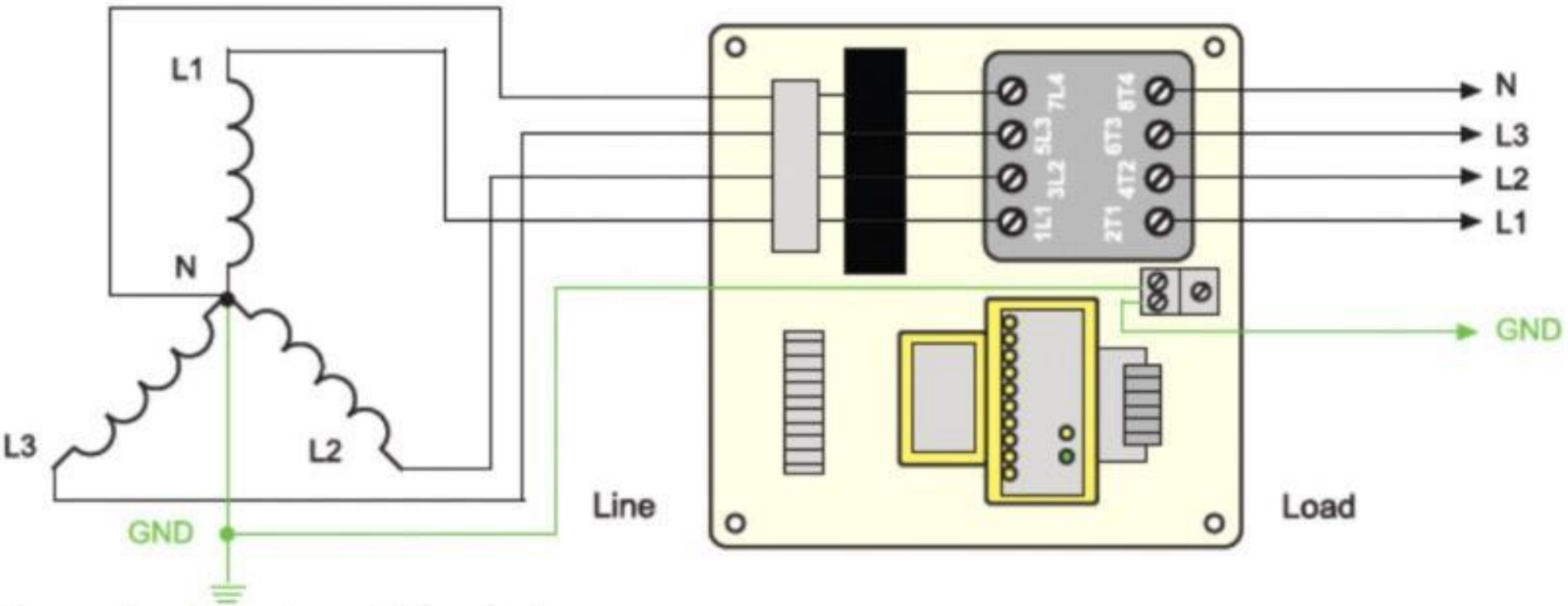
- GFCI requirements for receptacles at commercial/industrial applications have been expanded to recognize ground faults other than 15 and 20 ampere, 125 volt applications only
- Expansion includes "Other Than Dwelling Unit" receptacles for:
  - All **single-phase** receptacles rated **150 volts to ground** or less, **50 amperes** or less
  - All **three-phase** receptacles rated **150 volts to ground** or less, **100 amperes** or less
- These GFCI requirements still include coverage of 125-volt, single-phase, 15- and 20-ampere receptacles

210.8(B) *(cont.)*
GFCI Protection at Other Than Dwelling Units

- Class A GFCI devices *(4 to 6 mA)* cannot be used where the electrical equipment employs 480 or 600 volts or is a three-phase system
- Dangers and shock hazards of electrocution exist for these applications as well
- Shock hazards are not limited to 15 and 20 ampere, 125 volt receptacle alone at commercial/industrial applications
- Class C, D and E GFCI devices operate at **20 mA** or less to prevent fibrillation and require an equipment grounding conductor (EGC) in the protected circuit with an internal means within the device to **monitor EGC continuity**

210.8(B) Three-Phase GFCI Protection

Three-Phase, Four-Wire Configurations (L1, L2, L3, N)



(Illustration Courtesy of Bender)

(Other Than Dwelling Units) All single-phase receptacles rated 150 volts to ground or less, 50 amperes or less; and three-phase receptacles rated 150 volts to ground or less, 100 amperes or less, installed in specified locations shall have ground-fault circuit-interrupter protection for personnel

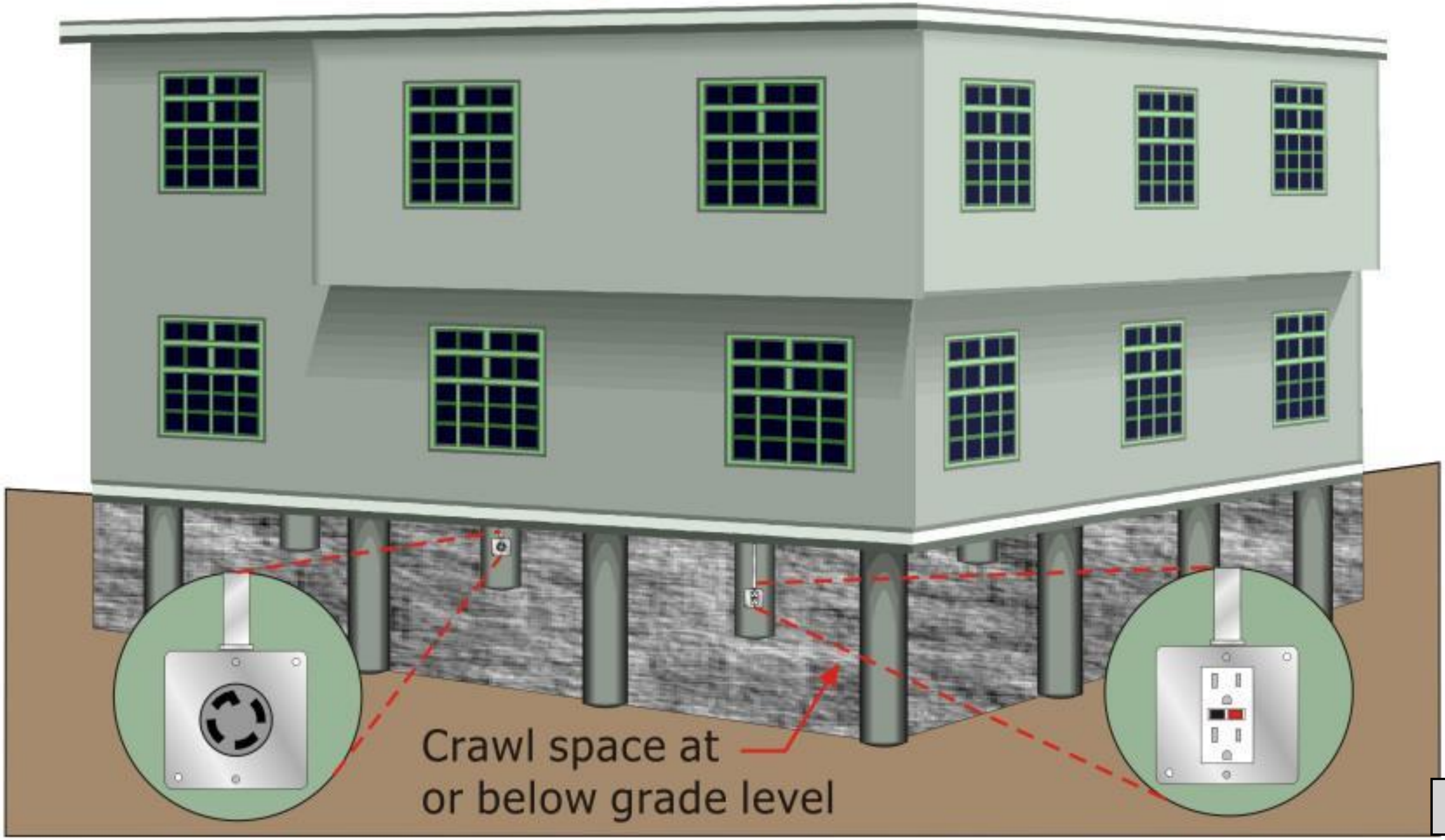
Photo Courtesy of Littlefuse

210.8(B)(9) GFCI Protection for Non-Dwelling Unit Crawl Spaces

- GFCI protection added for non-dwelling unit crawl spaces
- GFCI required for all **single-phase** receptacles rated **150 volts to ground** or less, **50 amperes** or less and **three-phase** receptacles rated **150 volts to ground** or less, **100 amperes or less**
- Similar requirements found at **210.8(A)(4)** for dwelling units
- Non-dwelling unit crawl space GFCI requirement not limited to 125-volt receptacles
- Death rate from shock hazards in crawl spaces higher than injury rate (86.7%)

210.8(B)(9) GFCI for Non-Dwelling Unit *(Commercial, Industrial)* Crawl Spaces

All single-phase receptacles (150 volts to ground or less, 50 amperes or less) and three-phase receptacles (150 volts to ground or less, 100 amperes or less) installed in non-dwelling unit crawl spaces requires GFCI protection



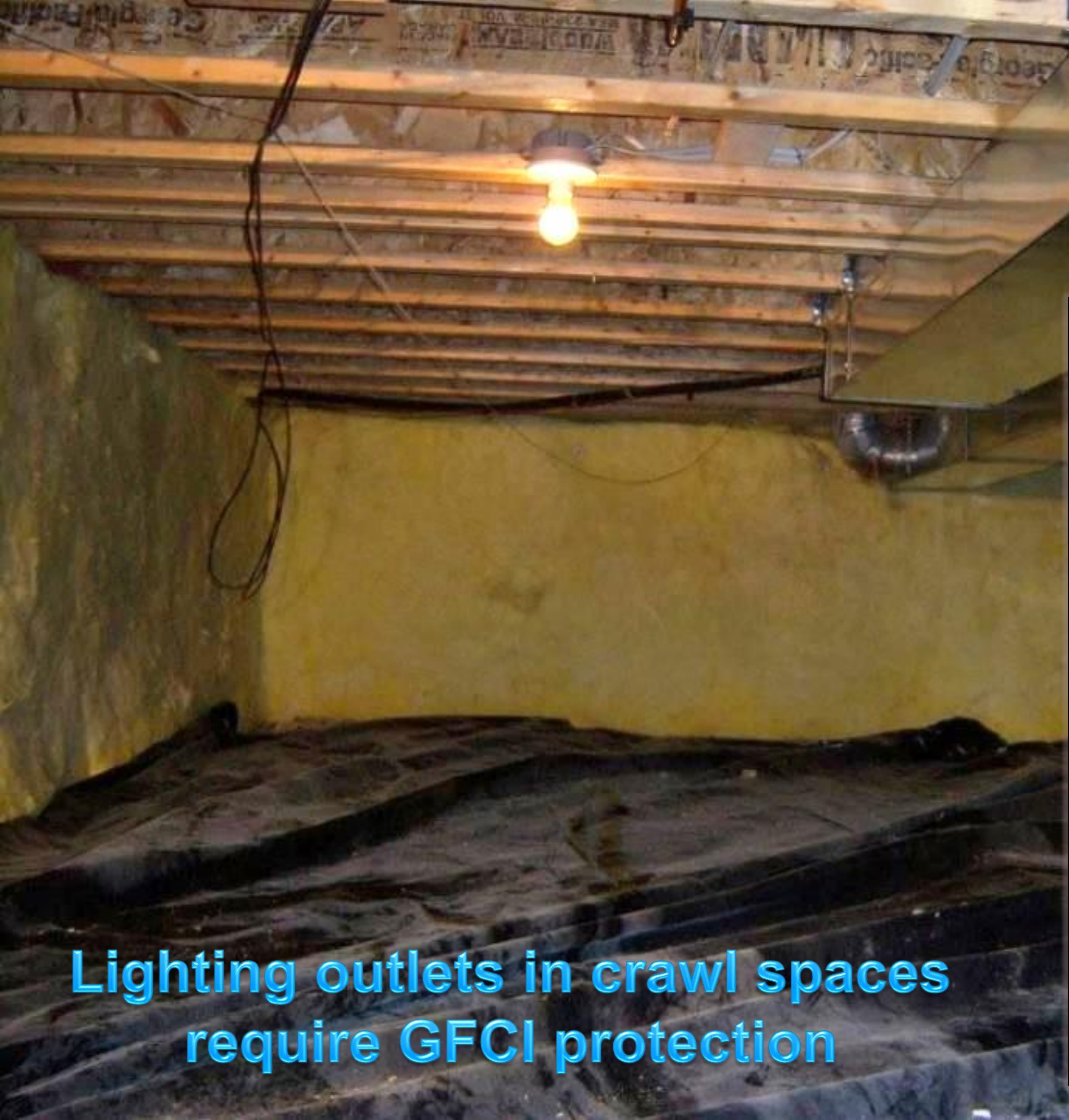
210.8(B)(10) GFCI Protection - Non-Dwelling Unit Unfinished Basements

- GFCI protection for receptacles installed in **unfinished basements** has been expanded to include **non-dwelling unit** (commercial/industrial)
- Revisions to the parent text at 210.8(B) has expanded the receptacles involved to those that are **single-phase** rated **150 volts to ground** or less, **50 amperes or less** and **three-phase** receptacles rated **150 volts to ground** or less, **100 amperes or less**
- Similar requirements found at **210.8(A)(5)** for dwelling units
- Same shock hazards exist in an unfinished basement of a commercial building as they do in dwelling units

Unfinished non-dwelling unit basement

210.8(E) GFCI Protection - Crawl Space Lighting Outlets

- GFCI protection is now required for **lighting outlets** not exceeding 120 volts in **crawl spaces** where the space is at or below grade level
- Applies to **all crawl spaces**, dwelling unit and non-dwelling units alike
- This new GFCI requirement for lighting outlets was predicated on a fatality of a worker in a crawl space *(broken incandescent light bulb of a keyless lampholder)*
- Numerous open-bulb keyless or pullchain lampholders installed in crawl spaces and are constantly being damaged

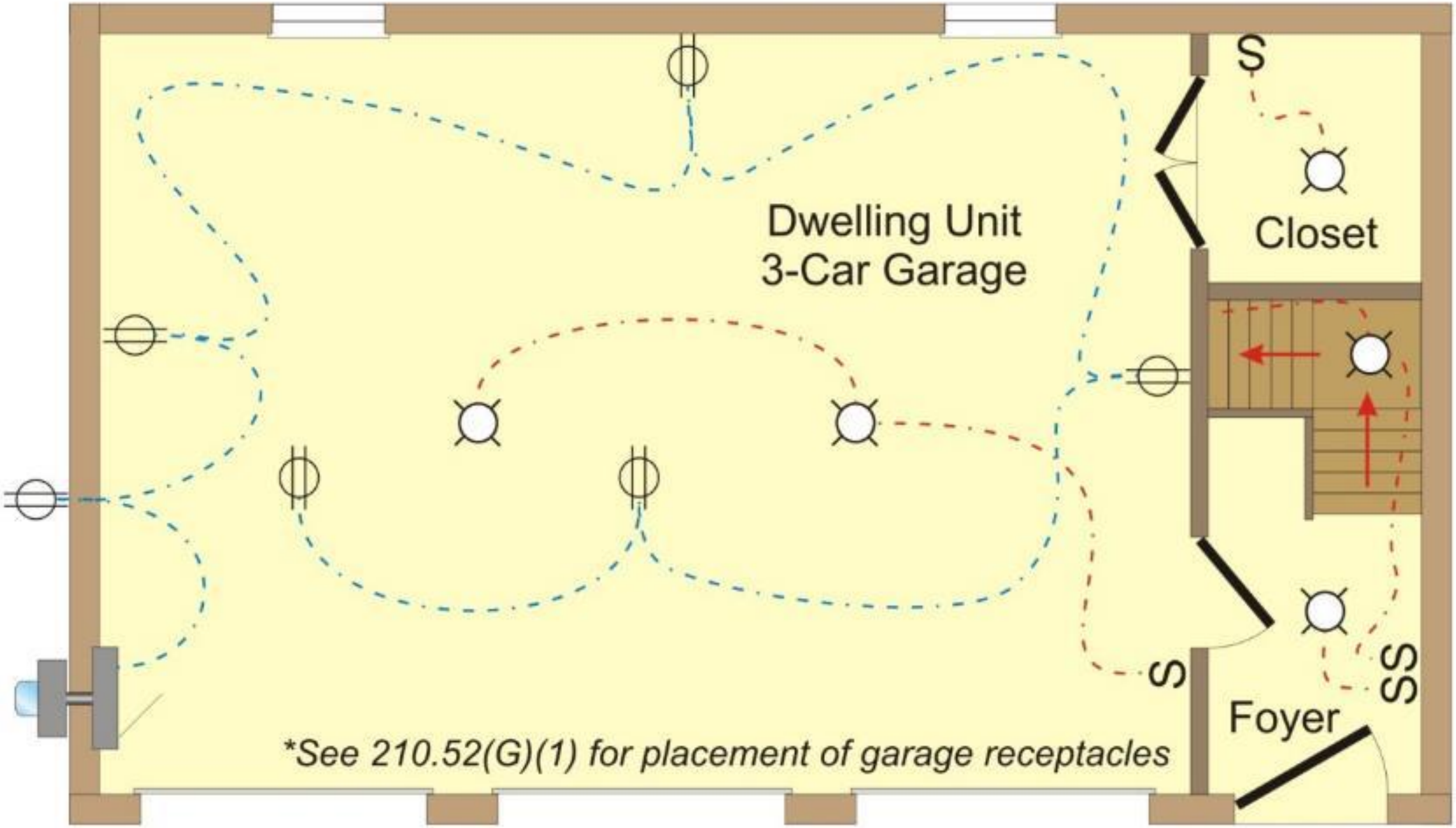


Lighting outlets in crawl spaces require GFCI protection

210.11(C)(4) Garage Branch Circuits

- New requirement added for minimum rated 120 volt, **20 ampere** branch circuit for dwelling unit garage receptacles
- Garage receptacle outlet branch circuit **prohibited from serving other outlets** *(see exception)*
- Exception for readily accessible receptacles located **outdoors**
- 15 ampere rated branch circuit in the modern dwelling unit garage is typically not sufficient for appliance and tools rated at 12 to 16 amperes
- Lighting outlets in the dwelling unit garage required to be supplied by general lighting circuits

210.11(C)(4) Garage Branch Circuit(s)



At least one 120-volt, 20-ampere branch circuit shall be installed to supply receptacle outlets in dwelling unit garages (no other outlets)

Exception permits supply of readily accessible outdoor receptacle outlets

210.12(C) AFCI Protection for Guest Rooms and Guest Suites

- New provisions added requiring **AFCI protection** for **guest rooms** and **guest suites** of hotels and motels
- 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 require AFCI protection
- Previous *Code* called for AFCI Protection if “permanent provisions for cooking” were present *(see 210.18, now 210.17)*
- Same AFCI protection deserved while occupying a hotel room as afforded at a dwelling unit
- AFCI protection plays an important role in protecting property and the lives of personnel

210.12(C) AFCI Protection for Guest Rooms and Guest Suites of Hotels and Motels

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 provided with AFCI protection

~~210.17~~ 625.40

Electric Vehicle Branch Circuit

- The requirement for an **individual branch circuit** for **electric vehicle outlets** has been relocated from 210.17 to 625.40
- Previous requirement for a "separate" branch circuit was changed to an "individual" branch circuit *(separate branch circuit not defined anywhere in the Code)*
- Each individual circuit for an EV outlet shall have no other outlets
- There is still no requirement for an outlet to be installed specifically for the purpose of charging of an electric vehicle
- Ensures EV charging can be completed safely and effectively without overloading an existing branch circuit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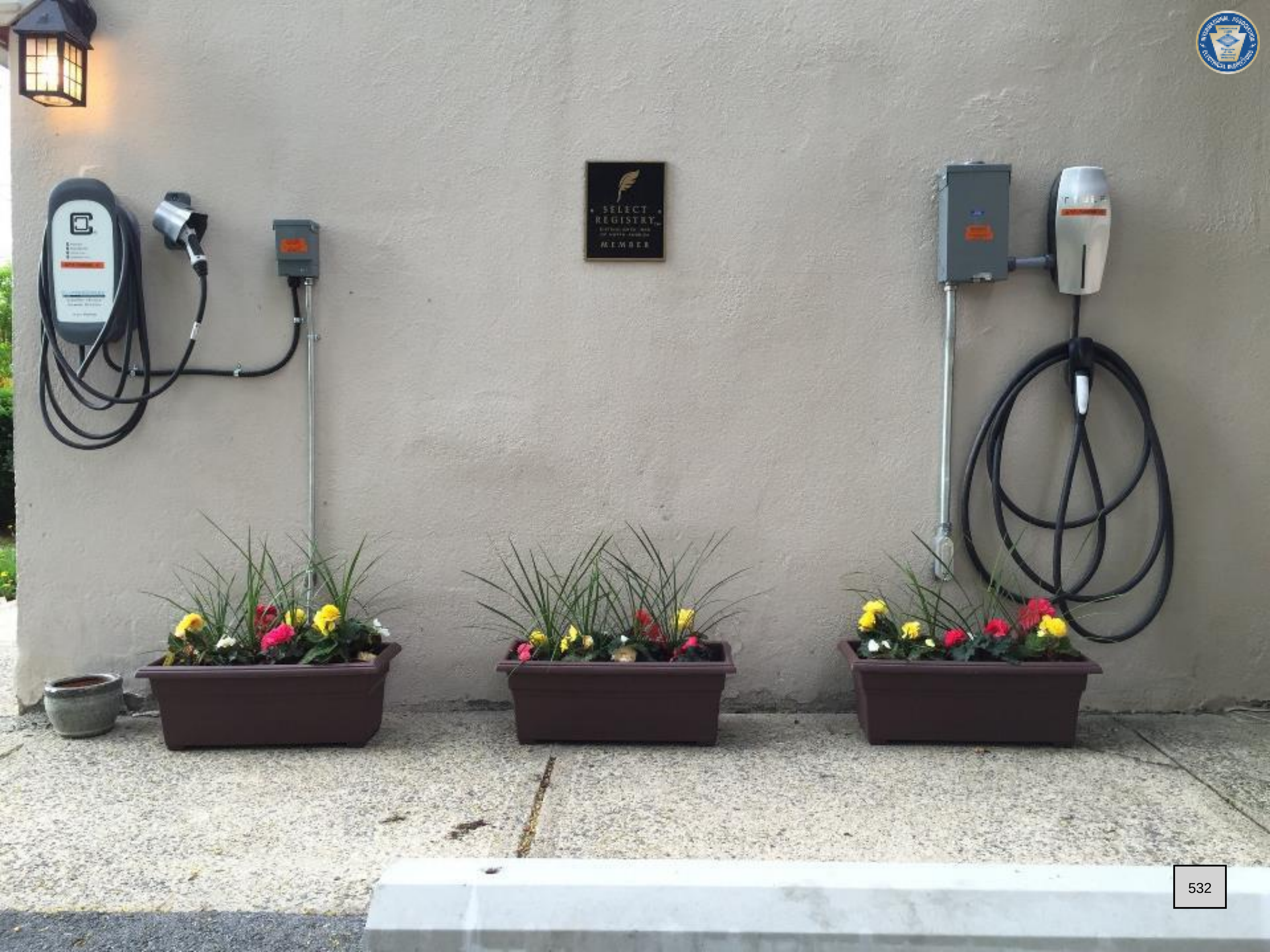

SELECT REGISTRY
MEMBER

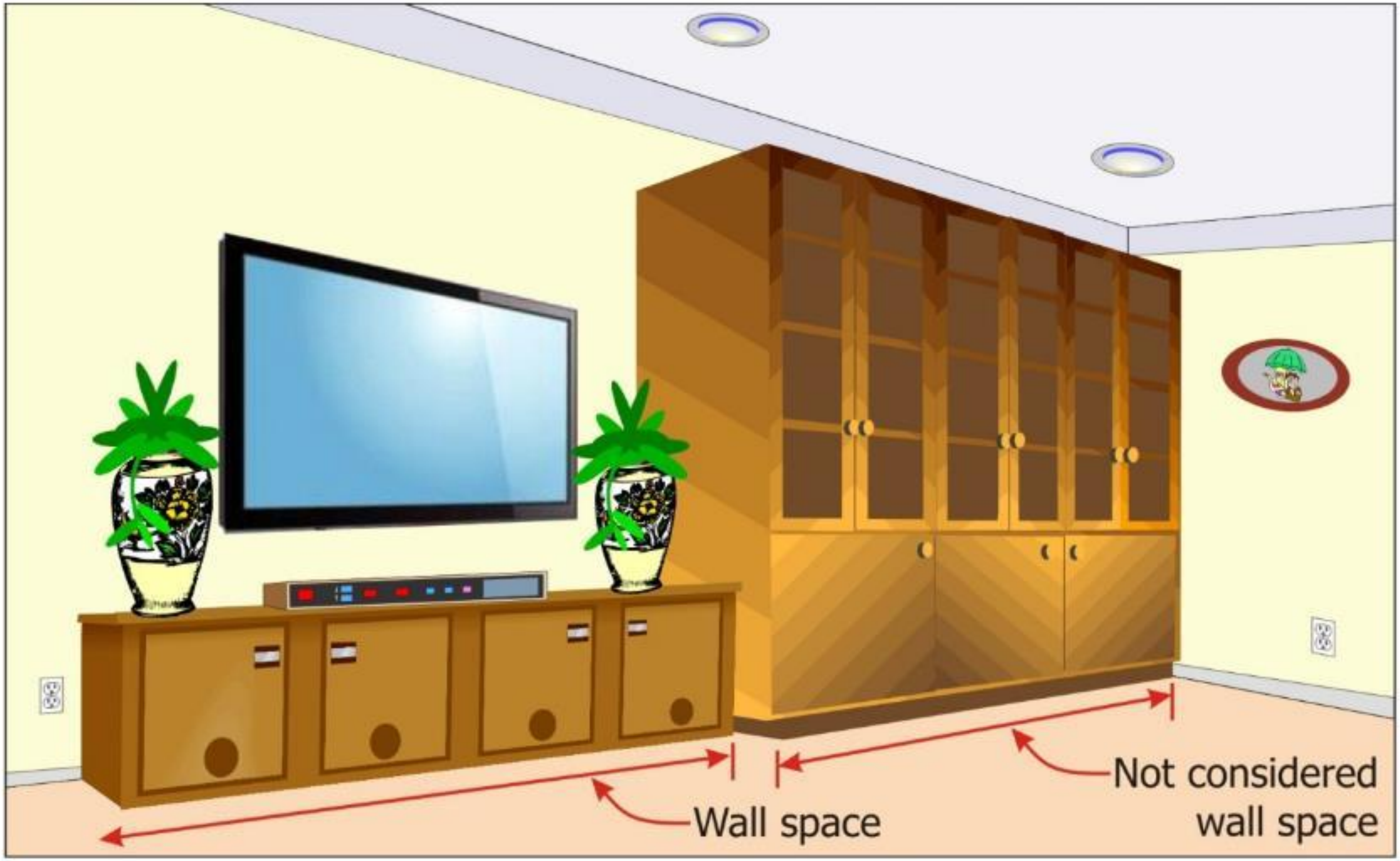
210.52(A)(2)(1) Receptacle Wall Space

- Fixed cabinets **"that do not have countertops or similar work surfaces"** were added as an item that will constitute a **break in a wall space** for receptacle spacing reasons at dwelling units

- Separates "fixed cabinets" such as kitchen pantry-type cabinets *(but not limited to kitchen cabinets)* that do not have countertops or similar work surfaces from short desk-type cabinets with countertops that are clearly intended as work surfaces

- This change will ensure that receptacle outlets are required and installed for such things as laptop computers, printers, televisions, etc.

210.52(A)(2)(1) Receptacle Wall Space



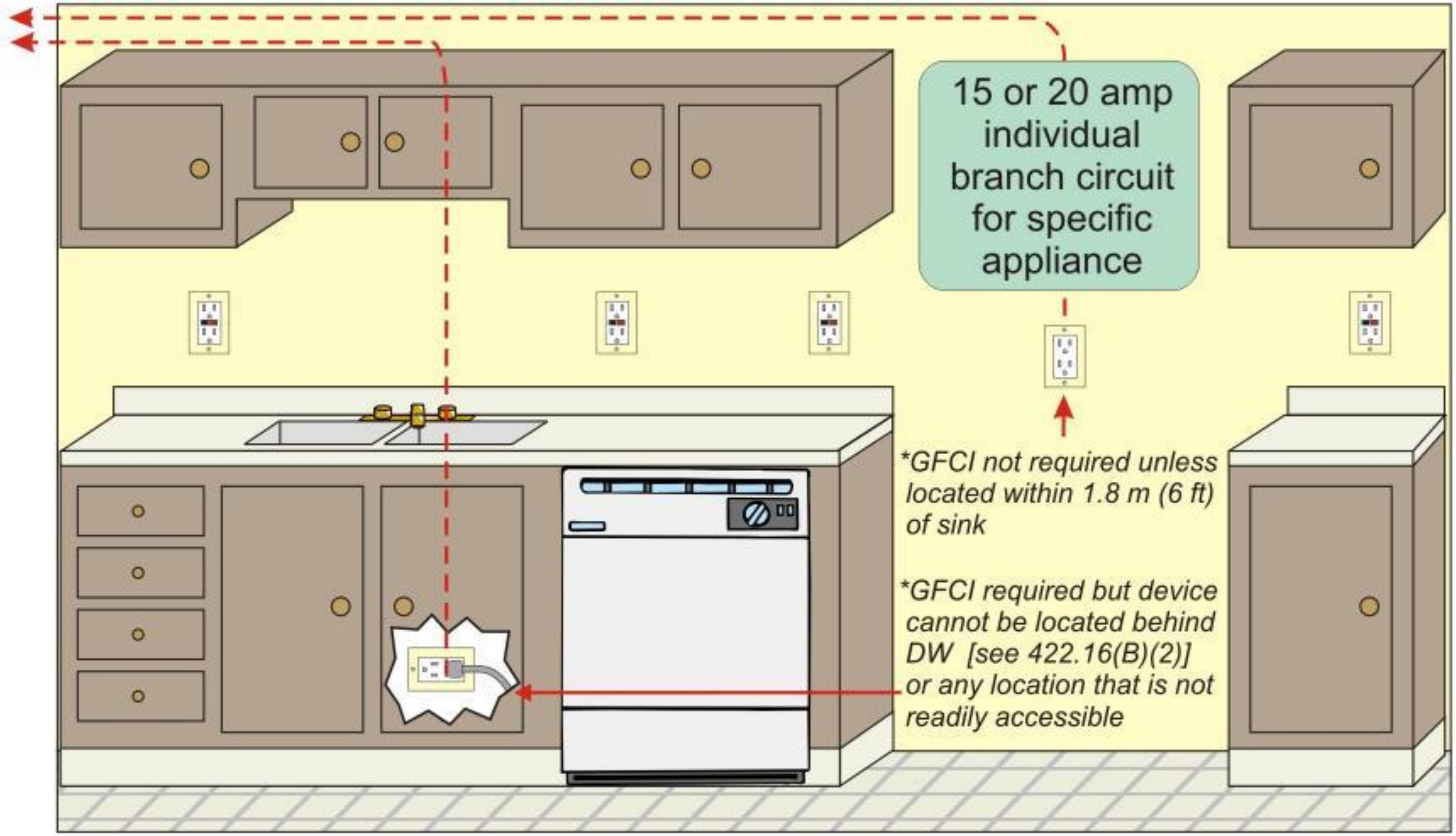
Any space 600 mm (2 ft) or more in width and unbroken along the floor line by doorways and similar openings, fireplaces, and fixed cabinets that do not have countertops or similar work surfaces

210.52(B)(1) Ex. No. 2

~~Refrigerator~~ Appliance Branch Circuit

- Any dwelling unit **kitchen appliance** is now permitted *(by the exception)* to be supplied by an individual branch circuit rated **15 amperes or greater**
- 210.52(B)(1) requires receptacle outlet serving the **refrigeration equipment** be supplied from one of the 20-ampere rated small-appliance branch circuits
- Previous exception allowed refrigerator to be supplied by an individual branch circuit rated 15 amperes or greater *(why just refrigerator?)*
- Revised exception will now allow an individual branch circuit 15 amperes or greater for kitchen appliances such as **garbage disposal**, **dishwasher**, or permanently installed **microwave**

210.52(B)(1) Ex. No 2 Appliance Branch Circuit



15 or 20 amp individual branch circuit for specific appliance

*GFCI not required unless located within 1.8 m (6 ft) of sink

*GFCI required but device cannot be located behind DW [see 422.16(B)(2)] or any location that is not readily accessible

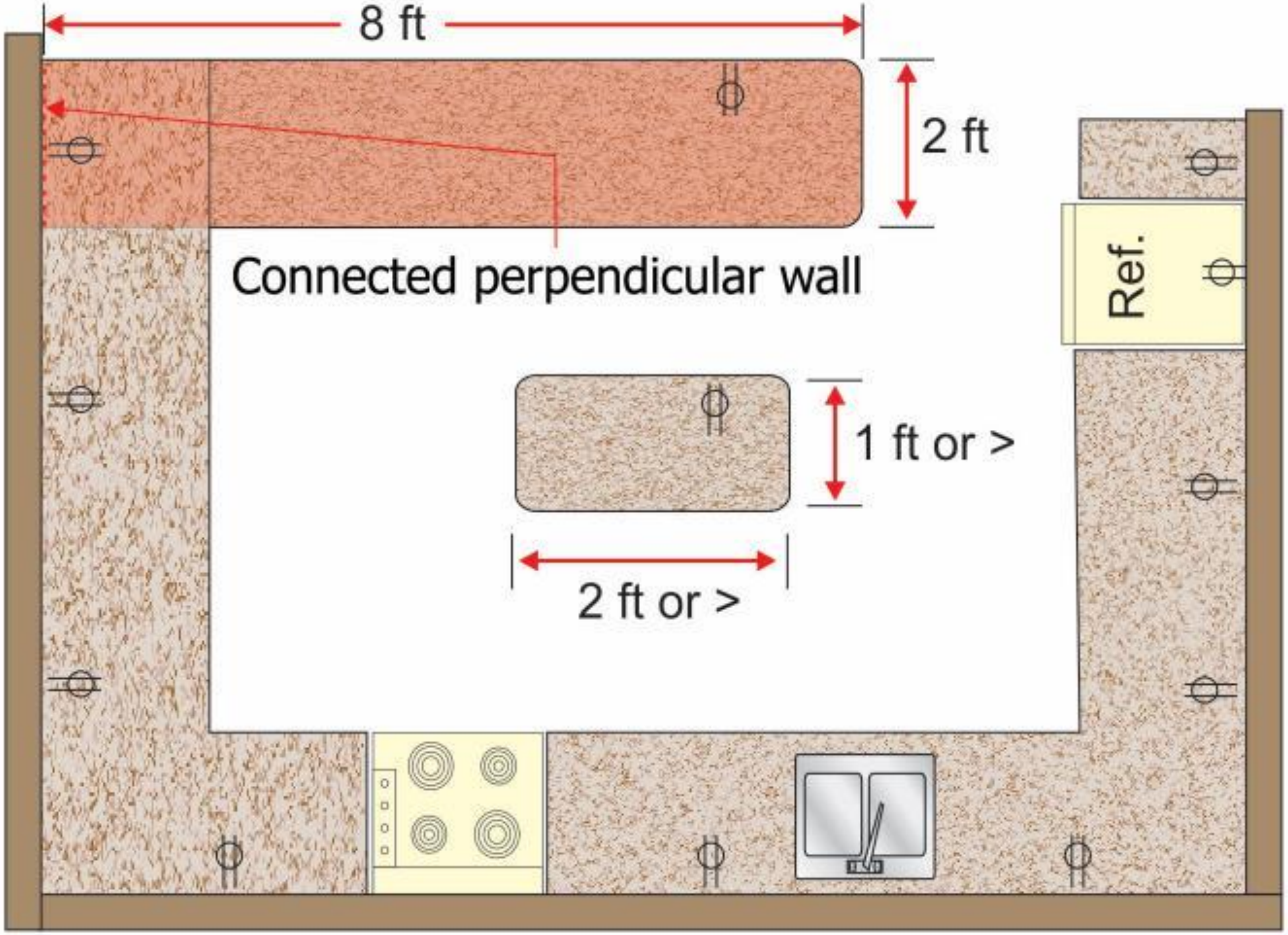
Refrigeration equipment generally required to be served by one of the two or more 20-ampere small-appliance branch circuits

The receptacle outlet for any specific appliance is permitted to be supplied from an individual branch circuit rated 15 amperes or greater

210.52(C)(3) Peninsula Countertop Space

- At least one receptacle outlet is required **at each peninsular countertop long dimension space** with a long dimension of 600 mm (24 in.) or greater and a short dimension of 300 mm (12 in.) or greater
- This measurement must now be taken from the “**connected perpendicular wall**”
- Previously when measured from the **connecting edge** rather than the wall, at least one receptacle outlet was located somewhere at or on the peninsular countertop itself

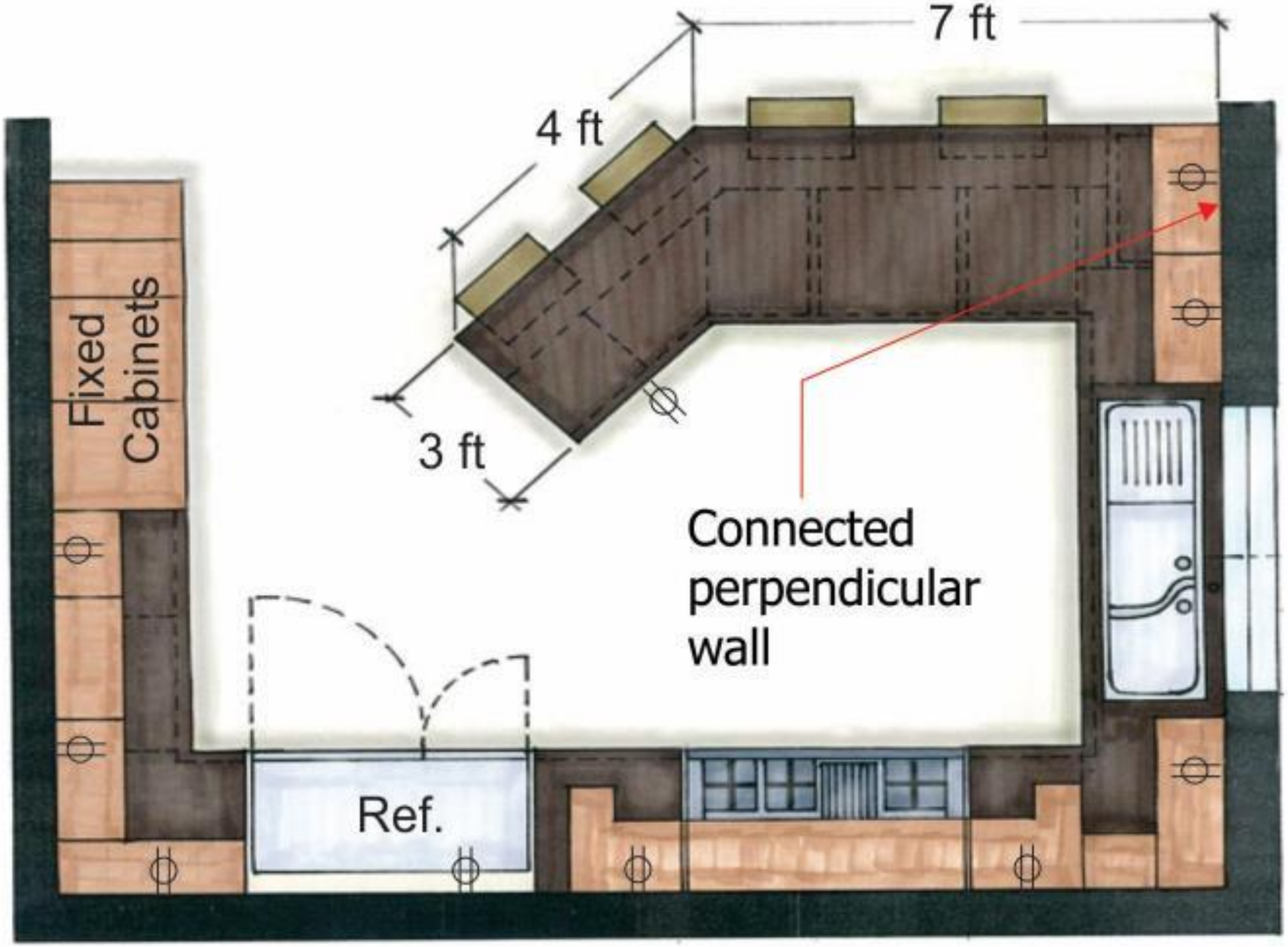
210.52(C)(3) Peninsular Countertop Spaces



At least one receptacle outlet to be installed at each peninsular countertop long dimension space with a long dimension of 600 mm (24 in.) or greater and a short dimension of 300 mm (12 in.) or greater

Measurements to be measured from the "connected perpendicular wall"

210.52(C)(3) Peninsular Countertop Spaces



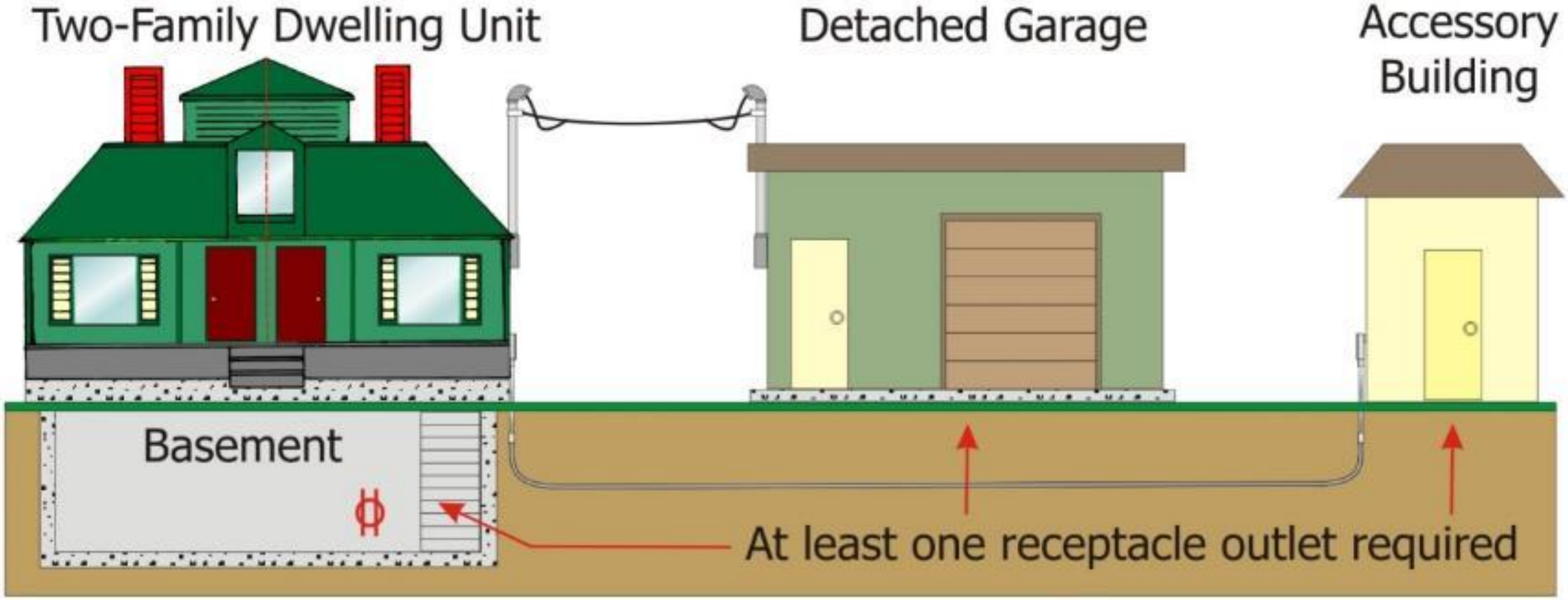
At least one receptacle outlet to be installed at each peninsular countertop long dimension space with a long dimension of 600 mm (24 in.) or greater and a short dimension of 300 mm (12 in.) or greater

Measurements to be measured from the "connected perpendicular wall"

210.52(G) Receptacles for Basements, Garages, and Accessory Buildings

- Receptacle requirements for dwelling unit garages, basements, and accessory buildings expanded to **two-family dwellings** *(not just one-family dwellings)*
- **At least one receptacle outlet** is required to be installed in each attached garage and detached garage with electric power, each separate unfinished portion of a basement, and each accessory building with electric power
- Same level of electrical safety has been extended to two-family dwellings as it has been for one-family dwellings *(potential of a hazard the same at both)*
- Helps elimination of resorting to running extension cords as a substitute for permanent wiring in these specified areas if no receptacle outlet were present

210.52(G) Receptacle for Basements, Garages, and Accessory Buildings



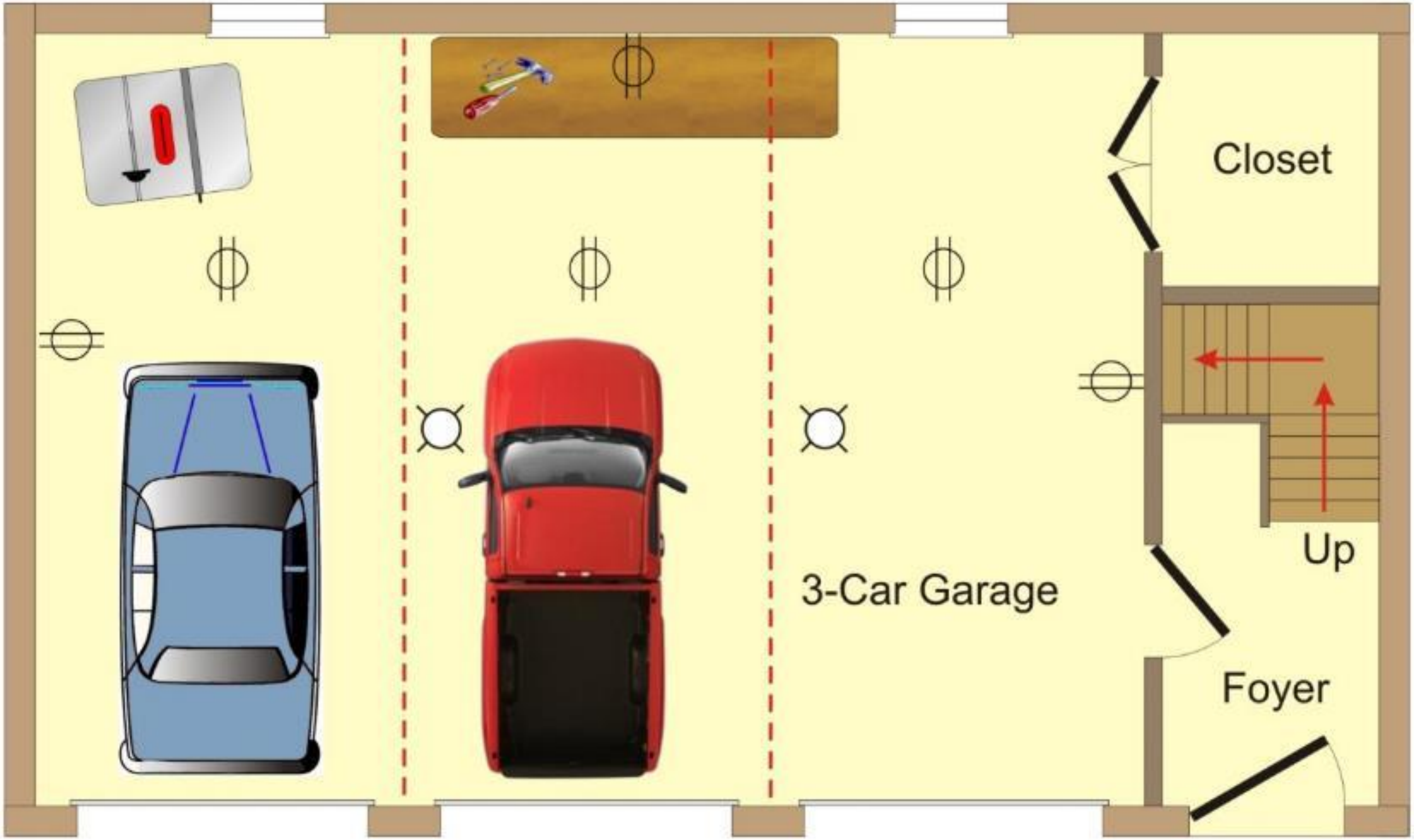
At one- and two-family dwellings, at least one 125-volt, 15- or 20-ampere receptacle outlet, in addition to those for specific equipment, shall be installed in areas specified below:

- Attached garages and in each detached garage with electric power
- Accessory buildings with electric power
- Unfinished basements - each seperate portion of the basement

210.52(G)(1) Dwelling Unit Garages

- At least one receptacle outlet is required to be installed “**in each vehicle bay**” and not more than **1.7 m (5½ ft)** above the floor
- Applies to each attached garage and in each detached garage with electric power
- Branch circuit supplying these receptacle(s) **cannot serve outlets outside of the garage** *(with the exception of readily accessible receptacles located outdoors)*
- Helps address increased activities within a modern day dwelling unit garages *[such as the possibility of the existence of electric vehicle (EV) charging equipment]*

210.52(G)(1) Dwelling Unit Garages



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

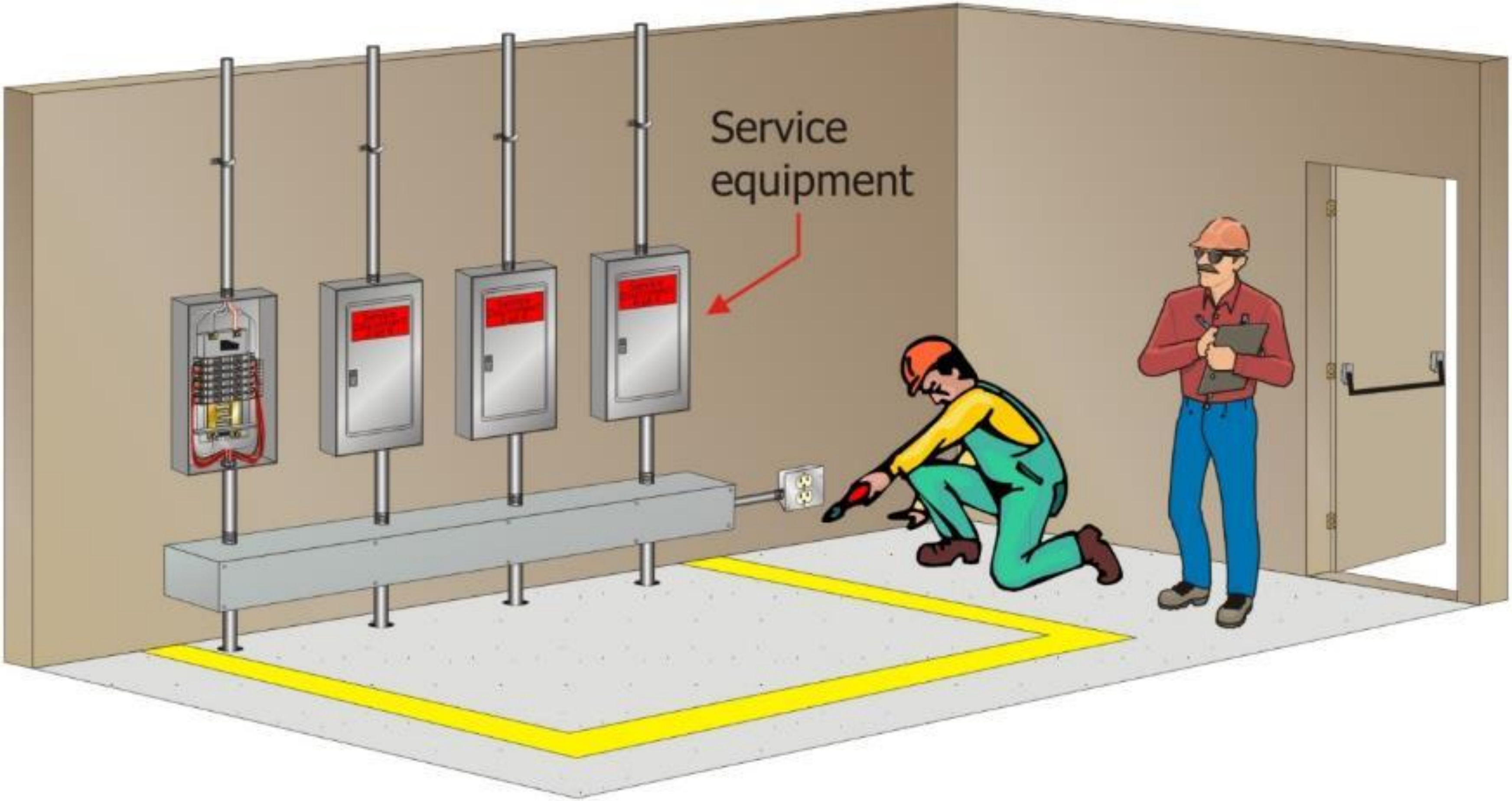
Note: *See 210.11(C)(4) for garage branch circuit requirements*


1
2
3
4

210.64 Electric Service Areas

- At least one 125-volt, single-phase, 15- or 20-ampere-rated receptacle outlet is still required to be installed at the electrical service equipment
- Maximum distance required receptacle outlet(s) can be located from the electrical service has been shortened to **7.5 m (25 ft)** and limited to **indoor service equipment only**
- This required receptacle outlet(s) is now required to be installed in an accessible location and **must be located within the same room or area** as the service equipment
- Does not apply to one- and two-family dwellings
- **New exception** added exempting services dedicated to equipment covered in **Articles 675 and 682** when the service voltage is **greater than 120 volts to ground**

210.64 Receptacle at 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 all indoor electrical service equipment and located within the same room or area as the service equipment *(other than one- and two-family dwellings)*

Exception added for service areas covered in Articles 675 and 682

210.64 Receptacle at Electrical Service Areas

Article 682 Natural and Artificially Made Bodies of Water

Article 675 Electrically Driven or Controlled Irrigation Machines

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 all indoor electrical service equipment and located within the same room or area

Exception added for services dedicated to equipment covered in Articles 675 and 682 when the service voltage is greater than 120 volts to ground

210.70(C) Lighting Outlets Required (All Occupancies)

- Lighting outlet requirements for storage or equipment spaces added for **non-dwelling unit utility rooms and basements**
- Title changed from “Other Than Dwelling Units” to “**All Occupancies**”
- Revised to mirror *Code* text at 210.70(A)(3) for dwelling units
- This lighting outlet requirement for storage or equipment spaces now applies to both dwelling and non-dwelling unit locations such as:
  - attics
  - underfloor spaces
  - utility rooms and
  - basements

210.70(C) Lighting Outlet(s) All Occupancies

At non-dwelling unit attics, underfloor spaces, utility rooms, and basements, at least one lighting outlet containing a switch or controlled by a wall switch must be installed where these spaces are used for storage or contain equipment requiring servicing *[See 210.70(A)(3) for dwelling units]*

At least one switch to be located at the "usual point of entry" to space with lighting outlet(s) located "at or near the equipment requiring servicing"

210.71 Receptacles for Meeting Rooms

- New provisions added for **receptacle outlets placement** and **wall spacing requirements** in **non-dwelling unit meeting rooms** such as found at hotels and convention centers
  - *Examples of rooms that are **not** meeting rooms include auditoriums, schoolrooms, and coffee shops*
- No previous *Code* requirement to provide receptacle outlets in meeting rooms of commercial or non-dwelling occupancies
- 125-volt, 15- or 20-ampere receptacle outlets installed in meeting rooms were due in part to building owners and designers recognize the need for access to electrical power for a multitude of different types of portable equipment

210.71 Meeting Rooms *(cont.)*

- 210.71(A) General
  - Each meeting room of **not more than 93 m2 (1000 ft^2)** in other than dwelling units shall have outlets for nonlocking-type, 125-volt, 15- or 20-ampere receptacles
  - Outlets to be installed in accordance with **210.71(B)** *(see next slide)*
  - Where a room or space is provided with **movable partition(s)**, each room size shall be determined with the partition in the position that results in the smallest size meeting room

210.71 Meeting Rooms *(cont.)*

- 210.71(B) Receptacle Outlets Required
  - Total number of receptacle outlets, including floor outlets and receptacle outlets in fixed furniture, shall not be less than as determined by **210.71(B)(1) and (2)** *(see next slide)*
  - These receptacle outlets shall be permitted to be located as determined by the designer or building owner

210.71 Meeting Rooms *(cont.)*

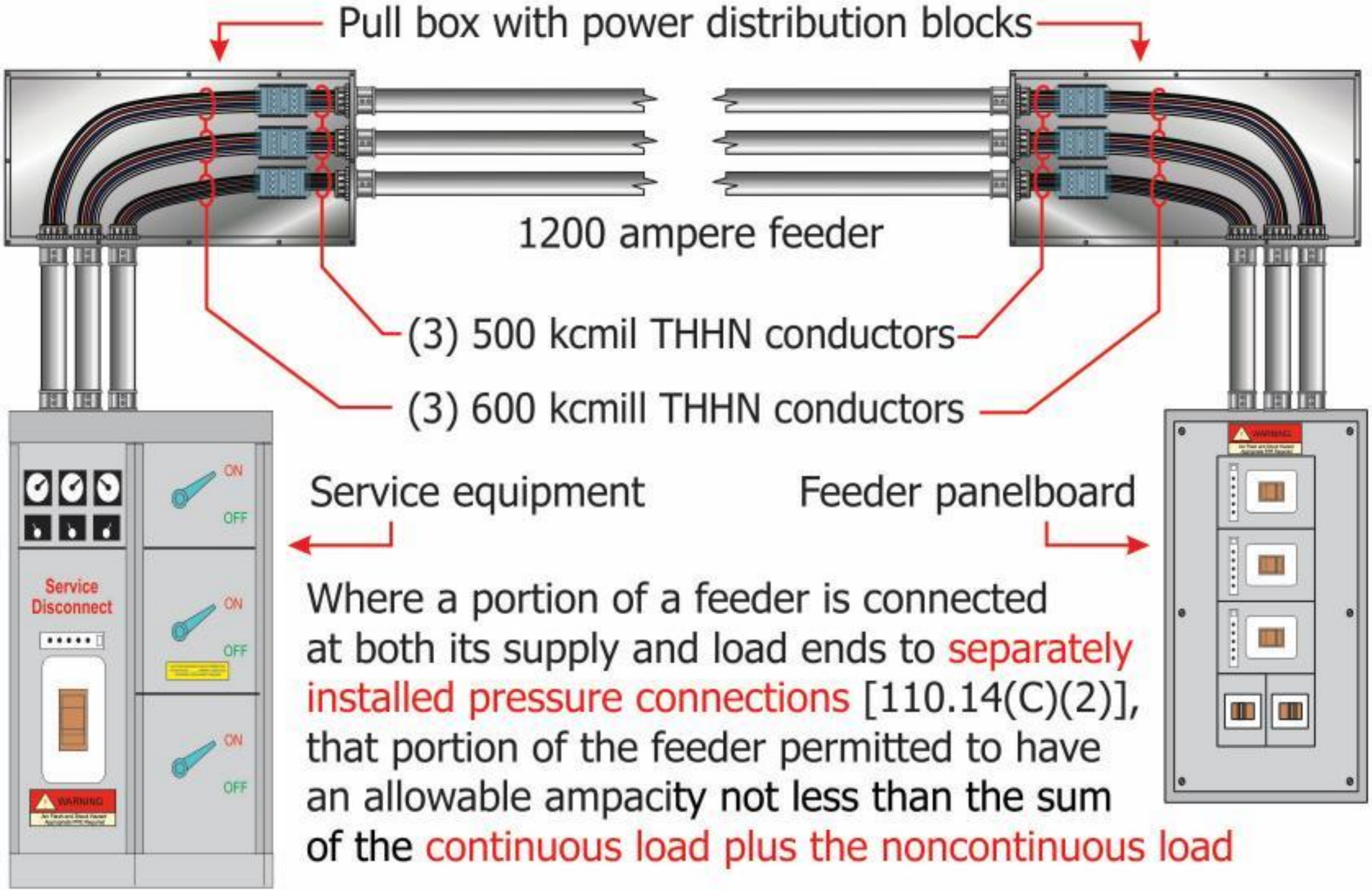
- 210.71(B) Receptacle Outlets Required *(cont.)*
  - (1) Receptacle Outlets in Fixed Walls
    - Receptacle outlets shall be installed in accordance with **210.52(A)(1) through (A)(4)**
  - (2) Floor Receptacle Outlets
    - Meeting rooms that are at least 3.7 m **(12 ft) wide** and that has a floor area of at least 20 m² **(215 ft²)** shall have at least **one receptacle outlet located in the floor** at a distance not less than 1.8 m **(6 ft)** from any fixed wall for each 20 m² (215 ft²) or major portion of floor space


ANALYSIS OF CHANGES – 2014 NEC
NEC 2008

215.2(A)(1)(a) Ex. No. 2
Feeder Rating and Size

- **New exception** added that allows a portion of a feeder that is connected at both its supply and load ends to **separately installed pressure connections** to have an allowable ampacity **not less than the sum of the continuous load plus the noncontinuous load** *(rather than the noncontinuous load plus 125 percent of the continuous load)*
- The previous exceptions that appeared after 215.2(A)(1)(b) have been relocated to appear after 215.2(A)(1)(a)
- Makes it clear that these exceptions apply to the main rule that feeder conductors must have an allowable ampacity of not less than the noncontinuous load plus 125 percent of the continuous load

215.2(A)(1)(a) Ex. No. 2 Feeder Rating and Size



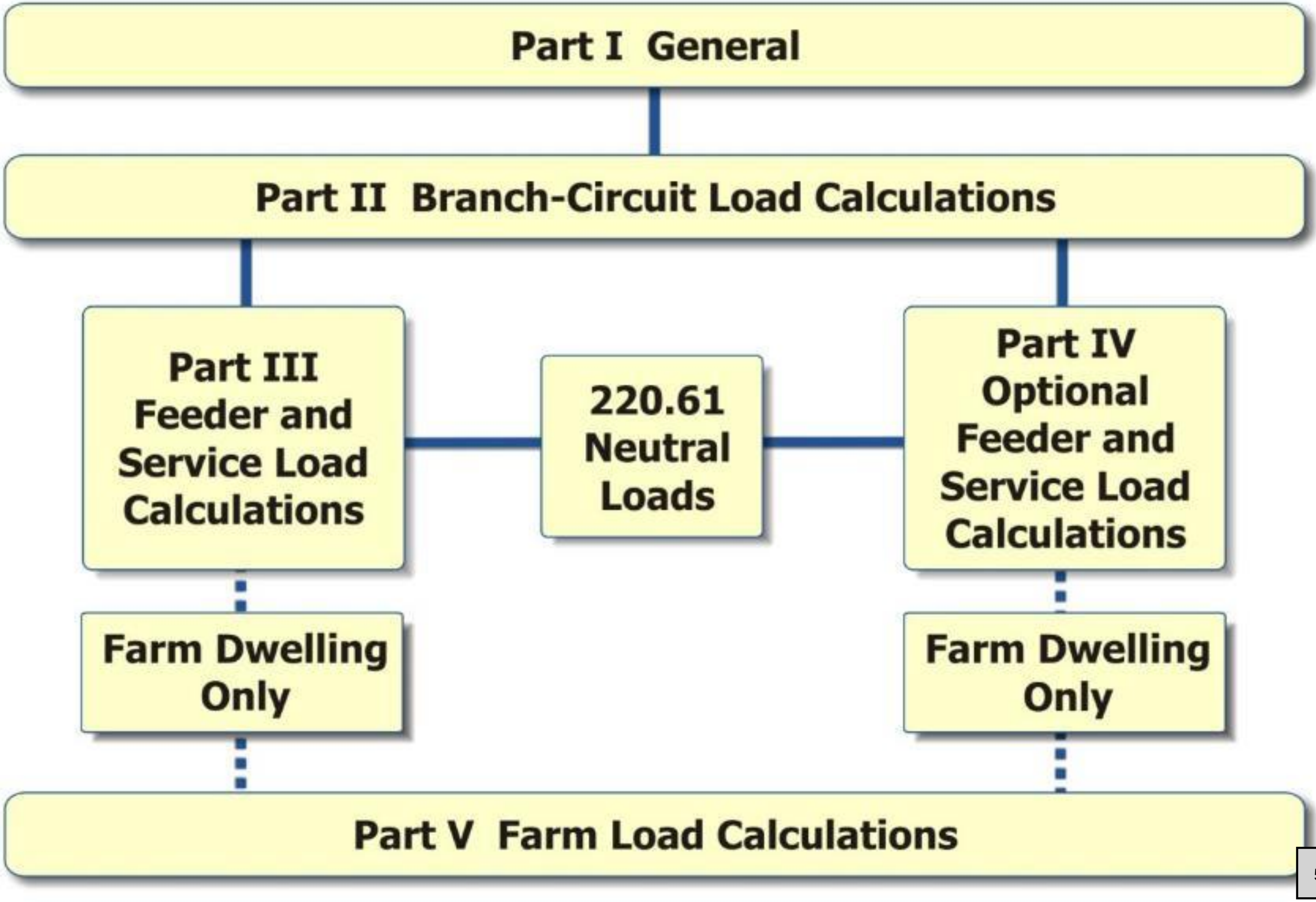
Where a portion of a feeder is connected at both its supply and load ends to separately installed pressure connections [110.14(C)(2)], that portion of the feeder permitted to have an allowable ampacity not less than the sum of the continuous load plus the noncontinuous load

No portion of a feeder installed under the provisions of this exception shall extend into an enclosure containing either the feeder supply or the feeder load terminations, as covered in 110.14(C)(1)

Article 220 and 220.1 Branch-Circuit, Feeder, and Service Load Calculations

- Title and Scope of Article 220 were revised to enhance clarity of what is covered by Article 220
- The word **“Load”** was added to the title of the article and the word **“loads”** was added a couple of times in the scope
- Revisions make it clear that the place for calculating loads is Article 220
- Place for determining branch circuit and feeder conductor sizes are Articles 210 and 215

Article 220 Branch-Circuit, Feeder, and Service Load Calculations



Part I General

Part II Branch-Circuit Load Calculations

Part III Feeder and Service Load Calculations

220.61 Neutral Loads

Part IV Optional Feeder and Service Load Calculations

Farm Dwelling Only

Farm Dwelling Only

Part V Farm Load Calculations

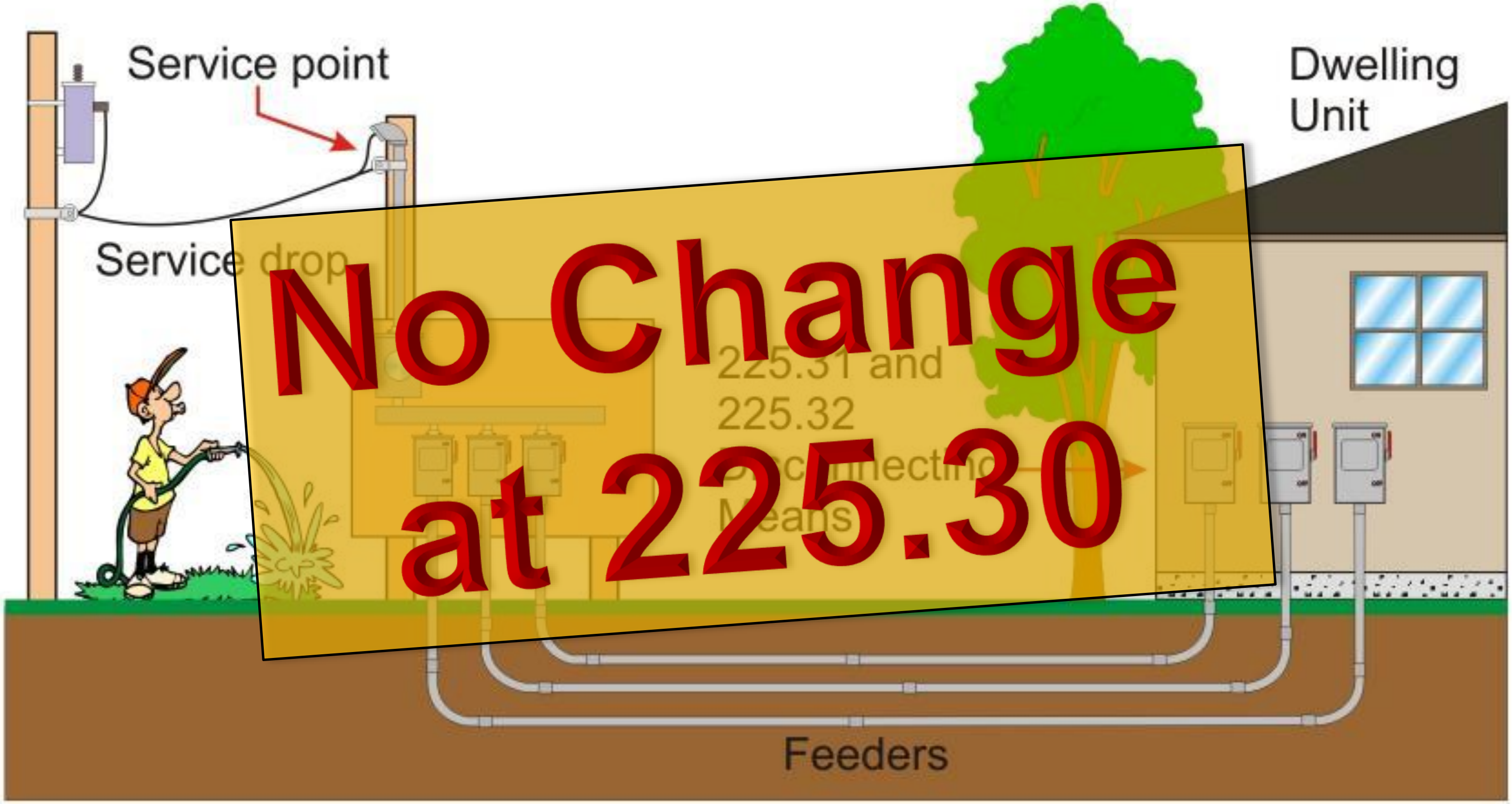
225.30(F) Number of Supplies (Feeders)

- **Multiple feeders** are now allowed to enter a one- or two-family dwelling under certain restrictions including that the feeder disconnects at the building served **must be grouped**
- **This 2017 *NEC* change was overturned as it did not pass written ballot resulting from Certified Amending Motion (CAM) 70-3**
- **This failed ballot resulted in returning the *Code* language at 225.30 to the 2014 *NEC Code* language**

No Change at 225.30

225.30(F) Number of Supplies (Feeders)

Feeders are generally limited to one feeder on the load side of the service equipment per building or structure *[see permissive conditions at 225.30]*



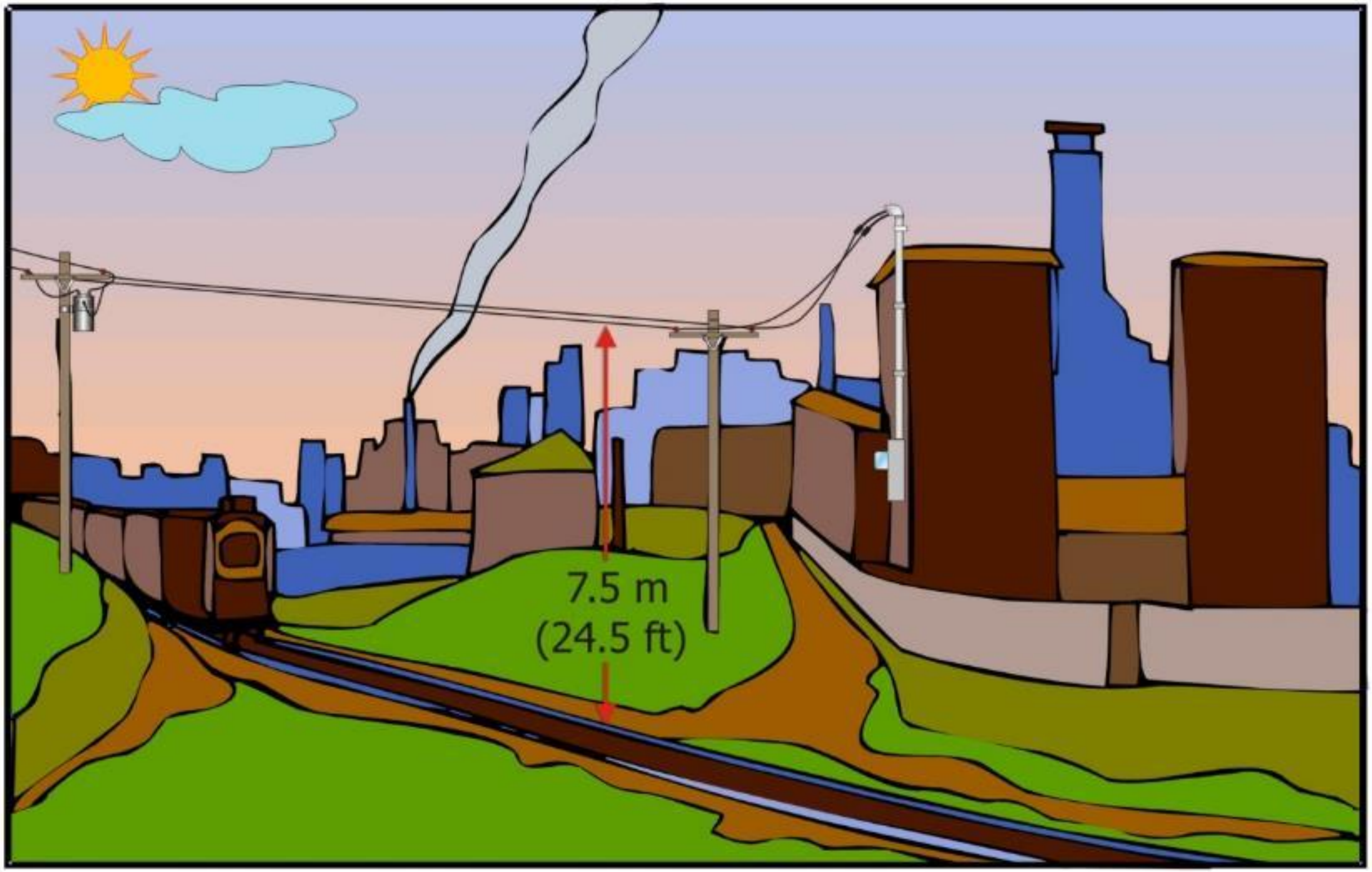
No Change at 225.30

Multiple feeders are now allowed to enter a one- or two-family dwellings under certain restrictions that include the feeder disconnects at the building served must be grouped

230.24(B)(5) Vertical Clearance for Overhead Service Conductors

- New vertical clearance of **7.5 m (24.5 ft)** added for overhead service conductors installed **over railroad tracks**
- Coordinates with the same requirement for outside overhead branch circuits and feeders in Article 225 *(see 225.18)*
- Vertical clearance requirements for overhead service conductors should be at least equal to the same requirements for outside overhead branch circuits and feeders
- 7.5 m (24.5 ft) clearance requirement is derived from and matches vertical clearance requirements found in ANSI Standard C2, ***National Electrical Safety Code (NESC)***

230.24(B)(5) Clearance for Overhead Service Conductors



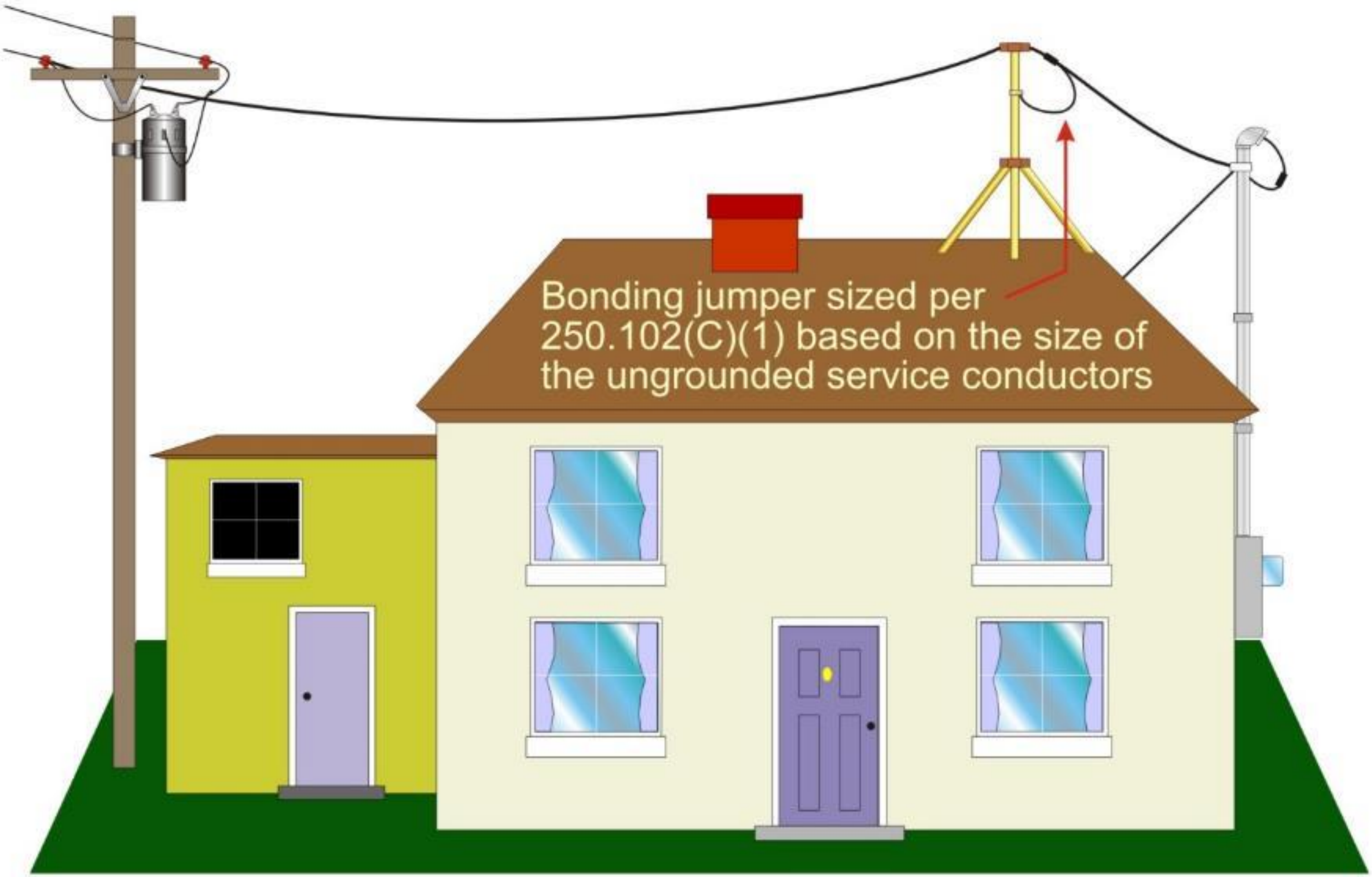
Overhead service conductors (not over 600 volts) shall have a minimum clearance from track rails of a railroad of not less than 7.5 m (24.5 ft)


SRCX
4017
BNSF
488120

230.29 Supports Over Buildings

- **Metal support structures** that support overhead service conductors installed over a roof are now **required to be bonded** to the grounded overhead service conductor
- These metal structures, sometimes referred to as a "**roof jack**" in the field, should be adequately bonded to limit a potential shock hazard
- The bonding jumper used to accomplish this bonding is to be sized per the requirements of **250.102** and **Table 250.102(C)(1)**
- This is based on the size of the ungrounded service conductors
- Similar to bonding requirements for bonding of ferrous metallic raceways used to chase or enclose a grounding electrode conductor *[see 250.64(E)]*

230.29 Supports Over Buildings



Bonding jumper sized per 250.102(C)(1) based on the size of the ungrounded service conductors

Metal support structures supporting overhead service conductors passing over a roof required to be bonded to grounded overhead service conducto

Table 240.6(A) Standard Ampere Rating

- Standard ampere ratings for fuses and inverse time circuit breakers have been revised to be included in a **list format** located at **new Table 240.6(A)**
- Revision to "list format" style has a long precedence in the *NEC*
- Converting a long list of items that were previously in long sentences or paragraphs to a "list format" is one way to accomplish this goal
- This change makes the *Code* more "user friendly"

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

The standard ampere ratings for fuses and inverse time circuit breakers shall be considered as shown in Table 240.6(A)

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			

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

240.67 Arc Energy Reduction

- New arc energy reduction requirements have been added for **fuses rated 1200 amperes or higher**

- Benefits of an **arc energy reduction** requirement that reduces incident energy for circuit breakers rated 1200 amperes and greater have been recognized and implemented by the requirements at **240.87**

- Arc energy reduction is designed to limit the arc-flash energy to which an electrical worker or maintenance personnel could be exposed

- Applies when working on the load side of an overcurrent devices rated or can be adjusted to **1200 amperes or higher**

240.67 Arc Energy Reduction *(cont.)*

- The **incident energy** in an arcing event is directly proportional to the time frame for such an event
- Installation requirements of **240.87 for circuit breakers** and these new requirements at **240.67 for fuses** provide a means to reduce the level of incident energy
- This has a future effective date of **January 1, 2020**

240.67 Arc Energy Reduction

Where fuses rated 1200 amperes or higher are installed, 240.67(A) and (B) shall apply

This requirement shall become effective January 1, 2020

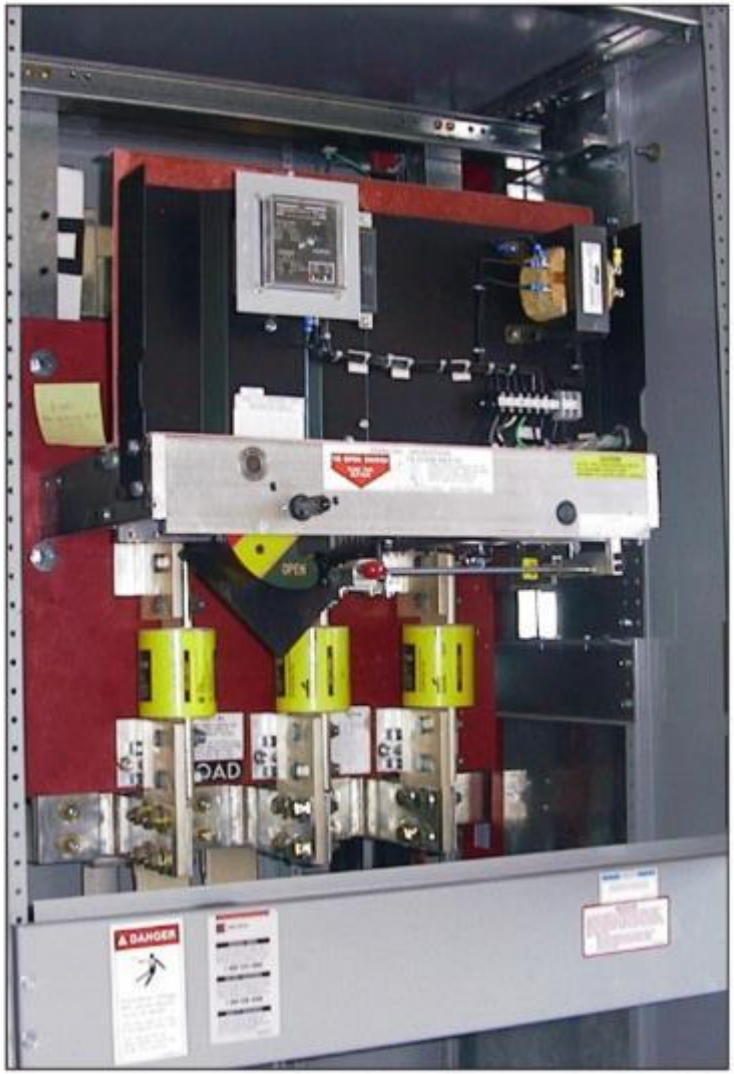
A fuse shall have a clearing time of 0.07 seconds or less at the available arcing current, or one of the following shall be provided:

(1) Differential relaying

(2) Energy-reducing maintenance switching with local status indicator

(3) Energy-reducing active arc flash mitigation system

(4) An approved equivalent means



Courtesy of Eaton Corporation

250.22 Circuits Not to Be Grounded

- Class 2 load side circuits for **suspended ceiling low-voltage power grid distribution systems** were added to the list of circuits not to be grounded
- Natural step as Article 393 stipulates that the "Class 2 load side circuits for suspended ceiling low-voltage power grid distribution systems **shall not be grounded**" *[see 393.60(B)]*
- Supply side of these Class 2 power sources are to be grounded by connection to an EGC *[see 393.60(A)]*
- The ungrounded nature of the load side of this low-voltage system helps ensure safety similar to other identified low-voltage systems not to be grounded at 250.22

250.22 Circuits Not to Be Grounded

The following circuits shall not be grounded:

(1) Circuits for electric cranes operating over combustible fibers in Class III locations, as provided in 503.155

(2) Circuits in health care facilities as provided in 517.61 and 517.160

(3) Circuits for equipment within electrolytic cell working zone as provided in Article 668

(4) Secondary circuits of lighting systems as provided in 411.6(A)

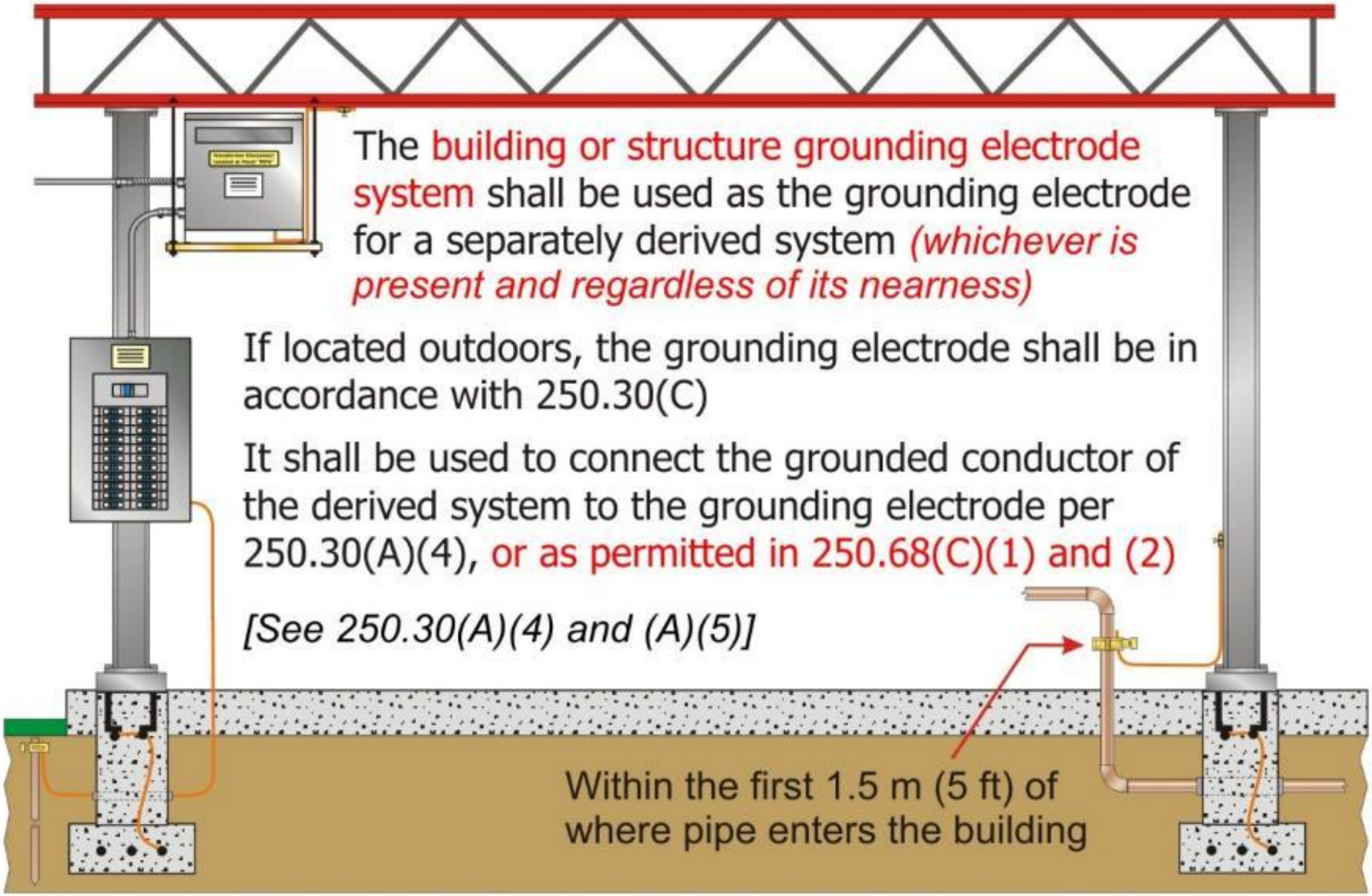
(5) Secondary circuits of lighting systems as provided in 680.23(A)(2)

(6) Class 2 load side circuits for suspended ceiling low-voltage power grid distribution systems as provided in 393.60(B)

250.30(A)(4) and (5)
Grounding Separately Derived Systems

- **Metal water piping** or **building steel** used as the first options of a grounding electrode system for a separately derived system have been removed
- **Any** of the building or structure grounding electrode(s) that are **present** can now be used as the grounding electrode(s) for a separately derived system
- The grounding electrode(s) used for the separately derived system do not have to be located near the grounding electrode conductor connection
- The **metal water piping** and the **structural metal frame** as covered in **250.68(C)(1) and (2)** have been recognized as conductors to extend the grounding electrode connection at 250.30(A)(5)

250.30(A) Grounding Separately Derived Systems



The building or structure grounding electrode system shall be used as the grounding electrode for a separately derived system *(whichever is present and regardless of its nearness)*

If located outdoors, the grounding electrode shall be in accordance with 250.30(C)

It shall be used to connect the grounded conductor of the derived system to the grounding electrode per 250.30(A)(4), or as permitted in 250.68(C)(1) and (2)

[See 250.30(A)(4) and (A)(5)]

Within the first 1.5 m (5 ft) of where pipe enters the building

Structural metal frame of a building or concrete-encased electrodes permitted as a bonding conductor to interconnect electrodes or as GEC

250.30(A)(6)(a)
Common GE Conductor

- A **metal water pipe** *[complying with 250.68(C)(1)]* was added to the allowable methods for a common grounding electrode conductor for multiple separately derived systems
- Building or structure employing multiple separately derived systems permits a **common grounding electrode conductor** to be utilized for connection of the grounded conductor of the separately derived systems to the grounding electrode(s)
- For metal water pipe to qualify as a common grounding electrode conductor, connection must be made to an **interior metal water pipe** that is electrically continuous with a metal underground water pipe electrode and made within the **first 1.52 m (5 ft)** from the point of entrance to the building *(with industrial exception) [see 250.68(C)(1)]*

250.30(A)(6)(a)
Common GE Conductor *(cont.)*

- Revisions were also made to the provisions of a **metal structural frame of a building or structure** qualifying as a common grounding electrode conductor for multiple separately derived systems
- Revised by adding the word “**structural**” to the reference to give a better description to this method
- *Code* reference of **250.52(A)(2)** was changed to **250.68(C)(2)**
- **250.52(A)(2)** pertains to the conditions a metal structural framing member must meet in order to qualify as a grounding electrode
- **250.68(C)(2)** relates to a metal structural frame of a building or structure being used as a conductor to interconnect electrodes that are part of the grounding electrode system

250.30(A)(6)(a) Common GE Conductor

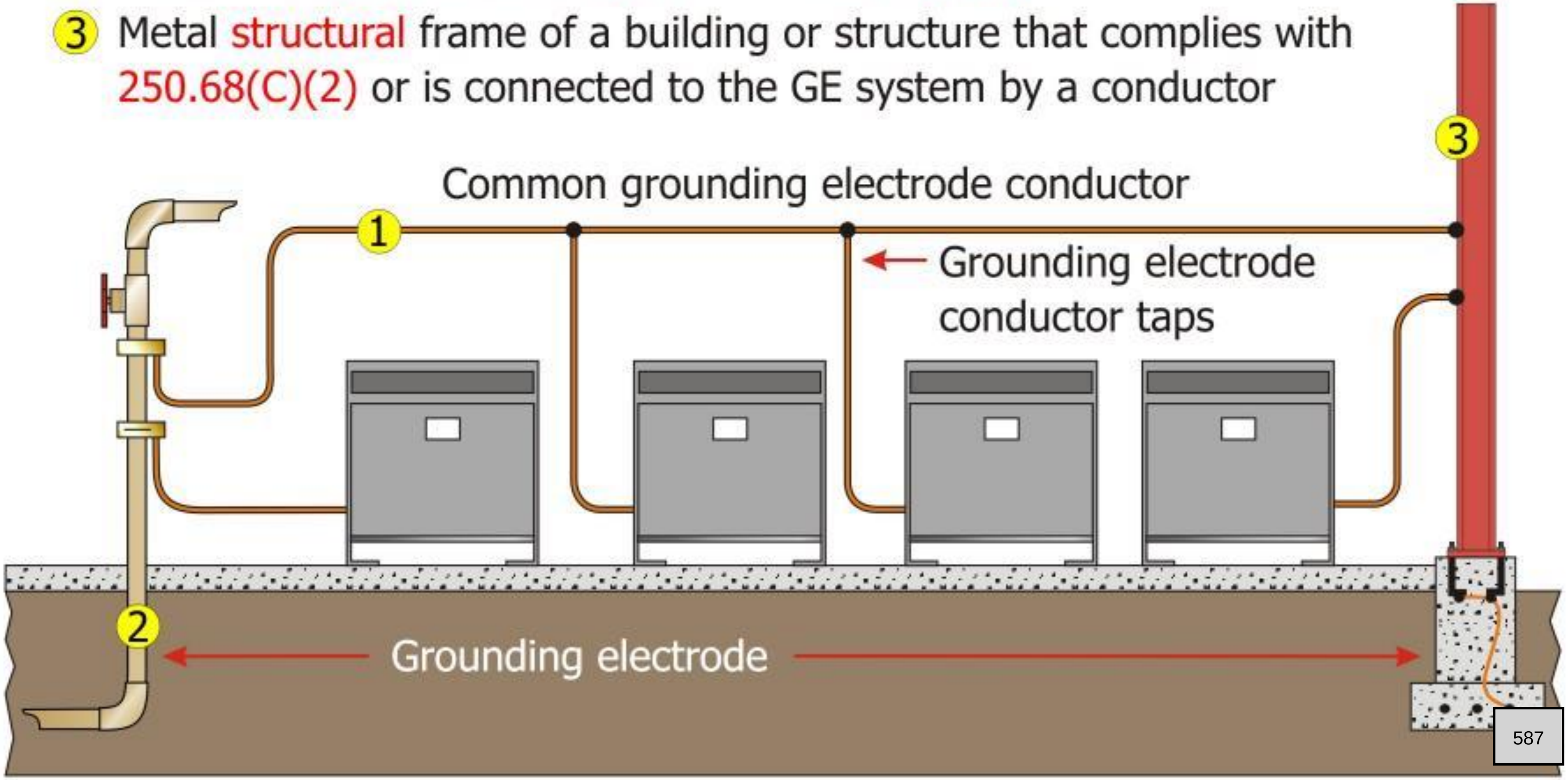
A common grounding electrode conductor for multiple separately derived systems shall be permitted

Common grounding electrode conductor permitted to be one of the following:

① Wire-type conductor (3/0 AWG copper or 250 kcmil aluminum minimum)

② Metal water pipe that complies with 250.68(C)(1) *[first 1.52 m (5 ft), etc.]*

③ Metal structural frame of a building or structure that complies with 250.68(C)(2) or is connected to the GE system by a conductor



250.52(A)(2)
Metal In-Ground Support Structure

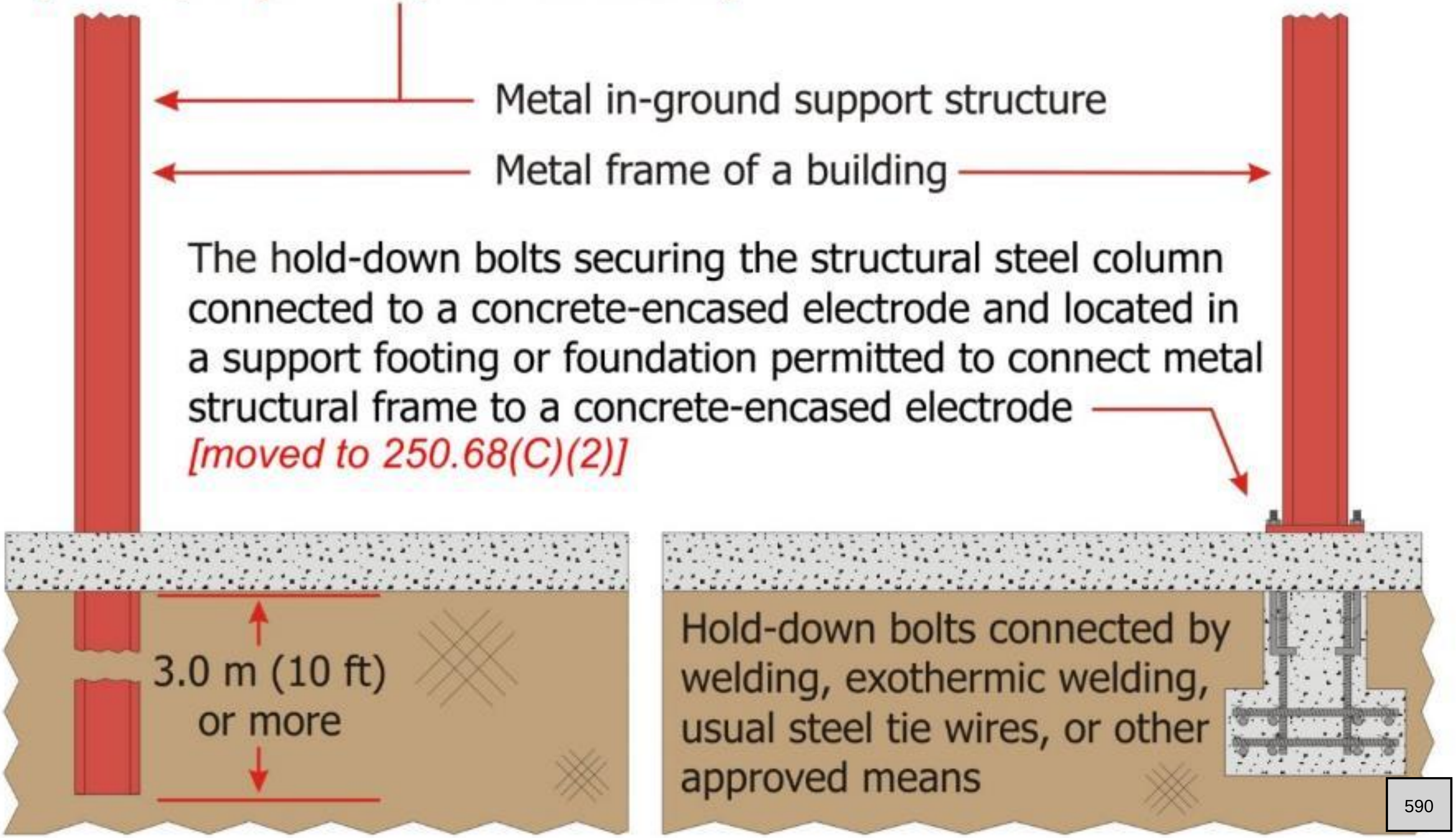
- The title of 250.52(A)(2) was changed from "**~~Metal Frame of a Building~~**" to "**Metal In-Ground Support Structure**"
- New title is more in line with the definition of a grounding electrode in Article 100 *(conducting object through which a direct connection to earth is established)*
- Only one item *(the metal support)* remains that would qualify as a "metal in-ground support structure" grounding electrode
- To qualify as an in-ground support structure, must be:
    - In direct contact with the earth vertically **3.0 m (10 ft) or more** *(with or without concrete encasement)*

250.52(A)(2)
Metal In-Ground Support Structure *(cont.)*

- Previous condition of a **metal structural member connected to a concrete-encased electrode** through the hold-down bolts, etc. qualifying as a grounding electrode has not been deleted
- **Relocated to 250.68(C)(2)** *(Grounding Electrode Connections)* as it is no longer appropriate for 250.52(A)(2) *(Electrodes Permitted for Grounding)*
- Adds clarity to 250.68(C)(2) and should be preserved as a permitted connection method

250.52(A)(2) Metal In-Ground Support Structures

One or more structural 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)* qualifies as a grounding electrode *(if multiple are present, only one required to be used)*



Metal in-ground support structure

Metal frame of a building

The hold-down bolts securing the structural steel column connected to a concrete-encased electrode and located in a support footing or foundation permitted to connect metal structural frame to a concrete-encased electrode *[moved to 250.68(C)(2)]*

3.0 m (10 ft) or more

Hold-down bolts connected by welding, exothermic welding, usual steel tie wires, or other approved means

250.52(B)(3) Swimming Pools Not Permitted for Use as Grounding Electrodes

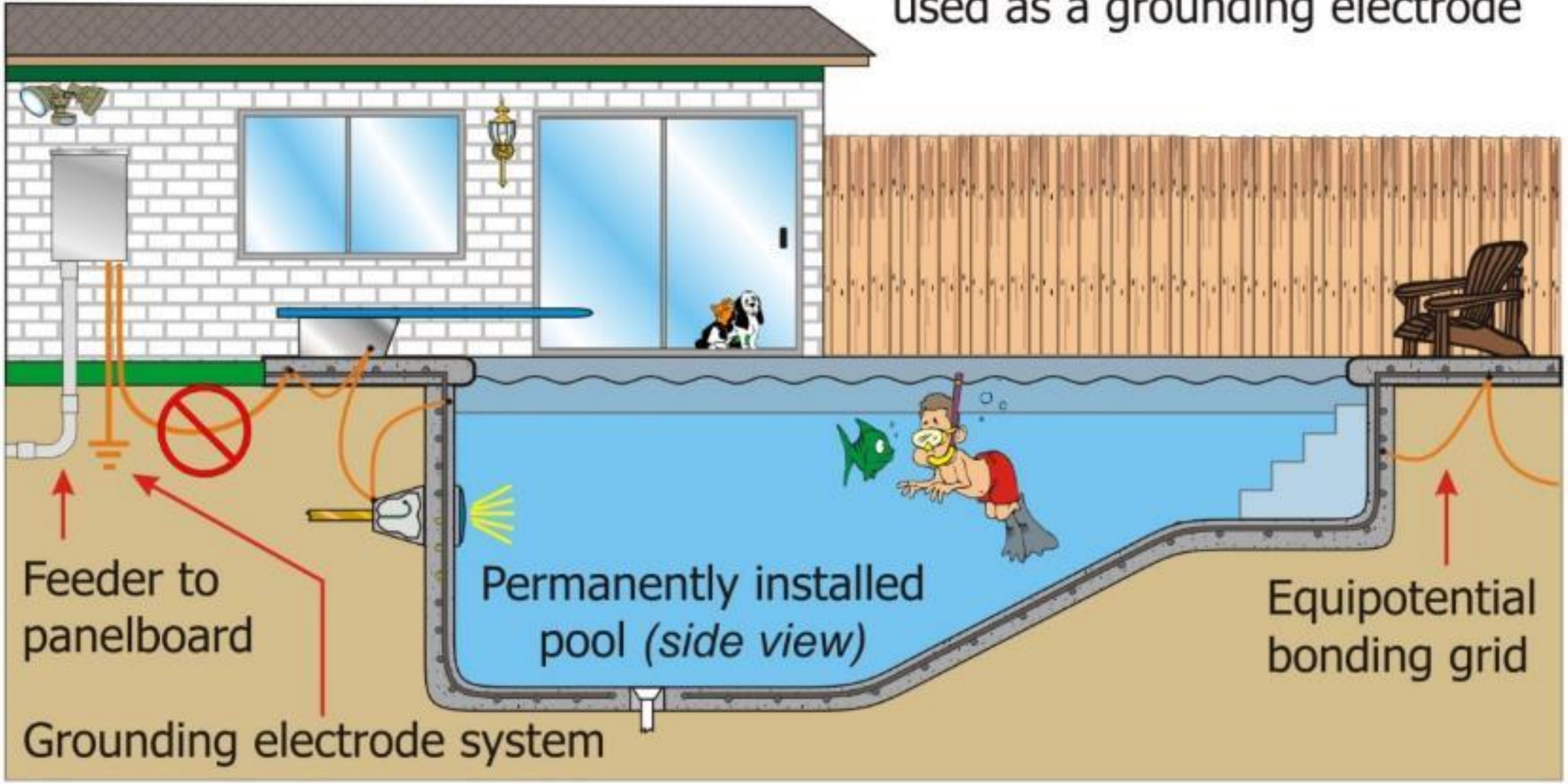
- Third item added to the list of objects that are **prohibited** from being used as a grounding electrode at 250.52(B)
- The structures and structural reinforcing steel of an **in-ground swimming pool** as described in 680.26(B)(1) and (B)(2) are now **prohibited from being used as a grounding electrode**
- Important clarification to point out the difference between grounding and bonding
- Equipotential bonding requirements of 680.26 are to reduce voltage gradients *(difference of voltage potential between two conducting objects)*, not to create a grounding electrode system for a building or structure

250.52(B)(3) Swimming Pools Not Permitted for Use as Grounding Electrodes *(cont.)*

- Third item added to the list of objects that are **prohibited** from being used as a grounding electrode at 250.52(B) *(cont.)*
- Items that shall not be used as a grounding electrode include:
  - Underground gas piping systems
  - An aluminum electrode
  - **Structures and structural reinforcing steel of an in-ground swimming pool**

250.52(B)(3) Not Permitted for Use as Grounding Electrodes

The structures and structural reinforcing steel of an in-ground swimming pool as described in 680.26(B)(1) and (B)(2) are prohibited from being used as a grounding electrode



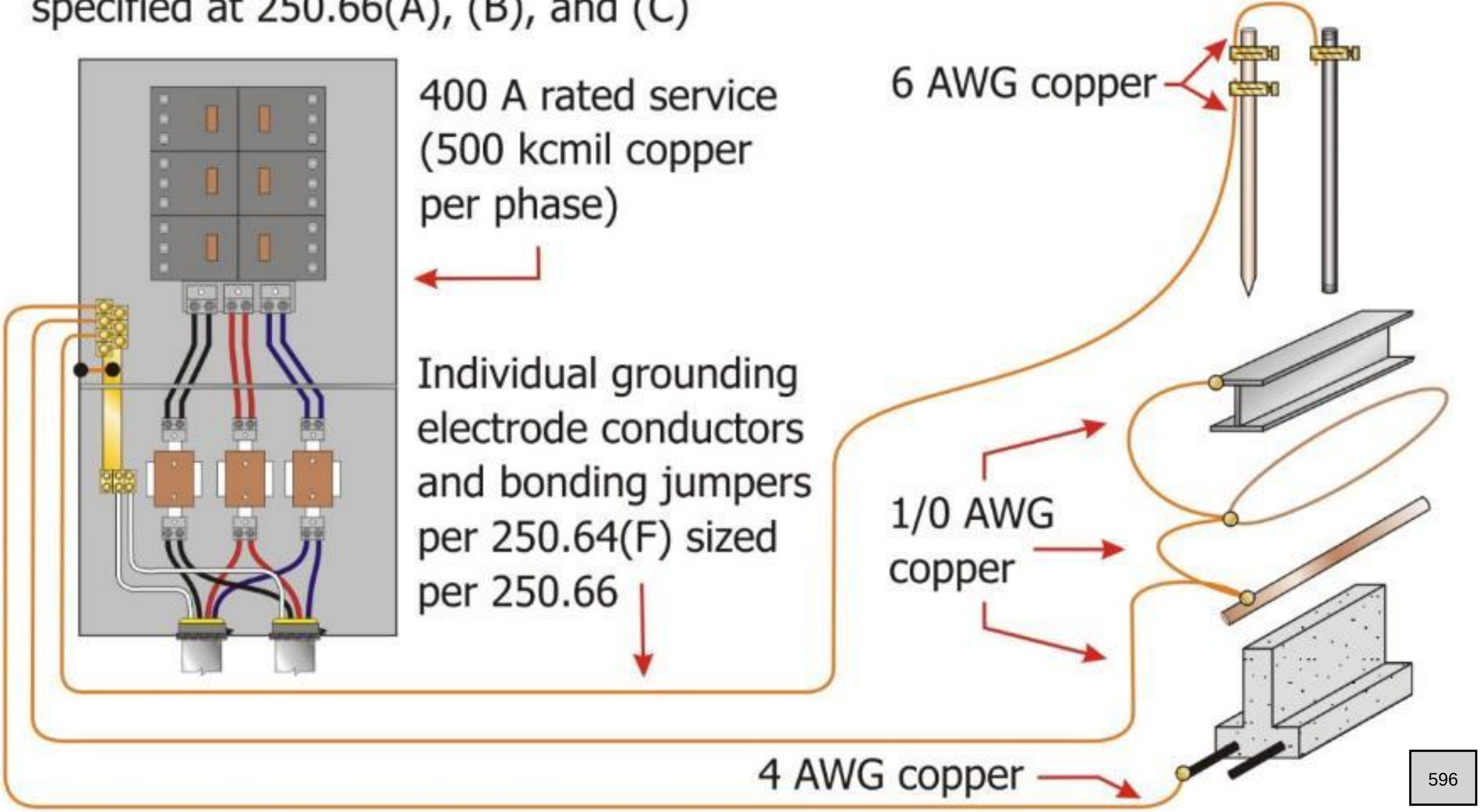
The provisions of 680.26 for equipotential bonding are to reduce voltage gradients *(difference of voltage potential between two conducting objects)*, not to establish a grounding electrode system for a building or structure

250.66(A), (B) and (C) Sizing of GECs

- The term **“sole connection”** was completely removed from 250.66(A), (B), and (C)
- New text makes it clear that the action of **“daisy chaining”** grounding electrodes with properly sized bonding jumpers to form a grounding electrode system is an acceptable practice…
- as long as any downstream grounding electrode would not require a larger grounding electrode conductor or bonding jumper
- The term **"or bonding jumper"** was added to each subdivision to use the correct terminology when “daisy chaining” occurs past the first grounding electrode in the chain of multiple electrodes

250.66(A), (B) and (C) Sizing of GECs

If the grounding electrode conductor or bonding jumper connected to the electrodes described at 250.66(A), (B), and (C) does not extend on to other types of electrodes that require a larger size conductor, the grounding electrode conductor(s) shall not be required to be larger than the sizes specified at 250.66(A), (B), and (C)



400 A rated service (500 kcmil copper per phase)

Individual grounding electrode conductors and bonding jumpers per 250.64(F) sized per 250.66

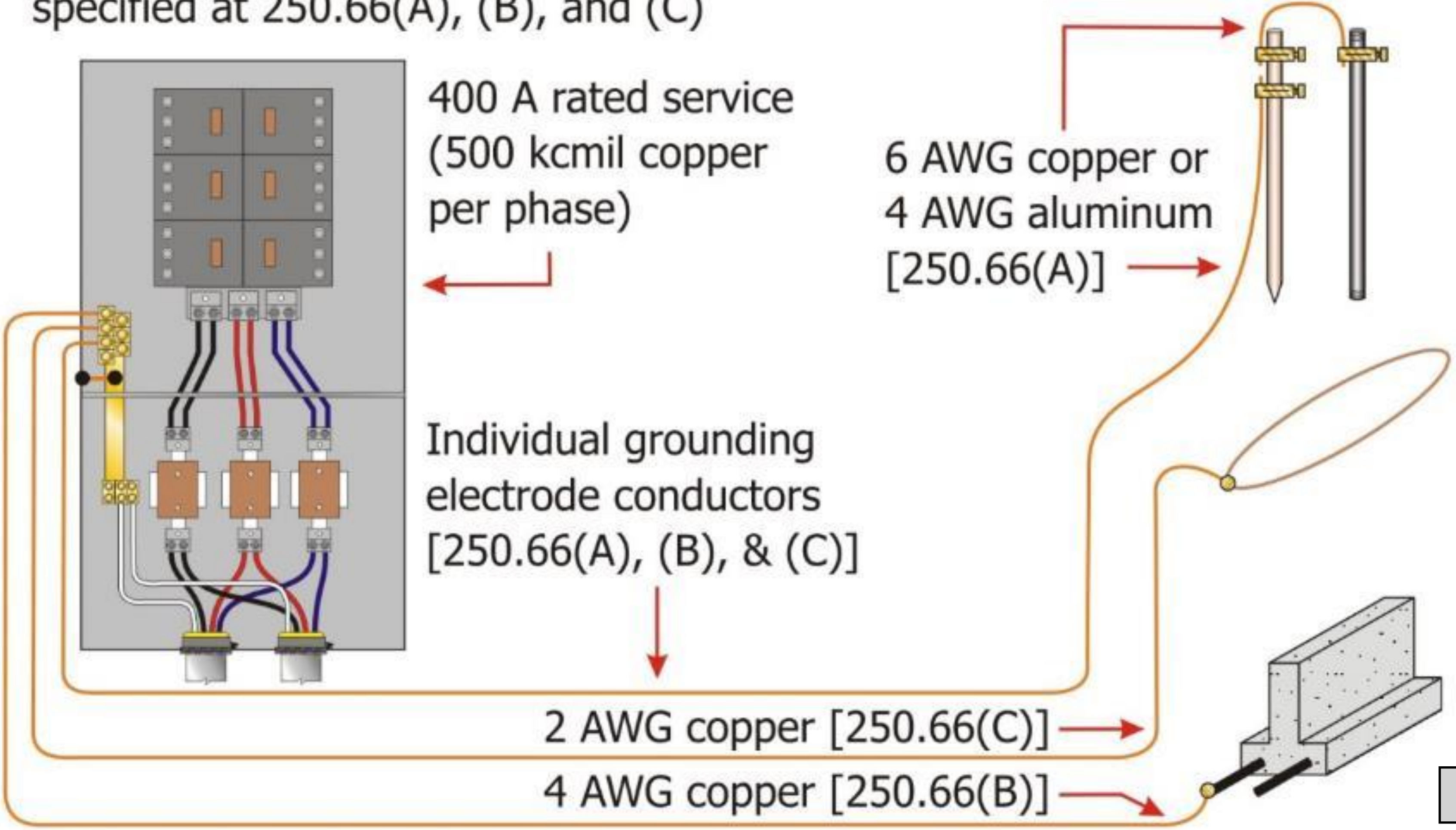
6 AWG copper

1/0 AWG copper

4 AWG copper

250.66(A), (B) and (C) Sizing of GECs

If the grounding electrode conductor or bonding jumper connected to the electrodes described at 250.66(A), (B), and (C) does not extend on to other types of electrodes that require a larger size conductor, the grounding electrode conductor(s) shall not be required to be larger than the sizes specified at 250.66(A), (B), and (C)



400 A rated service (500 kcmil copper per phase)

6 AWG copper or 4 AWG aluminum [250.66(A)]

Individual grounding electrode conductors [250.66(A), (B), & (C)]

2 AWG copper [250.66(C)]

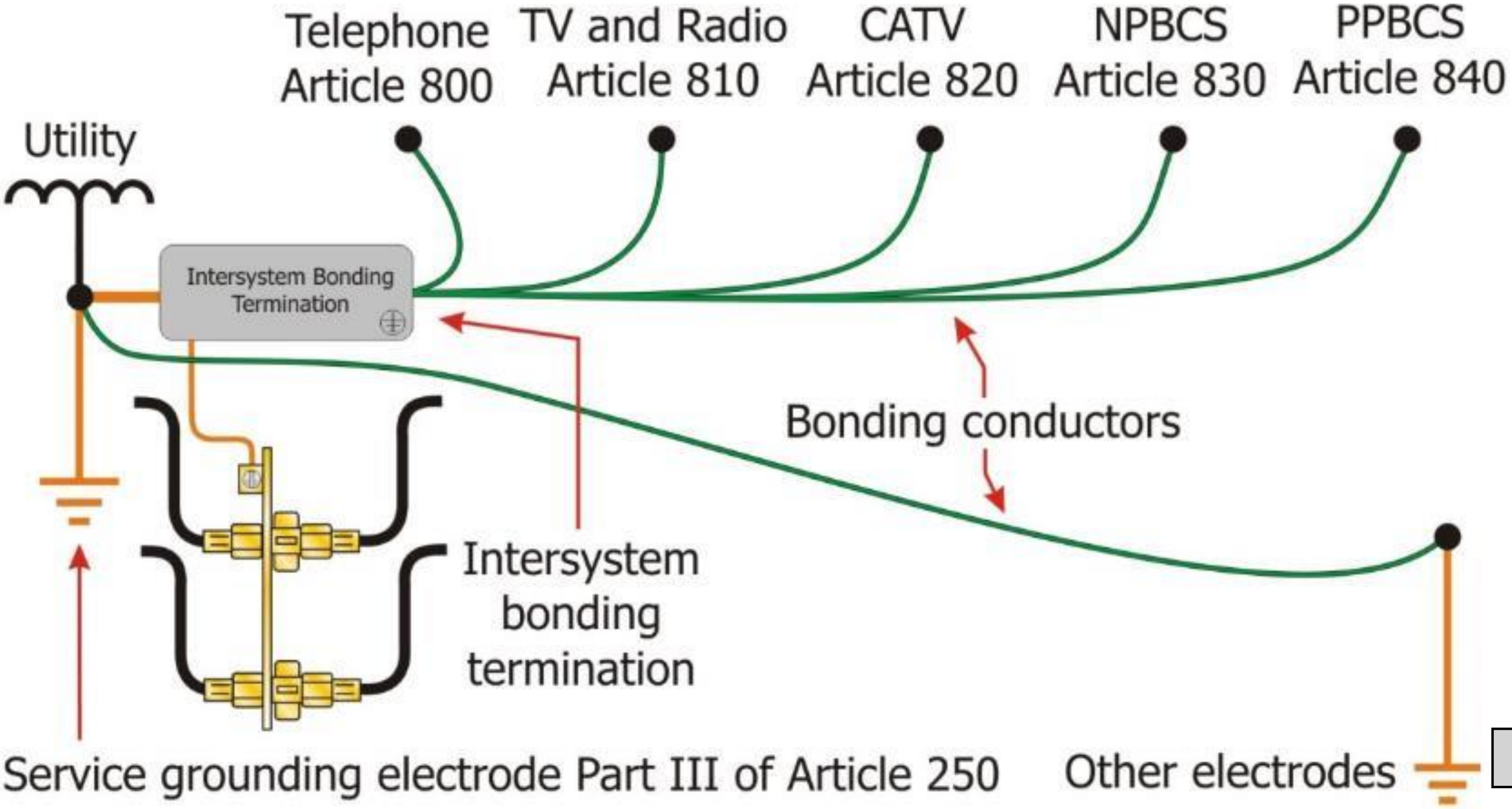
4 AWG copper [250.66(B)]

250.94(A) and (B)
Bonding for Communication Systems

- The title of the section was changed from “Bonding for ~~Other~~ Systems” to “Bonding for **Communication** Systems”
- Existing text for the intersystem bonding termination was placed under **250.94(A)** and titled, “**The Intersystem Bonding Termination Device**”
- New **250.94(B)** titled, “**Other Means**” added permitting intersystem bonding connections to an **aluminum or copper busbar** that will accommodate at least three terminations for communication systems as well as “**other connections**”
- A new exception was added for both 250.94(A) and (B) offering relief from an intersystem bonding connection means “where communications systems are not likely to be used”

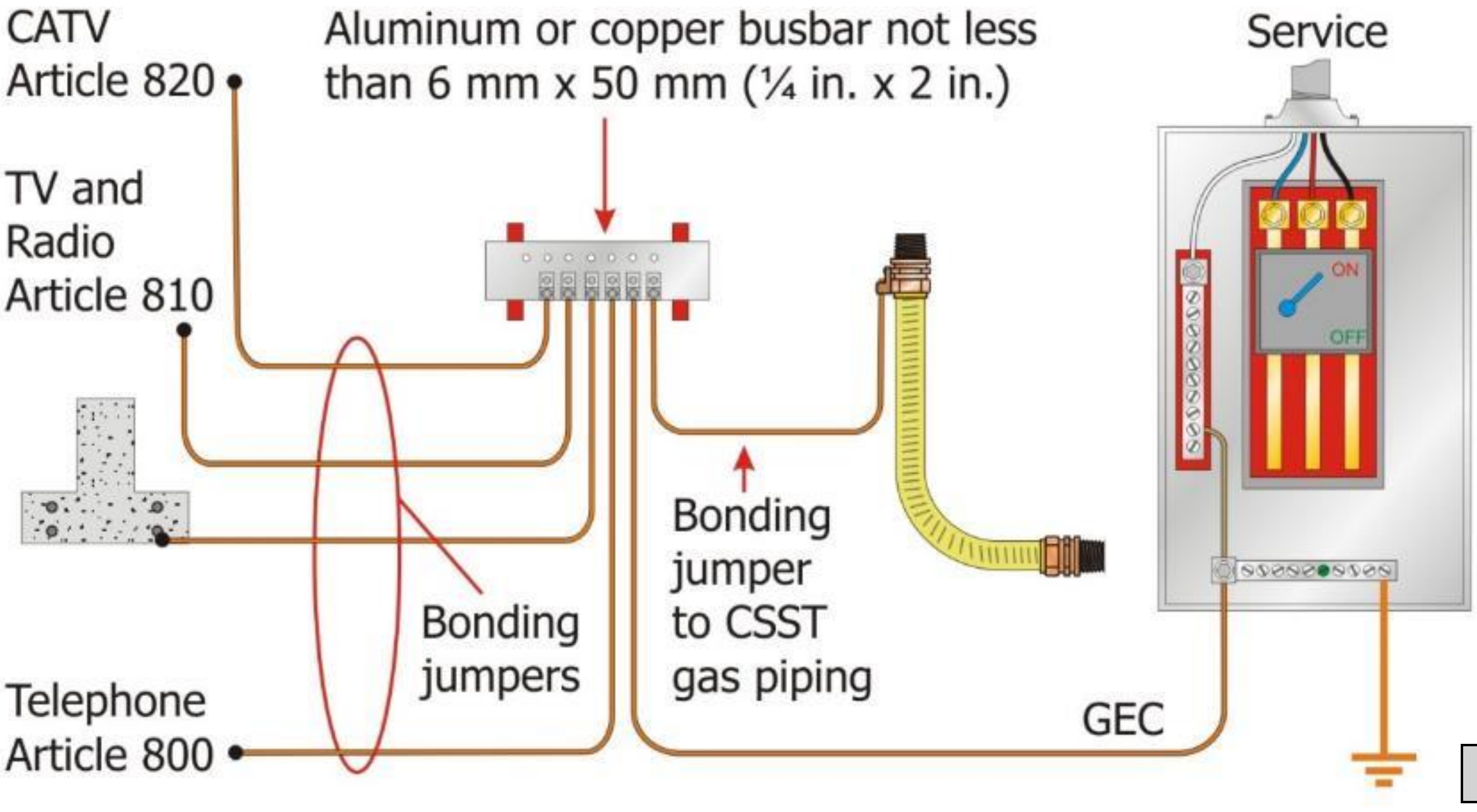
Bonding for ~~Other~~ Communication Systems

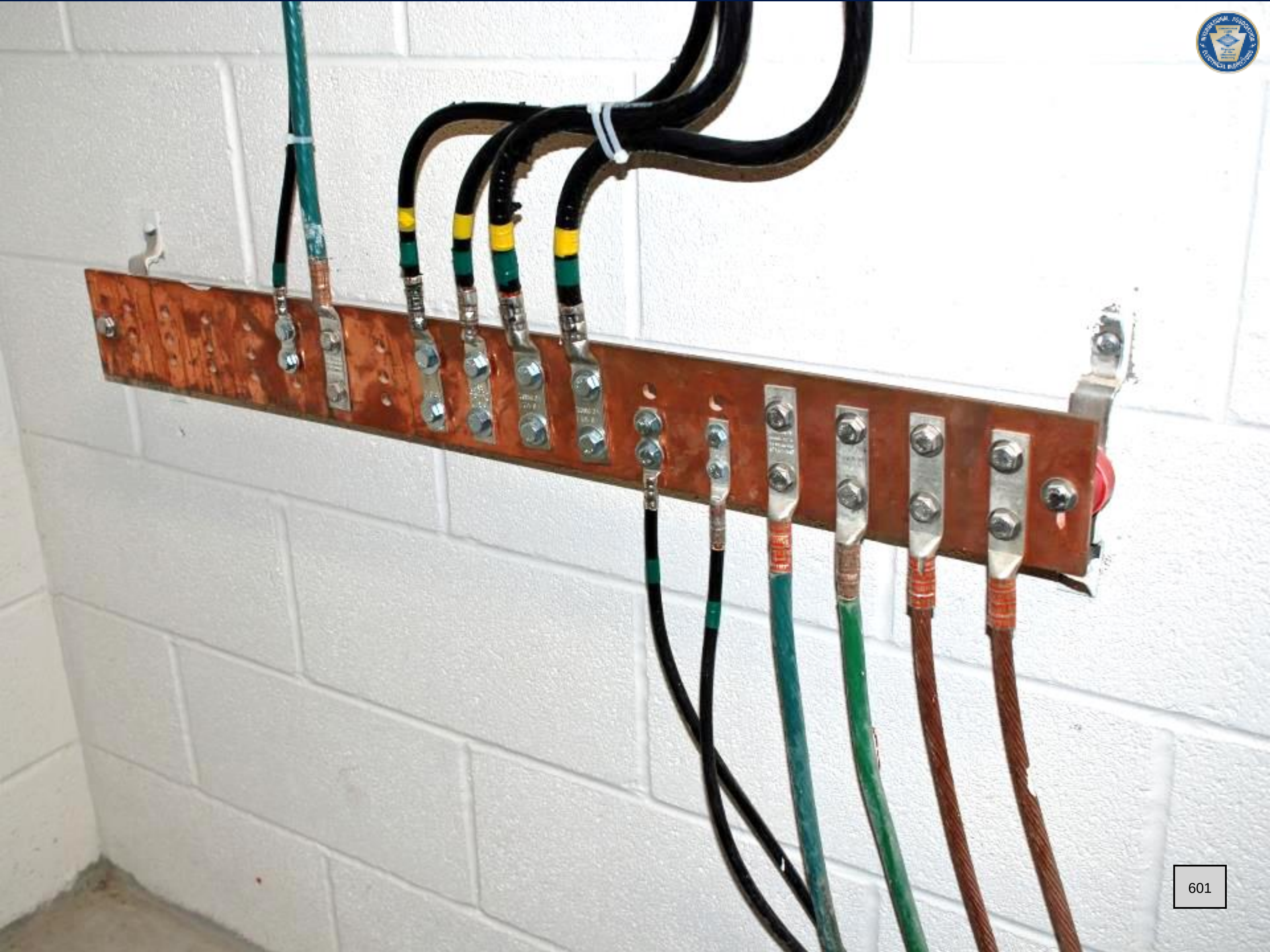
250.94(A) The Intersystem Bonding Termination Device. An intersystem bonding termination (IBT) for connecting intersystem bonding conductors shall be provided external to enclosures at the service equipment or metering equipment enclosure and at the disconnecting means for any additional buildings or structures.

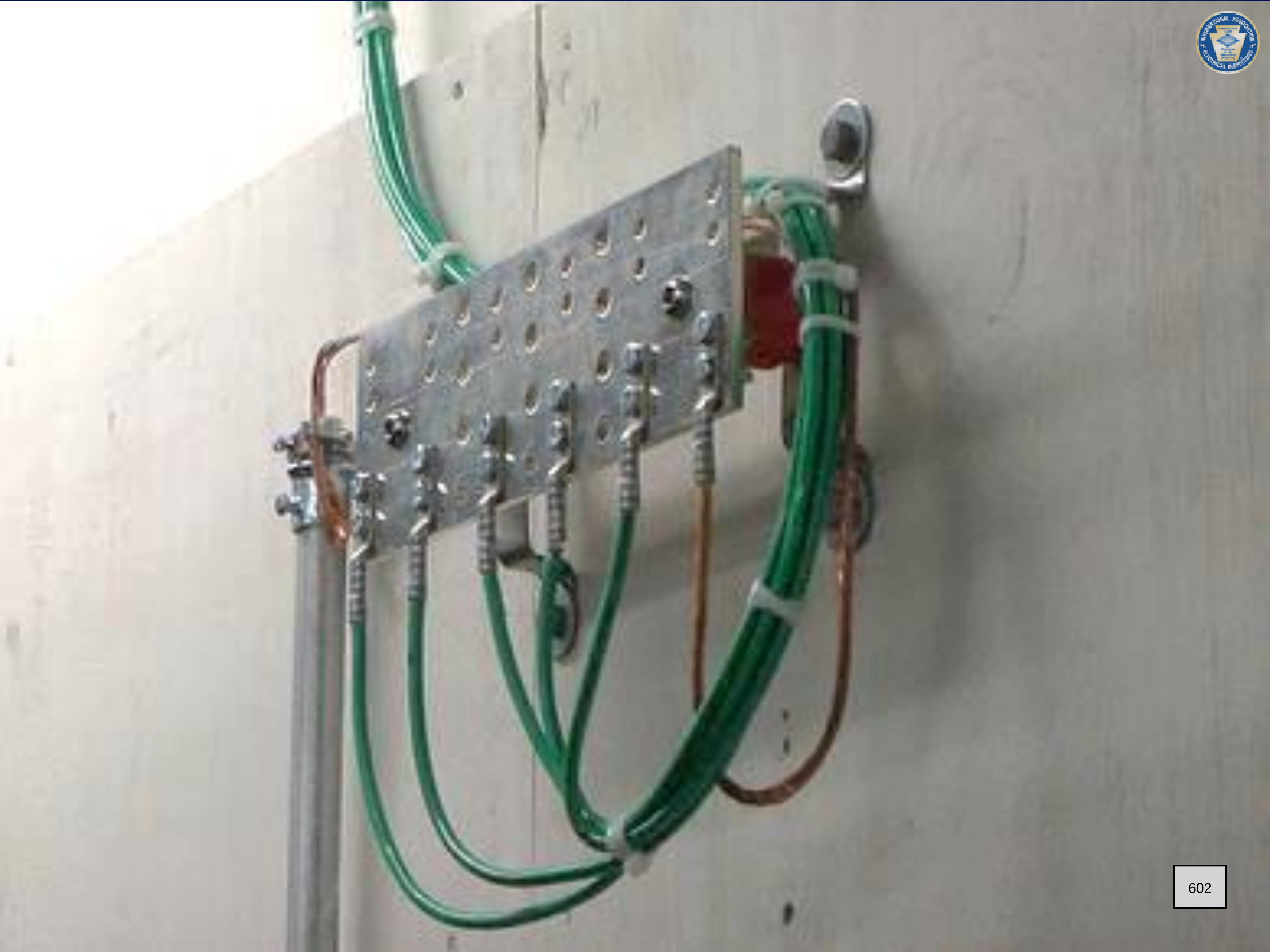


Bonding for ~~Other~~ Communication Systems

250.94(B) Other Means. Connections to an aluminum or copper busbar not less than 6 mm thick × 50 mm wide (¼ in. thick × 2 in. wide) and of sufficient length to accommodate at least three terminations for communication systems in addition to other connections.







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

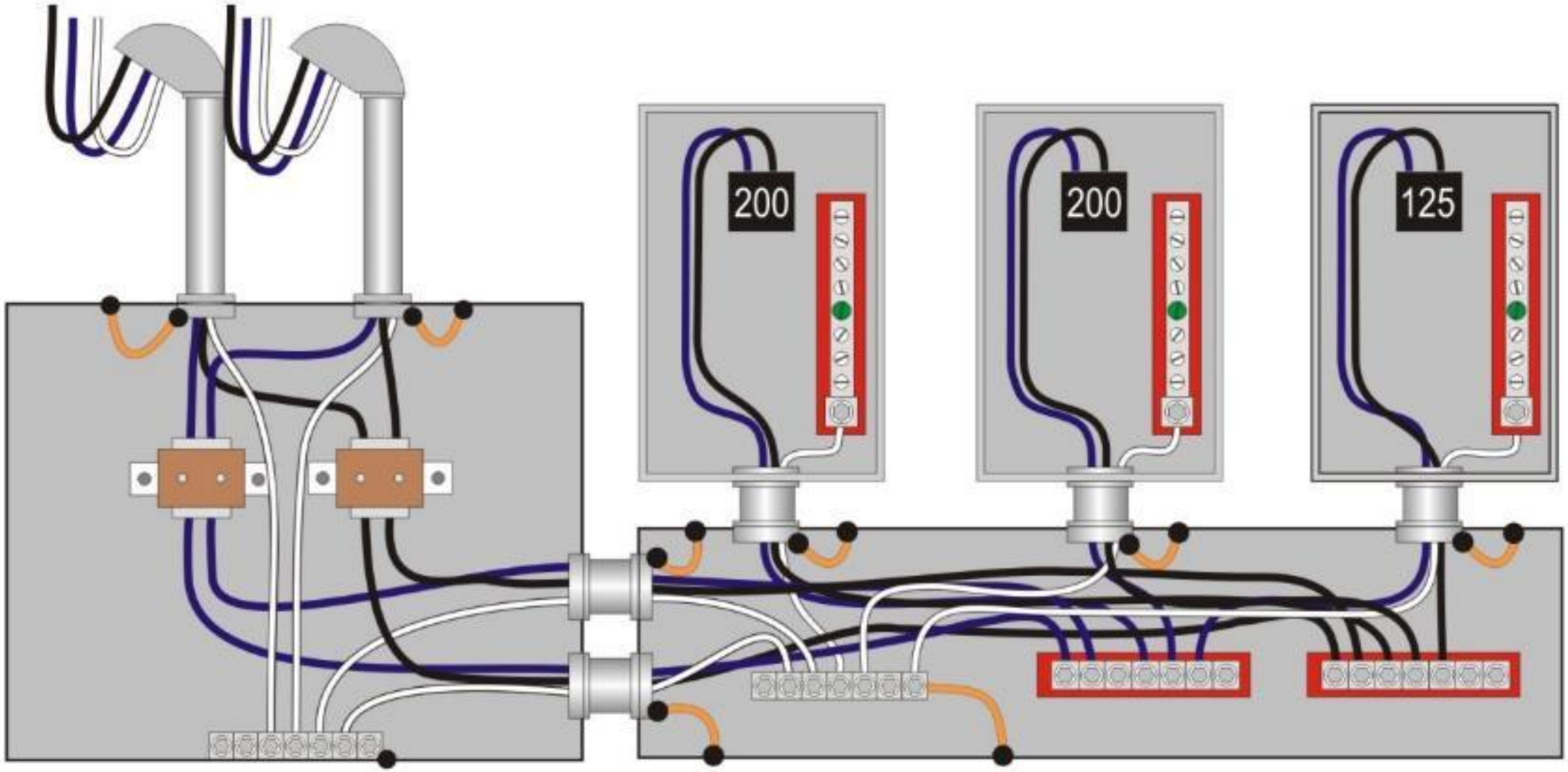
- The term "**Grounded Conductor**" was added to the title of 250.102 to more accurately reflect what the section addresses

- Change harmonizes the title with the content of the section

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

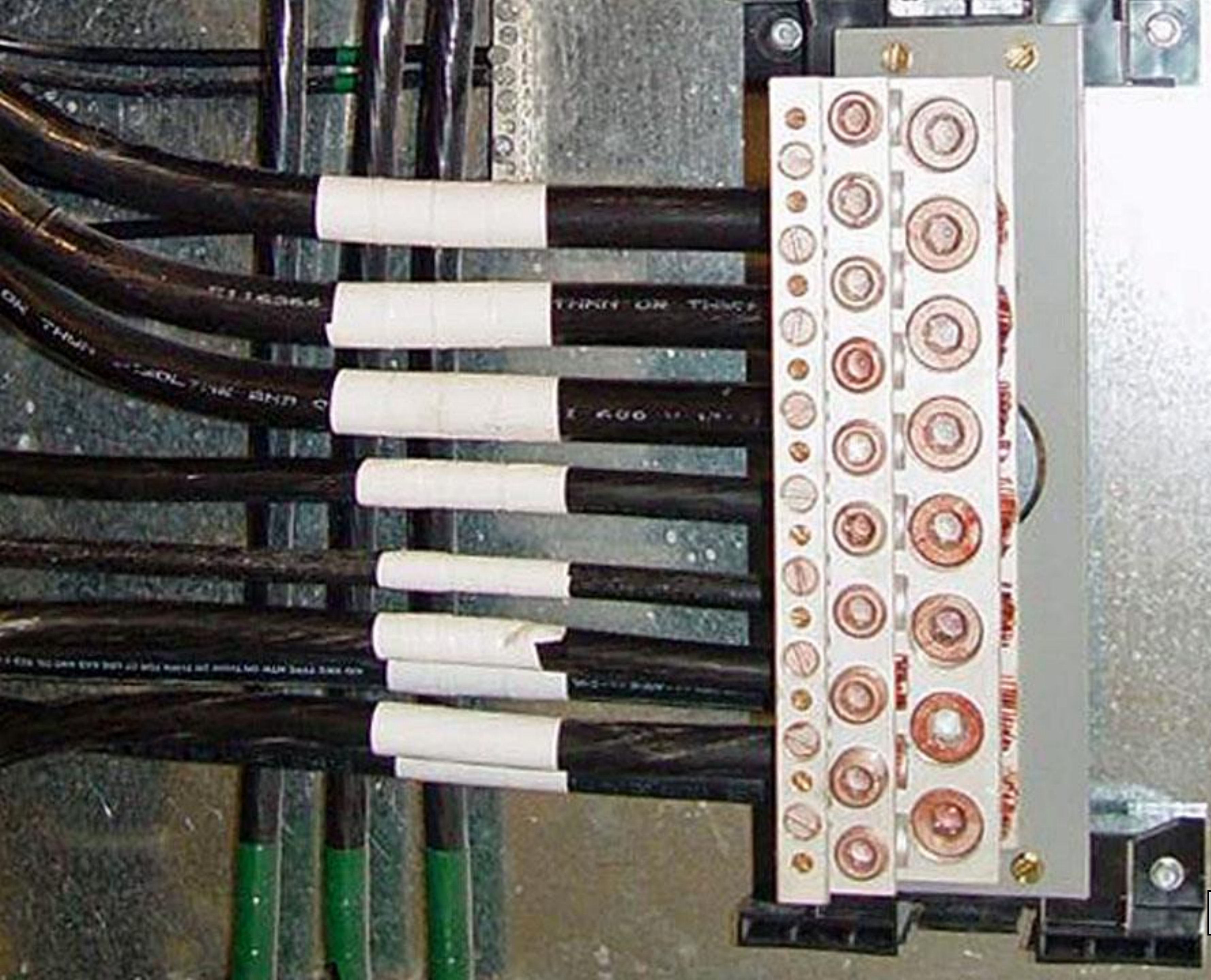
- The term "**Aluminum and copper-clad aluminum**" added to the choices of material acceptable for bonding jumpers
- Title of 250.102(C)(2) has been revised from "Size for Parallel Conductor Installations in Two or More Raceways" to "**Size for Parallel Conductor Installations in Two or More Raceways 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



Grounded conductors, bonding conductors, and bonding jumpers of copper, aluminum, copper-clad aluminum, or other corrosion-resistant material are to be sized in accordance with 250.102 and Table 250.102(C)(1)

Supply-side bonding jumpers installed in parallel in two or more raceways or cables to comply with 250.102(C)(2)

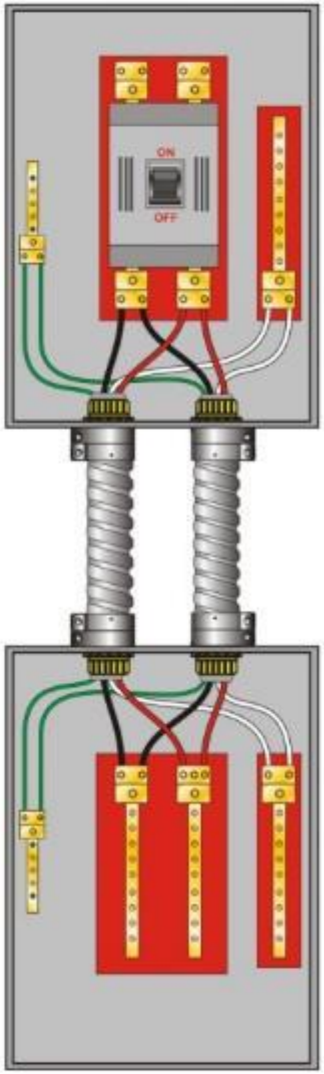

E116364
THHN OR THWN
600 V

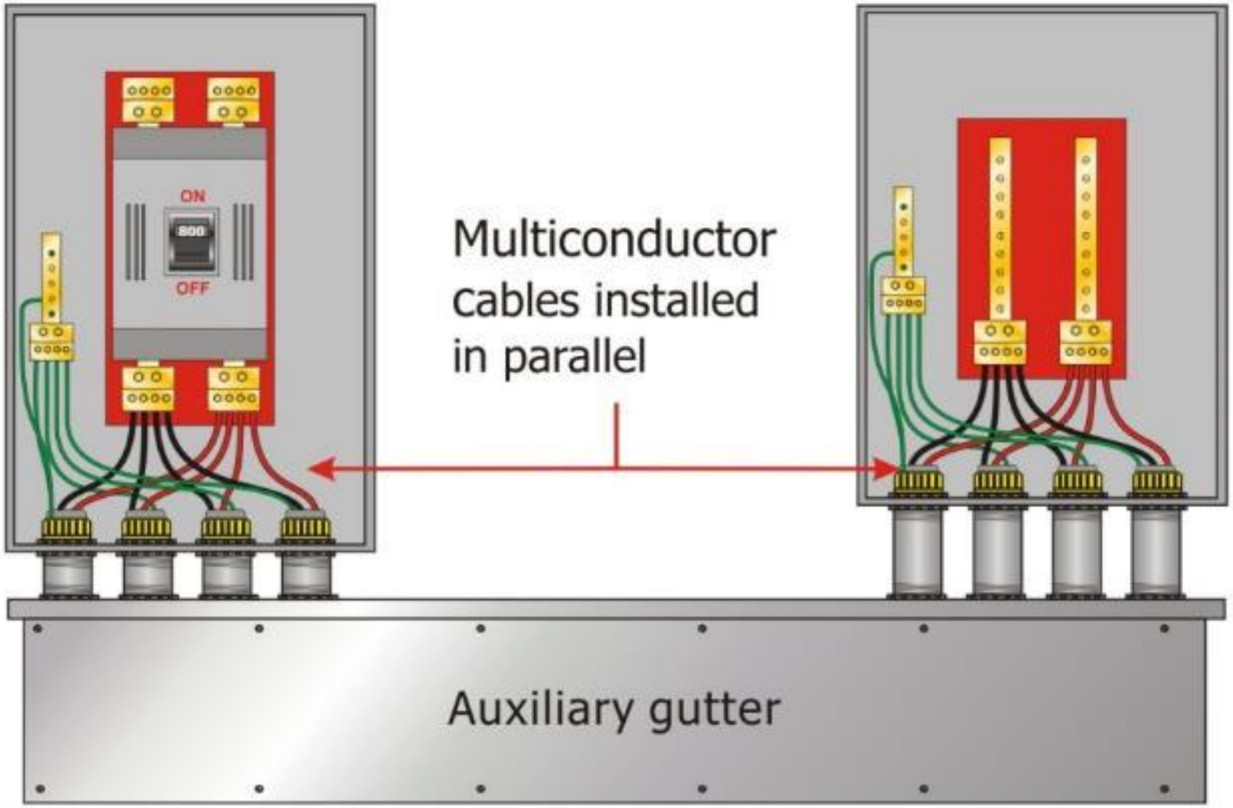
250.122(F) EGCs Installed in Parallel

- 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

Rules for equipment grounding conductors installed in parallel in single or multiple raceways or cables and in cable tray, have been expanded to cover EGCs installed in auxiliary gutters and as part of a multiconductor cable





If multiconductor cables are installed in parallel in the same raceway, auxiliary gutter, or cable tray, a single EGC is permitted in combination with the EGCs provided within the multiconductor cables *(must be connected together)*

250.148 Continuity and Attachment of EGC to Boxes

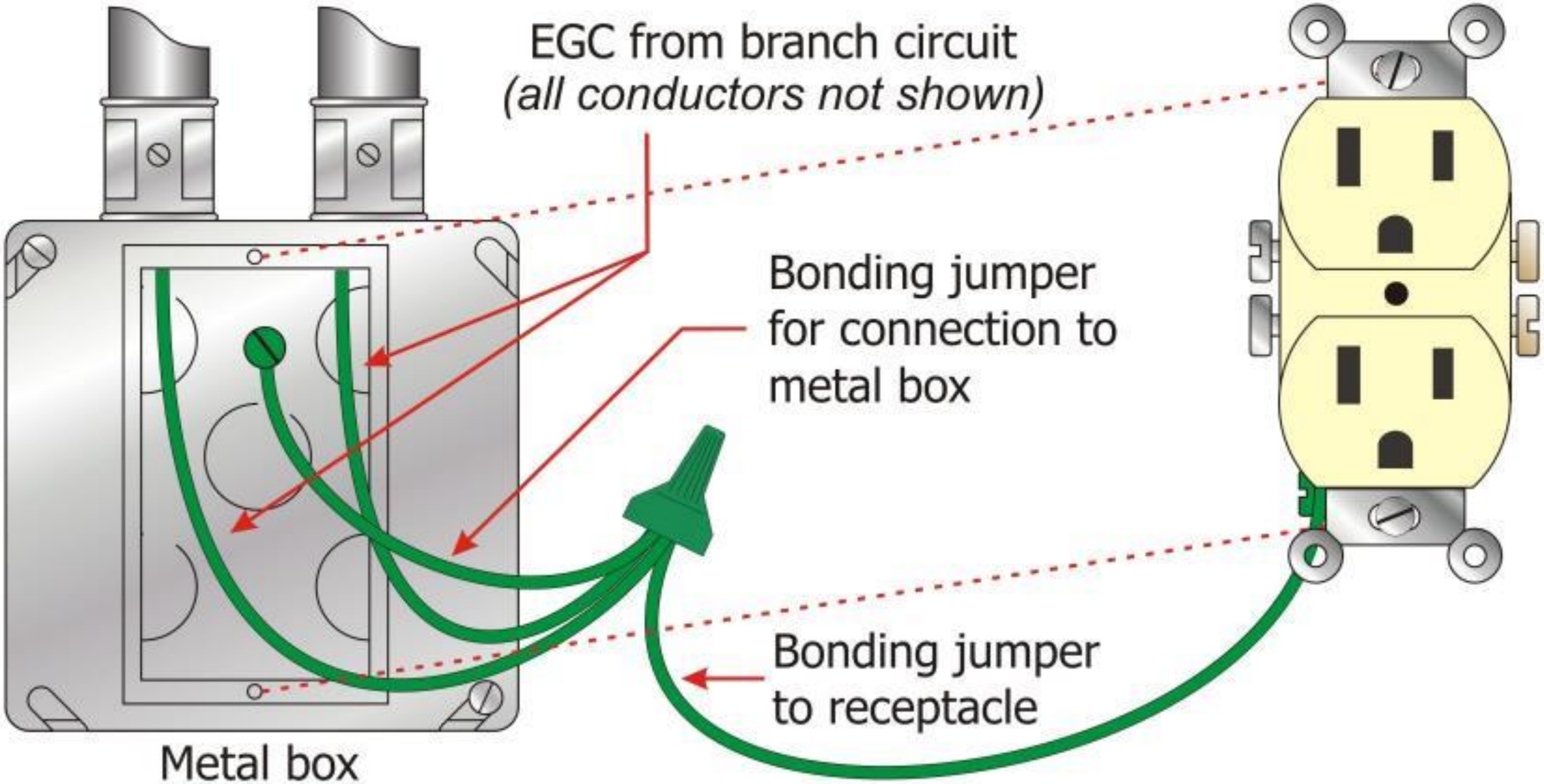
- Revision clarified that **all equipment grounding conductors** associated with any and all circuits in the box must be connected together and to the box *(not just EGCs of each associated circuit)*

- 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

250.148 Continuity and Attachment of EGC 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) (EGC) associated with any of those circuit conductors shall be connected within the box or to the box with devices suitable for the use



EGC from branch circuit
(all conductors not shown)

Bonding jumper
for connection to
metal box

Bonding jumper
to receptacle

Metal box

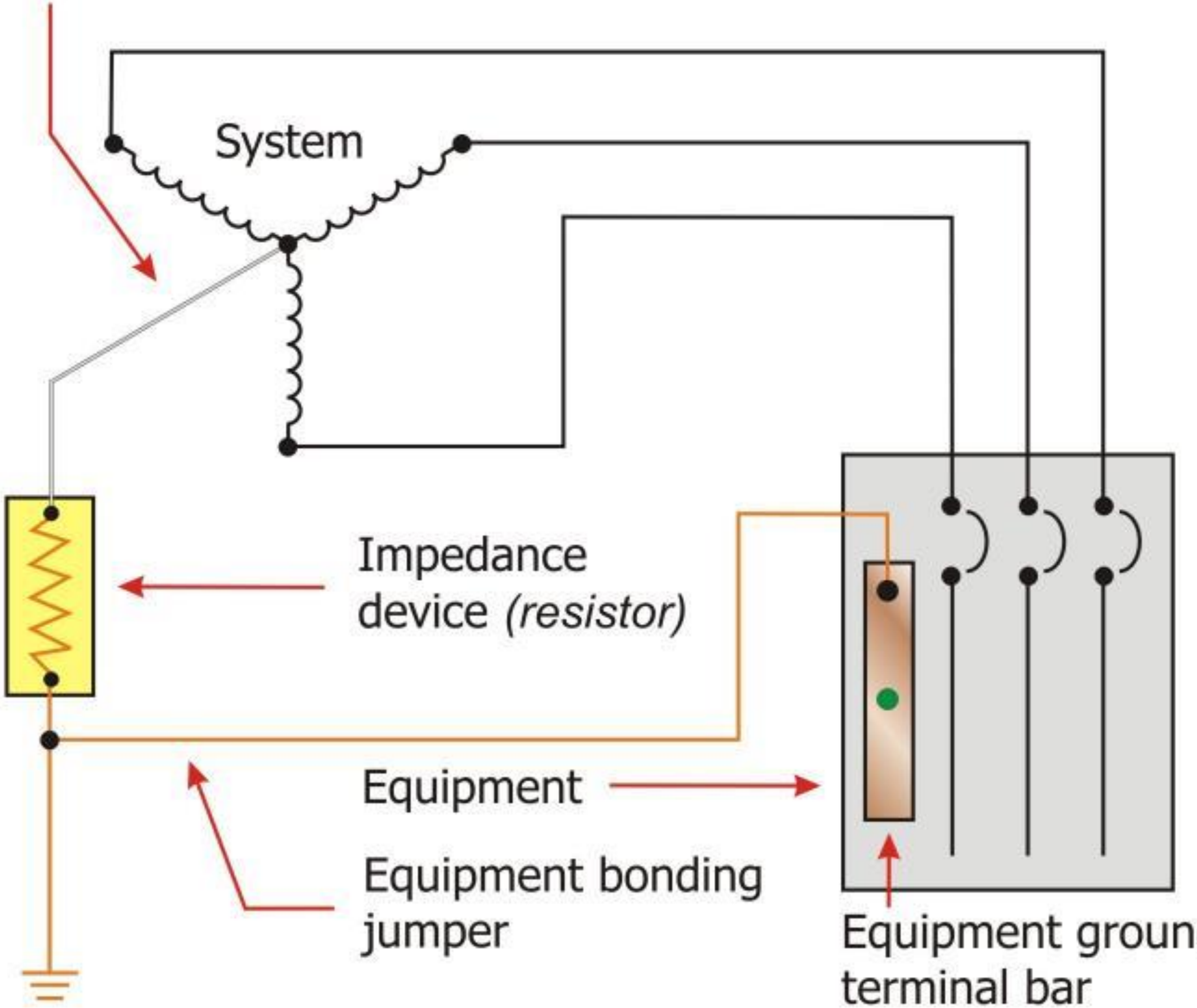
See exception for isolated ground receptacles at 250.146(D)

250.187(B) Identification and Insulation of Impedance Grounded Neutral Systems

- Neutral conductor for an **impedance grounded neutral systems** *(over 1000 volts)* must be identified and insulated to the **maximum neutral voltage** rather than the same insulation as the phase conductors
- Maximum voltage on the neutral conductor in a three-phase impedance grounded neutral system is **57.7%** of the phase-to-phase voltage, or 2400 volts for a 4160-volt system
- No hazard or disadvantage from a different insulation rating on the neutral conductor
- Revisions also reformatted 250.187 into a list format to provide clearer statement for enforcement and improves clarity

250.187 Impedance Grounded Neutral Systems

Neutral conductor for an impedance grounded neutral systems over 1000 volts must be insulated to the maximum neutral voltage rather than the same insulation as the phase conductors



Impedance device *(resistor)*

Equipment

Equipment bonding jumper

Equipment grounding terminal bar

Chapter Three Wiring Methods And Materials

Table 300.5 Minimum Cover Requirements

- Two **new footnotes** were added to Table 300.5 allowing lesser depths for **listed low-voltage lighting system** and for pool, spa, and fountain lighting where part of a listed low-voltage lighting system
- Removes conflicts between manufacturing instructions that require their secondary wiring to be installed at **lesser depths than Table 300.5**
- In some instances, these conductors are to be buried at **less than 150 mm (6 in.)** to conform to the manufacturers installation instructions
- Resolves a conflict between the product standard UL 1838 *[and 110.3(B)]* and Table 300.5

Table 300.5 Minimum Cover Requirements

Minimum Cover Requirements, 0 to 1000 Volts, Nominal, Burial to Millimeters (Inches)

	Type of Wiring Method or Circuit									
Location of Wiring Method or Circuit	Column (1) Direct-Buried Cables or Conductors		Column (2) Rigid Metal Conduit or Intermediate Metal Conduit		Column (3) Nonmetallic Raceways Listed for Direct Burial (No Concrete Encasement)		Column (4) Residential BC (120 Volts or Less, GFCI, Max. OCPD of 20 Amperes)		Column (5) Irrigation and Landscape Ltg (30 Volts Max., Type UF or Other Identified Cable or Raceway	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
All locations not specified below	600	24	150	6	450	18	300	12	150[a, b]	6[a, b]
In trench below 50 mm (2 in.) thick concrete or equivalent	450	18	150	6	300	12	150	6	150	6
Under a building *(see NEC text)*	0	0	0	0	0	0	0	0	0	0
Under min.102 mm (4 in.) thick concrete exterior slab with no vehicular traffic [slab extending not less than 152 mm (6 in.)]	450	18	100	4	100	4	150 *(direct burial)* 100 *(in raceway)*	6 4	150 *(direct burial)* 100 *(in raceway)*	6 4
Under streets, highways, roads, alleys, driveways, parking lots	600	24	600	24	600	24	600	24	600	24
One- and two-family dwelling driveways/parking areas, (dwelling-related purposes only)	450	18	450	18	450	18	300	12	450	18
In or under airport runways	450	18	450	18	450	18	450	18	450	18

Reproduction of NEC Table 300.5 (in part)(see next slide for Footnotes and Notes to table)

Table 300.5 Minimum Cover Requirements

Minimum Cover Requirements, 0 to 1000 Volts, Nominal, Burial to Millimeters (Inches)

[a] A lesser depth shall be permitted where specified in the installation instructions of a listed low-voltage lighting system.

[b] A depth of 150 mm (6 in.) shall be permitted for pool, spa, and fountain lighting, installed in a nonmetallic raceway, limited to not more than 30 volts where part of a listed low-voltage lighting system.

Notes:

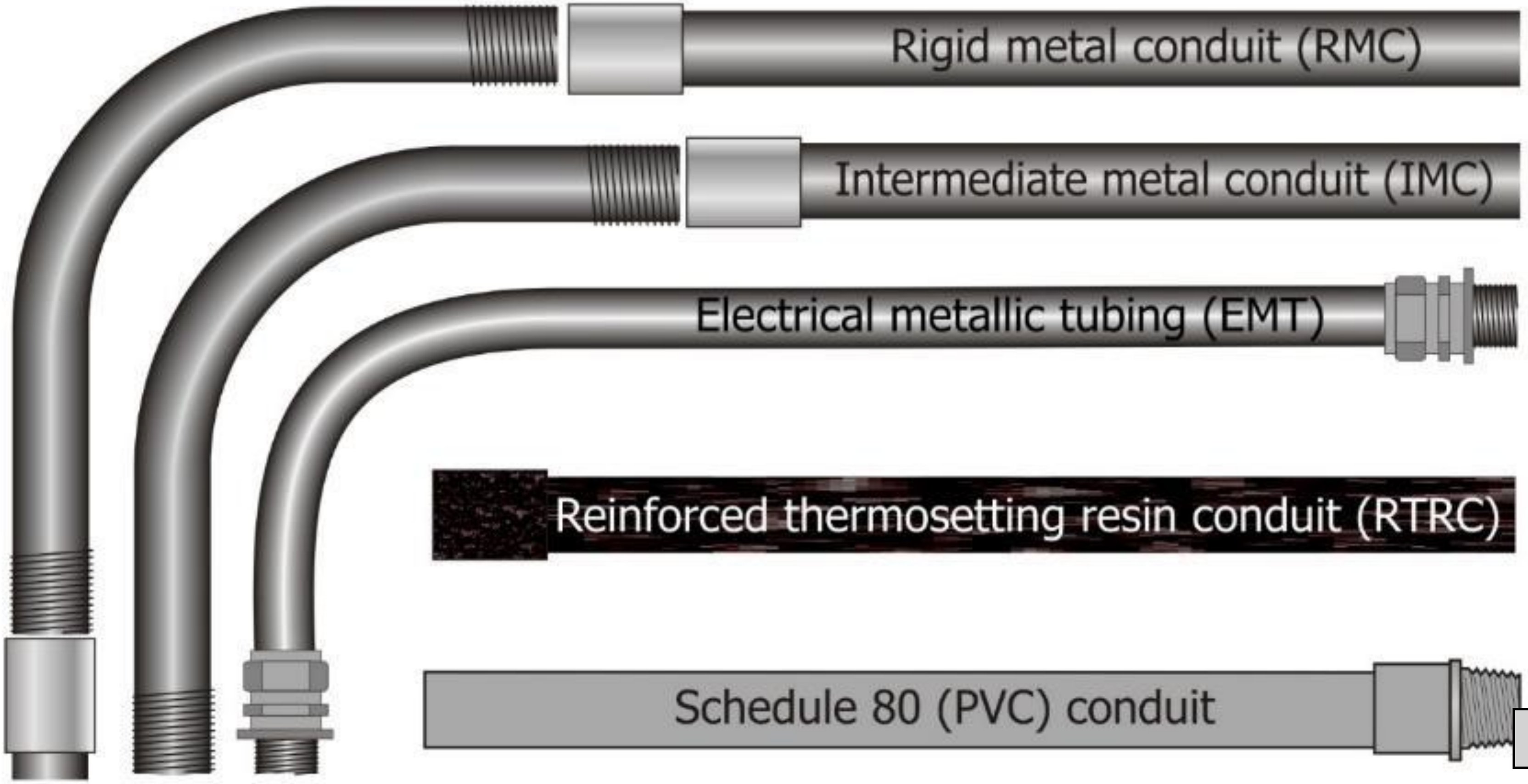
1. Cover is defined as the shortest distance in ~~millimeters~~ mm (~~inches~~ in.) measured between a point on the top surface of any direct-buried conductor, cable, conduit, or other raceway and the top surface of finished grade, concrete, or similar cover.
2. Raceways approved for burial only where concrete encased shall require concrete envelope not less than 50 mm (2 in.) thick.
3. Lesser depths shall be permitted where cables and conductors rise for terminations or splices or where access is otherwise required.
4. Where one of the wiring method types listed in Columns 1 through 3 is used for one of the circuit types in Columns 4 and 5, the shallowest depth of burial shall be permitted.
5. Where solid rock prevents compliance with the cover depths specified in this table, the wiring shall be installed in a metal raceway, or a nonmetallic raceway permitted for direct burial. The raceways shall be covered by a minimum of 50 mm (2 in.) of concrete extending down to rock.

300.5(D)(4)
Protection from Physical Damage

- **Electrical metallic tubing *(EMT)*** was added to the list of acceptable wiring method that can be used to provide protection from physical damage for conductors installed underground and subject to physical damage
- EMT is permitted to be installed in concrete, in direct contact with the earth, or in areas subject to severe corrosive influences **where protected by corrosion protection and approved as suitable for the condition**
- Corrosion protection is a requirement for listed EMT per UL 797 *(Electrical Metallic Tubing - Steel)* and in accordance with 300.6

300.5(D)(4) Protection from Physical Damage

Where direct-buried conductors and cables are installed in enclosures or raceways and are subject to physical damage, electrical metallic tubing (EMT), rigid metal conduit (RMC), intermediate metal conduit (IMC), reinforced thermosetting resin conduit (RTRC) (Type RTRC-XW), Schedule 80 rigid polyvinyl chloride (PVC) conduit, or equivalent is allowed to be used to provide protection from physical damage

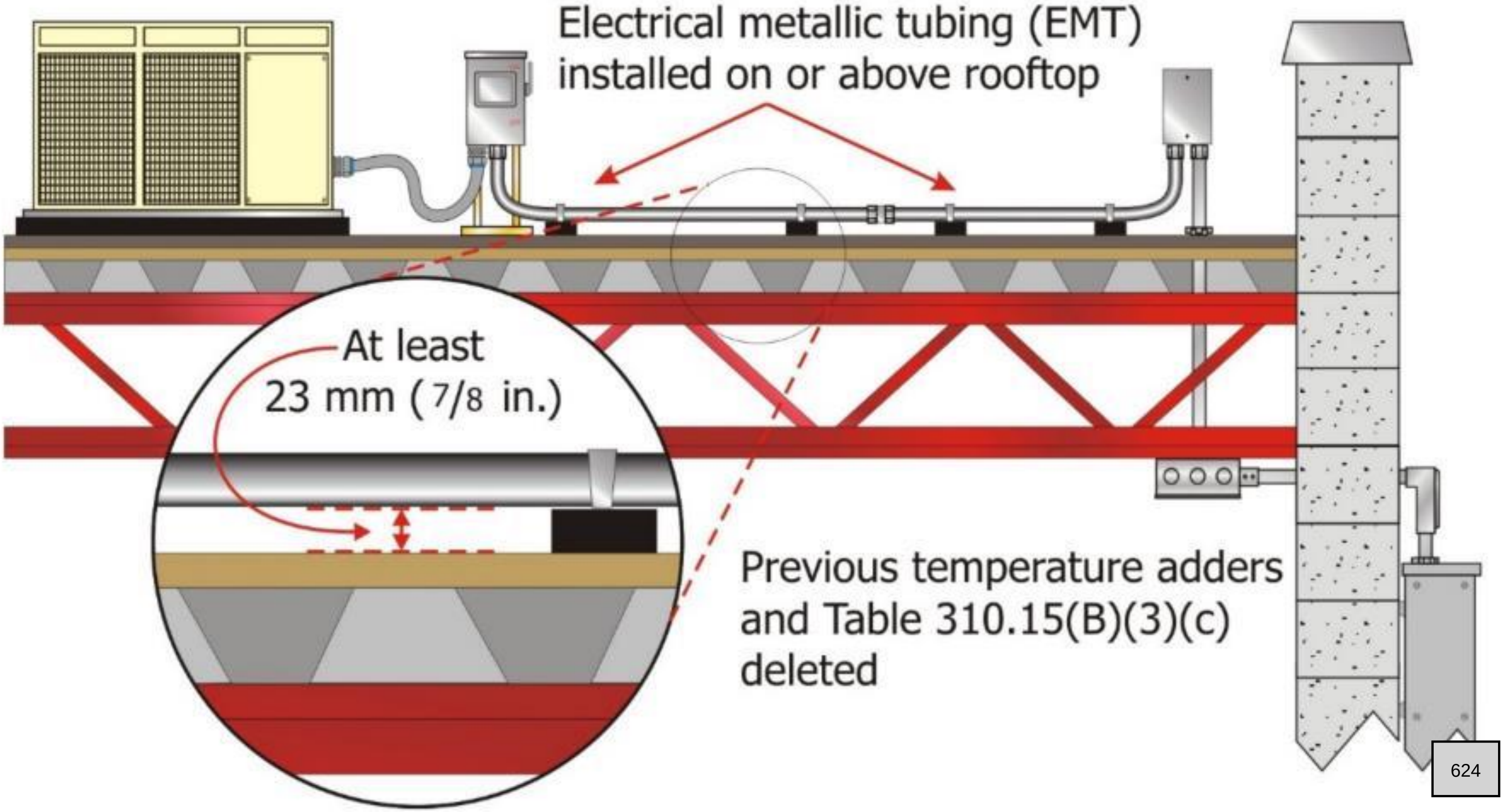


310.15(B)(3)(c)
Raceways and Cables on Rooftops

- Previous **Table 310.15(B)(3)(c)** was **deleted** and replaced with new text added at 310.15(B)(3)(c)
- Raceways and cables not in direct contact with the rooftop surface no longer require **rooftop temperature adder**
- New text requires a temperature adder of **33°C (60°F)** only when a raceway or cable is installed **directly on or less than 23 mm (⅞ in.)** above a rooftop
- Allows for the use of "shallow type unistrut" that is of the ⅞ in. size as well as other commonly installed listed raceway supports of larger sizes
- Pre-existing allowable ampacity and temperature correction factors adequately size the conductors to ensure that the conductors operate within a comfortable safety zone

310.15(B)(3)(c) Raceways and Cables on Rooftops

Where raceways or cables are exposed to direct sunlight on or above rooftops, they shall be installed 23 mm (7/8 in.) above the roof or be subject to a rooftop temperature adder of 33°C (60°F) *(see exception for Type XHHW-2 conductors)*



Electrical metallic tubing (EMT) installed on or above rooftop

At least 23 mm (7/8 in.)

Previous temperature adders and Table 310.15(B)(3)(c) deleted

310.15(B)(7) Single-Phase Dwelling Unit Services and Feeders

- The provisions for sizing dwelling unit service *(and main power feeder)* was expanded to single-phase, **208Y/120-volt systems** as well as single-phase, 120/240-volt systems
- Explanatory language added to address the permitted application of correction or adjustment factors required by **310.15(B)(2)(a)** ***(Temperature Correction Factors)*** or **310.15(B)(3)(a)** ***(More Than Three Current-Carrying Conductors)*** applied to the ampacity associated with the temperature rating of the conductors
- New informational note added with direction to **240.6(A)** for service ratings based on **standard ampacity ratings** for application of 310.15(B)(7)
- Previous **Table 310.15(B)(7)** *(removed in 2014 cycle)* was added back into the *Code (see* ***Example D7*** *of Informational Annex D)*

310.15(B)(7) 120/240 Volt or 208Y/120 Volt, Single-Phase Dwelling Services and Feeders

Single-phase, 120/240-volt services or feeders (100 - 400 ampere) and single-phase, 208Y/120-volt feeders (100 - 400 ampere), supplying the entire dwelling unit load permitted to have an ampacity not less than 83% of the service or feeder rating

Correction or adjustment factors required by 310.15(B)(2) or (3) permitted to be applied to the ampacity associated with the temperature rating of these conductors

Service/feeder ratings addressed by this section are based on the standard ampacity ratings from 240.6(A)

6675 MEDITERRANEAN
SERVICE DISCONNECT
BLDG 3 34 UNITS
1200 AMP MAIN 120/208V 3PH
A-BLK B-RED C-BLUE
FED FROM 750 KVA XFMR

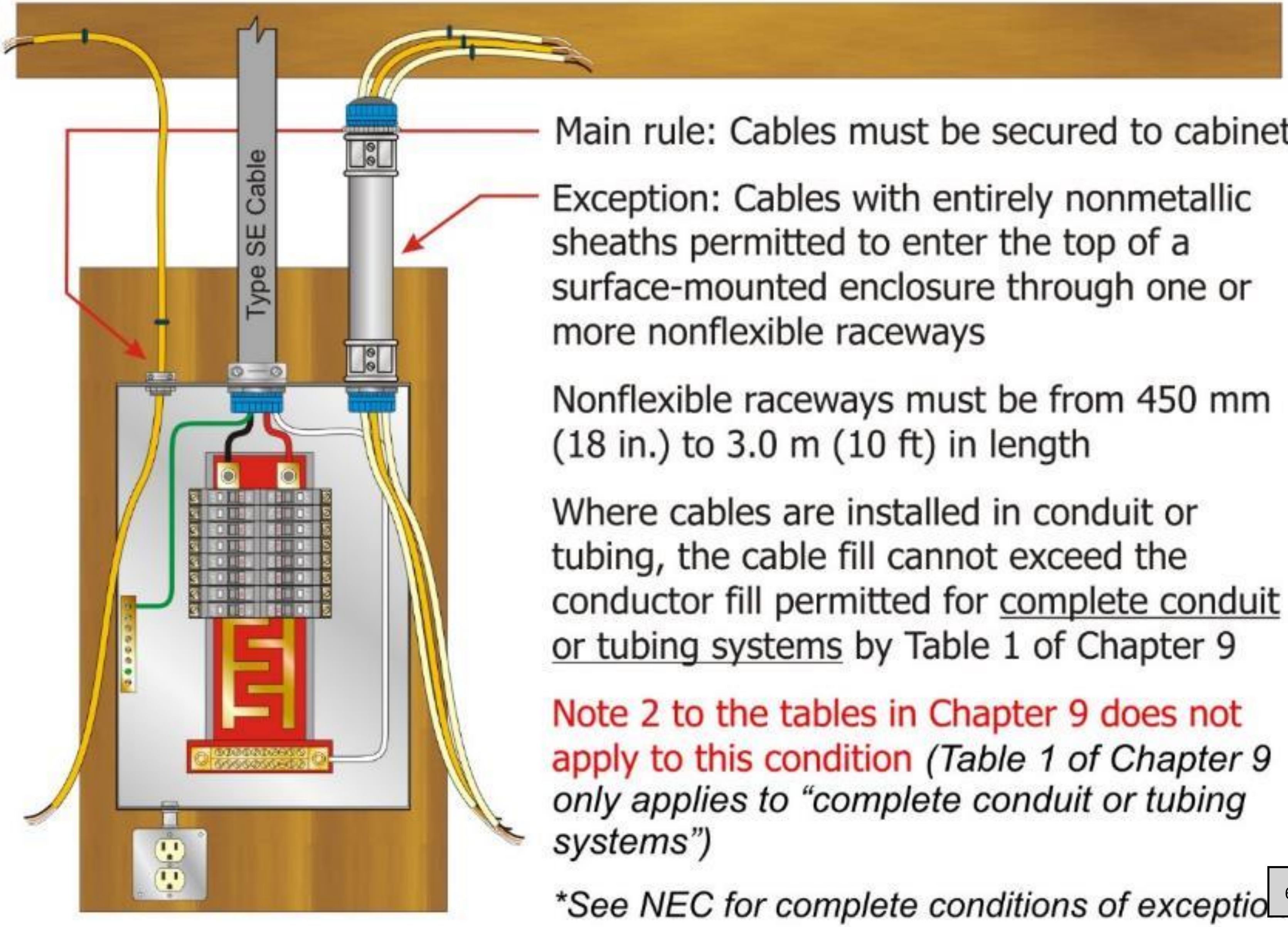
312.5(C), Ex., Item (g) Cable Raceway

- New sentence added to Item (g) indicating that **Note 2 to the tables in Chapter 9 does not apply** to a “sleeve” of conduit or tubing required by 312.5(C), Exception

- In order to meet this exception, cables with entirely nonmetallic sheaths permitted to enter the top of a surface-mounted enclosure through one or more nonflexible raceways not less than 450 mm (18 in.) and not more than **3.0 m (10 ft)** in length

- This limited length of raceway is required to be restricted on conductor fill to the limits of **Chapter 9, Table 1** *(53% of the cross-sectional area of the conduit or tubing for one conductor, 31% for two conductors, and 40% for over 2 conductors)*

312.5(C), Ex., Item (g) Cable Raceway



Main rule: Cables must be secured to cabinet

Exception: Cables with entirely nonmetallic sheaths permitted to enter the top of a surface-mounted enclosure through one or more nonflexible raceways

Nonflexible raceways must be from 450 mm (18 in.) to 3.0 m (10 ft) in length

Where cables are installed in conduit or tubing, the cable fill cannot exceed the conductor fill permitted for complete conduit or tubing systems by Table 1 of Chapter 9

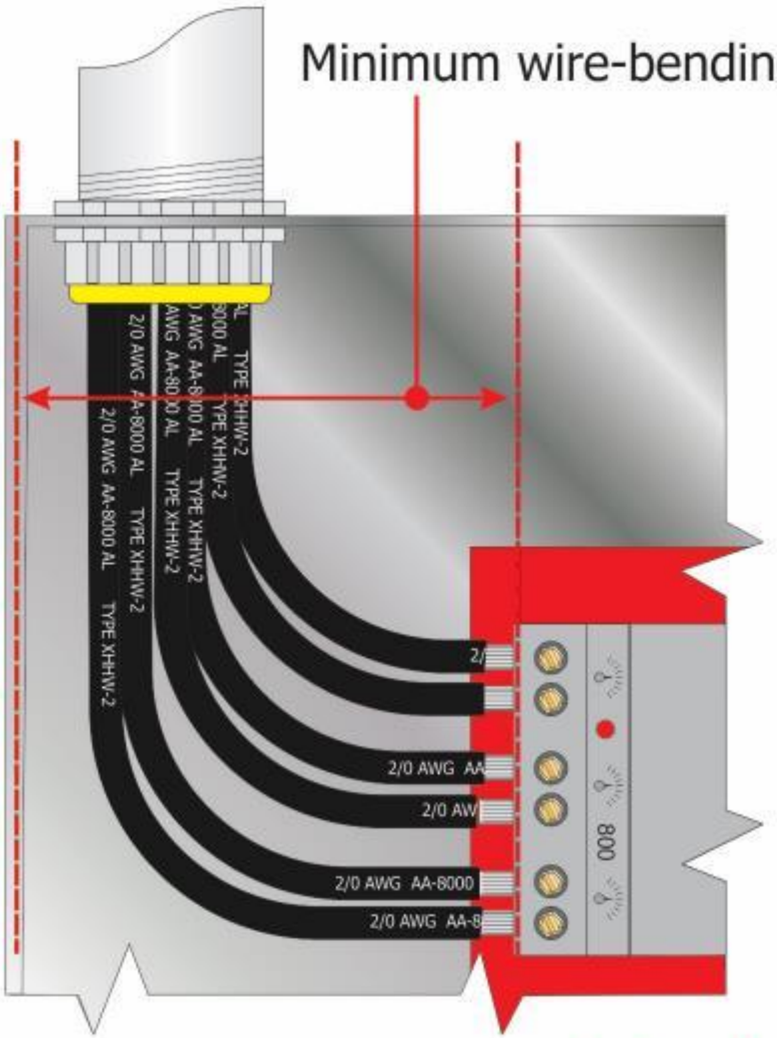
Note 2 to the tables in Chapter 9 does not apply to this condition *(Table 1 of Chapter 9 only applies to "complete conduit or tubing systems")*

**See NEC for complete conditions of exceptio*

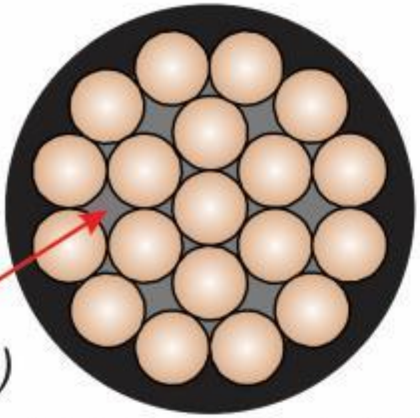
Table 312.6(A) Minimum Wire-Bending Space at Terminals and Minimum Width of Wiring Gutters

- New column was added to Table 312.6(A) addressing wire-bending space for **compact stranded AA-8000 aluminum alloy conductors** for consistency
- Requirements for wire-bending space at terminals and the use of Table 312.6(A) or Table 312.6(B) remained the same
- Need for consistency between Table 312.6(A) and (B)
- Dimensions added for aluminum conductors are consistent with minimum safety standards
- Provides a useful correlation with comparable material in Table 312.6(B)

Table 312.6(A) Minimum Wire-Bending Space at Terminals and Minimum Width of Wiring Gutters



Minimum wire-bending space



Interstices
(spaces or gaps)

Standard strands

Compact strands

A new column for compact stranded AA-8000 aluminum conductors has been added to Table 312.6(A) for minimum wire-bending space at termina

Table 312.6(A) Minimum Wire-Bending Space at Terminals and Minimum Width of Wiring Gutters

Wire Size (AWG or kcmil)		Wires per Terminal									
		1		2		3		4		5	
All Other Conductors	**Compact Stranded AA-8000 Aluminum Alloy Conductors (see Note 2)**	**mm**	**in.**	**mm**	**in.**	**mm**	**in.**	**mm**	**in.**	**mm**	**in.**
14-10	12-8	Not Specified		—	—	—	—	—	—	—	—
8-6	6-4	38.1	1½	—	—	—	—	—	—	—	—
4-3	2-1	50.8	2	—	—	—	—	—	—	—	—
2	1/0	63.5	2½	—	—	—	—	—	—	—	—
1	2/0	76.2	3	—	—	—	—	—	—	—	—
1/0-2/0	3/0-4/0	88.9	3½	127	5	178	7	—	—	—	—
3/0-4/0	250-300	102	4	152	6	203	8	—	—	—	—
250	350	114	4½	152	6	230	8	254	10	—	—
300-350	400-500	127	5	203	8	254	10	305	12	—	—
400-500	600-750	152	6	203	8	254	10	305	12	356	14
600-700	800-1000	203	8	254	10	305	12	356	14	406	16
750-900	—	203	8	305	12	356	14	406	16	457	18
1000-1250	—	254	10	—	—	—	—	—	—	—	—
1500-2000	—	305	12	—	—	—	—	—	—	—	—

Note 1: Bending space at terminals shall be measured in a straight line from the end of the lug or wire connector *(in the direction that the wire leaves the terminal)* to the wall, barrier, or obstruction.

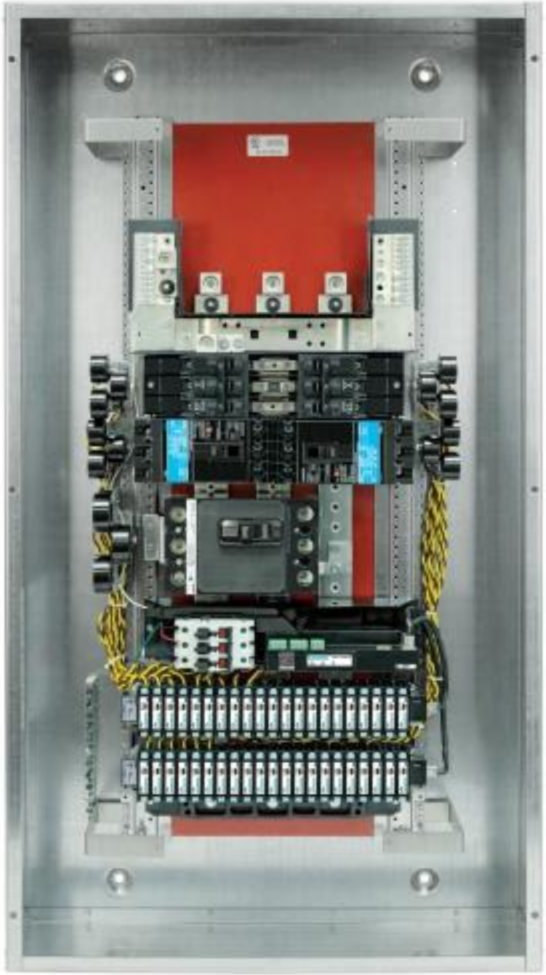
Note 2: This column shall be permitted to be used to determine the minimum wire-bending space for compact stranded aluminum conductors in sizes up to 1000 kcmil and manufactured using AA-8000 series electrical grade aluminum alloy conductor material in accordance with 310.106(B). The minimum width of the wire gutter space shall be determined using the all other conductors value in this table.

312.8(B) Power Monitoring Equipment

- New language was added to allow **power monitoring equipment** within the wiring space of enclosures for switches or overcurrent devices with specific conditions
- This equipment is now required to be **listed for the application** when installed in the free spaces of cabinets and cutout boxes
- Satisfies a demand from the electrical industry for installation of such listed power monitoring equipment for measuring, monitoring, and controlling circuits as part of load monitoring or energy management system

312.8(B) Switch and Overcurrent Device Enclosures With Power Monitoring Equipment

Power monitoring equipment is now required to be listed for the application when installed in free spaces of cabinets and cutout boxes



Courtesy of Siemens

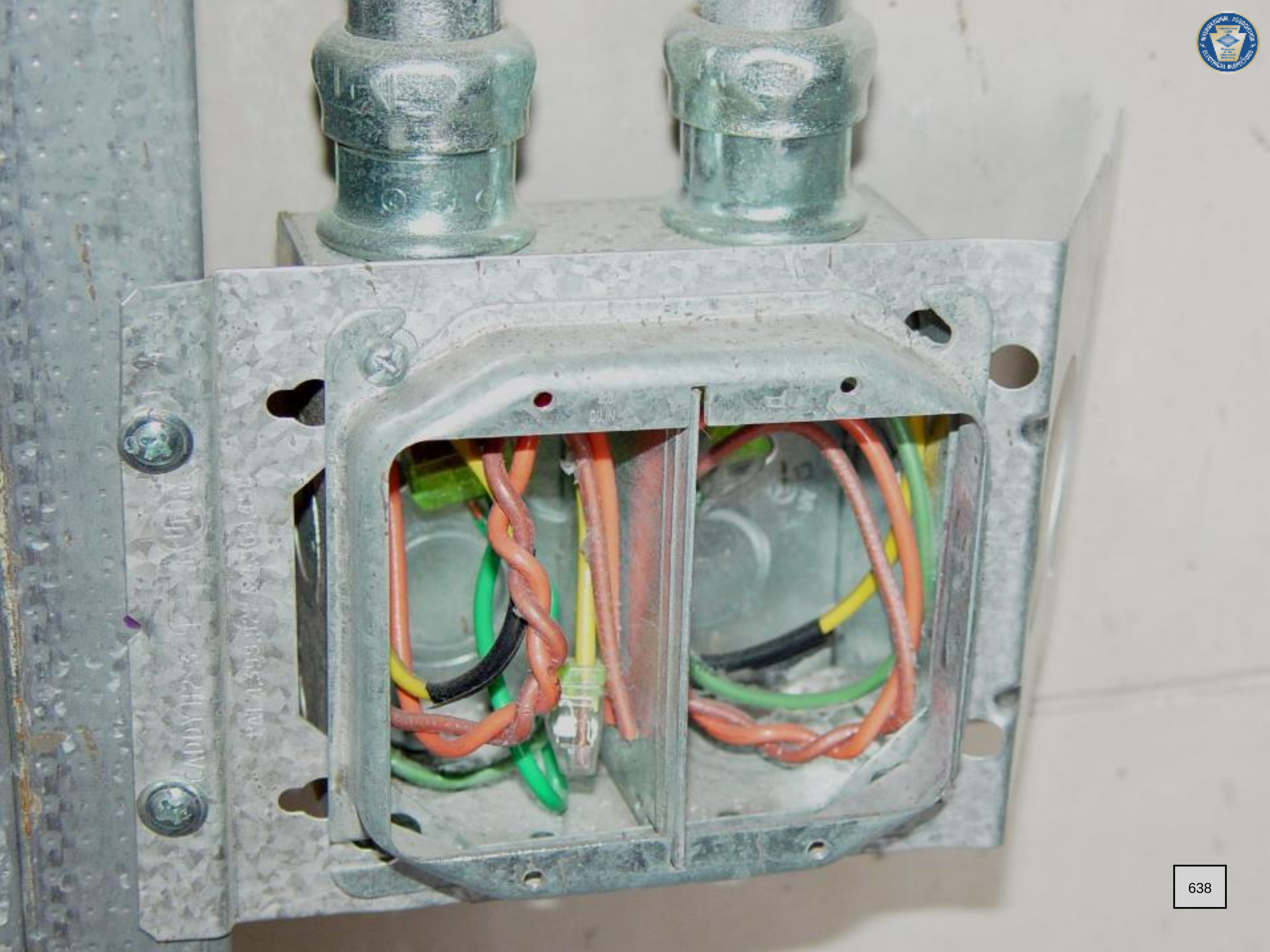
Power Monitoring Equipment - The wiring space of enclosures for switches or overcurrent devices permitted to contain power monitoring equipment where all of the following conditions are met:

(1) Identified as field installable accessory as part of the listed equipment, or is listed kit evaluated for field installation in switch or overcurrent device enclosures

(2) Total area of all conductors, splices, taps, and equipment at any cross section of the wiring space does not exceed 75 percent of the cross-sectional area of that space

314.16(A) and (B) Box Fill Calculations

- The volume or space that is occupied by an **internal barrier** in a box or enclosure has been added to the items addressed for performing a box fill calculation
- **Nonmetallic box barriers** are generally provided with its volume markings, but **metal barriers** for metal boxes are not currently marked with their volume consumption
- New added sentence at 314.16(B) will also make it clear that **each space** within a box installed with an interior barrier will need to be **calculated separately**
- Each barrier (if not marked) shall be considered to take up:
  - 8.2 cm^3 **(½ $in.^3$) if metal**
  - 16.4 cm^3 **(1 $in.^3$) if nonmetallic**



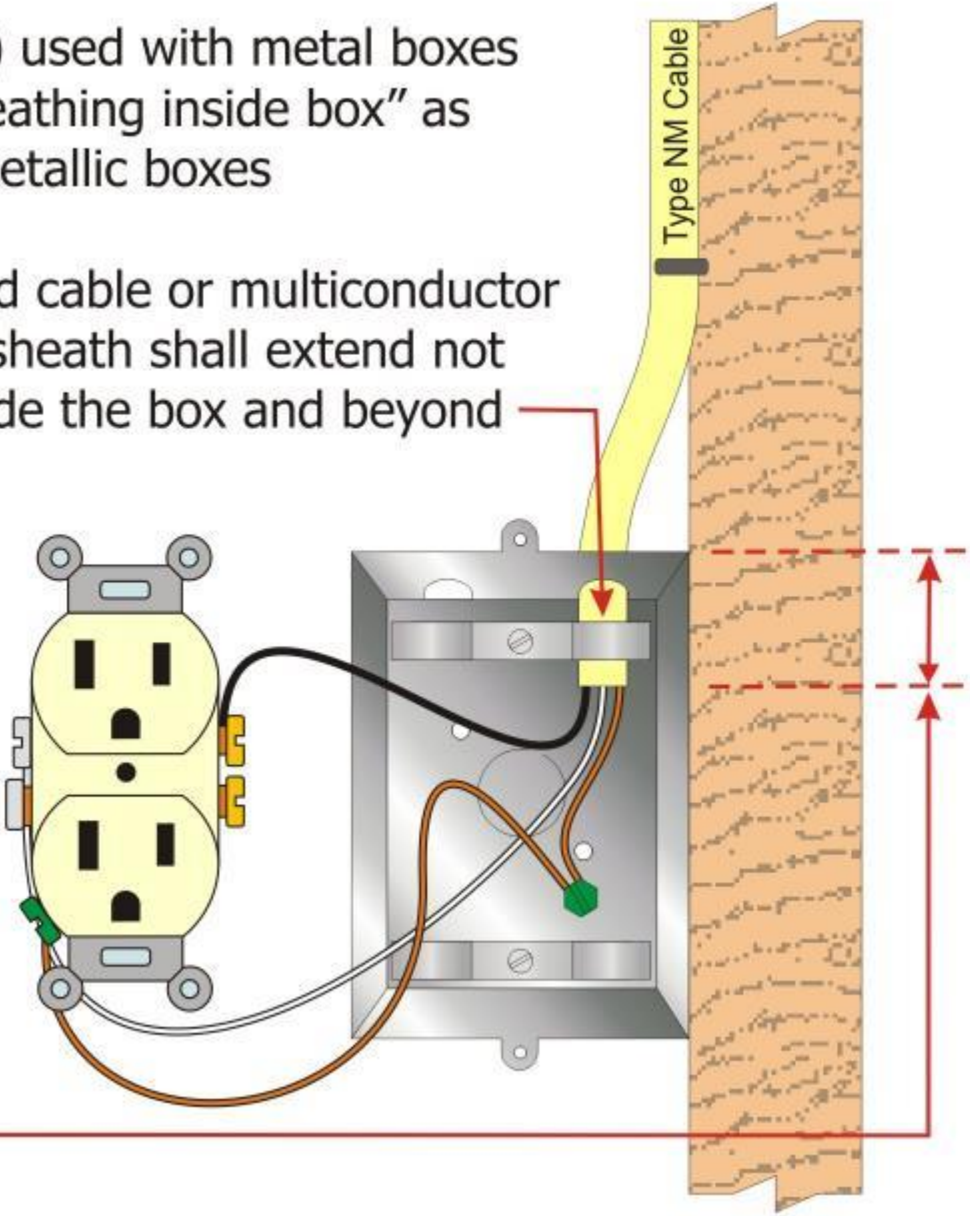
314.17(B) Cable Entering Metal Box

- The outside sheath of Type NM or Type UF cable used with **metal box** must now extend not less than **6 mm (¼ in.)** inside the box and beyond any cable clamp
- Same as currently required for nonmetallic boxes
- Same protection for cables and their associated conductors is needed when entering a metal box or conduit body as well
- Assures that cable clamp of a metal box will not be tightened down upon an exposed insulated conductor of a Type NM or Type UF cable

314.17(B) Type NM Cable Entering Metal Boxes

Type NM cable (or Type UF) used with metal boxes now requires the same "sheathing inside box" as currently required for nonmetallic boxes

Where nonmetallic-sheathed cable or multiconductor Type UF cable is used, the sheath shall extend not less than 6 mm (¼ in.) inside the box and beyond any cable clamp



Minimum 6 mm (¼ in.)

314.27(E)
Separable Attachment Fittings

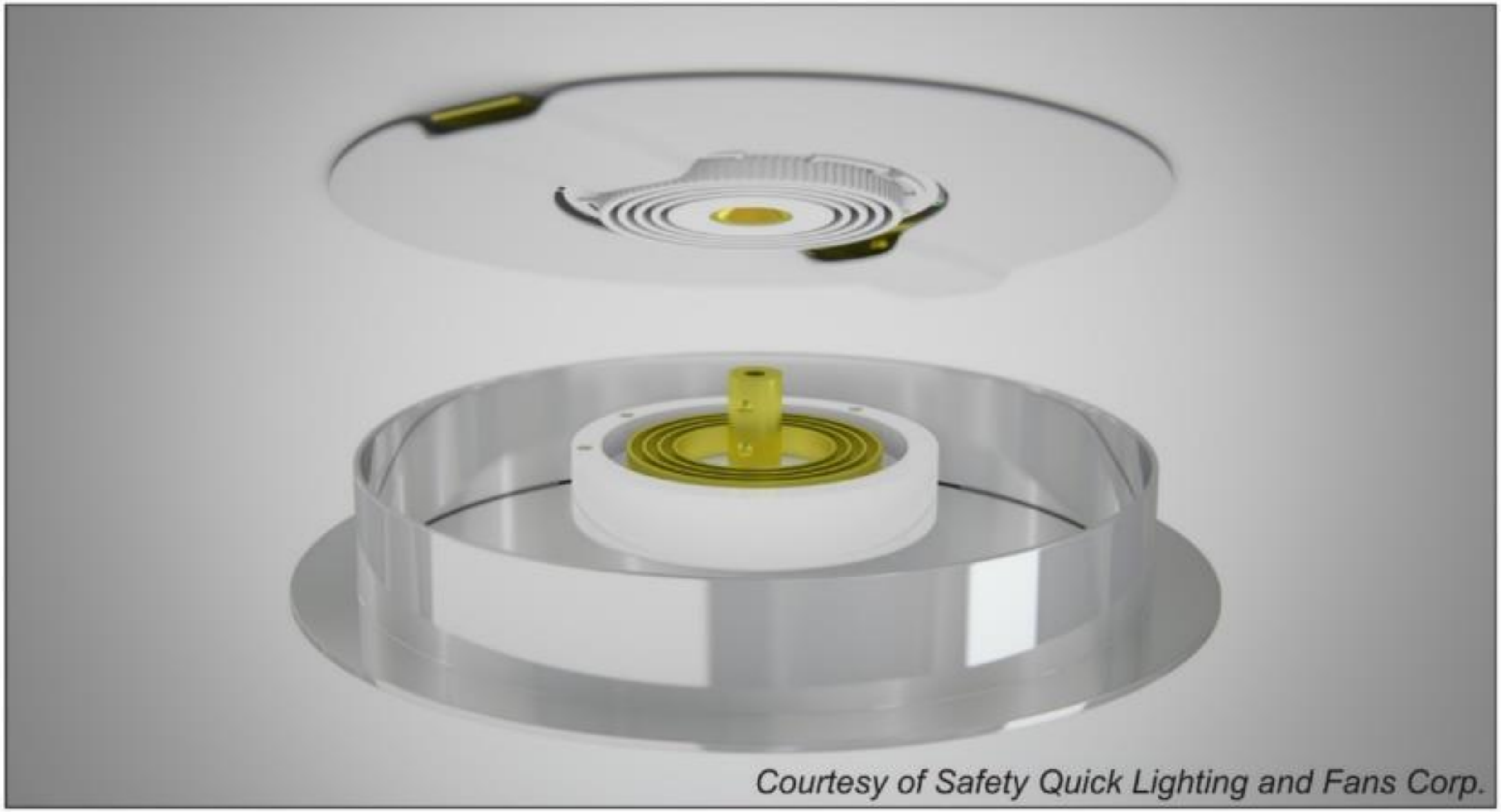
- Outlet boxes now permitted to support **listed locking support and mounting receptacles** used in combination with **compatible attachment fittings** for supporting a luminaire, lampholder, or ceiling suspended (paddle) fan
- Listed locking support and mounting receptacles are **an option** for mounting *(not a requirement)*
- Recognizes new listed technology designed to power and support luminaires and or ceiling suspended *(paddle)* fans
- Listed product provides a secure mounting mechanism and will facilitate interchange of luminaires and ceiling suspended *(paddle)* fans in a safe and efficient manner

314.27(E)
Separable Attachment Fittings *(cont.)*

- New provision for **listed locking support and mounting receptacles** for luminaires coincides with the revised definition of a "**receptacle**" in Article 100
- **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.
- Similar *Code* language was added at **422.18** for support of ceiling-suspended (paddle) fans

314.27(E) Separable Attachment Fittings

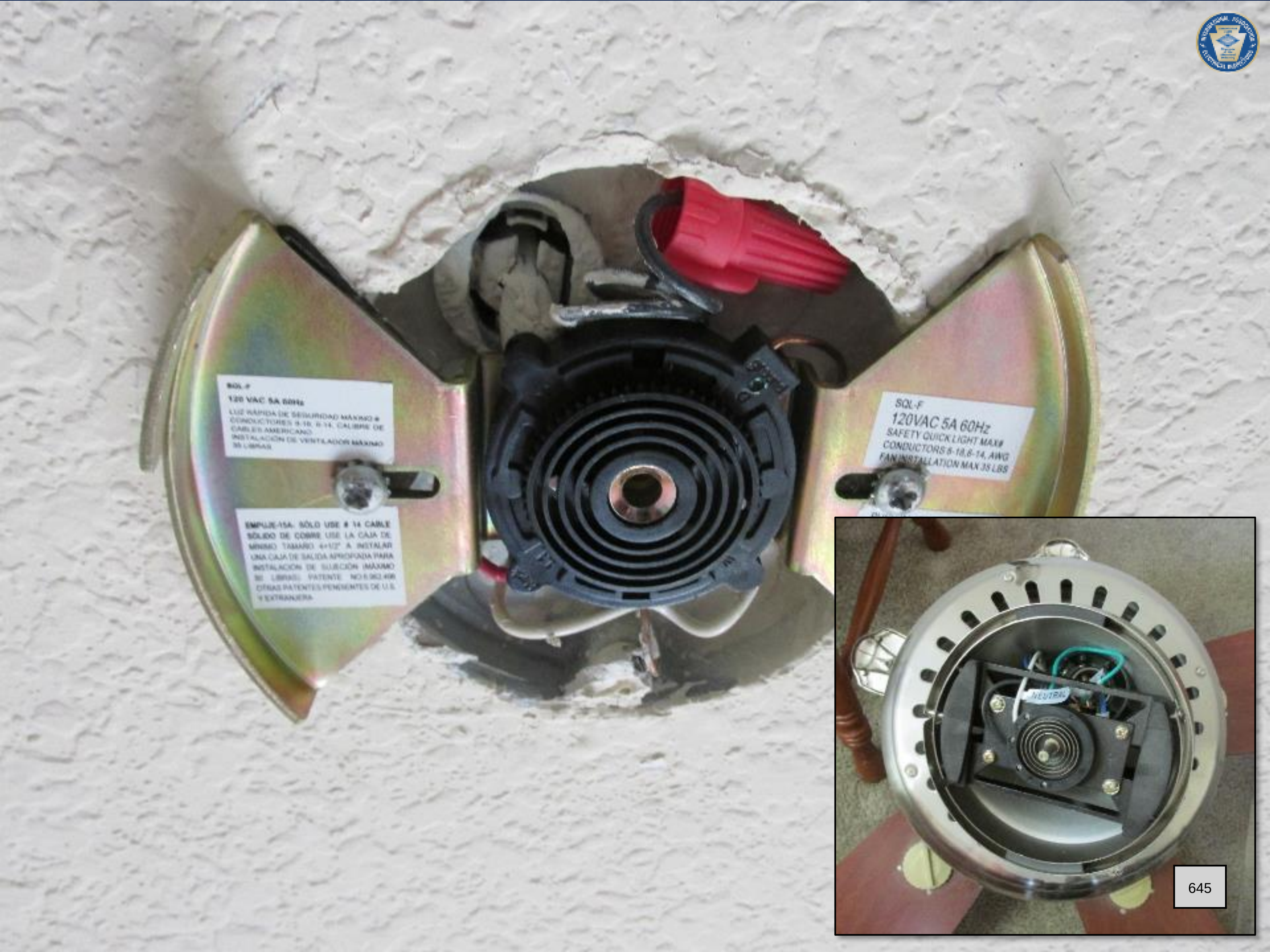
Outlet boxes permitted to support listed locking support and mounting receptacles used in combination with compatible attachment fittings



Courtesy of Safety Quick Lighting and Fans Corp.

Separable attachment fittings must be identified for the support of equipment within the weight and mounting orientation limits of the listing

Supporting receptacle installed within a box must be included in box fill calculati


SQL-F
120 VAC 5A 60Hz
LUZ RÁPIDA DE SEGURIDAD MÁXIMO # CONDUCTORES 6-18, 6-14, CALIBRE DE CABLES AMERICANO
INSTALACIÓN DE VENTILADOR MÁXIMO 35 LIBRAS
EMPUJE-15A: SÓLO USE # 14 CABLE SÓLIDO DE COBRE USE LA CAJA DE MÍNIMO TAMAÑO 4+1/2" A INSTALAR UNA CAJA DE SALIDA APROPIADA PARA INSTALACIÓN DE SUJECIÓN (MÁXIMO 50 LIBRAS). PATENTE NO 6,962,498 OTRAS PATENTES PENDIENTES DE U.S. Y EXTRANJERA
SQL-F
120VAC 5A 60Hz
SAFETY QUICK LIGHT MAX#
CONDUCTORS 6-18,6-14, AWG
FAN INSTALLATION MAX 35 LBS
NEUTRAL

320.6 Listing Requirements

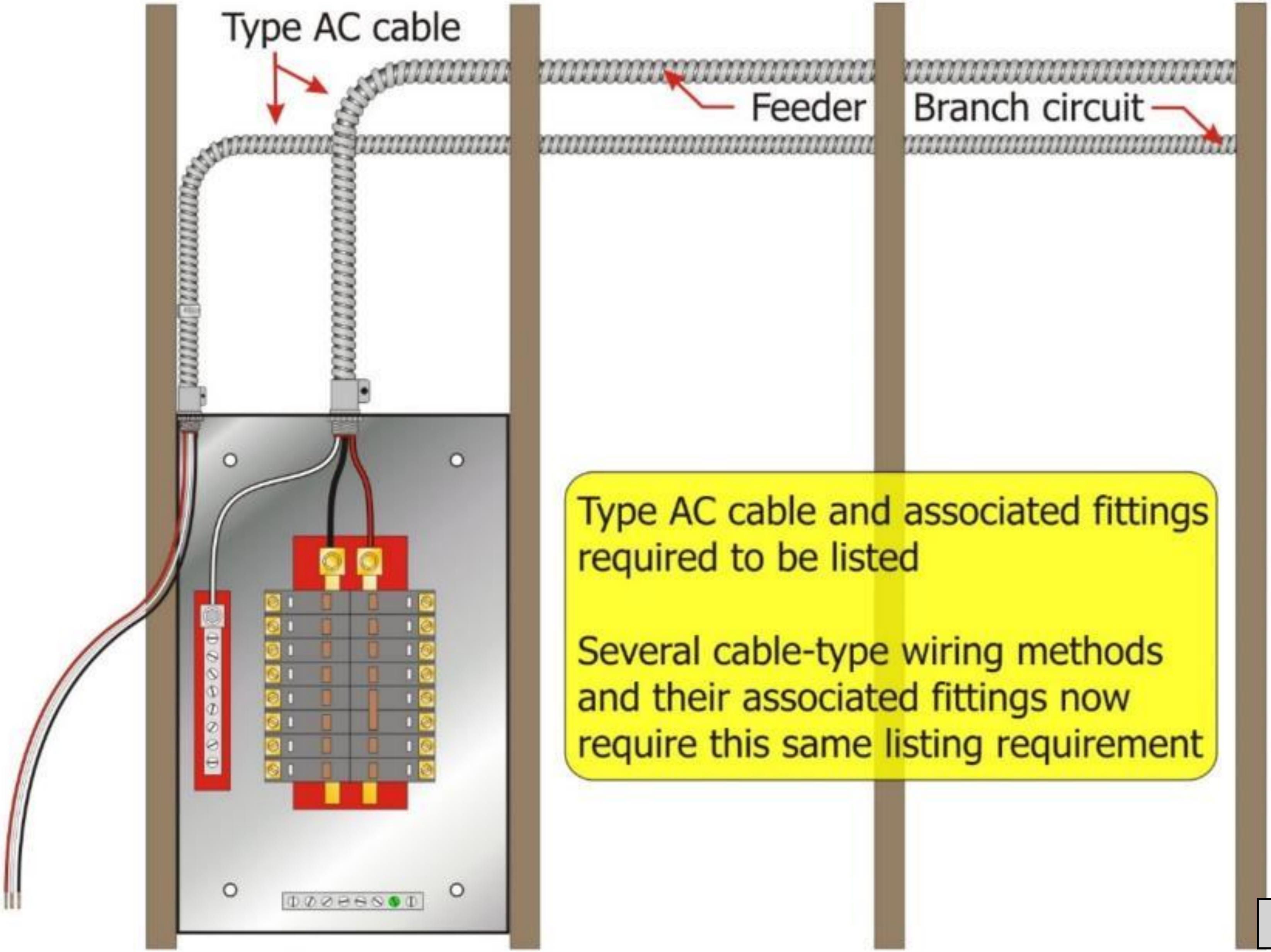
- New listing requirements were added in a number of the cable-type wiring method articles that will require the **wiring method *(cable)* and associated fittings** to be **listed**

- Must be listed for use with each other

- A non-listed cable-type wiring method may not function correctly with listed termination fittings

- This will ensure that the cable installed in the field has been evaluated to the appropriate product standard and listed for use in accordance with *NEC* regulations

320.6 Listing Requirements



Type AC cable and associated fittings required to be listed

Several cable-type wiring methods and their associated fittings now require this same listing requirement

320.6 Listing Requirements

- The same requirement that the wiring method (cable) and associated fittings be listed occurred at the following locations:

320.6	Type AC cable	FR 1808	PI 1332
322.6	Type FC cable	FR 1801	PI 1334
328.6	Type MV cable	FR 1814	PI 1336
330.6	Type MC cable	FR 1816	PI 1337
332.6	Type MI cable	FR 1806	PI 1338
334.6	Type NM cable	FR 1824	PI 886
336.6	Type TC cable	FR 1833	PI 1339
338.6	Type SE cable	FR 1827	PI 1341
340.6	Type UF cable	FR 1829	PI 887

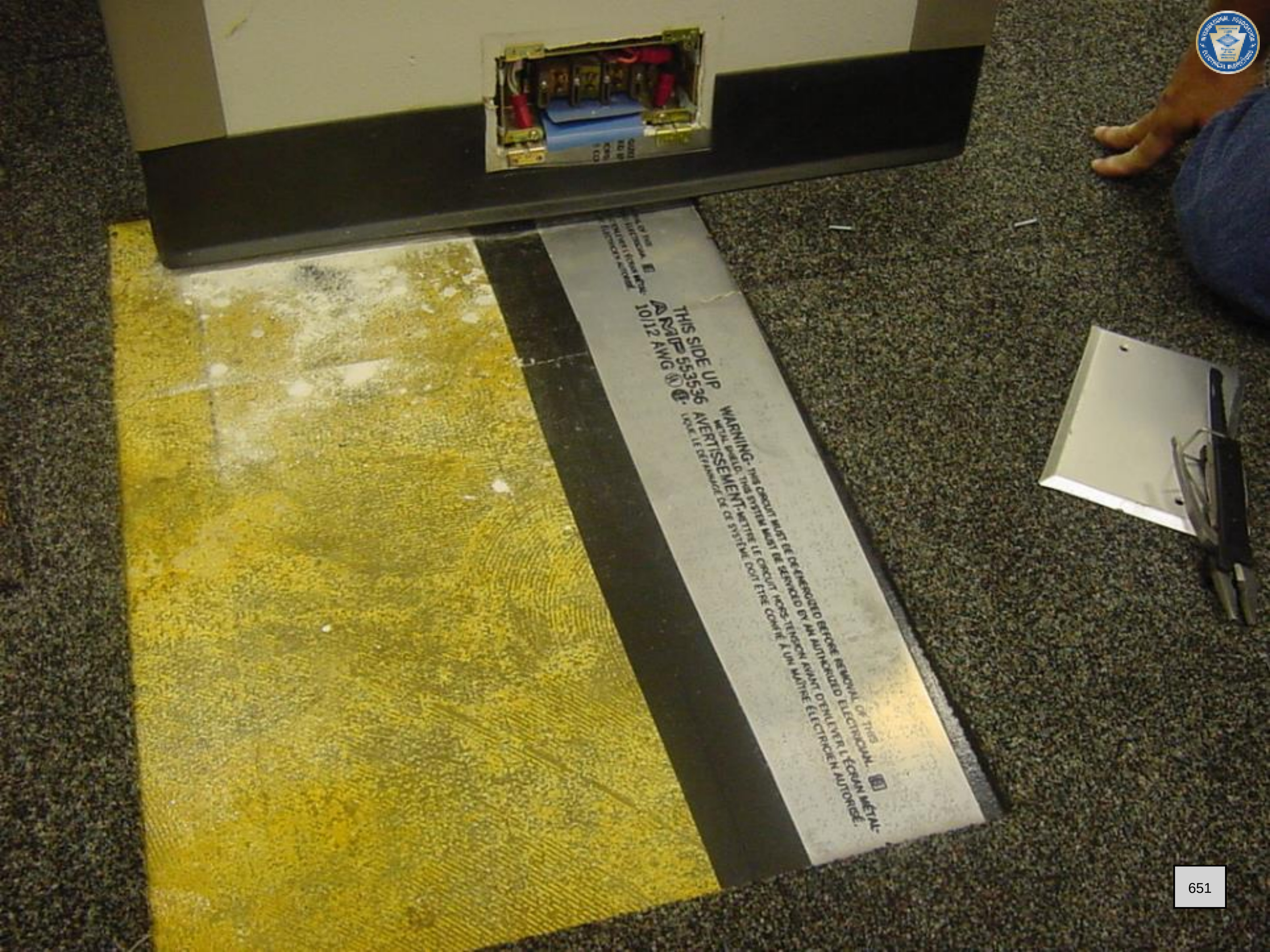
324.12(5) Uses Not Permitted
Flat Conductor Cable: Type FCC

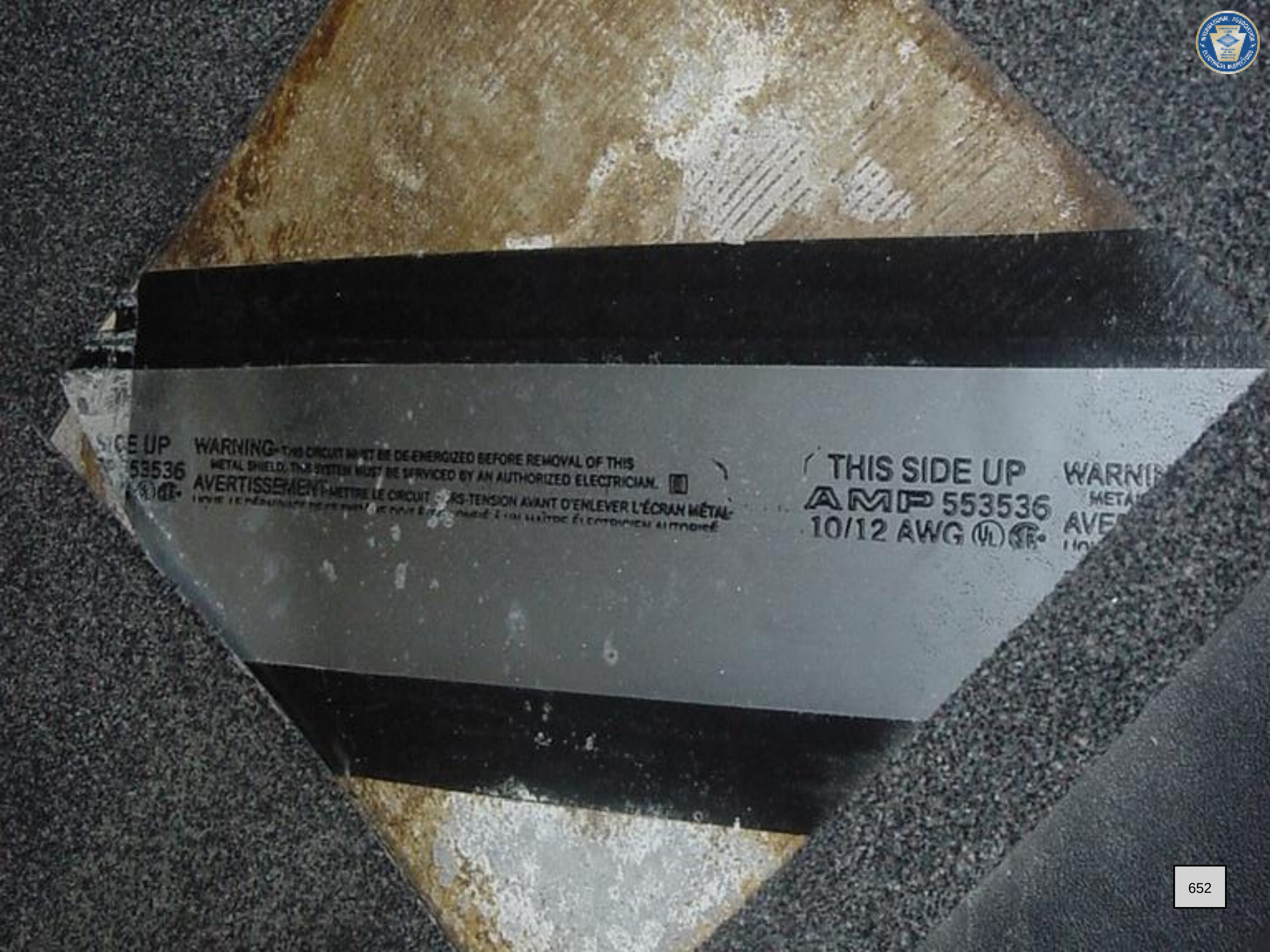
- Type FCC cable will now be permitted in **administrative office areas of hospitals and school buildings**
- Type FCC cable systems are still prohibited:
  - in outdoor or in wet locations
  - where subject to corrosive vapors
  - in any hazardous *(classified)* location
  - in school and hospital buildings *(non-administrative areas)* or
  - in residential buildings
- Type FCC cable systems is safe and reliable when installed and maintained in accordance their product specifications

324.12(5) Uses Not Permitted Flat Conductor Cable: Type FCC *(cont.)*

- Certain areas in a school building, hospitals and emergency care centers do not present safety risks that would deter the use of **Type FFC cable** such as administration offices

- Today’s modern workspace environments often requires flexibility in the design of these spaces often resulting in **open room environments** with little to no access to the building’s perimeter wall receptacle outlets


THIS SIDE UP
AMP 553536
10/12 AWG
WARNING: THIS CIRCUIT MUST BE DE-ENERGIZED BEFORE REMOVAL OF THIS METAL SHIELD. THIS SYSTEM MUST BE SERVICED BY AN AUTHORIZED ELECTRICIAN.
AVERTISSEMENT-METTRE LE CIRCUIT HORS-TENSION AVANT D'ENLEVER L'ÉCRAN MÉTAL-LIQUE. LE DÉPANNAGE DE CE SYSTÈME DOIT ÊTRE CONFIÉ À UN MAÎTRE ÉLECTRICIEN AUTORISÉ.


SIDE UP
53536
WARNING- THIS CIRCUIT MUST BE DE-ENERGIZED BEFORE REMOVAL OF THIS METAL SHIELD. THE SYSTEM MUST BE SERVICED BY AN AUTHORIZED ELECTRICIAN.
AVERTISSEMENT- METTRE LE CIRCUIT HORS-TENSION AVANT D'ENLEVER L'ÉCRAN MÉTAL-
THIS SIDE UP
AMP 553536
10/12 AWG
WARNI
METAL
AVE

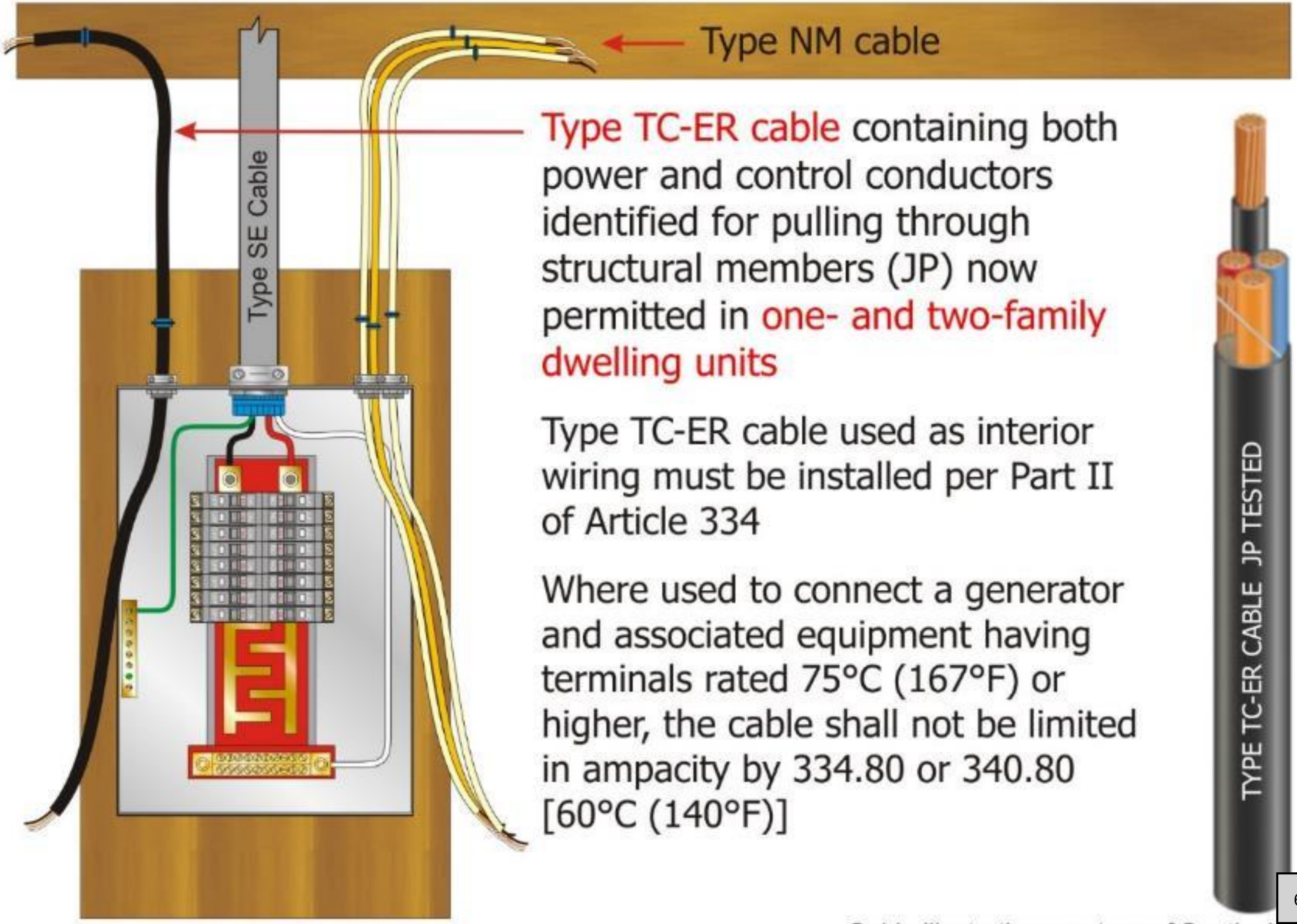
336.10(9) Power and Control Tray Cable: Type TC

- **Type TC-ER** cable with a designation of "**JP**" will now be allowed exposed without a raceway at **dwelling units**
- There are now 9 different list items under "Uses Permitted" for Type TC cable
- Type TC-ER cable containing both power and control conductors that is identified for pulling through structural members to be installed in **one- and two-family dwelling units**
- The "**-ER**" suffix stands for "**Exposed Run**"
- The "**-JP**" suffix stands for "**Joist Pull**"

336.10(9) Power and Control Tray Cable: Type TC *(cont.)*

- Type TC-ER cable meets or exceeds:
  - Construction specifications for nonmetallic-sheathed cable (Type NM cable)
  - UL product standard crush and impact ratings for Type NM cable and Type SE and SER cable
  - UL crush and impact tests for Type MC cable
- This type of cable has gained popularity when installing a standby power generator at a dwelling unit
- By allowing Type TC-ER cable to be installed exposed in a dwelling unit, the installer can secure the cable to the lower side of joists in unfinished basements or crawl spaces without installing a raceway for the cable

336.10(9) Uses Permitted for Type TC Cable



Type TC-ER cable containing both power and control conductors identified for pulling through structural members (JP) now permitted in one- and two-family dwelling units

Type TC-ER cable used as interior wiring must be installed per Part II of Article 334

Where used to connect a generator and associated equipment having terminals rated 75°C (167°F) or higher, the cable shall not be limited in ampacity by 334.80 or 340.80 [60°C (140°F)]

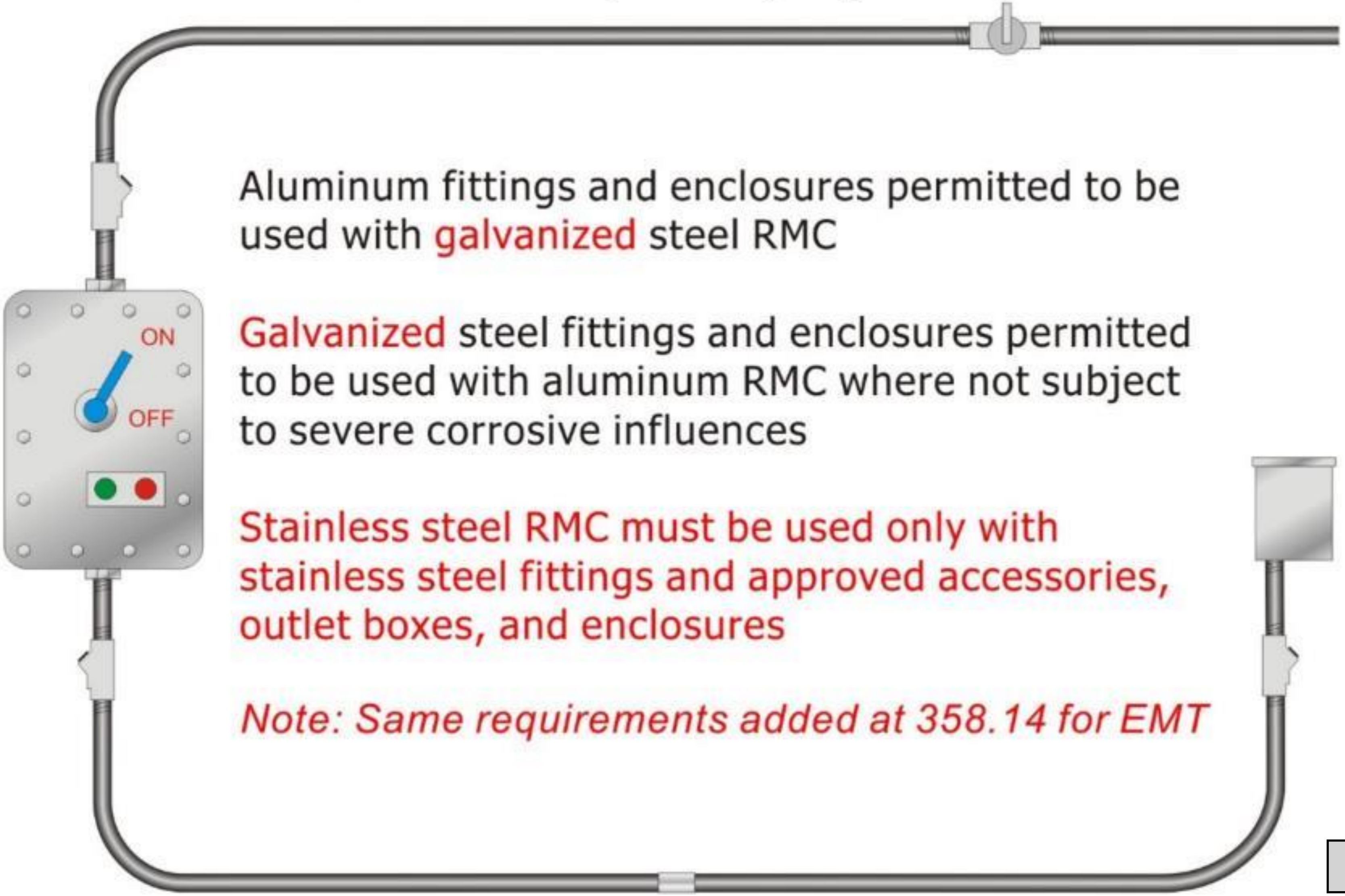
Cable illustration courtesy of Southwire

344.14 Dissimilar Metals: Type RMC

- **Stainless steel RMC** can only be used with stainless steel fittings, approved accessories, stainless steel outlet boxes, and stainless steel enclosures
- Revisions clarify the acceptable fittings that can be used with different types of RMC, based on **galvanic compatibility**
- A galvanic action or corrosion is an electrochemical process in which one metal corrodes preferentially to another when both metals are in electrical contact *(in the presence of an electrolyte)*
- Stainless steel RMC used with aluminum or galvanized fittings, accessories, outlet boxes and enclosures could result in a galvanic action and leading to corrosion of the stainless steel

344.14 Dissimilar Metals: Type RMC

Where practicable, dissimilar metals in contact anywhere in the system shall be avoided to eliminate the possibility of galvanic action



Aluminum fittings and enclosures permitted to be used with galvanized steel RMC

Galvanized steel fittings and enclosures permitted to be used with aluminum RMC where not subject to severe corrosive influences

Stainless steel RMC must be used only with stainless steel fittings and approved accessories, outlet boxes, and enclosures

Note: Same requirements added at 358.14 for EMT

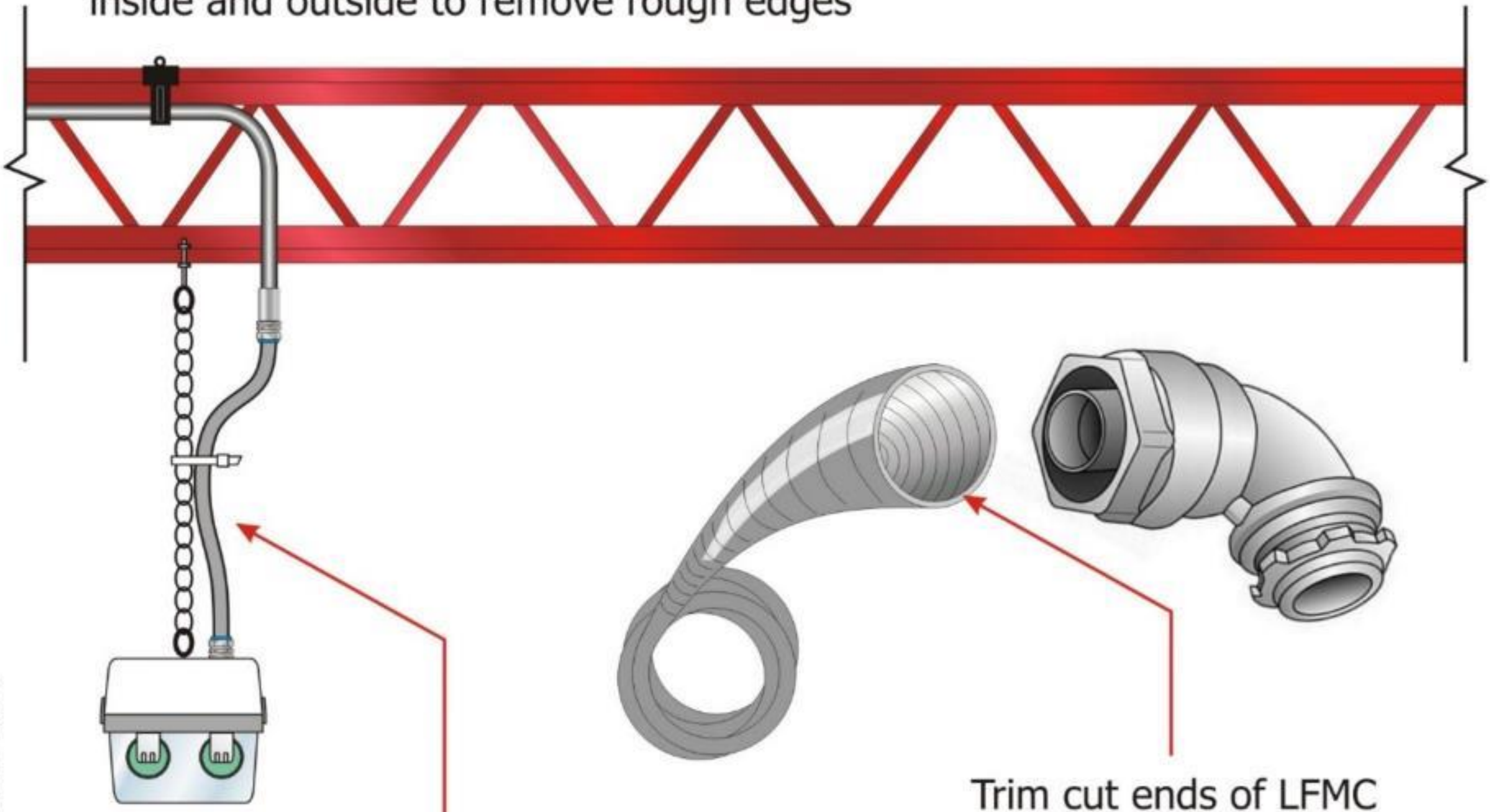
Stainless Steel
Rigid RMC

350.28 Trimming of LFMC

- New language added requiring cut ends of liquidtight flexible metal conduit *(Type LFMC)* to be **trimmed inside and outside** to remove rough edges
- Proper trimming of Type LFMC is necessary as to allow the proper installation of the steel grounding ferrule
- Important to maintain ground continuity of the steel sheath of Type LFMC
- Trimming of the cut ends should be done to prevent chafing of pulled conductors
- Provides consistency between Article 350 and Article 356 (LFNC) and other *NEC* articles for trimming and reaming

350.28 Trimming of LFMC

All cut ends of liquidtight flexible metal conduit (LFMC) shall be trimmed inside and outside to remove rough edges



Trim cut ends of LFMC

Liquidtight flexible metal conduit installed where flexibility is necessary after installation


03MAR16

358.10 Uses Permitted – Type EMT

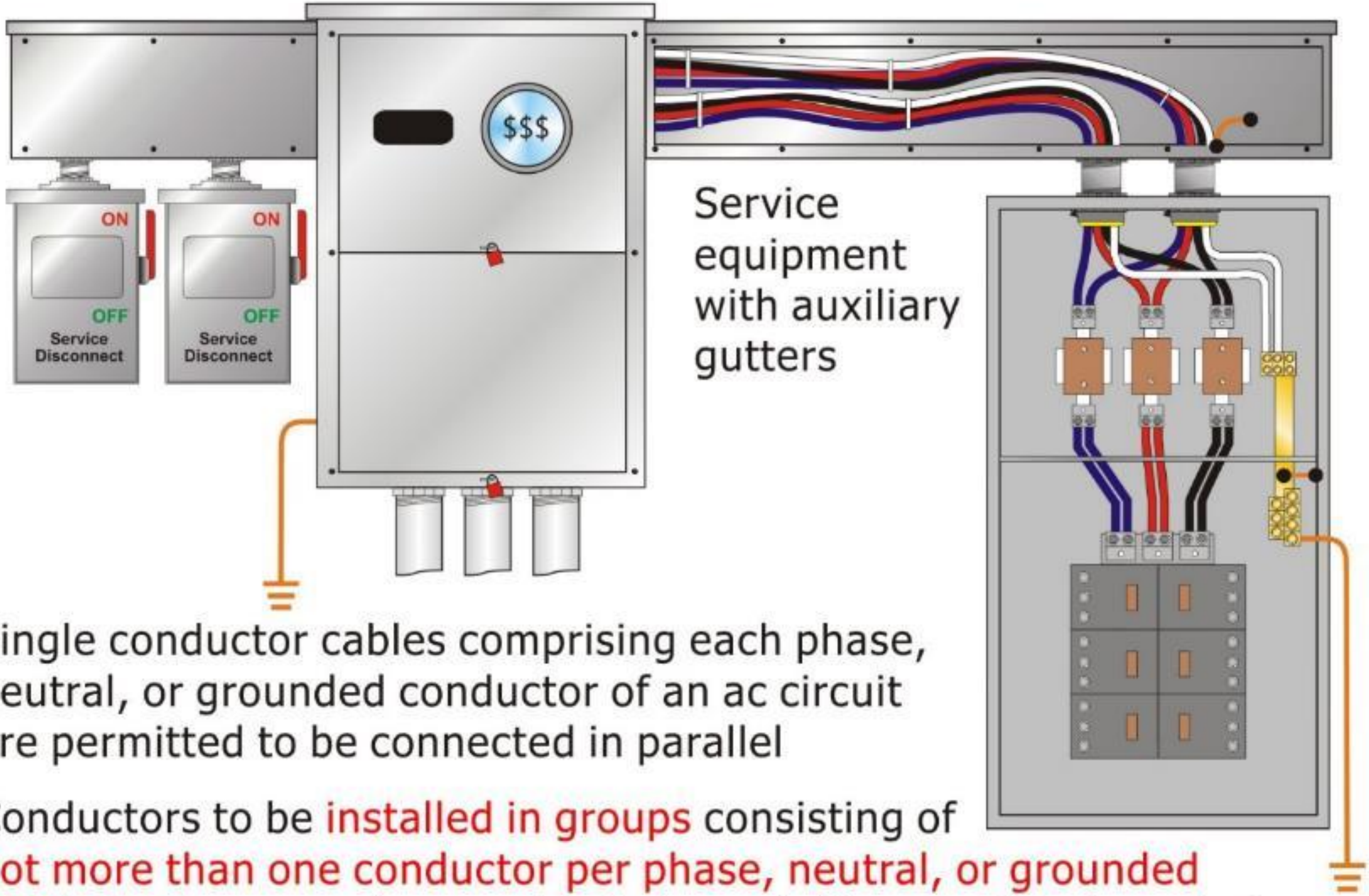
- The "Uses Permitted" for EMT has been revised for consistency with other steel conduit articles *(Type IMC and RMC)*
- Some requirements or "uses" for EMT were moved from 358.12 *(Uses Not Permitted)* and reworded using positive language
- Provisions for stainless steel EMT were also added
- Clarification of the use of galvanized steel, stainless steel, and aluminum EMT in corrosive environments and concrete
- If supplementary corrosion protection is required or desired, it can be provided by a factory-applied PVC coating, paint approved for the purpose, or tape wraps approved for the application

366.20

Parallel Conductors In Auxiliary Gutters

- Language added to address how to install **conductors in parallel in an auxiliary gutter**
- An auxiliary gutter is designed for conductors to be laid or set in place after the enclosures have been installed as a complete system
- Documented failures of paralleled conductors have occurred when these conductors were installed in wireways and auxiliary gutters and were **not grouped together**
- Leads to overheating and insulation breakdown due to the **induction process**
- Primary concerns when installing conductors in parallel are ensuring that each conductor in the paralleled set has the **same electrical characteristics** as the others in the same set

366.20 Parallel Conductors in Auxiliary Gutters



Service equipment with auxiliary gutters

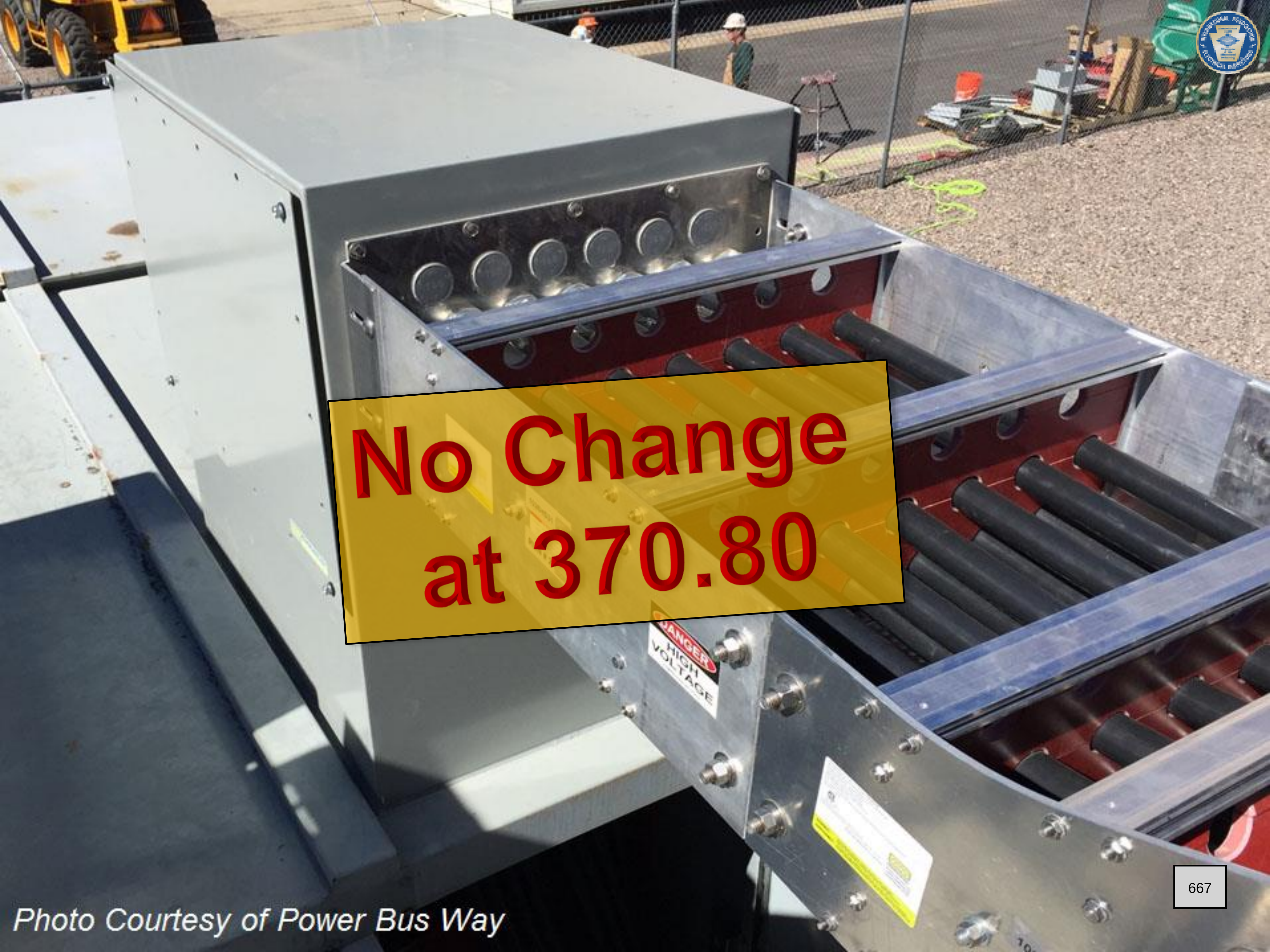
Single conductor cables comprising each phase, neutral, or grounded conductor of an ac circuit are permitted to be connected in parallel

Conductors to be installed in groups consisting of not more than one conductor per phase, neutral, or grounded conductor to prevent current imbalance in the paralleled conductors due to inductive reactance

370.80 Cablebus-Ampacity of Conductors

- Additional information was proposed to be added to provide clarity for the allowable ampacities for cables installed in cablebus assemblies (Article 370) and aligns ampacities with cable tray installations (Article 392)
- **This 2017 *NEC* change was overturned by the NFPA Standards Council at its August 3-4, 2016 meeting *(see Standards Council Agenda Item 16-8-3-f)***
- **Standards Council decision on CAM 70-13 and Second Revision 2110 returned the *Code* language at 370.80 to the 2014 *NEC Code* language**

No Change at 370.80



No Change at 370.80

Photo Courtesy of Power Bus Way

Chapter Four
Equipment for General Use

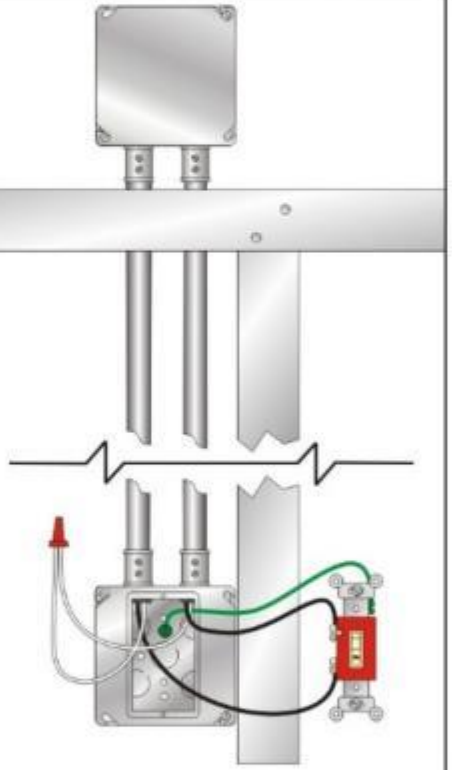
404.2(C)
Grounded Conductor at Switch Locations

- The previous seven “conditions” in which a grounded conductor was not required to be installed at lighting switch locations has been revised and reduced to only **five “conditions”**
- Previous condition **(4) and (5) moved** from these conditions to the parent text of 404.2(C) and reworded into positive language
- Enforceable language was added to require the grounded conductor to be **connected and used** by the switching device rather than simply be “present” at the switch enclosure
- Exception added to **exclude replacement or retrofit switches** installed in locations prior to local adoption of 404.2(C) where the grounded conductor cannot be extended without removing finish materials
- New exception also puts a limit to the number of electronic lighting control switches on a branch circuit **(5)** or feeder **(25)**

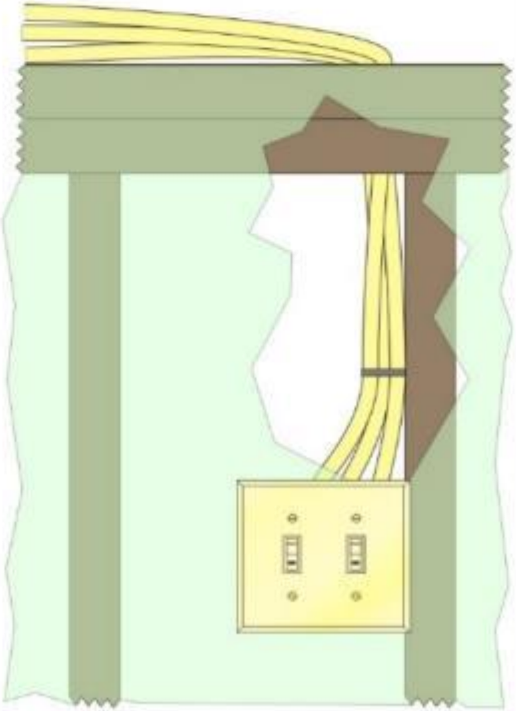
404.2(C) Grounded Conductor at Switch Locations

A grounded conductor is generally required to be installed and connected to the switching device at locations where switches control lighting loads that are supplied by a grounded general-purpose branch circuit

Grounded conductor is generally **NOT** required at the following locations:



Raceway system large enough for all contained conductors



Accessible for the installation of additional cable without removing finish materials

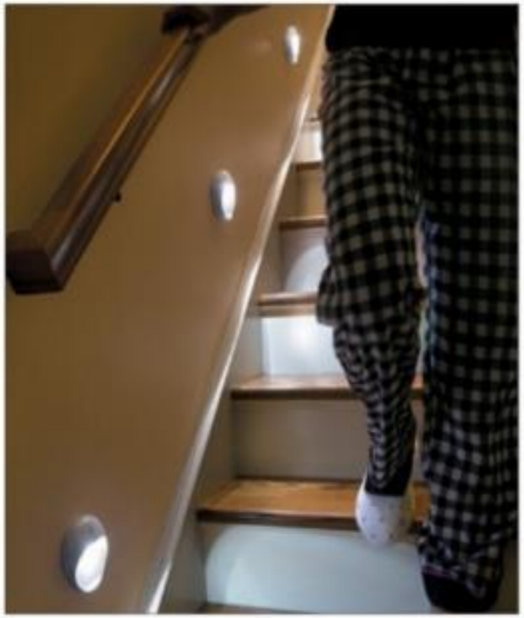
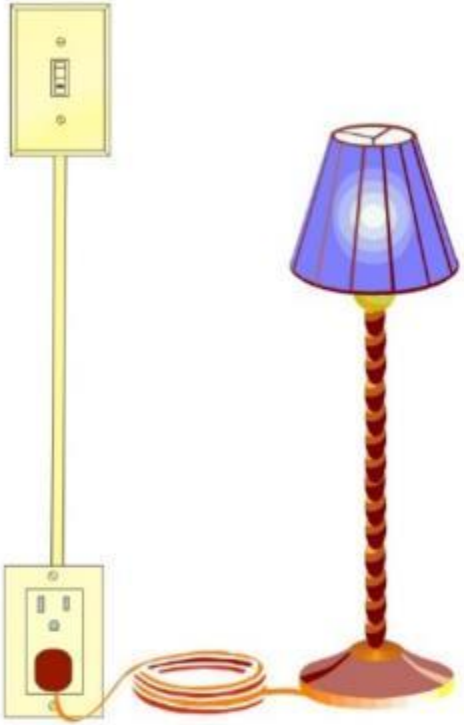
(Courtesy of Leviton/Cheetah USA)

Snap switches with integral enclosures comply with 300.15(E)

404.2(C) Grounded Conductor at Switch Locations

A grounded conductor is generally required to be installed and connected to the switching device at locations where switches control lighting loads that are supplied by a grounded general-purpose branch circuit

Grounded conductor is generally **NOT** required at the following locations:

 Where lighting in the area is controlled by automatic means *(such as a motion sensor)*	 Where a switch controls a receptacle load	 Switch for non-habitation type room or occupancies as defined by applicable building code

404.2(C) Grounded Conductor at Switch Locations

A grounded conductor is generally required to be installed and connected to the switching device at locations where switches control lighting loads that are supplied by a grounded general-purpose branch circuit

Grounded conductor is generally **NOT** required at the following locations:

Where multiple switch locations control the same lighting load such that the entire floor area of the room or space is visible from the single or combined switch locations, the grounded circuit conductor shall only be required at one location

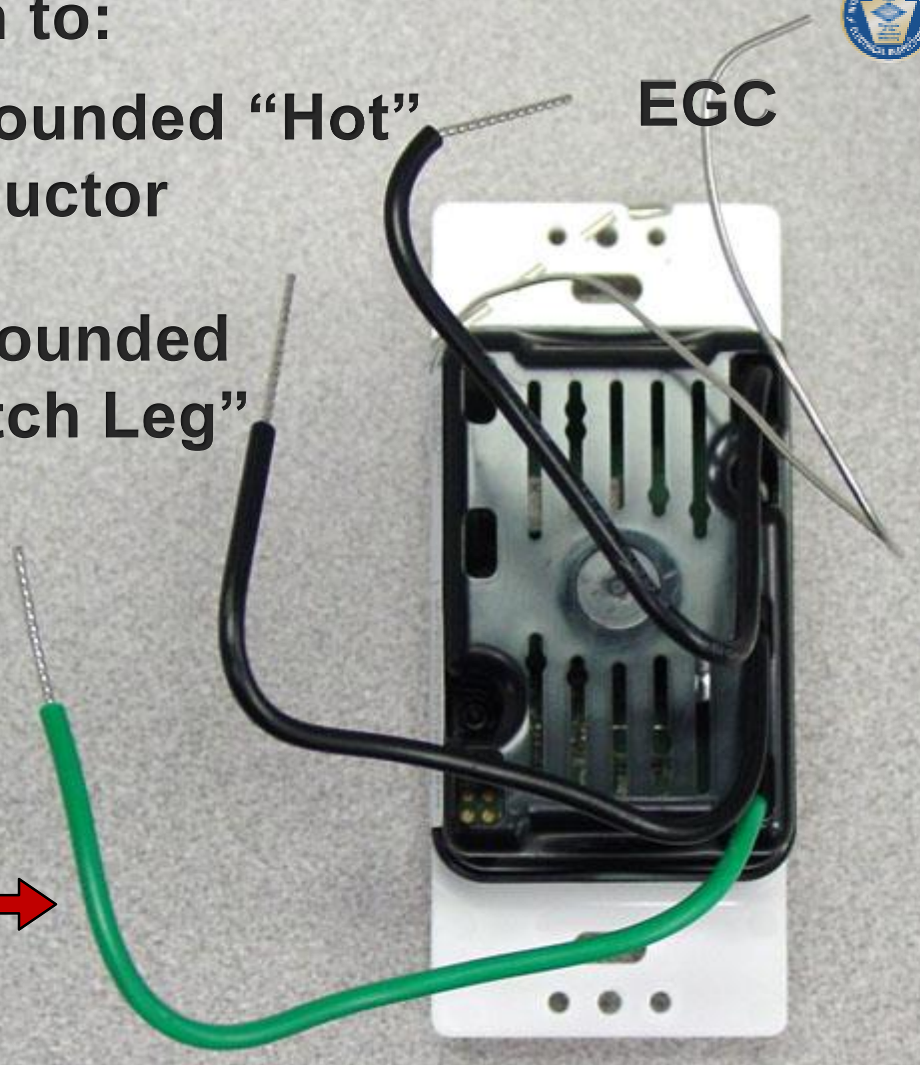
404.22
Electronic Lighting Control Switches

- New provisions added for "Electronic Lighting Controlled Switches" **prohibiting current** on the **equipment grounding conductor** with a future effective date
- In conjunction with revisions to 404.2(C), electronic lighting control switching devices to be listed and **"shall not introduce current on the equipment grounding conductor during normal operation"**
- Currently, readily-available existing listed electronic lighting control switching devices requiring EGC to be used as grounded conductor per the **manufacturer's instructions**
- This probation on introducing current on the EGC requirement has a future effective date on **January 1, 2020**

404.22
Electronic Lighting Control Switches *(cont.)*

- One of the main reasons to prohibit a grounded conductor from being connected to equipment grounding conductor(s) is to **eliminate circulating currents** from being introduced into the equipment grounding conductor path
- New language will require insulated grounded supply conductor to be **installed and used** with the proper listed electronic device
- **New exception** will recognize **retrofit** installation or **replacement** situation in existing situations where the grounded conductor is not installed

Connection to:



Ungrounded "Hot" Conductor

EGC

Ungrounded "Switch Leg"

Grounded Conductor (if present), EGC if Grounded Conductor is Not Present

406.2 Definition: Outlet Box Hood

- Definition for the term "**outlet box hood**" was added at 406.2
- Outlet box hoods commonly referred to in the field as "in-use" covers or "bubble" covers
- All outlet box hood covers should be required to be listed for use in a wet location when installed in a wet location
- Relied upon to provide environmental protection for enclosed devices such as GFCI receptacle outlet devices
- **Nonmetallic** outlet box hoods are typically constructed of UV resistant polycarbonate while the **metal enclosures** are typically made of powder-coated cast zinc

406.2 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.


EXTRA DUTY
LIFT ↑ OPEN


EXTRA DUTY


EXTRA DUTY
WHEN COVER CLOSED

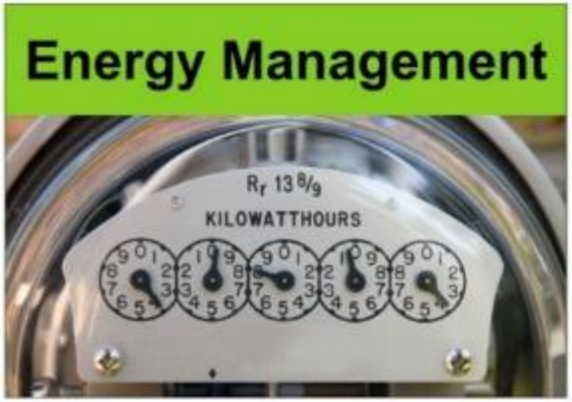

TAYMAC

406.3(E) Controlled Receptacle Marking

- The word "**Controlled**" is now required to be placed on the controlled receptacle along with the previous symbol
- The word "**Controlled**" was also added to Figure 406.3(E)
- The controlled receptacle symbol and the word "**Controlled**" are **to be placed on the controlled receptacle face** *(not the faceplate or cover)* and remain visible after installation
- This will assure that the end user of this receptacle knows that it is being controlled and **could become de-energized**
- This removes any misunderstanding due to a "symbol" on the receptacle that might not be understood by the end user

406.3(E) Controlled Receptacle Marking

All nonlocking-type, 125-volt, 15- and 20-ampere receptacles controlled by an automatic control device, energy management, or building automation shall be marked with the "Controlled Receptacle Marking Symbol" from Figure 406.3(E) and the word "CONTROLLED"



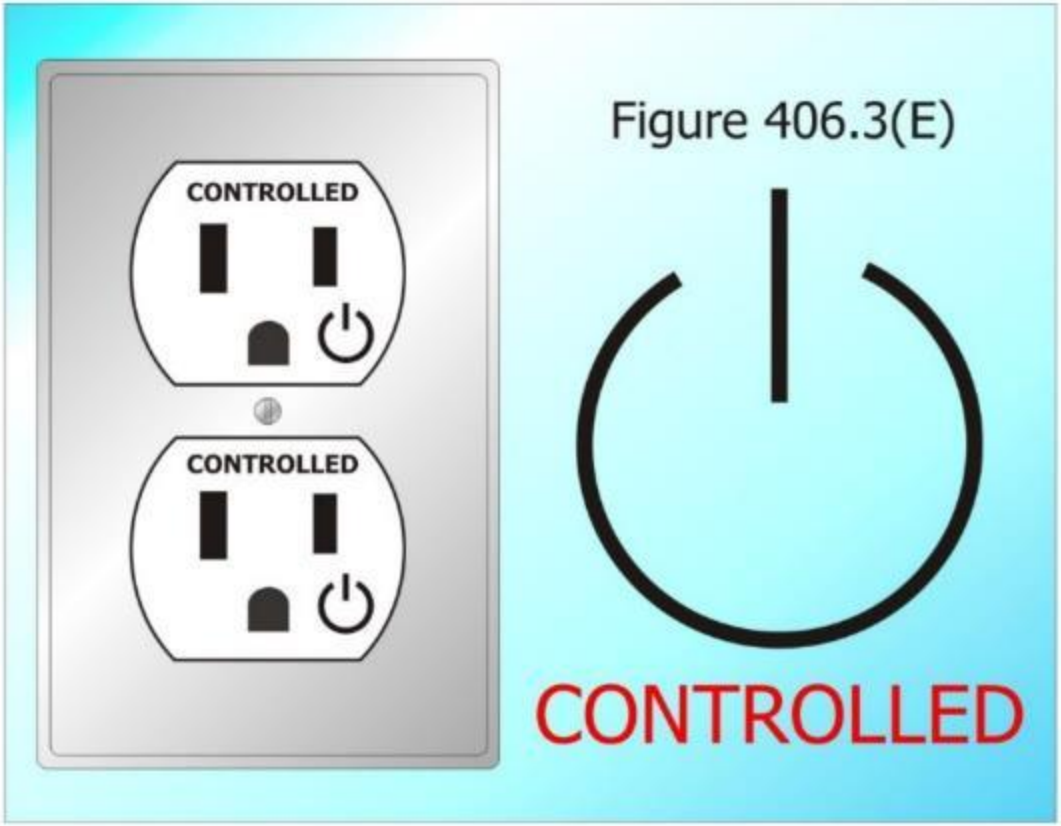


Figure 406.3(E)

For receptacles controlled by an automatic control device, the marking shall be located on the receptacle face and visible after installation

406.3(F) Receptacle with USB Charger

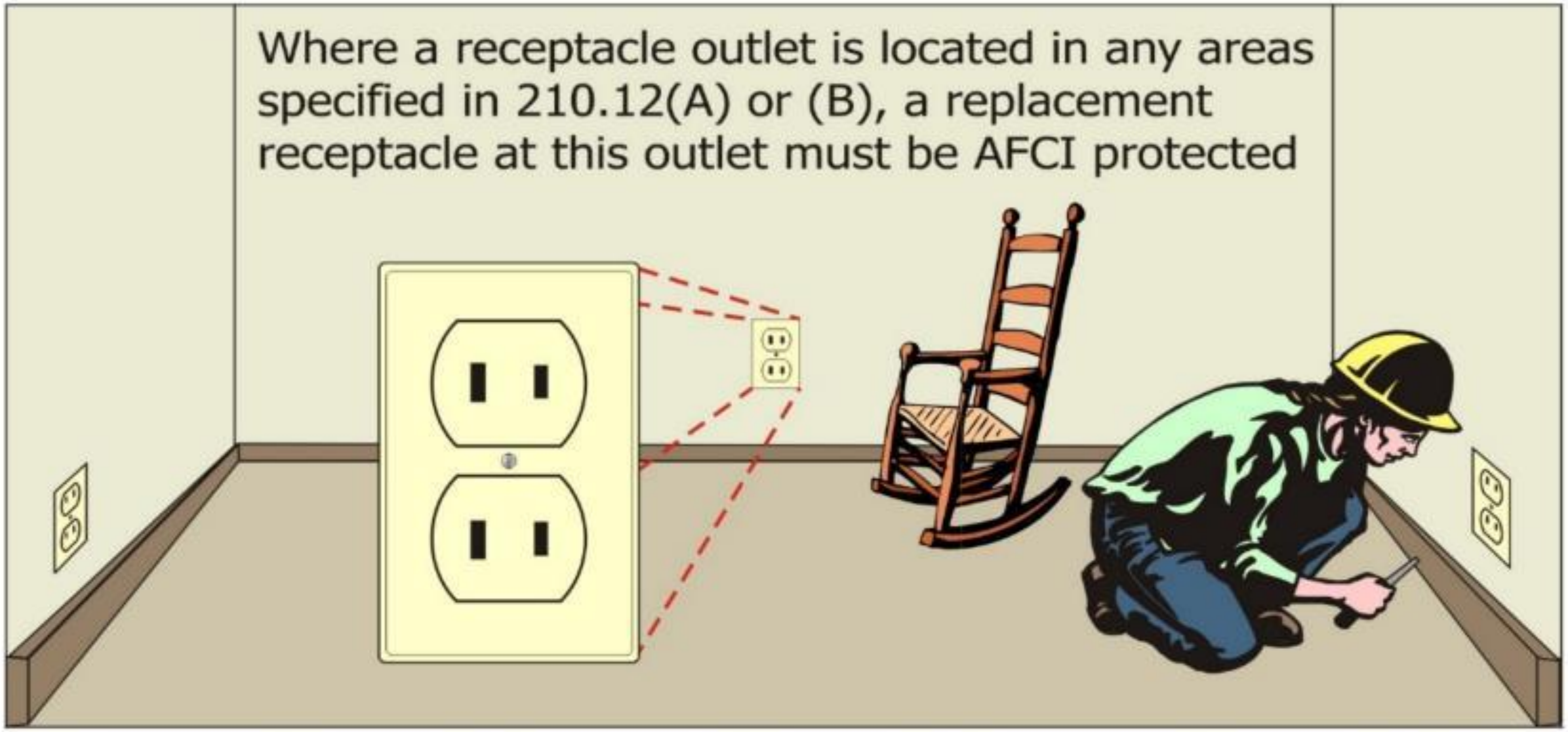
- New provisions added pertaining to 125-volt 15- or 20-ampere receptacle that additionally provides Class 2 power in the form of a **USB outlet and charger**
- New provisions require these devices to be **listed** and constructed such that the Class 2 circuitry is **integral with the receptacle**
- **Universal Serial Bus *(USB)*** is an industry standard that defines the cables, connectors and communications protocols used in a bus for connection, communication, and power supply between computers and electronic devices
- Some Class 2 power supply and Class 2 output connector(s) are intended to be secured and directly connected to a duplex receptacle *(not integral with the receptacle)*


SAMSUNG

406.4(D)(4), Ex. No. 1 and Ex. No. 2
AFCI for Replacement of Existing Receptacles

- Two new exceptions were added for AFCI requirements for replacement of existing receptacles
- First new exception recognizes applications where an existing two-wire receptacle is replaced and no equipment grounding conductor can be installed *(existing two-wire system)*
- Second new exception stipulates that the exception to 210.12(B) **does not apply** when replacing existing receptacles
- Exception to 210.12(B) permits existing branch circuit conductors to be modified or extended up to 1.8 m (6 ft) without AFCI protection where no additional outlets or devices are installed

406.4(D)(4) Replacement Receptacles (AFCI)


Where a receptacle outlet is located in any areas specified in 210.12(A) or (B), a replacement receptacle at this outlet must be AFCI protected

Ex. No. 1: AFCI protection not required where all of the following apply:

(1) Replacement complies with 406.4(D)(2)(b) *(two-wire system-GFCI)*

(2) Impracticable to provide an EGC as provided by 250.130(C)

(3) Listed combination type AFCI circuit breaker not commercially available

(4) GFCI/AFCI dual function receptacles not commercially available

Ex. No. 2: Exception at 210.12(B) shall not apply to replacement of receptacles

406.4(D)(4) Replacement Receptacles (AFCI)

Where a receptacle outlet is located in any areas specified in 210.12(A) or (B), a replacement receptacle at this outlet must be AFCI protected

Ex. No. 2: Exception at 210.12(B) shall not apply to replacement of receptacles

[210.12(B), Ex.: AFCI protection not required where the extension of the existing conductors is not more than 1.8 m (6 ft.) and does not include any additional outlets or devices]

406.4(D)(5) Tamper-Resistant Receptacles for Replacements

- Tamper-resistant receptacles required for replacement receptacles “**except where a non-grounding receptacle is replaced with another non-grounding receptacle**”
- Listed tamper-resistant receptacles are generally required to be provided where receptacles are replaced at receptacle outlets that are required to be tamper-resistant elsewhere in the *Code*
- Listed tamper-resistant receptacles are **not manufactured or available** in a nongrounding, two-prong receptacle style
- 406.4(D)(2)(a) permits a non-grounding-type receptacle as a replacement for another non-grounding-type receptacle

406.4(D)(5) Receptacle Replacement Tamper-Resistant Receptacles

Listed tamper-resistant receptacles are required for replacement receptacles where a receptacle outlet is required to be tamper-resistant elsewhere in the *Code* "except where a non-grounding receptacle is replaced with another non-grounding receptacle"

406.6(D) Receptacle Faceplate *(Cover Plates)* with Integral Night Light and/or USB Charger

- New requirements were added pertaining to receptacle faceplates with **integral night lights and/or USB chargers**
- These faceplates must be **listed** and constructed such that the night light and/or Class 2 circuitry is "**integral with the flush device cover plate**"
- Plug-in night light/covers that is not "integral with the flush device cover plate," but simply designed to be plugged directly into a receptacle outlet presents a problem
- The ease in removing these night light-type covers from the receptacle outlet increases its safety hazard

406.6(D) Receptacle Faceplate (Cover Plates) with Integral Night Light and/or USB Charger

Receptacle faceplates shall be installed so as to completely cover the opening and seat against the mounting surface

Courtesy of SnapPower

A flush device cover plate that additionally provides a night light and/or Class 2 output connector(s) shall be listed

The night light and/or Class 2 circuitry must be integral with the flush device cover plate

Courtesy of SnapPower

406.9(B)(1) Extra-Duty Outlet Box Hoods

- Other listed products, enclosures, or assemblies providing weatherproof protection that do not utilize an outlet box hood **need not be marked "extra duty"**
- These power outlets *(other listed products)* typically locate a receptacle behind a hinged steel cover, which is not an outlet box hood, and need not be identified as "extra duty"
- This has caused some **confusion over the lack of "extra duty" identification** on these types of listed assemblies
- This change provides needed clarity and eliminates confusion within the electrical industry

406.9(B)(1) Extra-Duty Outlet Box Hoods

An outlet box hood installed at an enclosure for 15 and 20 amperes, 125 and 250 volt receptacles in a wet location to provide weatherproof protection whether or not an attachment plug cap is inserted or not must be listed and identified as “extra duty”

Must be Marked “Extra Duty”

“Extra Duty” Not Required

Other listed products, enclosures, or assemblies providing weatherproof protection that do not utilize an outlet box hood need not be marked “extra duty”

406.12 Tamper-Resistant Receptacles

- Requirements for tamper-resistant *(TR)* receptacles **expanded** to locations **where small children are likely to congregate** and have ready access to energized receptacle outlets
- TR receptacles expanded to **250 volt receptacles** as well as 125 volt receptacles
- Receptacles rated at 250 volts are commonly used for air-conditioning and heating units in dwelling units, guest rooms and guest suites of hotels and motels as well as other locations
- TR receptacle requirements expanded to other dwelling unit areas such as **mobile and manufactured homes**
- Reorganized to put the areas that require TR receptacles into a **list format**

406.12
Tamper-Resistant Receptacles *(cont.)*

- Requirements for tamper-resistant *(TR)* receptacles **expanded** to locations **where small children are likely to congregate**:
  - Dwelling units (210.52)
  - **Mobile and manufactured homes (550.13)**
  - Guest rooms and guest suites of hotels and motels
  - Child care facilities
  - **Preschools and elementary education facilities**
  - **Medical and dental waiting rooms**
  - **Places of assembly occupancies (518.2)**
  - **Dormitories**

406.12 Tamper-Resistant Receptacles

All 15- and 20-ampere, 125- and 250-volt nonlocking-type receptacles in areas specified in 406.12(1) through (7) must be listed tamper-resistant receptacles: (1) Dwelling units in all areas specified in 210.52 and 550.13; (2) Guest rooms and guest suites of hotels and motels; (3) Child care facilities

(4) Preschools/elementary educational facilities; (5) Waiting rooms, etc. in medical/dental offices; (6) Places of waiting-transportation, gymnasiums, etc. (7) Dormitories

406.12 Tamper-Resistant Receptacles

All 15- and 20-ampere, 125- and 250-volt nonlocking-type receptacles in areas specified in 406.12(1) through (7) must be listed tamper-resistant receptacles: (1) Dwelling units in all areas specified in 210.52 and 550.13; (2) Guest rooms and guest suites of hotels and motels; (3) Child care facilities

Tamper-resistant receptacle requirements have been expanded to include: all areas specified in 550.13 at mobile and manufactured homes

406.12 Tamper-Resistant Receptacles

All 15- and 20-ampere, 125- and 250-volt nonlocking-type receptacles in areas specified in 406.12(1) through (7) must be listed tamper-resistant receptacles: (1) Dwelling units in all areas specified in 210.52 and 550.13; (2) Guest rooms and guest suites of hotels and motels; (3) Child care facilities

Tamper-resistant receptacle requirements have been expanded to include:
(4) Preschools and elementary education facilities

406.12 Tamper-Resistant Receptacles

All 15- and 20-ampere, 125- and 250-volt nonlocking-type receptacles in areas specified in 406.12(1) through (7) must be listed tamper-resistant receptacles: (1) Dwelling units in all areas specified in 210.52 and 550.13; (2) Guest rooms and guest suites of hotels and motels; (3) Child care facilities

Tamper-resistant receptacle requirements have been expanded to include: (5) Business offices, corridors, waiting rooms and the like in clinics, medical and dental offices and outpatient facilities

406.12 Tamper-Resistant Receptacles

All 15- and 20-ampere, 125- and 250-volt nonlocking-type receptacles in areas specified in 406.12(1) through (7) must be listed tamper-resistant receptacles: (1) Dwelling units in all areas specified in 210.52 and 550.13; (2) Guest rooms and guest suites of hotels and motels; (3) Child care facilities

Tamper-resistant receptacle requirements have been expanded to include: (6) Subset of assembly occupancies described in 518.2 to include places of waiting for transportation, gymnasiums, skating rinks, and auditoriums

406.12 Tamper-Resistant Receptacles

All 15- and 20-ampere, 125- and 250-volt nonlocking-type receptacles in areas specified in 406.12(1) through (7) must be listed tamper-resistant receptacles: (1) Dwelling units in all areas specified in 210.52 and 550.13; (2) Guest rooms and guest suites of hotels and motels; (3) Child care facilities

Tamper-resistant receptacle requirements have been expanded to include: (7) Dormitories

406.15

Dimmer-Controlled Receptacles *(Deleted)*

- Dimmer-controlled receptacle provisions have been **deleted**
- Section sought to correct incompatibilities between certain types of dimmer and certain cord-and-plug connected loads
- Such incompatibilities are currently dealt with in the **listing of specific load types** and the **listing of specific dimmer types**
- During the last *Code* revision cycle, new rules were added at 406.15 permitting certain receptacles to be controlled by a dimmer under specific conditions
- In conjunction with 404.15(E), dimmer switches are generally not permitted to control receptacle outlets
- Use of the term "nonstandard configuration" in previous *Code* was not defined with regard to plug/receptacle combinations

408.3(A)(2)
Barriers at Service Panelboards

- New requirements added for **barriers** to be placed in all **service panelboards** such that no uninsulated, ungrounded service busbar or service terminal be exposed to inadvertent contact by persons
- Identified as a safety concern by installers and proponents of electrical safety in the workplace
- An **exception** was also added eliminating the barriers at panelboards installed to comply with the requirements of **408.36, Ex. No. 1, 2, and 3**
- Exceptions to 408.36 address the "**six means of disconnect**" rules and the old "**split-bus**" panelboards that could be present

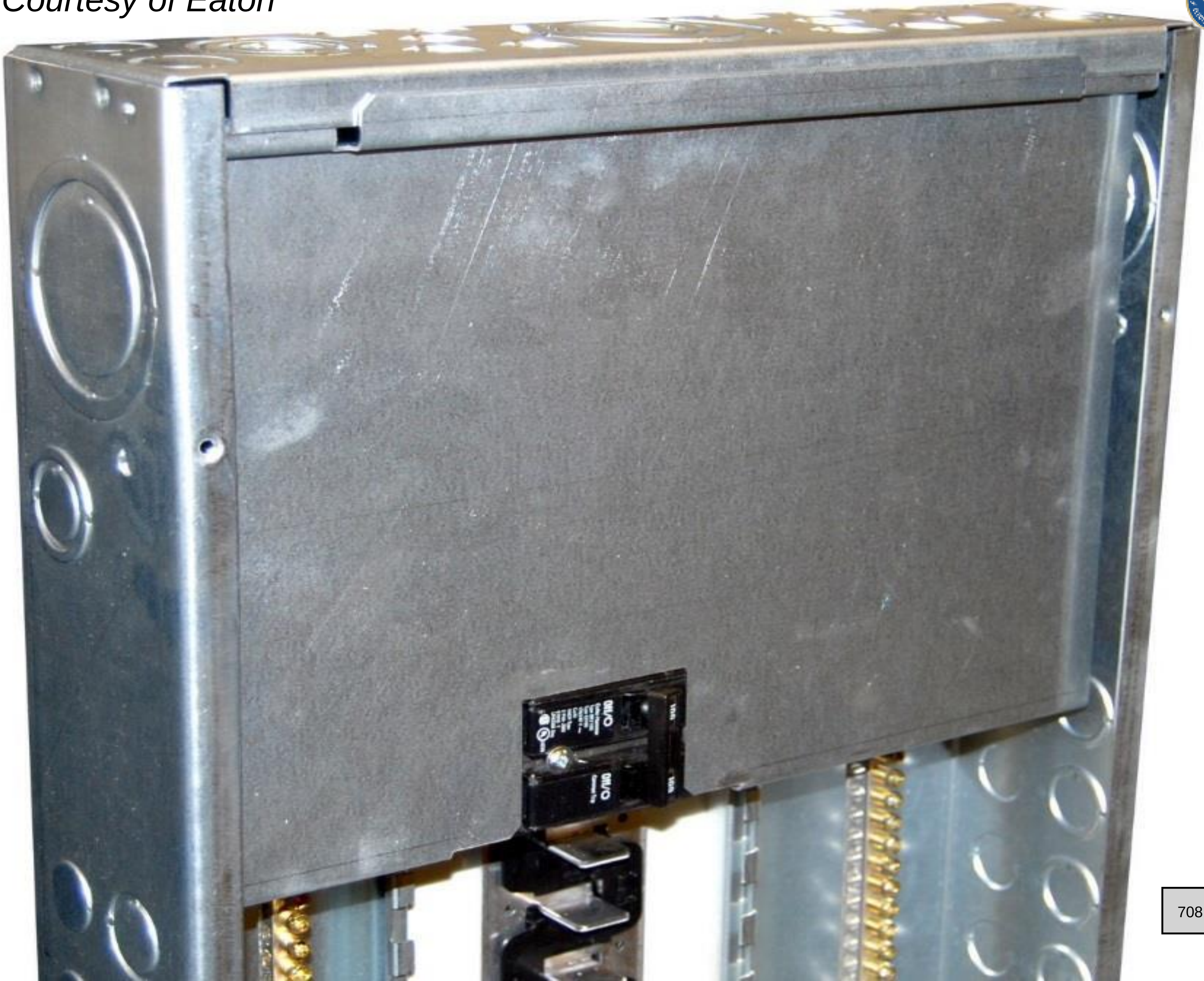
408.3(A)(2) Barriers at Service Panelboards

Barriers required in all service panelboards, switchboards, and switchgear such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations

Courtesy of Schneider Electric

Exception: *This requirement shall not apply to service panelboards with provisions for more than one service disconnect within a single enclosure as permitted in 408.36, Exceptions No. 1, 2, and 3*

Courtesy of Eaton



409.22(B) Short-Circuit Current Rating

- New requirements added for documentation of **available short-circuit current** at **industrial control panels**
- This information shall also include the **date the short-circuit current calculation was performed**
- Enforcement community has experienced difficult time enforcing proper short-circuit current ratings of industrial control panels
- New requirement provides much needed information to aid the electrical inspector *(AHJ)* when enforcing 409.22(A) which will ensure that the industrial control panel complies with its established short-circuit current rating

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ENCLOSED INDUSTRIAL CONTROL PANEL

No. CJ - 964990

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480 VAC 60Hz 3∅

50 Amps Max 5 Hp Max

SHORT CIRCUIT CURRENT RATING:

42 Ka @ 480 VAC

RMS SYMMETRICAL

Incoming Power Torque Value:35 in.lbs.

Grnd Lug:35 in.lbs.

Use Copper Wire 60 degree C.

Minimum Wire Size 16 Awg

Other Locations for Short-Circuit Current Rating Documentation

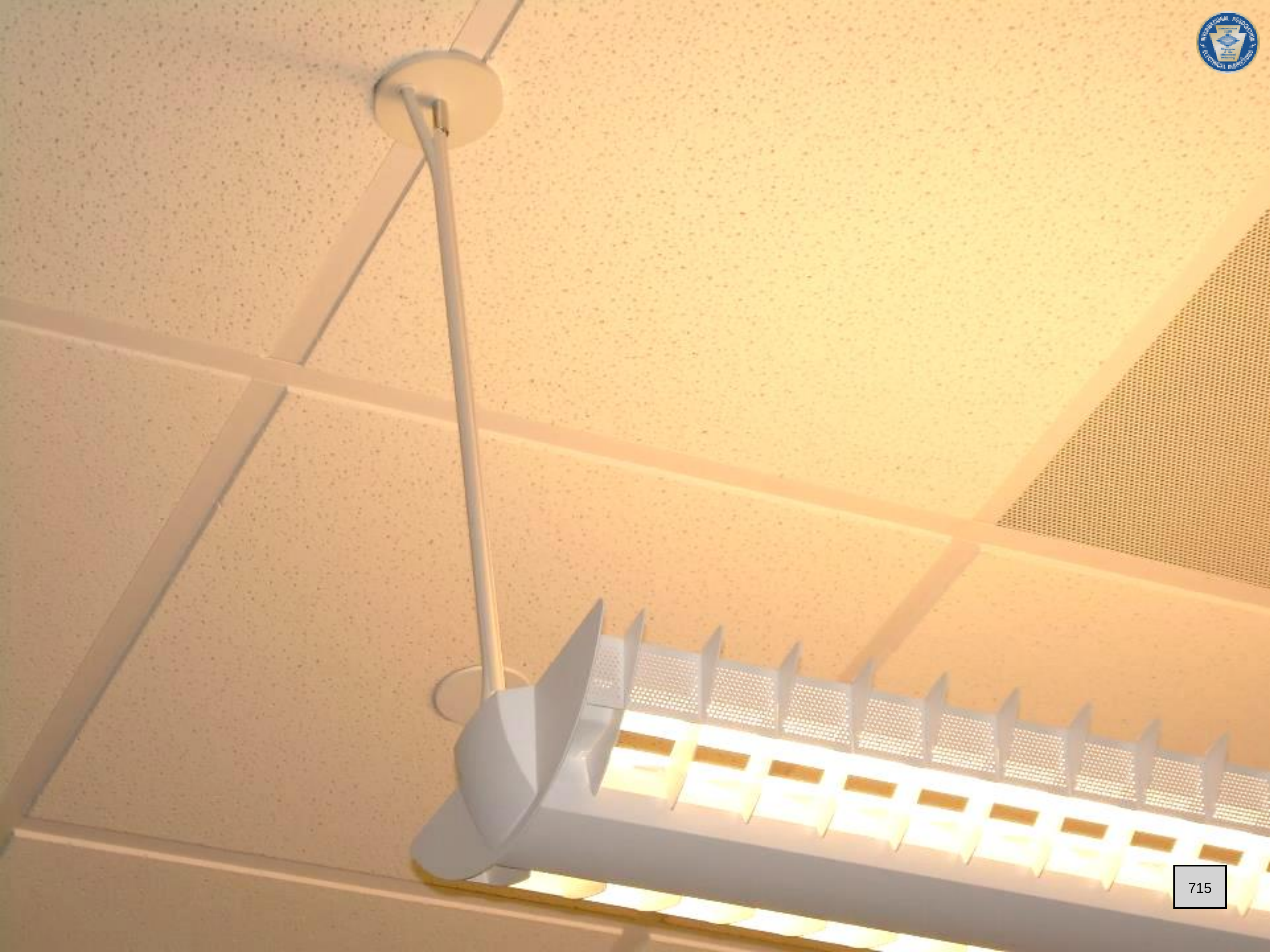
- Available short-circuit current documentation was added for other things such as:
  - Motor control centers
  - Air conditioning equipment
  - Elevators control panels
  - Industrial machinery
  - Emergency system transfer equipment for:
    - Emergency systems
    - Legally required standby systems
    - Optional standby systems
    - Critical operations power systems (COPS)

410.62(C)(1) Cord-Connected Installation of Lampholders and Luminaires

- Re-organization occurred to the requirements for cord-connected lampholders and luminaires of the electric-discharge and LED type
- New layout much easier to follow and comprehend
- Previous language at 410.62(C)(1) was one long sentence that was extremely difficult to follow
- New re-organized text provides improved clarity while retaining the core intent of these cord-connected requirements

410.62(C)(1) Cord-Connected *(cont.)* Installation of Lampholders and Luminaires

- Electric-discharge and LED luminaires permitted to be cord connected when the following conditions apply:
  - Luminaire is located directly below the outlet or busway
  - Flexible cord is visible for entire length outside the luminaire
  - Not subject to strain or physical damage
  - Terminated with one of the following methods:
    - Grounding-type attachment plug cap or busway plug
    - Part of a listed assembly incorporating a manufactured wiring system connector in accordance with 604.100(C)
    - Luminaire assembly with a strain relief and canopy having a maximum 150 mm (6 in.) long section of raceway for attachment to an outlet box above a suspended ceiling



Article 411 Low-Voltage Lighting

- Article 411 was re-organized and renamed
- Title changed from "~~Lighting Systems Operating at 30 Volts or Less and Lighting Equipment Connected to Class 2 Power Sources~~" to simply "**Low-Voltage Lighting**"
- Limitations of 411.3(A) and (B) for low-voltage lighting systems operating at **30 volts or less** and the limitations of Class 2 low-voltage lighting systems conforming to *NEC* Chapter 9, Table 11(A) or Table 11(B) was **removed**
- Low-voltage lighting systems addressed by Article 411 are now basically limited by the maximum rating of **25 amperes for the output circuits** of the power supply under all load conditions

422.2 Definition: Vending Machine

- Previous definition of “**Vending Machine**” has been **deleted**
- What constituted a vending machine?
- Vending machine are still required to be **GFCI** protected, but the requirement has been **re-located to 422.5(A)(5)**
- All appliances operating at 50 volts or more are now required be listed *(see new 422.6)*
- In determining what constitutes a vending machine, the user of the *Code* needs to rely on the **listing and the product standards** for vending machines
- Revision to require all appliances to be listed eliminates the need for a definition of vending machine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WESTERN FAMILY
Cola
Root Beer
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Coca-Cola
pepsi


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REAL ITALIAN PIZZA
HOT & CRISP, STRAIGHT OUT OF THE OVEN
Ready, sliced and served in a box in less than 3 minutes.
CHOOSE FROM TWO AUTHENTIC, ARTISAN 11" PIZZAS
MARGHERITA
HOT SALAMI
READY IN LESS THAN 3 MINUTES
REAL ITALIAN PIZZA
HOT AND CRISP, STRAIGHT OUT OF THE OVEN

CARVANA
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422.5 GFCI Protection for Appliances

- Ground-Fault Circuit-Interrupter **(GFCI) requirements** throughout Article 422 related to personnel hazards from specific equipment moved to a **single location** in Article 422
- New 422.5(B) was also added allowing **five options** for the **location and type of GFCI protective device** provided in order to deliver GFCI protection to specific appliances listed at 422.5(A)
- Collecting these specific GFCI requirements into one central location will increase clarity and usability
- Based on the voltage limitation of the product standard for GFCIs (UL 943), the "**250 volts or less**" value was initiated at 422.5
- Multiple GFCI protective devices permitted but not be required

422.5 GFCI Protection for Appliances *(cont.)*

- 422.5(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 ~~fountains~~ water coolers
    - (3) High-pressure spray washing machines — cord-and-plug-connected
    - (4) Tire inflation machines provided for public use
    - (5) Vending machines

422.5 GFCI Protection for Appliances *(cont.)*

- 422.5(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

422.5 GFCI Protection for Appliances

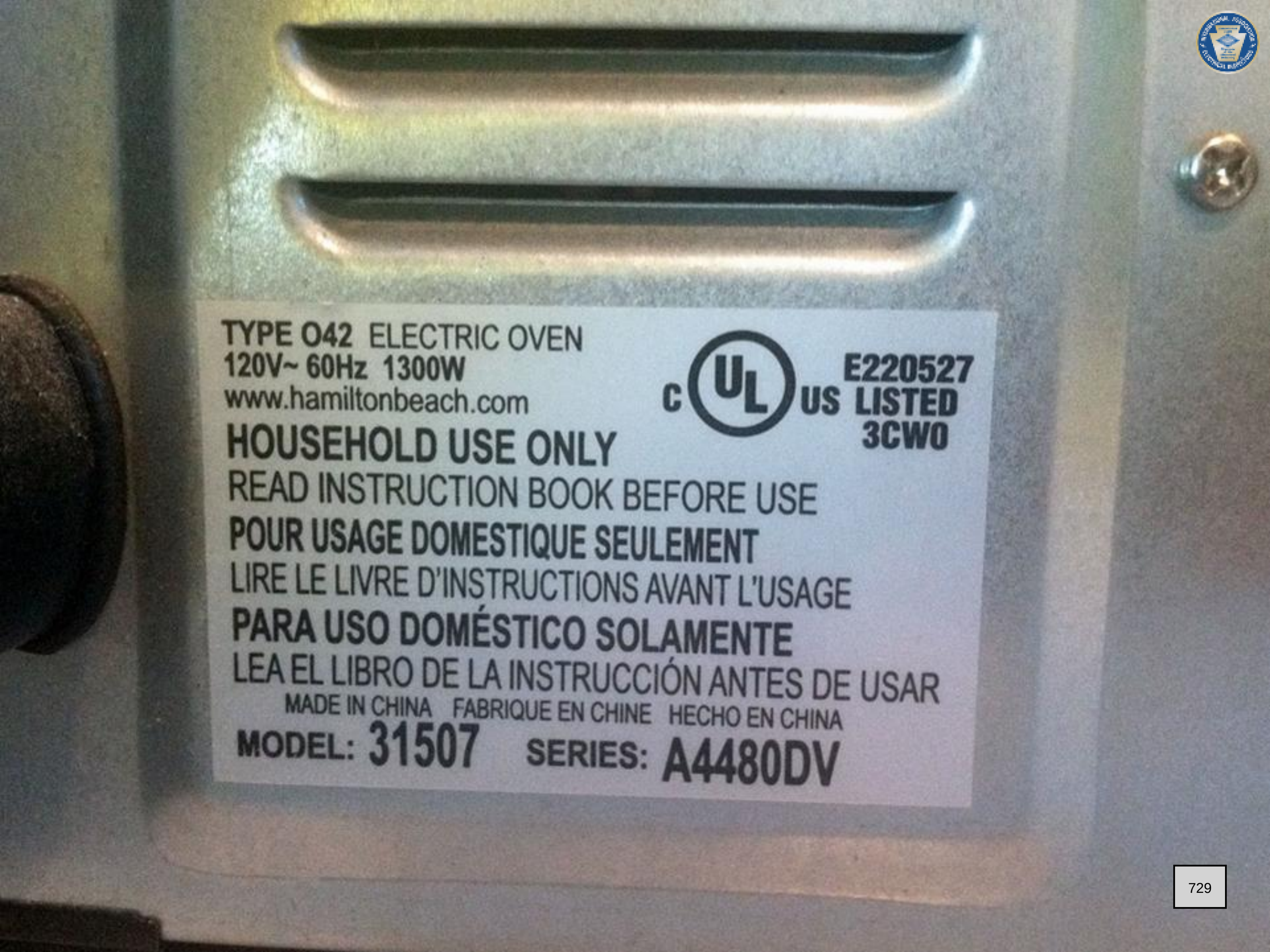
GFCI requirements for Appliances *(250 volts or less and 60 amperes or less, single- or 3-phase)* have been moved to one location in Article 422

(Multiple GFCI devices permitted but not be required)

(1) Automotive vacuum machines; (2) Drinking water coolers; (3) High-pressure spray washing machines *(cord-and-plug-connected)*; (4) Tire inflation machines (5) Vending machines

422.6 Listing Required *(Appliances)*

- New section has been added to Article 422 requiring all appliances operating at **50 volts or more** must be **listed**
- All appliances should be listed to help determine the proper classification of the equipment and to ensure application of proper product standard installation requirements
- Listing requirement for appliances helps ensure equipment is installed and used in accordance with any instructions included in the listing or labeling of that particular piece of equipment *[see 110.3(B)]*
- Relying *NEC* definitions and industry terms or product marketing information can and often does result in misinterpretation and misapplication of requirements for appliances



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LIRE LE LIVRE D'INSTRUCTIONS AVANT L'USAGE
PARA USO DOMÉSTICO SOLAMENTE
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MADE IN CHINA FABRIQUE EN CHINE HECHO EN CHINA
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422.14
Infrared Lamp Industrial Heating Appliances

- Rules for industrial infrared lamp heating appliances has been **deleted** from Article 422 and **relocated** in new Article 425 "**Fixed Resistance and Electrode Industrial Process Heating Equipment**" *(see new 425.14)*
- Creation of new Article 425 called for gathering of existing *NEC* requirements covering industrial heating equipment and relocating that information to its new home in Article 425
- Relocation brings requirements for commercial and industrial fixed resistance and process heating equipment into its own article while improving clarity and usability of the *NEC*
- Heating lamps are part of a larger group of commercial/industrial heating equipment that deserves its own article

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SUN-MITE INFRARED HEATER

MODEL: 223–90–THSS–****

LISTED

ELECTRICAL RATINGS:

****	
208V	4800W – 1 or 3PH – 50/60Hz
240V	4800W – 1 or 3PH – 50/60Hz
277V	4800W – 1 or 3PH – 50/60Hz
480V	4800W – 1 or 3PH – 50/60Hz

****
REFER TO ELECTRICAL RATINGS CHART FOR THE LAST FOUR DIGITS OF MODEL NUMBER

CAUTION: FOR SUPPLY CONNECTIONS USE NO. 14 AWG WIRES SUITABLE FOR AT LEAST 90C. DO NOT INSTALL THIS HEATER WITHOUT CONSULTING OPERATING INSTRUCTIONS. DO NOT INSTALL CLOSER THAN 24 INCHES TO A VERTICAL SURFACE OR 3 INCHES TO CEILING AND 72 INCHES FROM ANY COMBUSTIBLE SURFACE IN DIRECT RADIATION PATH. FOR OTHER MOUNTING VARIATIONS CONSULT OPERATING INSTRUCTIONS. DISCONNECT ALL SUPPLIES BEFORE WORKING ON ANY CIRCUIT.

ATTENTION: POUR LES RACCORDS D' ALIMENTATION, UTILISER DES FILS DE CALIBRE 14 AWG QUI CONVIENNENT À DES TEMPÉRATURES D' AU MOINS 90C. NE PAS INSTALLER CE DISPOSITIF DE CHAUFFAGE SANS CONSULTER LES INSTRUCTIONS RELATIVES À SON FONCTIONNEMENT. NE PAS INSTALLER À MOINS DE 61 cm D' UNE SURFACE VERTICALE OU DE 7.6 cm DU PLAFOND ET DE 182 cm DE TOUTE SURFACE COMBUSTIBLE EN VOIE DE RAYONNEMENT DE FUITE. CONSULTER LES INSTRUCTIONS DE FONCTIONNEMENT POUR D' AUTRES VARIATIONS D' INSTALLATION. DÉCONNECTER TOUTES LES ALIMENTATIONS AVANT D'EFFECTUER TOUT TRAVAIL SUR N' IMPORTE QUEL CIRCUIT.

CONSULT USER'S MANUAL FOR ALLOWABLE INSTALLATIONS.

NOT FOR INDOOR RESIDENTIAL USE

LBL 2403804 – 5

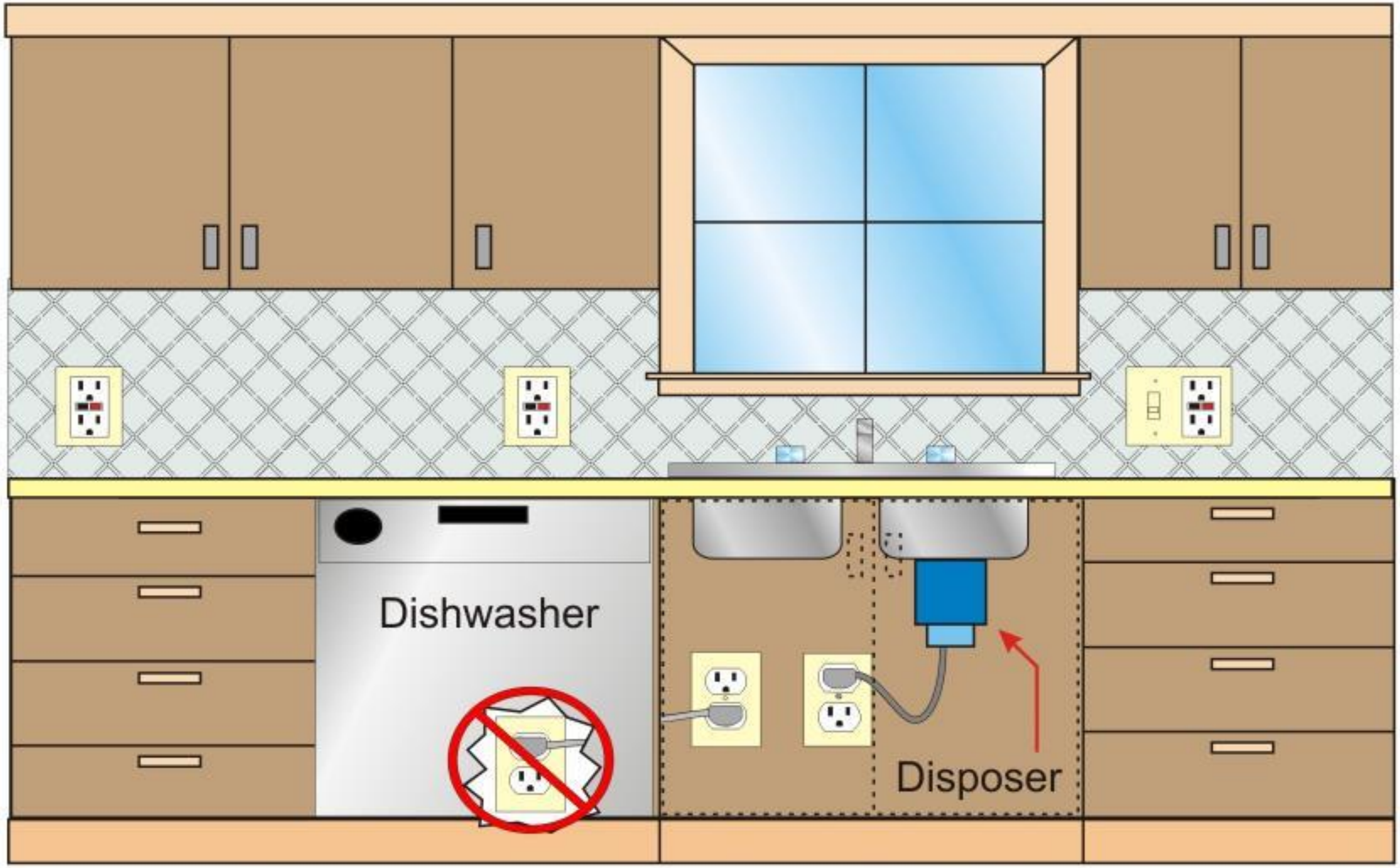
DATE OF MANUFACTURE 04/2008

W.O. W44347

422.16(B)(2) Built-In Dishwashers

- Cord-and-plug-connected built-in dishwashers are now only allowed to have the receptacle outlet located in the **space adjacent to the space occupied by the dishwasher**
- The maximum length of a cord for a built-in dishwasher was extended from the previous maximum length of 1.2 m (4 ft) to **2.0 m (6.5 ft)** measured from the face of the attachment plug to the plane of the rear of the appliance
- Other requirements for dishwashers and trash compactors remain the same as the 2014 *NEC*
- Change occurred to align 422.16(B)(2) with the product standard for household dishwashers, **UL 749**

422.16(B)(2) Built-In Dishwashers



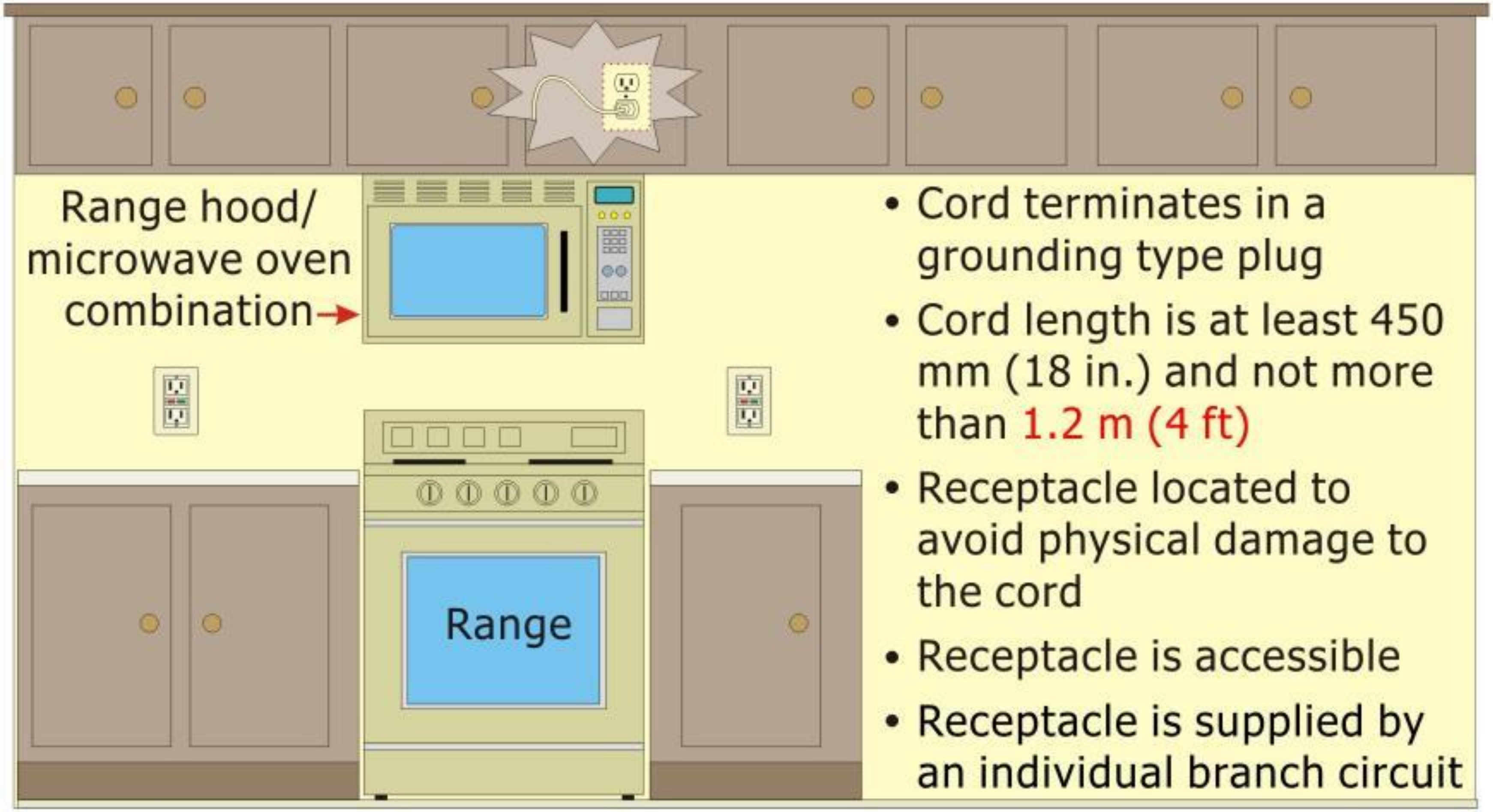
Receptacle outlet for cord-and-plug connected built-in dishwasher required to be located in the space adjacent to the space containing the dishwasher only with the length of a cord for a built-in dishwasher lengthened from 1.2 m (4 ft) to 2.0 m (6½ ft)

422.16(B)(4) Range Hoods

- The maximum length of a flexible cord for a cord-and-plug-connected range hood has been increased from 900 mm (36 in.) to **1.2 m (4 ft)**
- With some of the designs of the newer range hoods, the previous maximum length of 900 mm (36 in.) was simply **not sufficient**
- Putting undue stress and strain on the cord in order to reach the mating receptacle outlet
- The height *(top to bottom)* of some of the newer **chimney-type range hoods** is a concern for cord length as well

422.16(B)(4) Range Hoods

Range hoods permitted to be cord-and-plug connected where identified on installation instructions by manufacturer and meets the following:



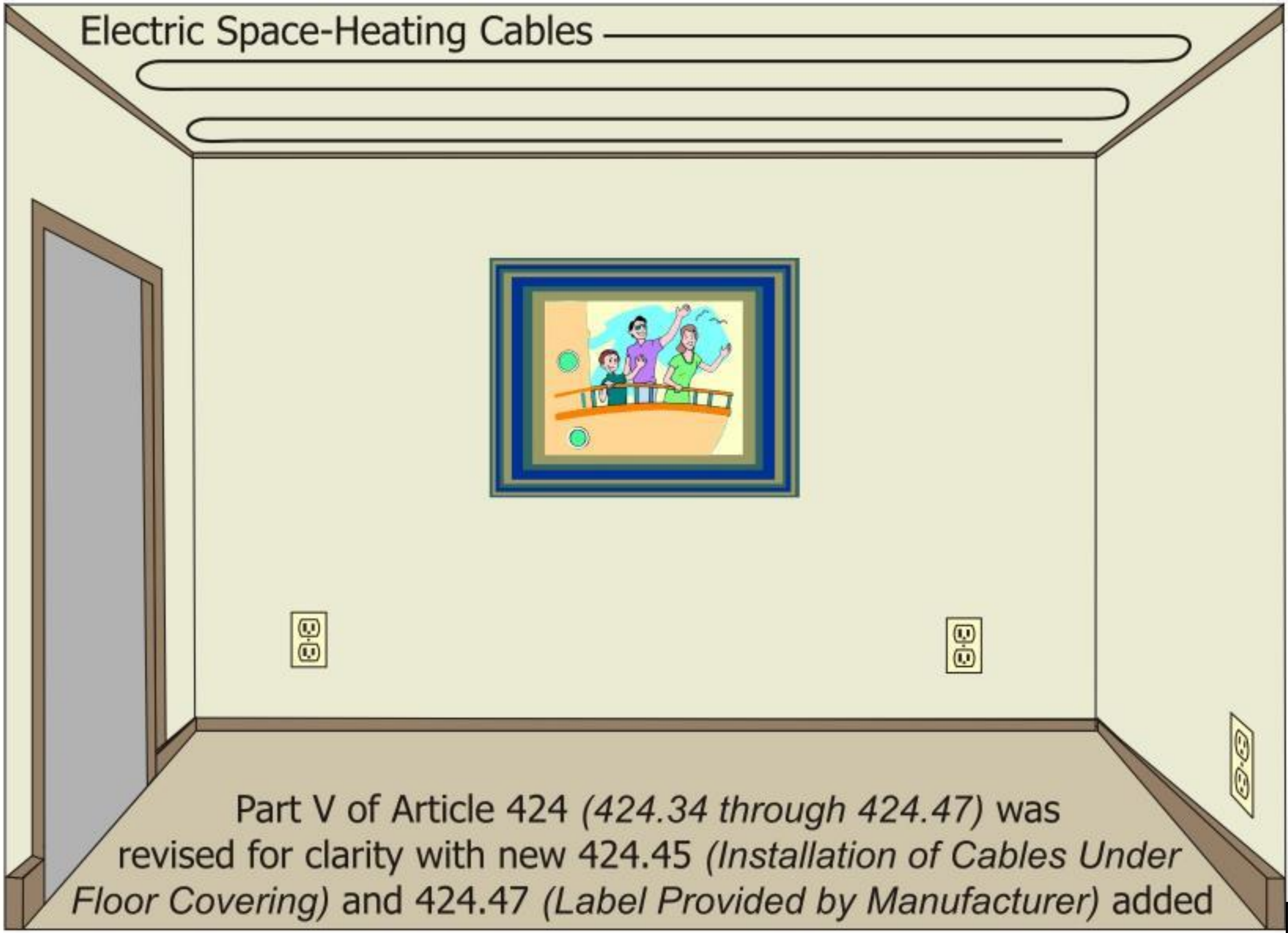
- Cord terminates in a grounding type plug
- Cord length is at least 450 mm (18 in.) and not more than 1.2 m (4 ft)
- Receptacle located to avoid physical damage to the cord
- Receptacle is accessible
- Receptacle is supplied by an individual branch circuit

Length of cord for cord-and-plug connected range hoods increased from 900 mm (36 in.) to 1.2 m (4 ft)

Article 424 Part V:
Electric Space-Heating Cables

- Part V of Article 424 was **revised** for simpler interpretation and application
- Two new sections were added to Part V of Article 424 ***(424.45 and 424.47)*** address proper installations of cables under floor coverings and labels provided by the manufacturer
- Previous edition of the *Code* did not properly address these added items in Part V of Article 424
- The previous requirements for **color coding of heating cable** leads was deleted as it was inconsistent with other heating products covered by Article 424

Article 424 Part V: Electric Space-Heating Cables



Part V of Article 424 *(424.34 through 424.47)* was revised for clarity with new 424.45 *(Installation of Cables Under Floor Covering)* and 424.47 *(Label Provided by Manufacturer)* added

424.45

Heating Cables Under Floor Coverings

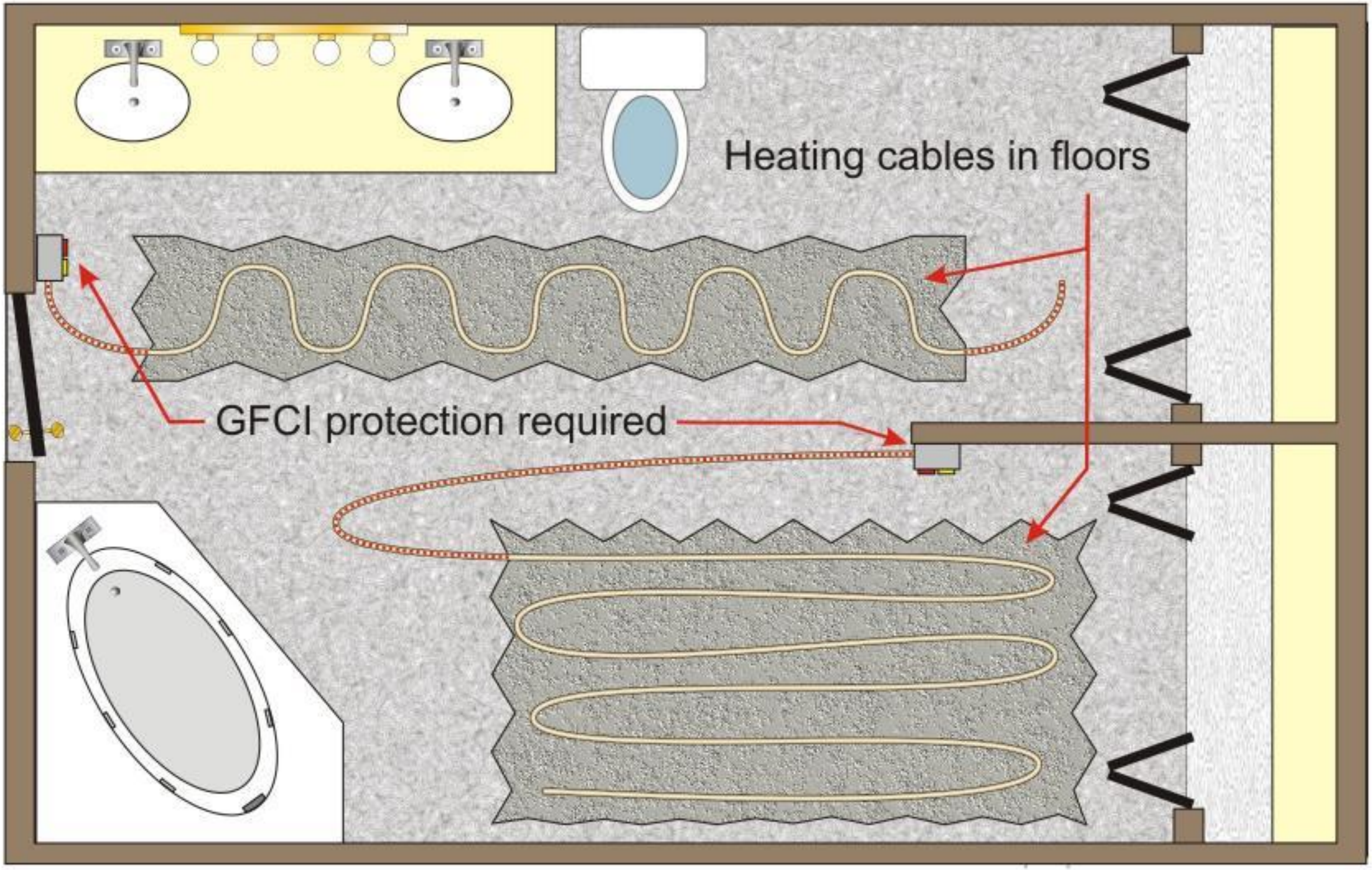
- New requirements added for the installation of **heating cables installed under floor coverings**

- Not new to the electrical industry, but installation requirements for these under flooring heating cables are **new for Article 424**

- Heating cables and heating panels have become very similar in terms of installation and use

- Previously the *Code* did not specifically mention under floor coverings for heating cables, which left some users of the *Code* unclear if heating cables installed under floor covering was permitted or not permitted

424.45 Heating Cables Under Floor Coverings



New requirements added in Part V of Article 424 giving specific instruction for the installation of heating cables installed under floor coverings

Ceramitech

424.47

Electric Space-Heating Cable Label

- New provisions added for manufacturers of electric space-heating cables to provide **marking labels** to be affixed to panelboards identify which branch circuits supply the circuits to those space-heating installations

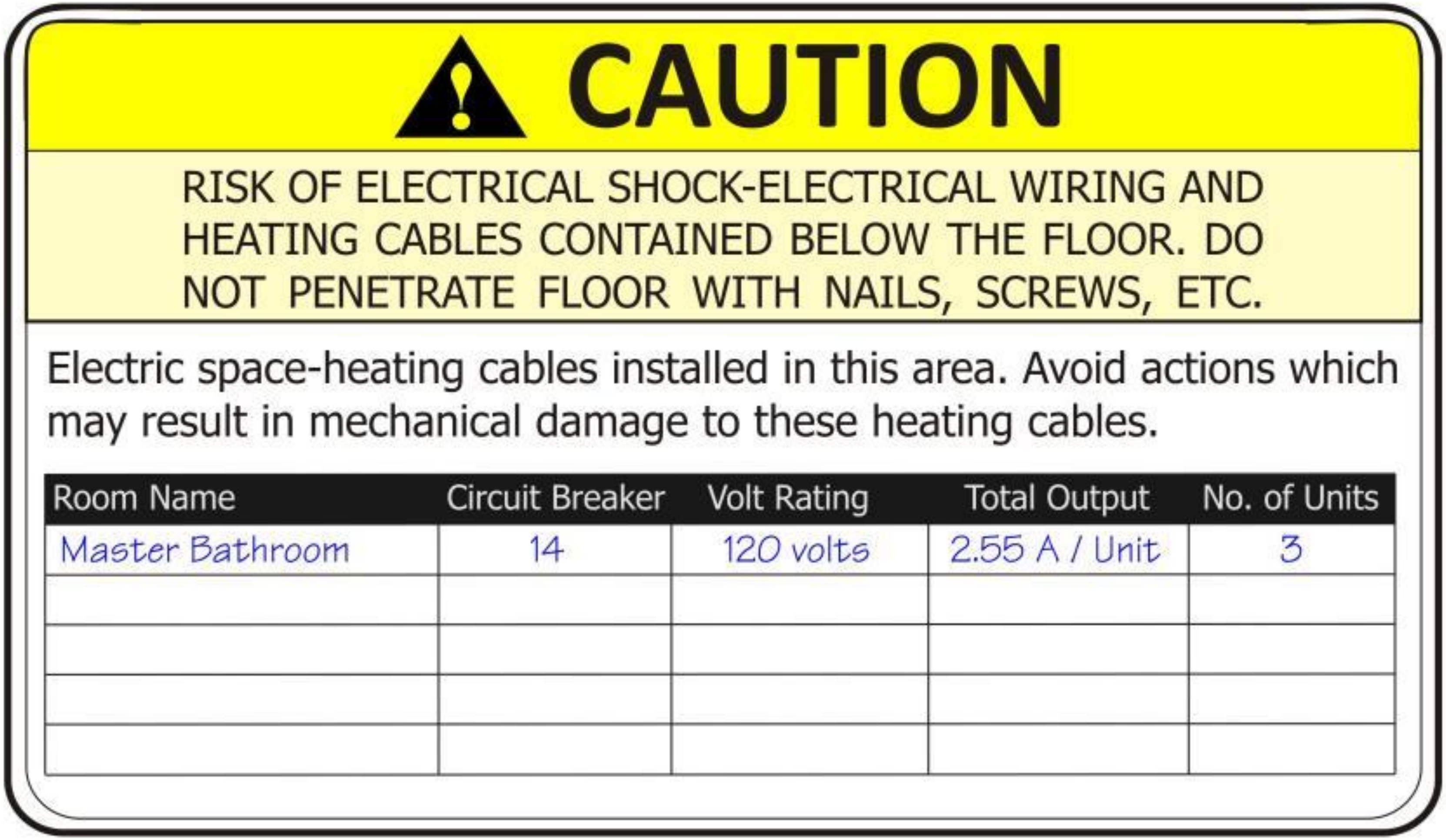
- Labels must also give the installer instructions to apply these labels to the supply panelboard

- Labeling **not required** if the electric space-heating cable installations are “**visible and distinguishable after installation**”

- Label to be applied to panelboard and filled out by installer

424.47 Label Provided by Manufacturer

Manufacturers of electric space-heating cables to provide marking labels that indicate electric space-heating cables present and instructions that the labels be affixed to panelboards identifying branch circuits supply heating cables



CAUTION

RISK OF ELECTRICAL SHOCK-ELECTRICAL WIRING AND HEATING CABLES CONTAINED BELOW THE FLOOR. DO NOT PENETRATE FLOOR WITH NAILS, SCREWS, ETC.

Electric space-heating cables installed in this area. Avoid actions which may result in mechanical damage to these heating cables.

Room Name	Circuit Breaker	Volt Rating	Total Output	No. of Units
Master Bathroom	14	120 volts	2.55 A / Unit	3

If the electric space-heating cable installations are visible and distinguishable after installation, labels not required to be provided and affixed to panelboards

Article 424 Part X Low-Voltage Fixed Electric Space-Heating Equipment

- A new **Part X** was added to Article 424 for **low-voltage fixed electric space-heating equipment**
- Previous editions of the *NEC* did not exclude these low voltage heating products, but did not address provisions for low voltage heating cables or heating panel products
- Without these new requirements, a “low-voltage” piece of equipment would have to meet all the same requirements as 120 volt or 240 volt rated equipment
- New requirements in Part X of Article 424 are very similar to provisions already in place in the *NEC* in Article 411 for low-voltage lighting systems

Article 424 Part X Low-Voltage Fixed Electric Space-Heating Equipment *(cont.)*

- For low-voltage fixed electric space-heating equipment addressed in Part X of Article 424, the rated output is limited to **25 amperes**, **30 volts (42.4 volts peak) ac**, or **60 volts dc** under all load conditions
- The **30-volt ac** and **60-volt dc** levels correlate with accepted levels considered by many to be a threshold of reduction in risk of electric shock
- Also aligns with the voltage levels for Class 2 ac and Class 2 dc voltage levels in **Chapter 9, Tables 11(A) and 11(B)**
- **25 ampere maximum output** current added to limit secondary current levels to levels associated with most low-voltage fixed electric space-heating equipment

Article 425 Fixed Resistance and Electrode Industrial Process Heating Equipment

- New Article 425 **Fixed Resistance and Electrode Industrial Process Heating Equipment** incorporated into the 2017 *NEC*
- In previous editions, the *NEC* did not adequately address requirements for industrial process heating equipment
- Previous 422.14 *(appliances with infrared heat lamps)* was relocated to new Article 425 *(see 425.14)*
- New article will provide clear requirements for installation and enforcement for such as working space, listing requirements, marking of equipment, overcurrent protection, protection from physical damage, installation in damp or wet locations, and spacing from combustible materials

Article 425 Fixed Resistance and Electrode Industrial Process Heating Equipment *(cont.)*

- New Article 425 "**Fixed Resistance and Electrode Industrial Process Heating Equipment**" will apply to such things as:
  - Boilers
  - Electrode boilers
  - Duct heaters
  - Strip heaters
  - Immersion heaters
  - Process air heaters
  - Other approved fixed electric equipment used for industrial process heating

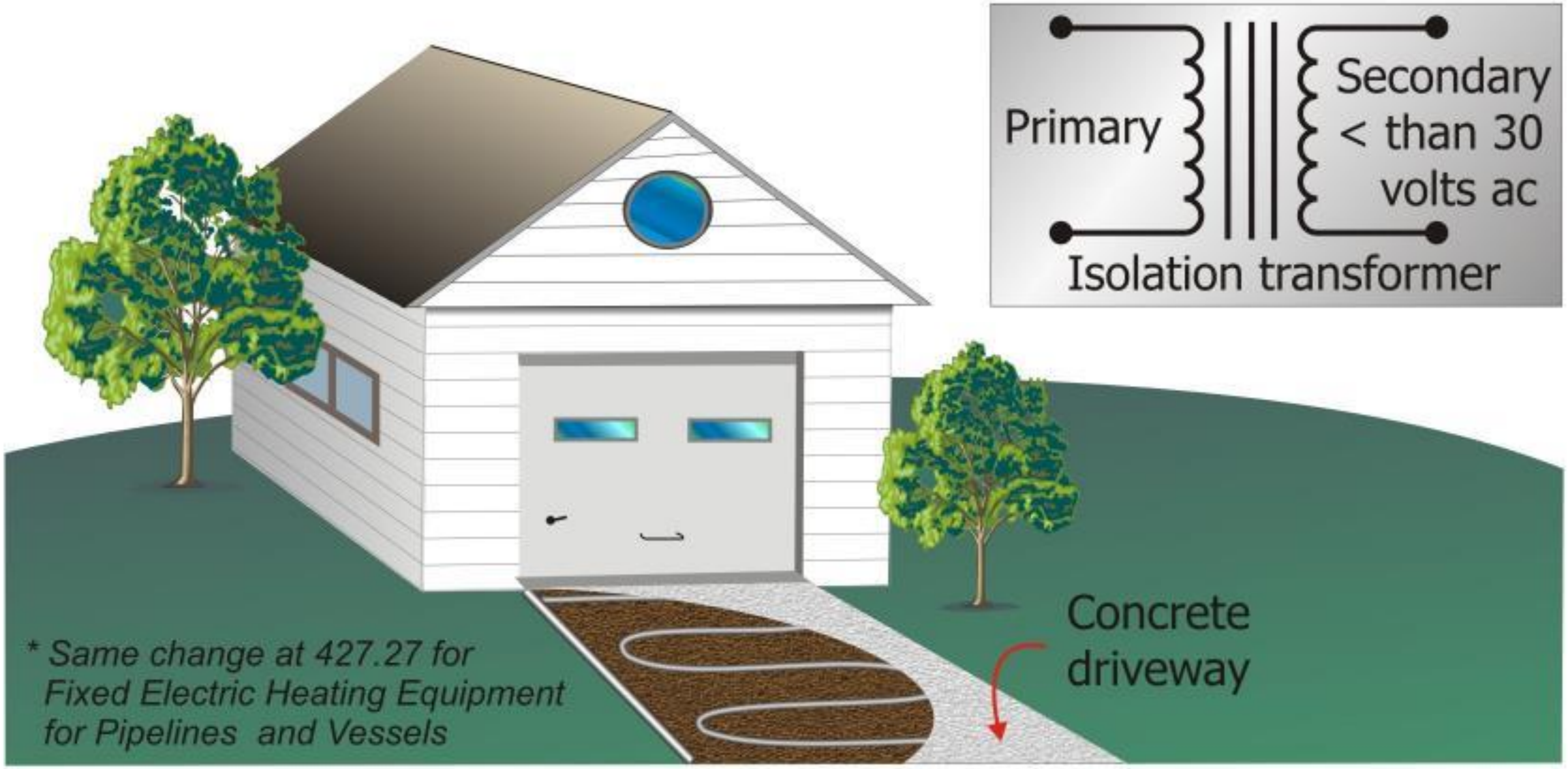
426.32 Impedance Heating Voltage Limitations

Fixed Outdoor Electric Deicing and Snow-Melting Equipment

- Allowance for voltage output greater than **30 volts ac** if an **impedance heating system** for fixed outdoor electric deicing and snow-melting equipment is provided with **Class A GFCI** protection has been **deleted**
- Secondary winding of an isolation transformer connected to an impedance heating elements cannot have an output voltage greater than 30 volts ac
- Higher operating current levels of electrical Impedance heating systems not compatible with Class A type GFCI protective device
- An impedance heating system cannot be designed to have a leakage under 5 mA *(making Class A GFCI protection obsolete)*
- Same revision occurred at **427.27** for impedance heating system for fixed electric heating equipment for pipelines and vessels

426.32 Impedance Heating Voltage Limitation
Fixed Outdoor Electric Deicing and Snow Melting Equipment

Secondary winding of an isolation transformer connected to the impedance heating elements shall not have an output voltage greater than 30 volts ac



** Same change at 427.27 for Fixed Electric Heating Equipment for Pipelines and Vessels*

The allowance for voltage output greater than 30 volts ac if an impedance heating system for fixed outdoor electric deicing and snow-melting equipment is provided with Class A GFCI protection has been deleted

430.2 Definition: Part-Winding Motors

- The definition of a **part-winding motor** was moved from 430.4 to its proper location at 430.2

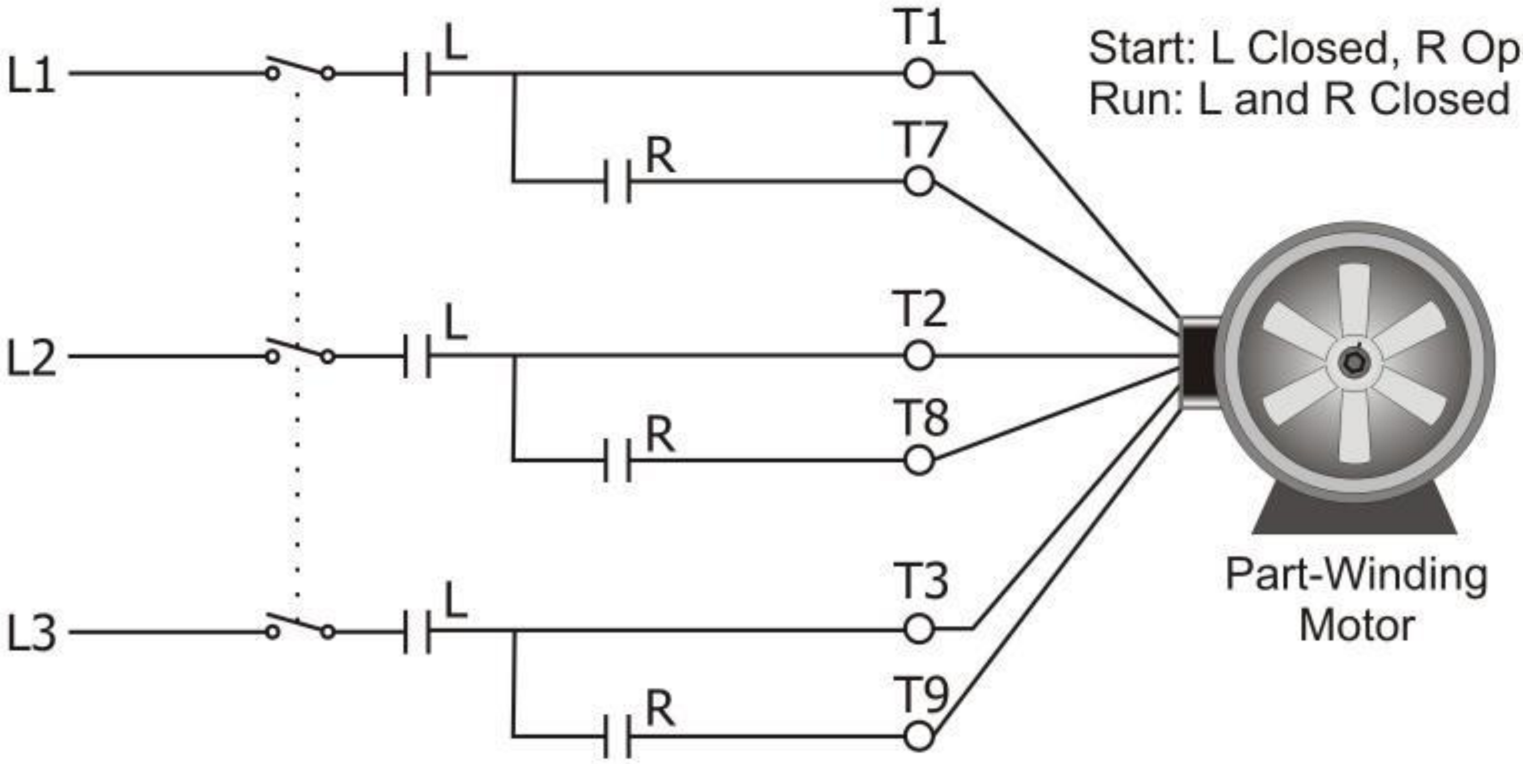
- The first paragraph of previous 430.4 seemed to be the very definition of a part-winding motor

- A part-winding or soft start motor is any system that is used to reduce inrush current, as well as strain on electrical circuits that supply power to motors

- Inrush current is the initial surge of current into the windings when the motor is started

430.2 Definitions: Part-Winding Motors

Part-Winding Motors. A part-winding start induction or synchronous motor is one that is arranged for starting by first energizing part of its primary (armature) winding and, subsequently, energizing the remainder of this winding in one or more steps. A standard part-winding start induction motor is arranged so that one-half of its primary winding can be energized initially, and, subsequently, the remaining half can be energized, both halves then carrying equal current. A hermetic refrigerant compressor motor shall not be considered a standard part-winding start induction motor.



Start: L Closed, R Open
Run: L and R Closed

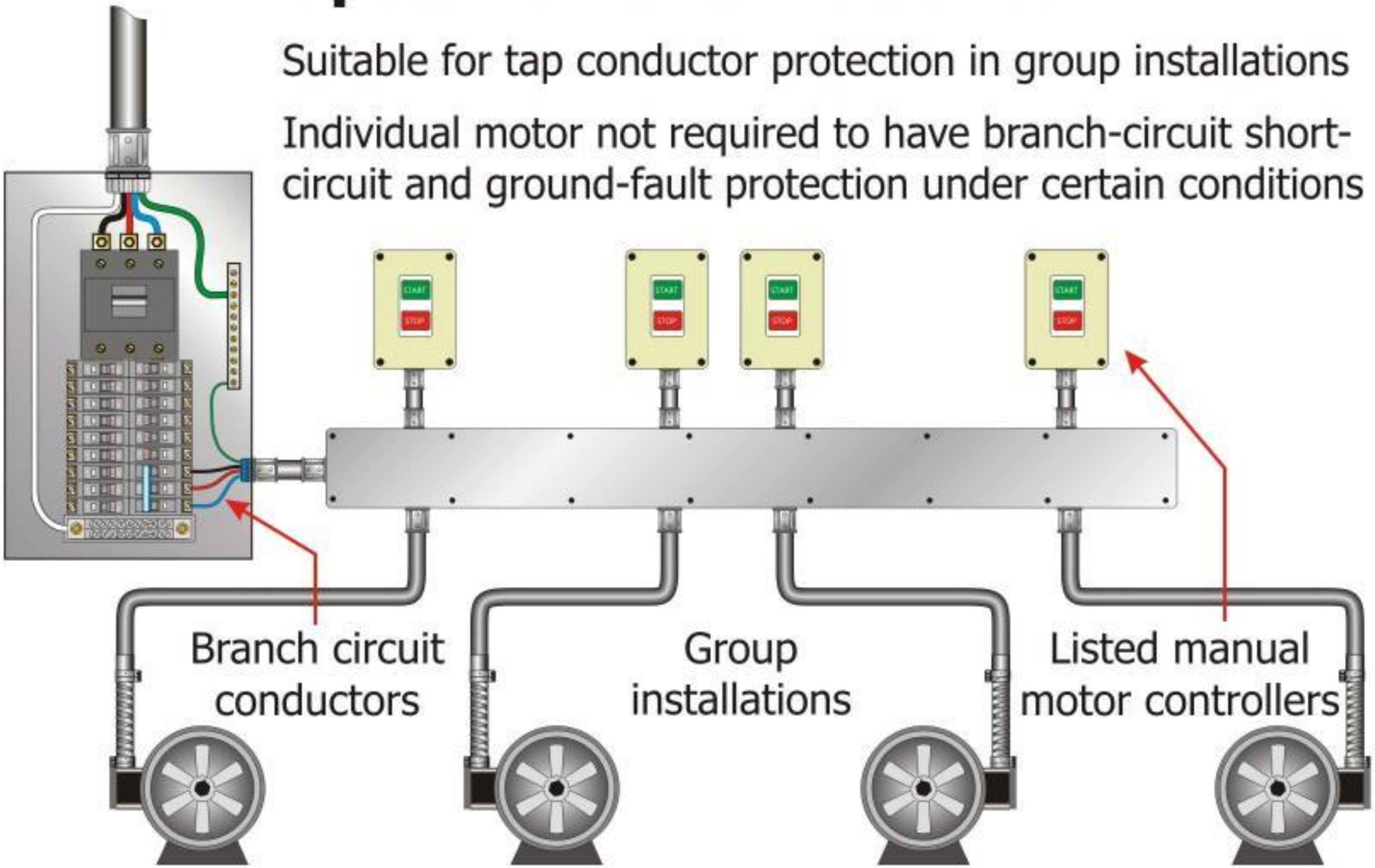
430.53(D)(4)
Single Motor Taps on One Branch Circuit

- New tap rule for single motor allows **7.5 m (25 ft) taps** with the same conditions as is allowed in other areas of the *NEC*
- The ampacity cannot be less than **one-third** that of the branch-circuit conductors
- Previous provisions allowed these taps to have an ampacity not less than one-tenth the rating or setting of the branch-circuit short-circuit and ground-fault protective device with the maximum length of 3 m (10 ft)
- 7.5 m (25 ft) tap allowance for single motor taps is a natural progression for the *NEC*

430.53(D)(4) Single Motor Taps on One Branch Circuit

Suitable for tap conductor protection in group installations

Individual motor not required to have branch-circuit short-circuit and ground-fault protection under certain conditions



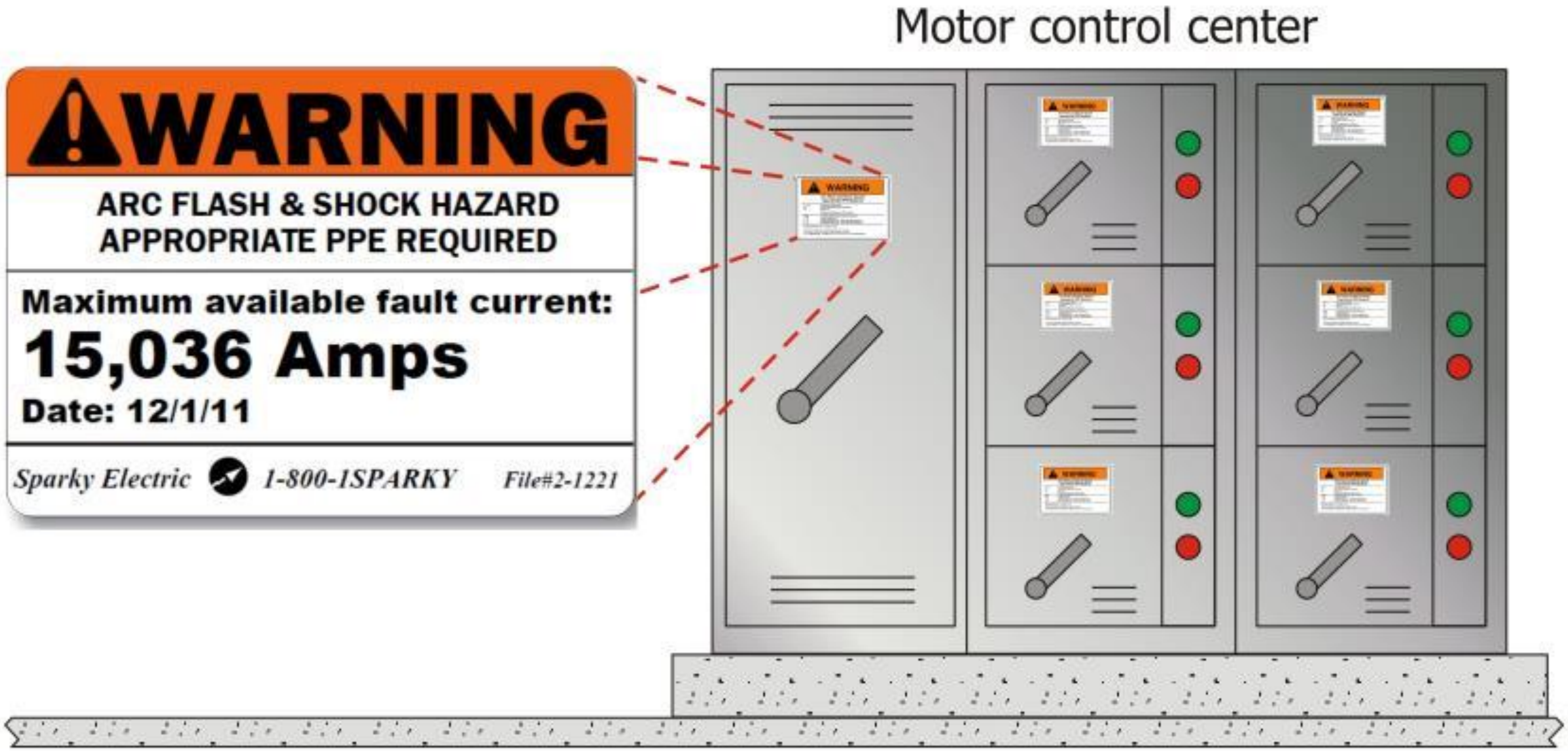
New 430.53(D)(4) increases the maximum length of the conductors of any tap supplying a single motor to 7.5 m (25 ft) when the ampacity is not less than one-third that of the branch-circuit conductors

430.99 Available Fault Current for Motor Control Centers

- New requirements added for **available short circuit current** at motor control center and the **date** the short circuit current calculation was performed
- **Documentation** also required to be made available to those authorized to inspect the installation of the motor control center
- Documentation shall include:
  - Available short circuit current *(fault current)* at the motor control center
  - Date the short circuit current calculation was performed
- This documentation can reduce liability *(for contractors, inspectors, and manufacturers)* by identifying equipment was originally installed with the correct short-circuit current rating

430.99 Available Fault Current for Motor Control Centers

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



WARNING

ARC FLASH & SHOCK HAZARD
APPROPRIATE PPE REQUIRED

Maximum available fault current:
15,036 Amps
Date: 12/1/11

Sparky Electric *1-800-1SPARKY* *File#2-1221*

New requirements added for available short circuit current at motor control centers and the date the short circuit current calculation was performed

Available Fault Current for Equipment

The available short circuit current required at equipment listed below and the date the short circuit current calculation was performed shall be documented and made available to those authorized to inspect the installation

NEC Section	Equipment	FR	SR	PI	PC
409.22(B)	Industrial Control Panels	FR 3002	SR 3003, SCR 1	PI 4421, PI 4733	PC 1800, PC 409
430.99	Motor Control Centers	FR 3016		PI 4437, PI 4712	
440.10	AC Equipment	FR 3006	SR 3005	PI 4432, PI 4438, PI 4697, PI 4729	PC 1808
620.51(D)(2)	Elevator Control Panels	FR 3393	SR 3334		
670.5	Industrial Machinery	FR 3336	SR 3336	PI 4709, PI 4427	PC 1301

Same available short circuit current documentation and the date the short circuit current calculation was performed was added at the above locations

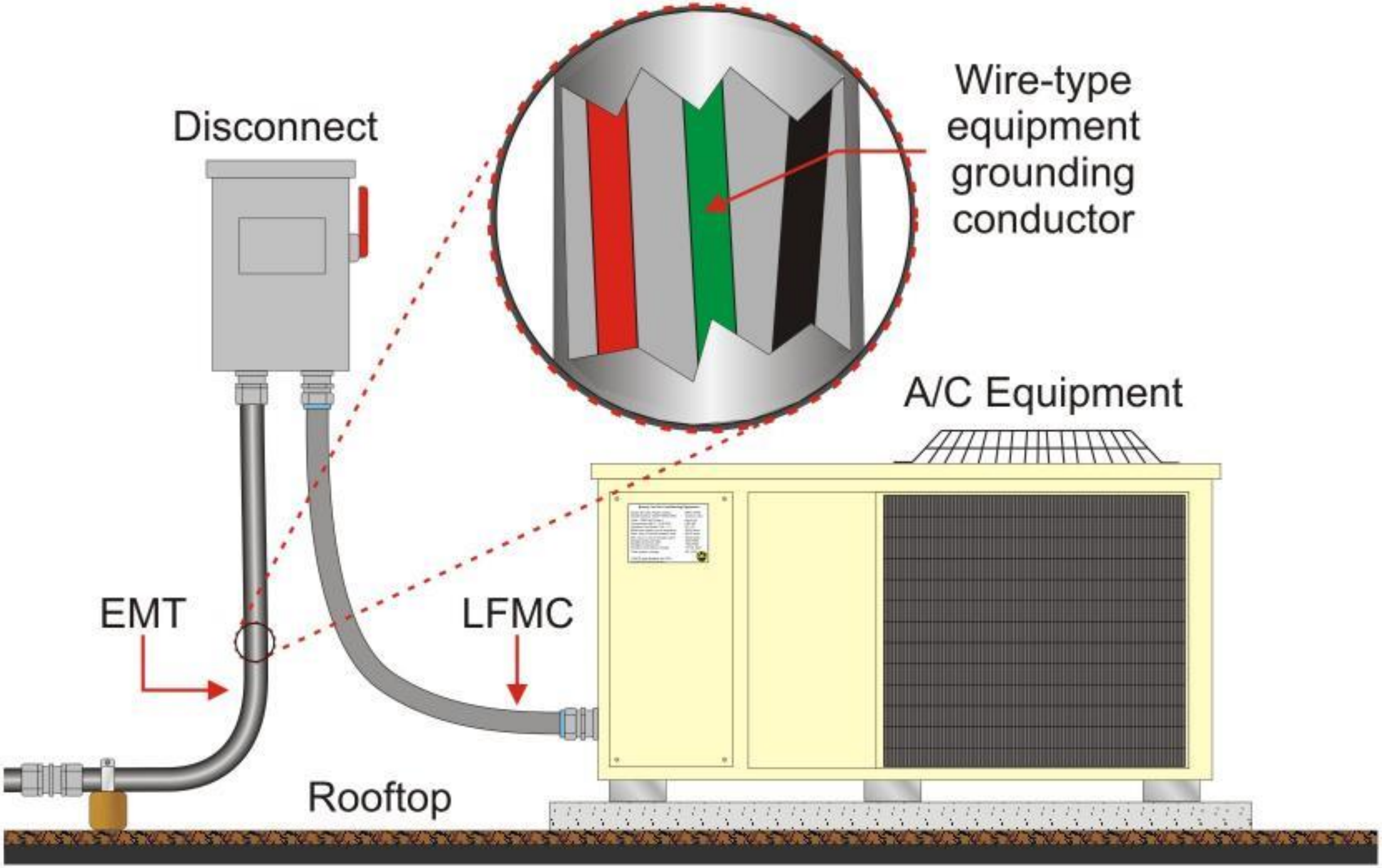
440.9 Grounding and Bonding of Rooftop A/C Equipment

- The outdoor portions of metallic raceway systems that use **non-threaded fittings** are now required to contain a **wire-type equipment grounding conductor** *(EGC)*
- Applies when installed outdoors on a roof to supply multimotor and combination-load equipment
- When installed on a rooftop to supply such things as rooftop HVAC equipment, some metallic raceway systems installations become compromised from activities such as snow removal or roof repair/replacement

440.9 Grounding and Bonding of Rooftop A/C Equipment *(cont.)*

- Concerns have been raised regarding metallic raceway systems and their ability to maintain their continuity as their own equipment grounding conductor *(EGC)*
- Metallic raceway systems on rooftops being subject to movement and damage that can result in separation of their non-threaded conduit or tubing fittings

440.9 Grounding and Bonding-Rooftop Equipment



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


1
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1

440.65

Protection Devices for Room A/C Units

- **Heat detecting circuit interrupter (HDCI)** was added to a list of devices for protection of single-phase room air conditioners
- HDCI technology is intended for use in dehumidifiers, room air conditioners and other refrigeration equipment
- Incorporates the functionality of a leakage current detector interrupter (LCDI), and is intended to interrupt power to the protected device when an overheating condition occurs
- HDCI devices have a maximum rating of 40 amperes and are intended for use on circuits rated 250 volts (ac) maximum

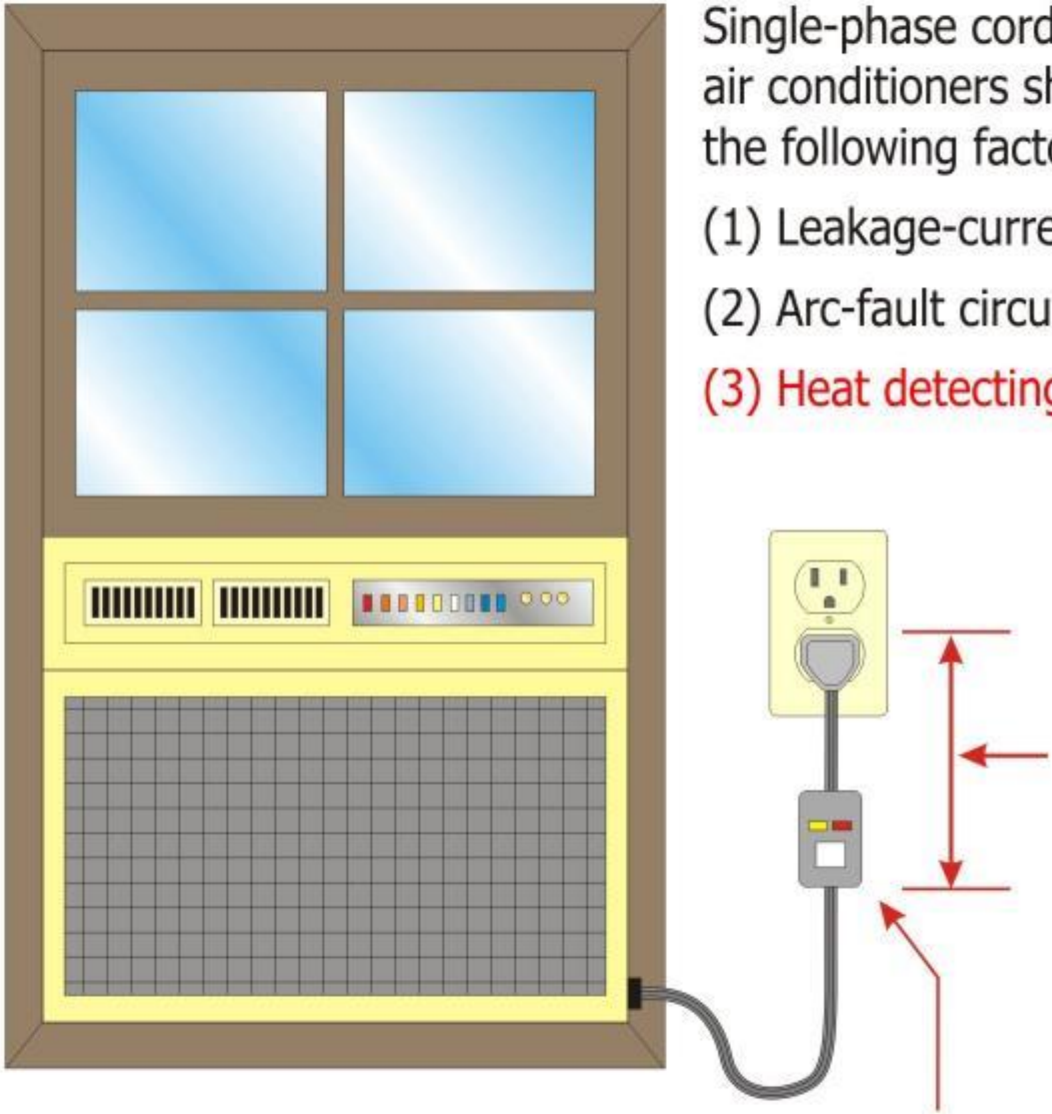
440.65 Protection Devices for Room AC Units

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)



LCDI, AFCI, or HDCI to be located within 300 mm (12 in.) of attachment plug

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

445.11 Nameplate Marking for Generators

- Nameplate marking requirements for generators have been **revised** and put into a **list format**
- **“Impedance” was replaced with “reactance”** as “impedance” was in conflict with the nationally recognized standard *(IEEE 115)* used to obtain subtransient, transient, synchronous, and zero sequence values for an alternator *(generator)*
- Inverter-based generators rated more than 15 kW are now also required to be marked with the **maximum short-circuit current** to verify proper overcurrent protection
- Manufacture’s marking provision required to indicate if the generator neutral is **bonded to the generator frame**
- Revised information will assist the AHJ in determining compliance with **445.13** *(ampacity of conductors for generators)*

UNBALANCED LOAD CAPABILITY-25%

GENERATOR SET DATA

MADE IN USA

MODEL 0051910

SERIAL 4307416

TYPE CODE SG030-A163.0V18HBYYC

ENGINE NO. 0E8336

RATED KW 30

RATED KVA 30

UPSIZE ALT.KW 40

VOLTS 120/240

AMPS 125

PHASE 1

POWER FACTOR 1.0

HERTZ 60

ALT. R.P.M. 1800

ENG. R.P.M. 1800

PROD. DATE 11/10/05

GENERAC POWER SYSTEMS, INC.
WAUKESHA, WI

CLASS H ROTOR H STATOR WINDING INSULATION AT 40°C AMBIENT

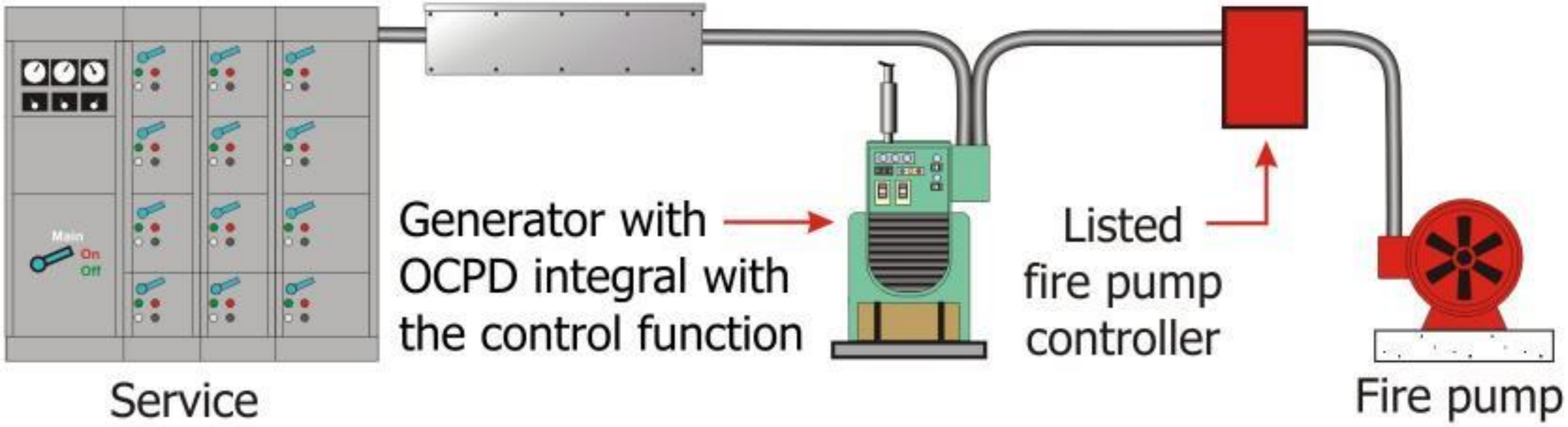
445.13(B) Generator OCPD Provided

- New requirement added to clarify **feeder taps** can be used if generator is equipped with an overcurrent relay or other overcurrent protective device
- Feeder tap rules of **240.21(B)** can be used
- New revision can be applied unless the tapped conductors are for portable generators rated 15 kW or less where field wiring connection terminals are not accessible
- This change should reduce confusion among some users of the *Code* about the conditions under which tap conductors for generators are acceptable

445.13(B) Generator OCPD Provided

Ampacity of conductors between a generator and the first overcurrent protection device cannot be less than 115% of the nameplate current rating on the generator nameplate

An exception permits these conductors to have an ampacity of not less than 100% of the generators nameplate current rating if the generator is designed to operate to prevent overloading *[see 445.13(A) and exception]*



Feeder tap rules of 240.21(B) can be used if the generator or generator set is equipped with an overcurrent relay or other overcurrent device

Tapped conductors are not allowed for portable generators rated 15 kW or less where field wiring connection terminals are not accessible

445.18 Generator Disconnecting Means and Shutdown of Prime Mover

- Generator disconnecting means requirements have been reorganized with added provisions for:
    - Disconnecting means
    - Shut down of the prime mover
    - Generators installed in parallel
- Generator is typically the combination of an electrical generator and an engine *(prime mover)* mounted together to form a single piece of equipment or a "gen-set"
- Lack of information and regulations for a "**prime mover**" was addressed for the 2017 *NEC* with the addition of 445.18(B) titled, "**Shutdown of Prime Mover**"

445.18 Generator Disconnecting Means and Shutdown of Prime Mover *(cont.)*

- Additional requirements were necessary to provide a remote shutdown means in the event of an emergency
- New shutdown means for the prime mover is needed to prevent the generator set from unexpectedly starting and running while the generator is shut down for such things as undergoing service
- New 445.18(C) was also added titled "**Generators Installed in Parallel**"
- Clarifies where generators are installed in parallel it is not necessary to provide a disconnecting means at each generator and at the paralleling equipment as long as the generator is capable of isolating the generator output terminals from the paralleling equipment


Cummins
Onan
GenSet
PROTOTYPE TEST
PTS
SUPPORTED
WARNING
Hazardous Voltage
Rotating Parts
HOT

445.20 GFCI Protection for Receptacles on 15-KW or Smaller Portable Generators

- **Listed cord sets** are now permitted to be used to incorporate ground-fault circuit-interrupter *(GFCI)* protection for portable generators manufactured or rebuilt prior to Jan 1, 2015
- GFCI requirements have been separated into two different categories for these generators:
  - **Unbonded** *(floating neutral)* generators and
  - **Bonded** neutral generators
- Unbonded *(floating neutral)* generators require GFCI protection at all 125-volt, 15 and 20 ampere receptacles, but only where both 125-volt and 125/250-volt receptacles exist on the generator

445.20 GFCI Protection for Receptacles on 15-KW or Smaller Portable Generators *(cont.)*

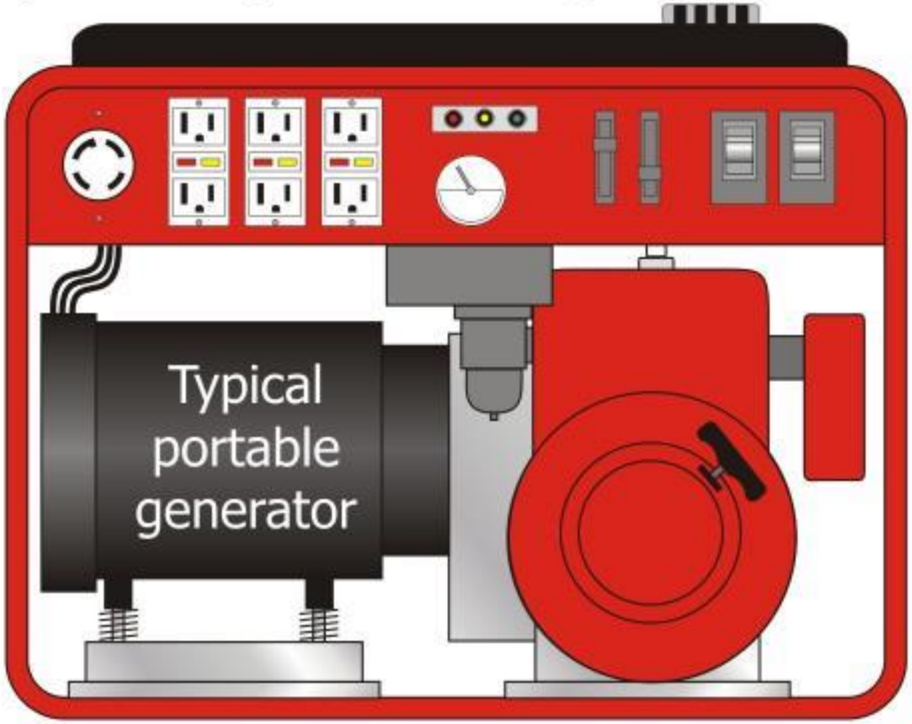
- An exception for unbonded *(floating neutral)* generators eliminates GFCI protection where the 125-volt receptacle outlets(s) is interlocked such that it is not available for use when any 125/250-volt receptacle(s) is in use
- New 445.20(B) requires all 125-volt, 15 and 20 ampere receptacles on bonded neutral generators to be provided with GFCI protection
- An exception to 445.20(A) and (B) permits GFCI protection in the form of listed cord sets or devices incorporating listed GFCI protection if the generator was manufactured or remanufactured prior to January 1, 2015

445.20 GFCI Protection for Receptacles on 15-kW or Smaller Portable Generators

Receptacle outlets that are a part of a 15-kW or smaller portable generator shall have listed GFCI for personnel integral to the generator or receptacle

445.20(A): Unbonded (floating neutral) generators with both 125-volt and 125/250-volt receptacle outlets require GFCI protection integral to the generator or receptacle on all 125-volt and 15- and 20-ampere receptacle outlets

See exception where the 125-volt receptacle outlets(s) is interlocked such that it is not available for use when any 125/250-volt receptacle(s) is in use)

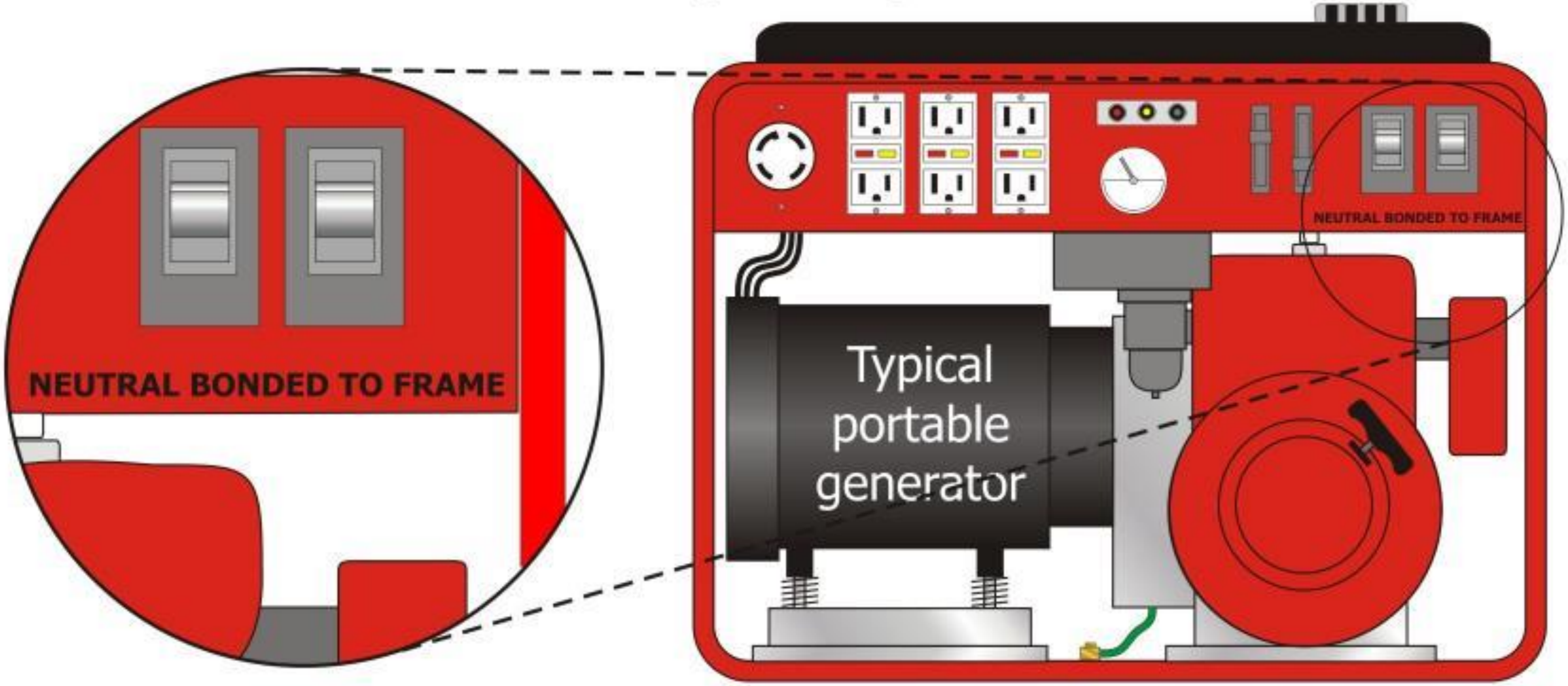


If the generator was manufactured or remanufactured prior to January 1, 2015, listed cord sets or devices incorporating listed GFCI protection for personnel identified for portable use shall be permitted

445.20 GFCI Protection for Receptacles on 15-kW or Smaller Portable Generators

Receptacle outlets that are a part of a 15-kW or smaller portable generator shall have listed GFCI for personnel integral to the generator or receptacle

445.20(B): Bonded neutral generators to be provided with GFCI protection on all 125-volt and 15- and 20-ampere receptacle outlets



If the generator was manufactured or remanufactured prior to January 1, 2015, listed cord sets or devices incorporating listed GFCI protection for personnel identified for portable use shall be permitted

Photo Courtesy of Generac

480.3 Equipment *(Storage Batteries)*

- 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


C&D
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Analysis of Changes – 2017 *NEC*

Training Presentation By:

International Association of Electrical Inspectors

File Attachments for Item:

EC-3 Ohio Automatic Sprinkler and Standpipe Systems (Fire Tech Productions)

All certifications (13 hours)

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

APPLICATION FOR CONTINUING EDUCATION APPROVAL
COURSE CONDITIONS AND GUIDELINES

The Ohio Board of Building Standards is committed to the ongoing education and professional development of board-certified personnel through the delivery of high-quality, accurate and engaging professional continuing education content. To this end, the Board reviews and approves Continuing Education Courses for building department personnel.

Board approval is granted for course instruction on current codes and standards, including the OBC, OMC, OPC, and RCO, and any other content areas directly related to the responsibilities of the certification for which credit is being requested.

Promotion: Any person or organization promoting an approved course is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, categories 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 may not falsely state BBS approval before approval is granted. Course providers may state that BBS approval is pending.

Application Submission: All Applications and associated materials shall be submitted by email in .pdf format. Instructions for completing the application are attached.

Certificate of Completion: Course providers shall 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.

Any person or organization administering an approved course shall return a completed BBS Course Attendance form by email.

Participants: Participants must attend the complete course as presented by the instructor to receive credit hours approved by the Board. The organization or instructor of online courses shall plan and execute methods to verify the individual’s attendance and completion of the course. No partial credit will be given to any participant who failed to complete the entire course as approved.

Board approval: All courses are approved for the calendar year in which application is made. Courses may be renewed so long as the referenced code is in effect, and the CEUs, certification and content remain unchanged. When the referenced code is updated, courses must be updated, and new approvals obtained.

Facility/training area: BBS Course may be delivered in person or online, or both, at the sponsor’s option.
Course facilities shall include the following:

In Person Classes:	**Online Classes:**
Sufficient seating capacity	Web-accessible
ADA accessible facilities	ADA accessible delivery
Appropriate Audio/Visual devices for delivery	Tech support available
Writing surfaces for participants	Live and recorded courses permitted

In-person facilities shall comfortably and safely seat at least the number of attendees present in the room and shall be climate controlled, non-smoking, and sound controlled so that outside noise will not interfere with the training.

Ohio | **Department of Commerce**

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Julie Miller
Organization: Fire Tech Productions
Address: 7976 Clyo Rd., Centerville, OH 45459
E-mail: julie@firetech.com Telephone: 937.434.3473
Website: firetech.com
Conference Sponsor (if applicable)____________________Conference Email:____________________

Check here if Course Renewal:________Prior course number ____________________ (*i.e. BBS2018-429*)
Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: Ohio Automatic Sprinkler & Standpipe Systems - NFPA 13 2016 - SSOH 102 2016
Course instructor: Tom Doty
Course description: Based on NFPA 13 2016, NFPA 13D and 13R 2016, NFPA 14 2016 and NFPA 25 2014, as well as the Ohio Fire and Building Codes 2017.
This course provides the knowledge to help you:
Identify the types of sprinkler and standpipe systems and their components
Determine sprinkler and standpipe system limitations and associated installation requirements defined in NFPA 13
Distinguish differences between 13D and 13R sprinkler systems
Locate Inspection, Testing, and Maintenance requirements for sprinkler and standpipe systems defined in NFPA 25
Instructional hours per session: 13.0 Number of Sessions:____________________
Course Date(s) and Location:____________________

Special Content:

Code Administration:______ Conference Course: ____________________
Existing Buildings: ______ Conference Name: ____________________
Electrical Instruction: ______ Conference location:____________________
Plumbing Instruction:______

Course to be offered online? X **On Demand** X **Webinar**________
Course Website: firetech.com
Detail online course participation confirmation method *(i.e. test, quizlets, participant activity confirmation)*:
100% completion/review of all lessons/knowledge checks and 70% passing on all quizzes/exams

Course applicable for the following certifications

Residential Certifications Only: ________ Commercial Certifications: X
Administrative Course, All Certifications: ________

Application materials included:

X Course Outline or Course Learning Objectives
_______ Presentation Materials/Slides (not required for roundtable courses)
_______ Assessment Materials (for online courses)
X Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Instructions for new Continuing Education Approval form

Provider Information

1. Please include all contact information.
2. If course is not part of a conference, leave conference sponsor and email blank.

Course Renewal

1. Indicate if the course is being submitted for renewal. Include prior approval letter and write in prior course number.
2. Certification approval for courses has now changed: all existing courses being renewed will be approved within the new classification system.
    a. Courses previously approved for only residential certifications will be approved for all residential certifications.
    b. Courses previously approved for at least on commercial certification will now be approved for all commercial certifications and all residential certifications.
    c. Courses on required instruction topics, Ohio Ethics, Code Administration and Existing Buildings, will be noted as Administrative Courses and be approved for all certifications.
3. Courses being renewed should skip the New Course information section and are not required to submit outline, agenda, slides or other instructional materials for review. Skip to Special Content, and mark any item that applies to the course.

New Course Information

1. Enter course title, name of instructor, and a brief description of the course content. Learning objectives may be substituted for course description, if desired.
2. Number of instructional hours per session is the length of instructional time.
3. Number of sessions: can be 1 or the number of sessions planned.
4. Course date(s) and location: not necessary at this time, enter if known.

Special Content

1. Indicate if the course will meet instructional time in Code Administration or Existing Buildings.
2. Indicate if the course is a plumbing or electrical course, for ESIAC review and trainee course tracking.
3. If the course is associated with a conference, indicate the conference name and location, as this will allow BBS to coordinate approvals with the conference provider.
4. If the course will be offered online, specify whether it will be on demand or offered as a virtual webinar, or both. Include website where the course will be provided.

Course applicable for the following certifications

This section represents a major change from previous BBS course approval forms.

1. If the course is only for residential certifications, check 'Residential Certifications Only'. The course, if approved, will be approved for all residential certifications.
2. If the course is appropriate for any commercial certifications, check Commercial Certifications. The course, if approved, will be approved for all commercial certification **AND** all residential certifications.
3. If the course is intended to meet required instruction in Code Administration (Chapter 1) or Existing Buildings (commercial or residential) check 'Administrative Course, All Certifications'.

Application Materials Included

This is a checklist for the course submitter's use, to be sure all materials necessary for review are included with the application. All materials should be submitted in .pdf format, along with the application, via email to Michael.Lane@com.ohio.gov or BBS@com.ohio.gov

Ohio Course Submission

Included in this document: Course Outline, Instructor resume(s)

Course: Ohio Automatic Sprinkler & Standpipe Systems - NFPA 13 2016 - SSOH 102 2016

Course Outline:

- **01.**

Course Navigation Video (Optional)

  - Course Navigation Video (Optional)

- **02.**

Course Title

  - Introduction
  - Occupancy Classification
  - Types of Sprinkler Systems and Sprinklers
  - Sprinkler System Components
  - Sprinkler Installation
  - Sprinkler System Design and Acceptance
  - Residential Systems Scope and Definitions
  - Residential Systems NFPA 13D Requirements
  - Residential Systems NFPA 13R Requirements
  - Standpipe System Terms and Definitions
  - Standpipe System Components
  - Standpipe System Installation
  - ITM Requirements NFPA 25
  - ITM of Valves
  - Ohio Fire and Building Code

- **03.**

Practice Exam

  - Practice Exam

Instructor Resume:

THOMAS DOTY

21 Meadowcrest Dr.

Franklin, OH 45005

937-434-3473

tom@firetech.com

Seasoned fire protection professional following strong adherence to the codes and top-notch attention to customer service.

Certifications include: Sprinkler/Standpipe • Fire Alarm and Detection Systems • Fire Pumps • Fire Service Mains • Portable Fire Extinguishers • Pre-Engineered Extinguishers – OTW • State of Kentucky Certified

PROFESSIONAL EXPERIENCE

- CertaSite, 2801 Thunderhawk Court, Dayton, Ohio 45414
  Installation Manager - 2021- Present

- Fire Tech Productions, Inc., 7986B Clyo Rd., Centerville, Ohio 45459
  President - 2015 - 2022

  Instructor/Developer - 2015 - Present

- Craynon Fire Protection Inc., 2801 Thunderhawk Court, Dayton, Ohio 45414
  Partner/Vice-President – 2011 – 2021

  Operations Manager -- 12/11/2005 – 2021

- Guardian Fire Protection, 480 Randy Lane, Monroe, Ohio 45050
  Owner – 11/30/2003 – 12/11/2005

- Sprinkler Inspection Services, Inc., 8 Perkins Drive, Alexandria, KY 41001
  Superintendent / Operations Manager – 10/07/1995 – 11/30/2003

- Bestol Plumbing Company, P.O. Box 4192, Branson, MO
  Foreman – 2/1995 – 10/1995

- Grinnell Fire Protection Systems, Inc., San Diego, CA
  Service Foreman – 8/1993 – 2/1995

- Advanced Fire Protection Company, 1657 Monte Vista Drive, Vista, CA 92084
  Owner – 10/1990 – 8/1993

- Ryan Automatic Sprinkler Company, San Marcos, CA
  Superintendent – 4/1988 – 10/1990

- Vanguard Fire Protection, Carlsbad, CA
  Foreman – 3/1985 – 4/1988

- Sentinel Fire Protection, San Diego, CA -- 8/1983 – 3/1985
- Local Union 669 – 5/1981 – 8/1983
- Local #821, Central Florida – 4/1980 – 5/1981
- American Automatic Fire Protection – 1/1979 – 4/1980
- Illinois Central Gulf Railroad – 4/1978 – 12/1978
- Orlando Automatic Sprinkler Company – 10/1976 – 3/1978

Ohio Automatic Sprinkler & Standpipe Systems - Introduction

Welcome! When you are ready to get started, click on the "**Begin**" button. This introduction provides a brief overview of what will be covered in the course.

You can come back to this module and reference this information anytime.

Topics that are covered in this introduction are as follows:

- Key references
- Preparing for the Exam
- Study Tips
- *NFPA* 13 2016, and *NFPA* 25 2014 Definitions

Overview

Glossary

Lesson 1 of 2

Overview

Welcome

Please review this introduction before getting started on the course.

We will look at key references and study tips. In addition, we will highlight key vocabulary terms in the glossary.

REFERENCES

Key References

As you work through this course, it is important to refer to your standards as the following references will be discussed.

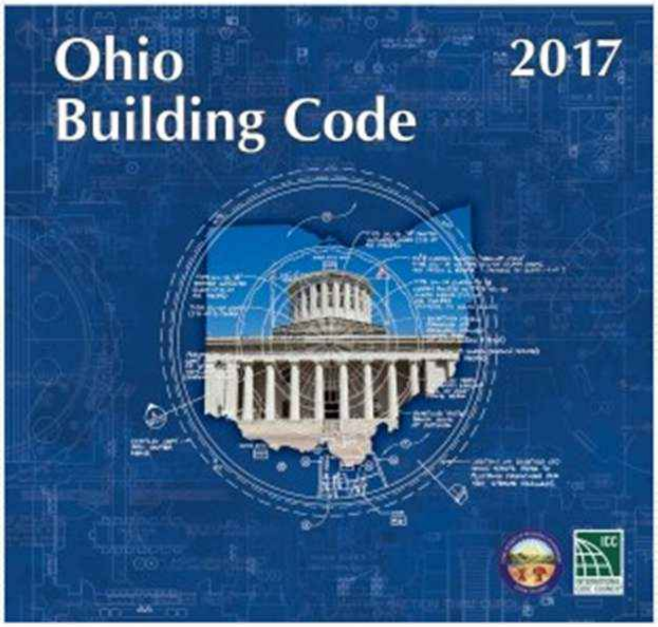
OHIO BUILDING CODE

OHIO FIRE CODE

NFPA 13

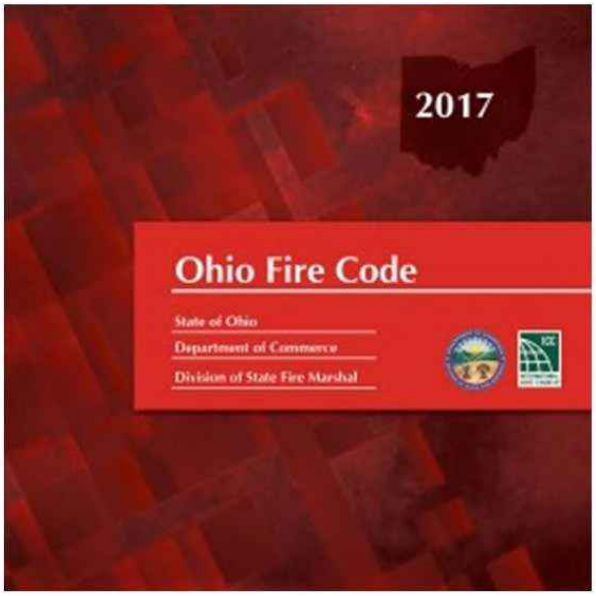
NFPA 13D

The ***Ohio Building Code,* 2017** establishes uniform minimum requirements for building construction, repair, alteration, and maintenance. These rules govern the intended use and occupancy of the buildings with respect to performance, extent of use, and standardization. The ***Ohio Building Code,* 2017** can be accessed through this link: https://codes.iccsafe.org/content/OHBCU2017



The ***Ohio Fire Code,* 2017**, establishes state fire marshal rules for the administration and enforcement of authorities. These rules govern the occupancy and maintenance of all structures and premises for precautions against fire and the spread of fire and general requirements of fire safety.

The Ohio Fire Code can be accessed through this link: https://codes.iccsafe.org/content/OHFCJAN2019E/ohio-administrative-code-1301-7-7-09-fire-protection-systems

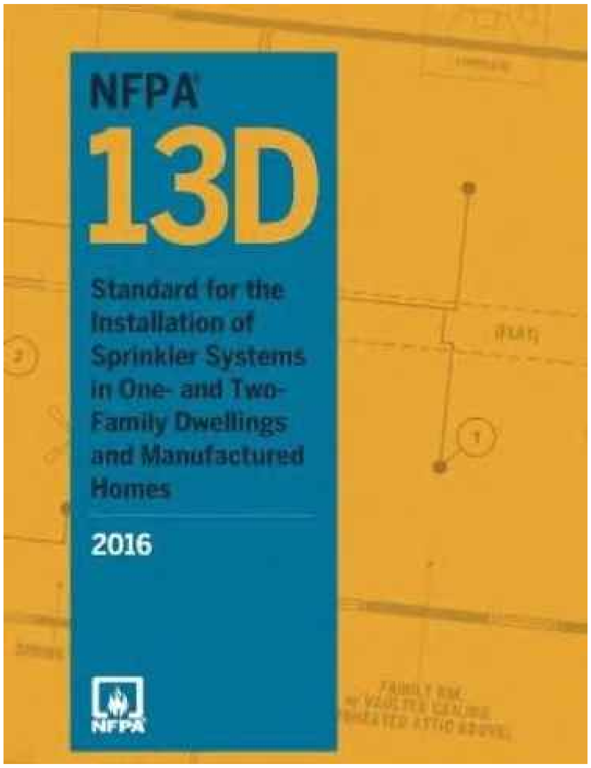


CODE | OHIO FIRE CODE | NFPA 13 | NFPA 13D

NFPA* 13 2016: *Standard for the Installation of Sprinkler Systems provides the minimum requirements for the design and installation of automatic fire sprinkler systems and exposure protection sprinkler systems covered within this standard.

OHIO BUILDING CODE | OHIO FIRE CODE | NFPA 13 | NFPA 13D

NFPA* 13D 2016: *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes covers the design, installation, and maintenance of automatic sprinkler systems for protection against fire hazards in one- and two-family dwellings and manufactured homes.



NFPA 13D

Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes

2016

NFPA

OHIO BUILDING CODE

OHIO FIRE CODE

NFPA 13

NFPA 13D

NFPA* 13R 2016: *Standard for the Installation of Sprinkler Systems In Low-Rise Residential Occupancies cover the design and installation of automatic sprinkler systems for protection against fire hazards in residential occupancies up to and including four stories in height in buildings not exceeding 60 ft (18 m) in height above grade plane.

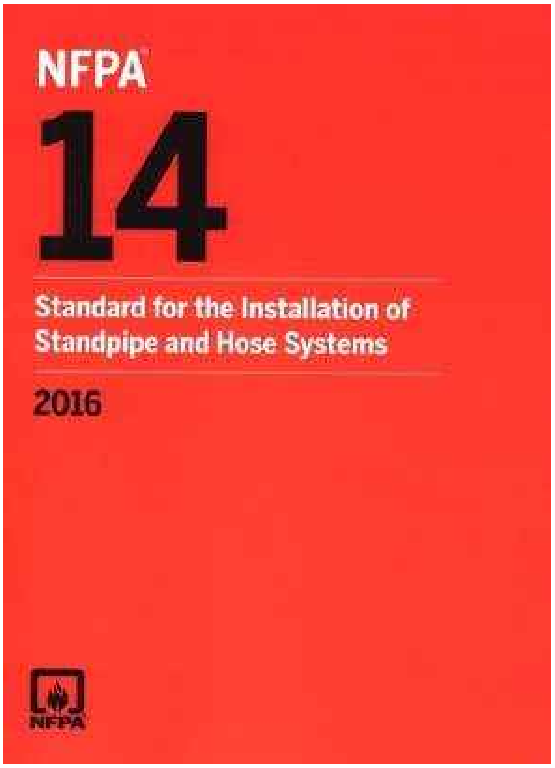
NFPA® 13R

Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies

2016

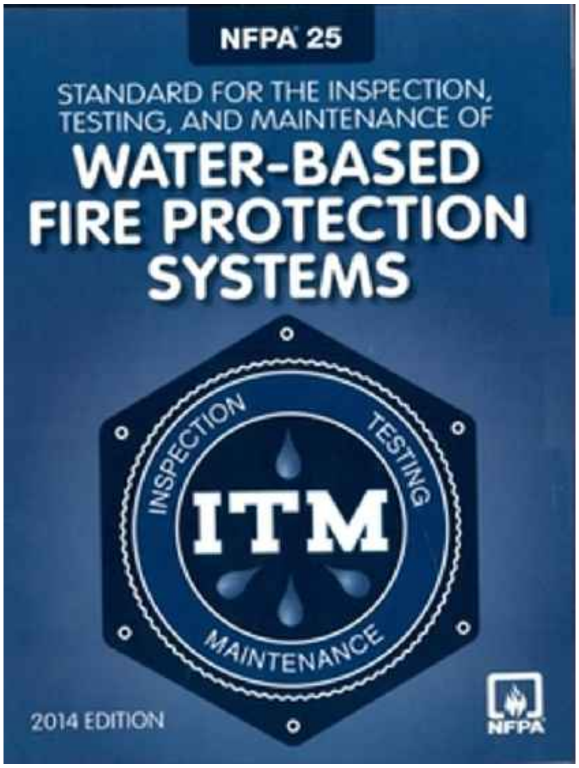
OHIO BUILDING CODE | OHIO FIRE CODE | NFPA 13 | NFPA 13D

NFPA* 14 2016: *Standard for the Installation of Standpipe and Hose Systems covers the minimum requirements for the installation of standpipes and hose systems.



OHIO BUILDING CODE
OHIO FIRE CODE
NFPA 13
NFPA 13D

NFPA 25 2014: Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems establishes the minimum requirements for the periodic inspection, testing, and maintenance of water-based fire protection systems and the actions to undertake when changes in occupancy, use, process, materials, hazard, or water supply that potentially impact the performance of the water-based system are planned or identified.



ⓘ The *NFPA* standards contain several Annexes with valuable examples and information. It is recommended you study this material as well.

OHIO CODES

Ohio Codes

The Ohio Fire Protection Exams are prepared from the *Ohio Building Code* Chapter 9, 2017 edition, the Ohio Administrative Code Section 1301:7-7-09 (*Ohio Fire Code*) 2017 edition, as well as the pertinent NFPA standards previously discussed. This course will focus on those referenced sections found in the *Ohio Building Code* and the *Ohio Fire Code*.

The Ohio Fire Code states that automatic sprinkler and standpipe systems shall be installed, inspected, tested, and maintained per *NFPA* 13 2016 and *NFPA* 25 2014. The code also defines specific rules for Ohio as well as reinforce some of the *NFPA* 13 2016 requirements.

- One of these requirements is to be certified and licensed by the state of Ohio.
- The only exception is for a provisional person in an approved formal apprenticeship program. They are permitted to work under the constant supervision of a certified person. The certified person is only allowed to supervise one provisional person.

CONTINUE

Additional Resources

Below is additional information and resources for the Ohio exam.

Ohio Department of Commerce – Division of State Fire Marshal:

Ohio Department of Commerce

To access the Ohio Department of Commerce – Division of State Fire Marshal, click on this "Click Here" button.

CLICK HERE

Ohio Department of Commerce phone: **(614) 752-7126**

The following downloadable PDF is for the Fire Protection Exam Application through the Ohio Department of Commerce:

PDF **FireProtectionExamApplication.pdf**
548.9 KB

PSI Candidate Information Bulletin

A very important source of information is the PSI Candidate Information Bulletin from PSI Services LLC. Take time to read it below in its **ENTIRETY**.

PDF **OhioCertificationExaminationBulletin.pdf**
230.9 KB

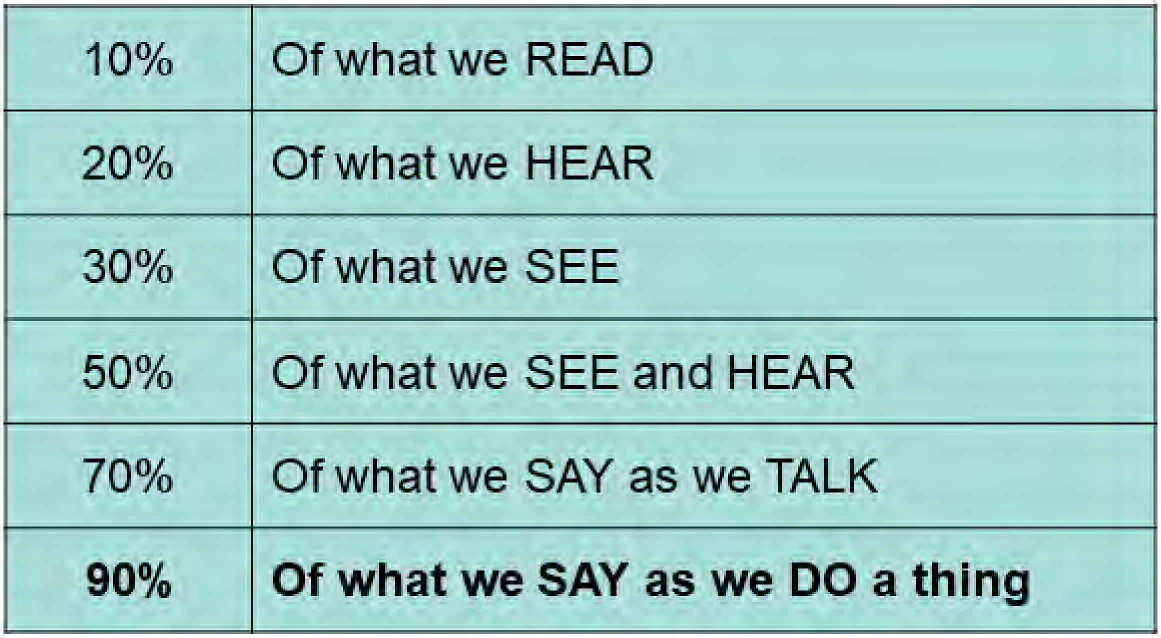
PSI Online Exams

To check for the most updated information on PSI Services, visit their website by clicking on this "Click Here" button.

CLICK HERE

HOW WE LEARN

Thinking about How We Learn



10%	Of what we READ
20%	Of what we HEAR
30%	Of what we SEE
50%	Of what we SEE and HEAR
70%	Of what we SAY as we TALK
90%	**Of what we SAY as we DO a thing**

Source: ***Skill With People*** by Les Giblin

Different people learn in different ways.

It is important to discover what works **best for you** and use your strengths to ensure you retain the material.

TRAINING MODULES

Training Modules

As you are studying, be prepared to **refer to your copy of the referenced** ***NFPA*** **standards constantly** throughout these modules. Be comfortable with the technical material.

Each training module is carefully planned and designed to **highlight areas of the standards that you need to know in order to increase your chances of success on the exam.** The goal of these training modules is to help you become knowledgeable of important areas of the standards and to gain a working understanding of how to apply these requirements on the job.

Take notes as you are studying, and **highlight** areas of the standards that are important to know.

Remember to write standard annotations

on a sticky note

rather than in the standard itself.

EXAMPLE

Note to self:

Table 14.3.1 Visual Inspection
#17 Initiating devices
(b) duct detectors
reference 17.7.5.5

p. 82

The more familiar you are with the requirements, tables, and figures, the better your chances of success on the exam.

QUIZZES

The Quizzes

Fire Tech provides a practice quiz associated with each training module, which should be taken following completion of the module. As you take each practice quiz, use your copy of the referenced *NFPA* standards to **look up every answer to each quiz question**. This will assist you in **becoming more familiar with the requirements and where they are located** in each of the codes and standards.

You will achieve the highest chances of success by **learning and understanding the training material.**

Fire Tech ***does not*** recommend that you solely attempt to memorize practice quiz questions. These questions are examples only and do not reflect actual test questions.

Additionally, **read each question carefully**. Sift through what is pertinent to the question and what is irrelevant information that may be included as a distractor.

You will achieve the highest chances of success by learning and understanding the training material. Fire Tech does **not** recommend that you solely attempt to memorize practice quiz questions.

KNOWLEDGE CHECKS

Knowledge Checks

To help you apply course material and prepare for the quizzes, **knowledge checks** are sprinkled throughout each course.

Completing these knowledge checks is **required** to proceed further in the lesson. If you're stuck on a question, refer to previous lesson material and use your NFPA standard to find the answer.

Knowledge checks will help you apply course material and prepare for course quizzes.

○ True

○ False

SUBMIT

Complete the knowledge check above before moving on.

Practice Exam

Once you have read all of the lessons in this course and passed all of the quizzes, you will be ready to take the **Practice Exam**.

The Practice Exam consists of questions from the quizzes and is presented in a randomized manner.

LEARNING STRATEGIES

Learning Strategies

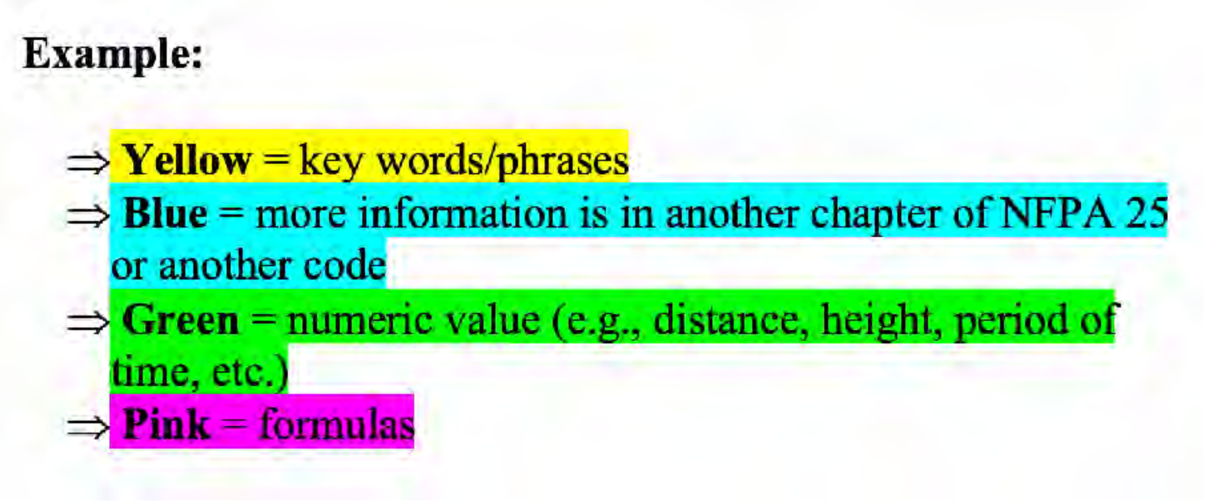
Click each of the strategies below and begin to incorporate them as you prepare for the Practice Exam.

Learning Strategies

Use these strategies to help you utilize the course materials.

Strategy 1

Create a color-coded highlighting system



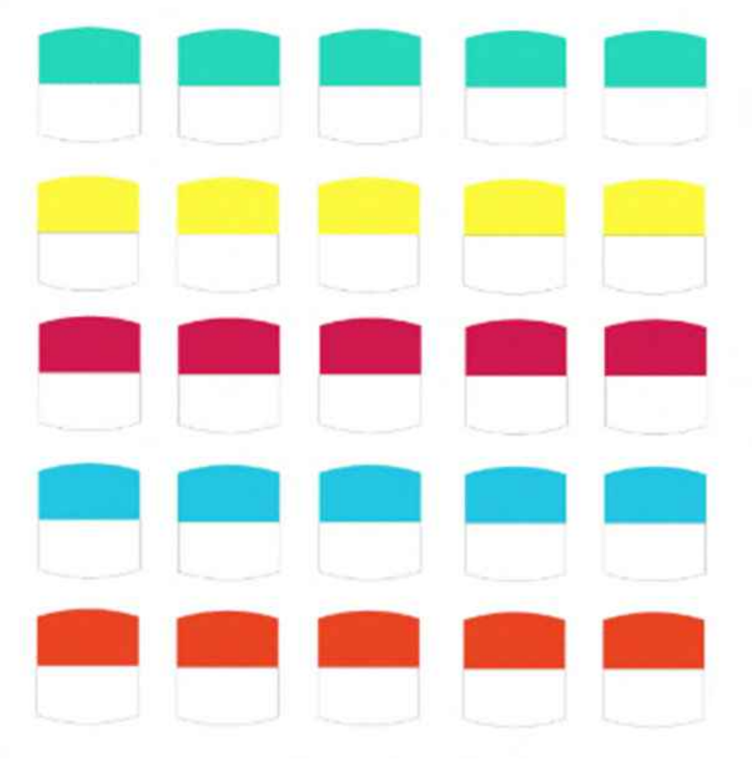
Example:

⇒ **Yellow** = key words/phrases
⇒ **Blue** = more information is in another chapter of NFPA 25 or another code
⇒ **Green** = numeric value (e.g., distance, height, period of time, etc.)
⇒ **Pink** = formulas

Fire Tech recommends highlighting important areas of the code. Some customers use up to four colors and different methods of highlighting. A simple strategy is to highlight based on type of information. Use one color for major sections or topics and another color for details and exceptions.

Strategy 2

Use tabs on your standards



Helps you look things up much faster! This can be especially helpful if you are looking up a reference for a customer.

Add tabs yourself or:

- purchase pre-tabbed standards from Fire Tech Productions
- purchase labeled tabs to add to your standard from Fire Tech Productions

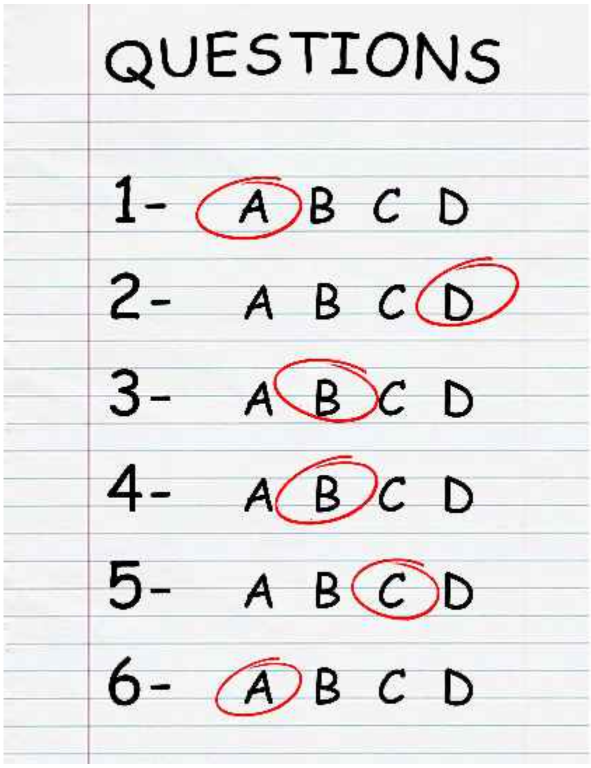
Strategy 3

Find a learning partner or a mentor

Have someone hold you accountable or quiz you, even if they're not taking the course themselves. Driving to and from a job site with a co-worker is a great opportunity to do this.

Strategy 4

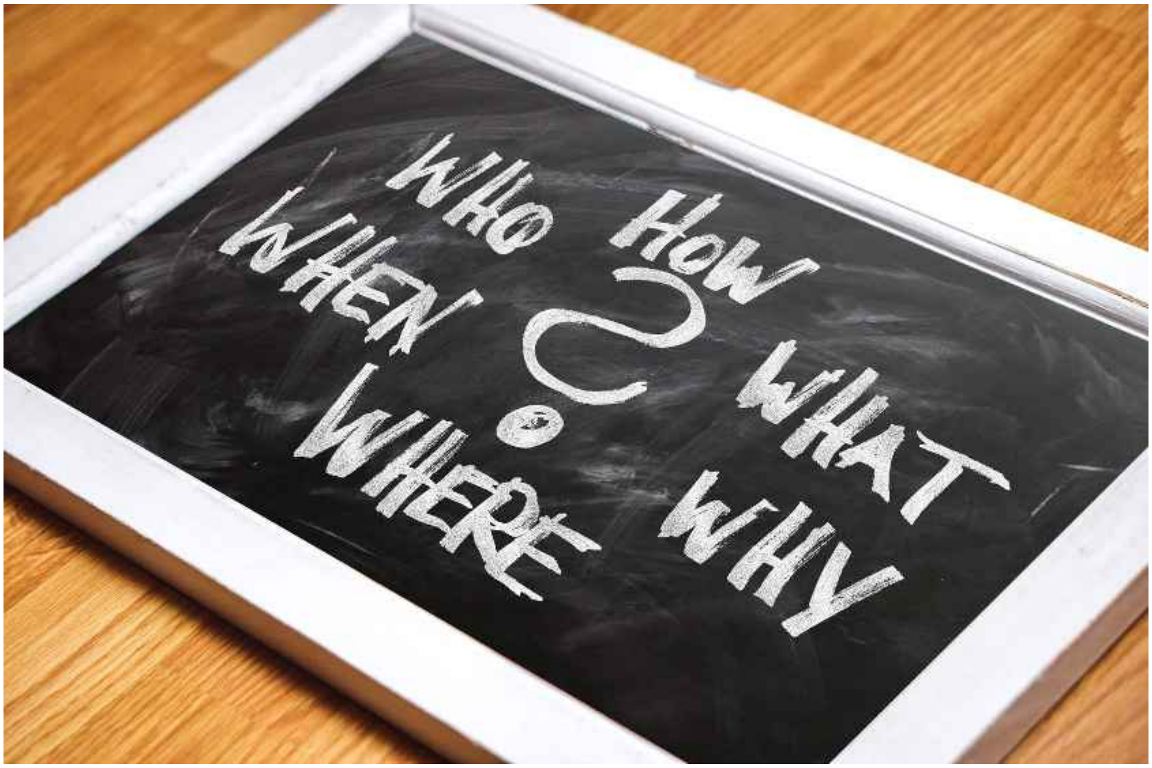
Practice



Take the practice quizzes and tests in the Fire Tech online course. Many studies show that recalling information helps to “make it stick”.

Strategy 5

Write your own questions



As you go through the material, turn the information into possible questions that you can go back and answer later. This will help you check how well you are retaining the information in the course.

Strategy 6

Make time for your course

Work on your course for at least **20 minutes** every day. Spreading out the course material over time is a much more effective way to learn.

Strategy 7

Make up songs

Our brains remember music really well. Put those formulas, definitions, or requirements to music.

Strategy 8

Teach someone else

It will solidify ideas in your brain and improve your understanding.

GLOSSARY

Lesson 2 of 2

Glossary

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Define key terms associated with sprinkler systems.

Key References

- *NFPA* 13 - *Standard for the Installation of Sprinkler Systems*, 2016

LET'S BEGIN

Key Terms

NFPA 13 2016, Chapter 3 and *NFPA* 25 2014

Below are key glossary terms that will be highlighted throughout this course. Click on each **+** symbol to see the definition for each word below.

Authority Having Jurisdiction (AHJ)

An organization, office, or individual responsible for enforcing requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure. (*NFPA* 13 2016, Section 3.2.2)

Automatic Sprinklers

A fire suppression or control device that operates automatically when its heat-activated element is heated to its thermal rating or above, allowing water to discharge over a specified area. (*NFPA* 13 2016, Section 3.3.1)

High-Piled Storage

Solid-piled, palletized, rack storage, bin box, and shelf storage in excess of 12 ft. in height. (*NFPA* 13 2016, Section 3.9.1.16)

Inspection

A visual examination of a system or portion thereof to verify that it appears to be in operating condition and is free of physical damage. (*NFPA* 25 2014, Section 3.3.23)

Limited-Combustible Material

A building construction material that does not comply with the definition of non-combustible material. (*NFPA* 13 2016, Section 3.3.16)

Listed –

Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose. (*NFPA* 13 2016, Section 3.2.3)

Low-Piled Storage –

Solid-piled, palletized, rack storage, bin box, and shelf storage up to 12 ft. in height. (*NFPA* 13 2016, Section 3.9.1.17)

Miscellaneous Storage –

Storage that does not exceed 12 ft. in height, is incidental to another occupancy use group, does not constitute more than 10% of the building area or 4000 ft^2 of the sprinklered area, whichever is greater, does not exceed 1000 ft^2 in one pipe or area, and is separated from other storage areas by at least 25 ft. (*NFPA* 13 2016, Section 3.9.1.18)

Non-Combustible Material –

A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat. (*NFPA* 13 2016, Section

3.3.17)

Obstructed Construction

Panel construction and other construction where beams, trusses, or other members impede heat flow or water distribution in a manner that materially affects the ability of sprinklers to control or suppress a fire. (*NFPA* 13 2016, Section 3.7.1)

The Annex provides many examples and figures of obstructed and unobstructed construction found in Figures A.3.7.1 and A.3.7.2. Take some time to review these examples.

Shall

Indicates a mandatory requirement. (*NFPA* 13 2016, Section 3.2.4)

Shop-Welded

Shop in the term shop-welded means either:

1. A sprinkler contractor's or fabricator's premise or
2. An area specifically designed or authorized for welding, such as a detached outside location, maintenance shop, or other areas (either temporary or permanent) of noncombustible or fire-resistive construction free of combustible and flammable contents and suitably segregated from adjacent areas. (*NFPA* 13 2016, Section 3.3.20)

Should

Indicates a recommendation or that which is advised but not required. (*NFPA* 13 2016, Section 3.2.5)

Small Room

A compartment of light hazard occupancy classification having unobstructed construction and a floor area not exceeding 800 ft^2. (*NFPA* 13 2016, Section 3.3.22)

Refer to NFPA 13 2016, Figure A.8.6.3.2.4(a) Small Room Provision – One Sprinkler

Sprinkler System

A system that consists of an integrated network of piping designed in accordance with fire protection engineering standards that includes a water supply source, a water control valve, a waterflow alarm, and a drain. (*NFPA* 13 2016, Section 3.3.23)

The portion of the sprinkler system above ground is a network of specifically sized or hydraulically designed piping installed in a building, structure, or area, generally overhead, and to which sprinklers are attached in a systematic pattern. The system is commonly activated by heat from a fire and discharges water over the fire area.

System Working Pressure

The maximum anticipated static (non-flowing) or flowing pressure applied to sprinkler system components exclusive of surge pressures and exclusive of pressure from the fire department connection. (*NFPA* 13 2016, Section 3.3.24)

Testing

A procedure used to determine the operational status of a component or system by conducting periodic physical checks, such as waterflow tests, fire pump tests, alarm tests, and trip tests of dry pipe, deluge, or preaction valves. (*NFPA* 25 2014, Section 3.3.47)

Unobstructed Construction

Construction where beams, trusses, or other members do not impede heat flow or water distribution in a manner that materially affects the ability of sprinklers to control or suppress a fire. (*NFPA* 13 2016, Section 3.7.2)

Unobstructed construction has horizontal structural members that are not solid, where the openings are at least 70% of the cross-section area, and the depth of the member does not exceed the least dimension of the openings, or all construction types, with the exception of panel construction, where the spacing of structural members exceeds 7.5 ft. on center.

CONTINUE

Please press the button to proceed.

Automatic Sprinkler & Standpipe Systems - Occupancy Classification

By the end of this module, you will be able to do the following:

- Define occupancy classifications.
- Identify examples of each occupancy classification.

Key References:

- *NFPA* 13 - *Standard for the Installation of Sprinkler Systems*, 2016

When you are ready to begin, click on the button above to start the course.

Occupancy Classification

Lesson 1 of 1

Occupancy Classification

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Define occupancy classifications.

☐ Identify examples of each occupancy classification.

Key References

- *NFPA* 13 - *Standard for the Installation of Sprinkler Systems*, 2016

LET'S BEGIN

Types of Occupancies

NFPA 13 2016, Section 5.1

A basic system layout assumes that you have the responsibility for determining the piping network and sprinkler position requirements for a given hazard. **Determining the hazard level of a system is the start of a system design.** Furthermore, the level of the hazard, or the severity of a potential hazard, dictates the system design.

Knowing the occupancy classification is necessary to determine the hazard level of a system design. **Hazard level** is based on the **quantity** and **combustibility** of the building contents and **rates of heat release** expected if a fire occurs. Occupancy classifications are categorized into three separate groupings:

- Light Hazard
- Ordinary Hazard
- Extra Hazard

LIGHT HAZARD OCCUPANCIES

Light Hazard Occupancies

NFPA 13 2016, Sections 5.2, 8.2, and 8.6

Light Hazard Occupancies are defined as occupancies or portions of other occupancies where the quantity and/or combustibility of contents is low and fires with relatively low rates of heat release are expected.

According to Chapter 8 of *NFPA* 13 2016, the following are the installation requirements for sprinkler systems in Light Hazard areas:

- Maximum sprinkler coverage is 225 ft^2
- Maximum distance between sprinklers is 15 ft
- Maximum distance between branch lines is 15 ft
- Maximum system area or size is 52,000 ft^2

LIGHT HAZARD EXAMPLES

Examples of Light Hazard classification include:

Churches

Hospitals

Educational facilities

Museums

Nursing and convalescent homes

Offices

Dormitories

ORDINARY HAZARD OCCUPANCIES

Ordinary Hazard Occupancies

NFPA 13 2016, Section 5.3

Ordinary Hazard Occupancies are separated into two groups: Group 1 and Group 2.

Ordinary Hazard (Group 1)

According to *NFPA* 13 2016, Section 5.3.1, Ordinary Hazard (Group 1) refers to occupancies or portions of other occupancies where combustibility is low, the quantity of combustible is moderate, stockpiles of combustibles do not exceed 8 ft., and fires with moderate rates of heat release are expected.

Ordinary Hazard (Group 2)

According to *NFPA* 13 2016, Section 5.3.2, Ordinary Hazard (Group 2) refers to occupancies or portions of other occupancies where the quantity and combustibility of contents are moderate to high, where stockpiles of contents with moderate rates of heat release do not exceed 12 ft. and stockpiles of contents with high rates of heat release do not exceed 8 ft.

According to Chapter 8 of *NFPA* 13 2016, the following are the installation requirements for sprinkler systems in Ordinary Hazard areas:

- Maximum sprinkler coverage is 130 ft^2
- Maximum distance between sprinklers is 15 ft
- Maximum distance between branch lines is 15 ft
- Maximum system area or size is 52,000 ft^2

ORDINARY HAZARD EXAMPLES

Examples of Ordinary Hazard (Group 1) classification include:

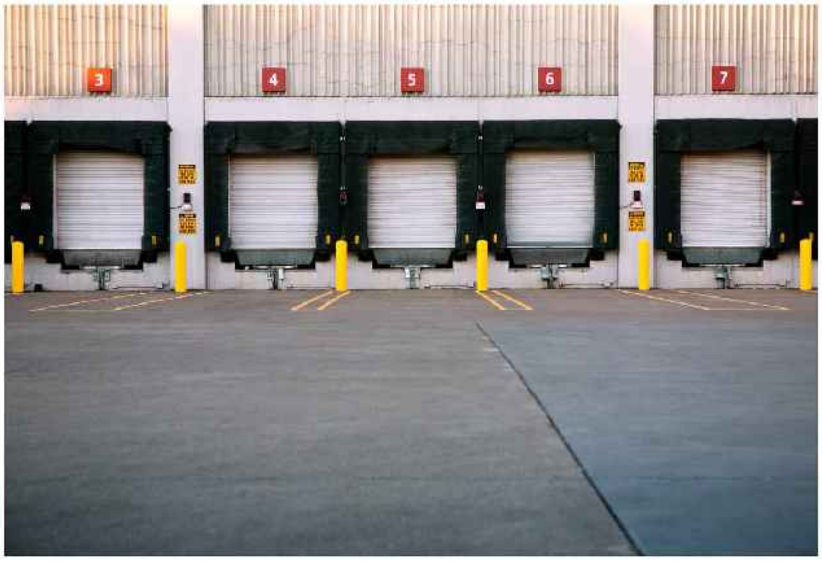
Parking garages

Bakeries

Glass and glass product manufacturing

Laundry facilities

Restaurant service areas



Exterior loading docks

Examples of Ordinary Hazard (Group 2) classification include:

- Distilleries
- Leather goods manufacturing
- The large stack room areas in libraries
- Plastics fabrication
- Tobacco products manufacturing
- Wood product assembly
- Other similar hazards

EXTRA HAZARD OCCUPANCIES

Extra hazard Occupancies

NFPA 13 2016, Sections 5.4, 8.2, and 8.6

Extra Hazard Occupancies are separated into two groups: Group 1 and Group 2.

Extra Hazard (Group 1)

According to *NFPA* 13 2016, Section 5.4.1, Extra Hazard (Group 1) refers to occupancies or portions of other occupancies where the quantity and combustibility of contents are very high and dust, lint, or other materials are present, introducing the probability of rapidly developing fires with high rates of heat release but with little or no combustible or flammable liquids.

Extra Hazard (Group 2)

According to *NFPA* 13 2016, Section 5.4.2, Extra Hazard (Group 2) refers to occupancies or portions of other occupancies with moderate to substantial amounts of flammable or combustible liquids or occupancies where shielding of combustibles is extensive.

According to Chapter 8 of *NFPA* 13 2016, the following are the installation requirements for sprinkler systems in Extra Hazard areas:

- Maximum sprinkler coverage is 100 ft^2
- Maximum distance between sprinklers is 12 ft
- Maximum distance between branch lines is 12 ft
- Maximum system area or size is 40,000 ft^2

EXTRA HAZARD EXAMPLES

Examples of Extra Hazard (Group 1) classification include:

Die casting operations

Plywood factory and particleboard manufacturing

Sawmills

Examples of Extra Hazard (Group 2) classification include:

- Asphalt saturating equipment
- Flammable liquid spraying
- Open oil quenching
- Plastics manufacturing
- Varnish and paint dipping

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SPRINKLER OCCUPANCIES

Installation Requirements

The following table outlines the sprinkler installation requirements for each occupancy classification mentioned in the above sections.

Sprinkler Occupancies	Maximum Sprinkler Coverage	Maximum Distance Between Sprinkler Heads	Maximum Distance Between Branch Lines	Maximum System Area or Size
Light Hazard	225 ft²	15 ft	15 ft	52,000 ft²
Ordinary Hazard	130 ft²	15 ft	15 ft	52,000 ft²
Extra Hazard	100 ft²	12 ft	12 ft	40,000 ft²

Click on the image to enlarge.

As with all things *NFPA*, there are exceptions. Please review the appropriate occupancies sections of *NFPA* 13 2016, Chapter 5.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Match the occupancy to its appropriate classification.

SUBMIT

Complete the knowledge check above before moving on.

After completing this module, you should now have a better understanding of the different occupancy classifications.

Click on the “Next” arrow up on the right-hand corner of the screen to continue to the quiz.

Automatic Sprinkler & Standpipe Systems - Types of Sprinkler Systems and Sprinklers

By the end of this module, you will be able to do the following:

- Compare and contrast the design features of different types of sprinkler systems.
- Identify sprinkler components, markings, and activation triggers.
- Recognize different types of sprinklers and explain their functionality.
- Describe the relationship between a sprinkler’s k-factor, flow rate, and pressure.

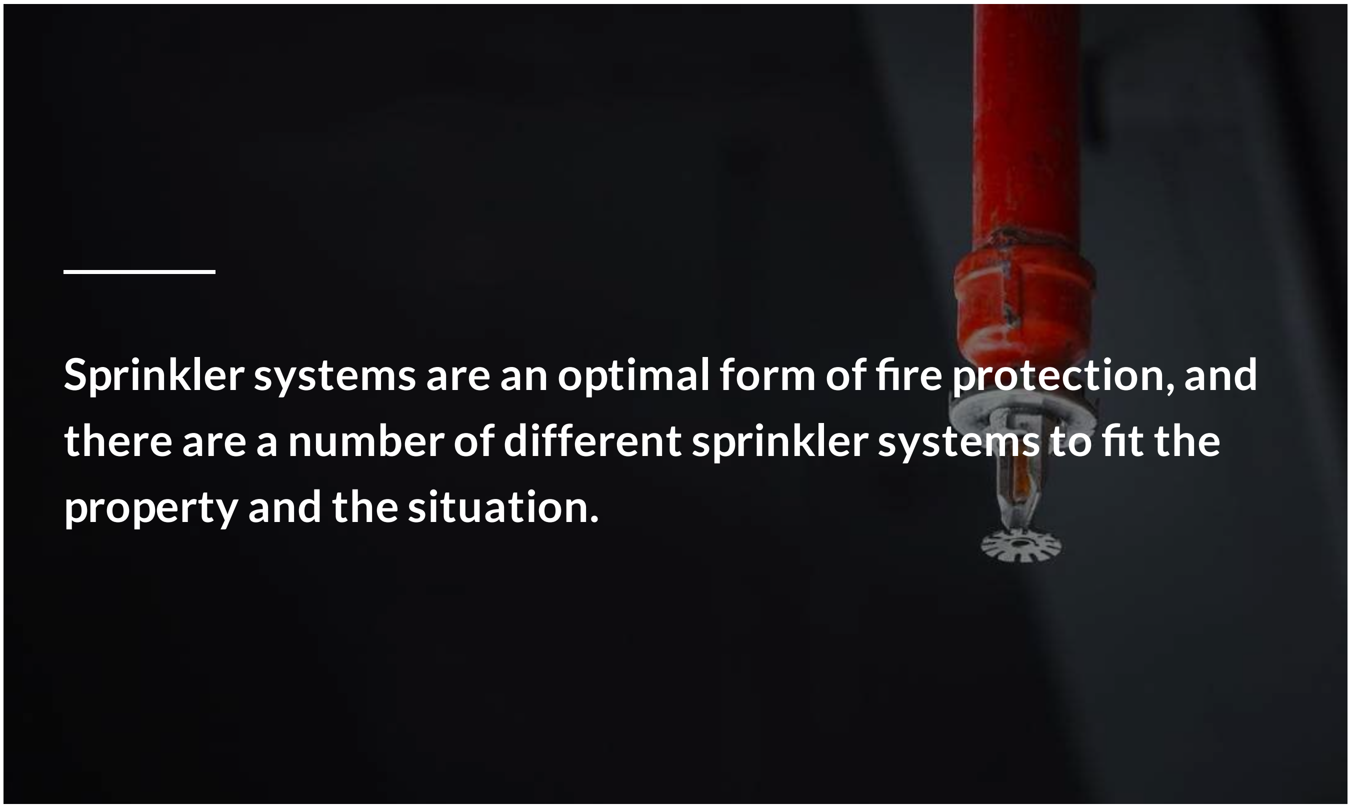
Key References for this module:

- *NFPA* 13 - *Standard for the Installation of Sprinkler Systems*, 2016

When you are ready to begin, click on the button above to start the course.

Lesson 1 of 2

Sprinkler Systems



Sprinkler systems are an optimal form of fire protection, and there are a number of different sprinkler systems to fit the property and the situation.

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Compare and contrast the design features of different types of sprinkler systems.

Key References

- *NFPA* 13 - *Standard for the Installation of Sprinkler Systems*, 2016

LET'S BEGIN

Types of Sprinkler Systems

Sprinkler systems are intended to either **control the fire or suppress the fire**. Different types of sprinkler systems are used depending on what they are intended to do, what materials they are intended to protect, and what area they need to cover.

The following are some of the most common types of sprinkler systems:

1. Wet Pipe Systems
2. Antifreeze Systems (a type of wet pipe system)
3. Dry Pipe Systems
4. Preaction Systems
5. Deluge Systems

WET PIPE SYSTEMS

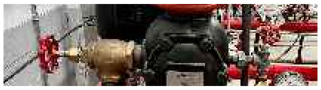
Wet Pipe Systems

NFPA 13 2016, Section 3.4.11

A **wet pipe system** is defined as a sprinkler system employing automatic sprinklers attached to a piping system containing water and connected to a water supply so that water discharges immediately from sprinklers opened by heat from a fire.

Wet pipe sprinkler systems are the **most common** type of sprinkler systems in use today. These systems **contain water at all times**, so wet pipe sprinkler systems are vulnerable to freezing.

Wet pipe systems have relatively few complicated and maintenance-driven components, thus they have an inherently **higher degree of reliability** than other system types.



Click on the image to enlarge

Click on the image to enlarge

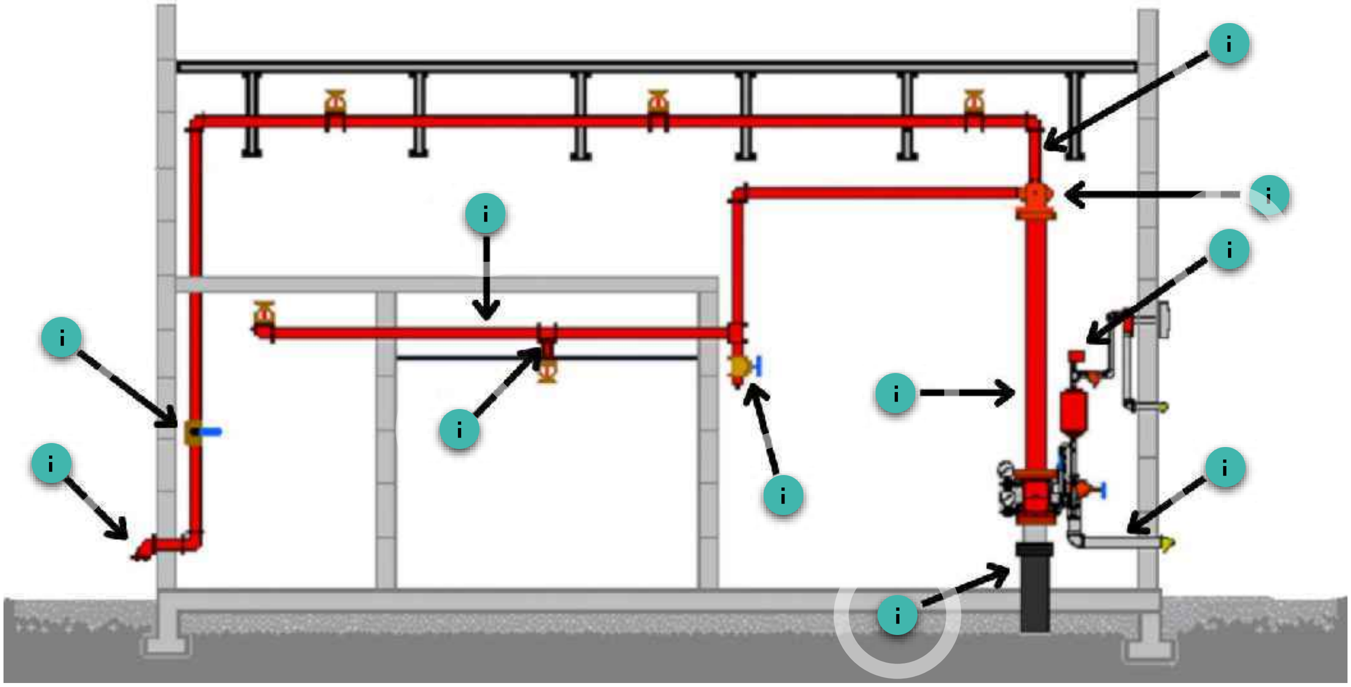
CONTINUE

Watch the video below to learn more about wet pipe systems.

Run time 4:38

CONTINUE

Click on the buttons of the wet pipe system diagram to view each component's definition.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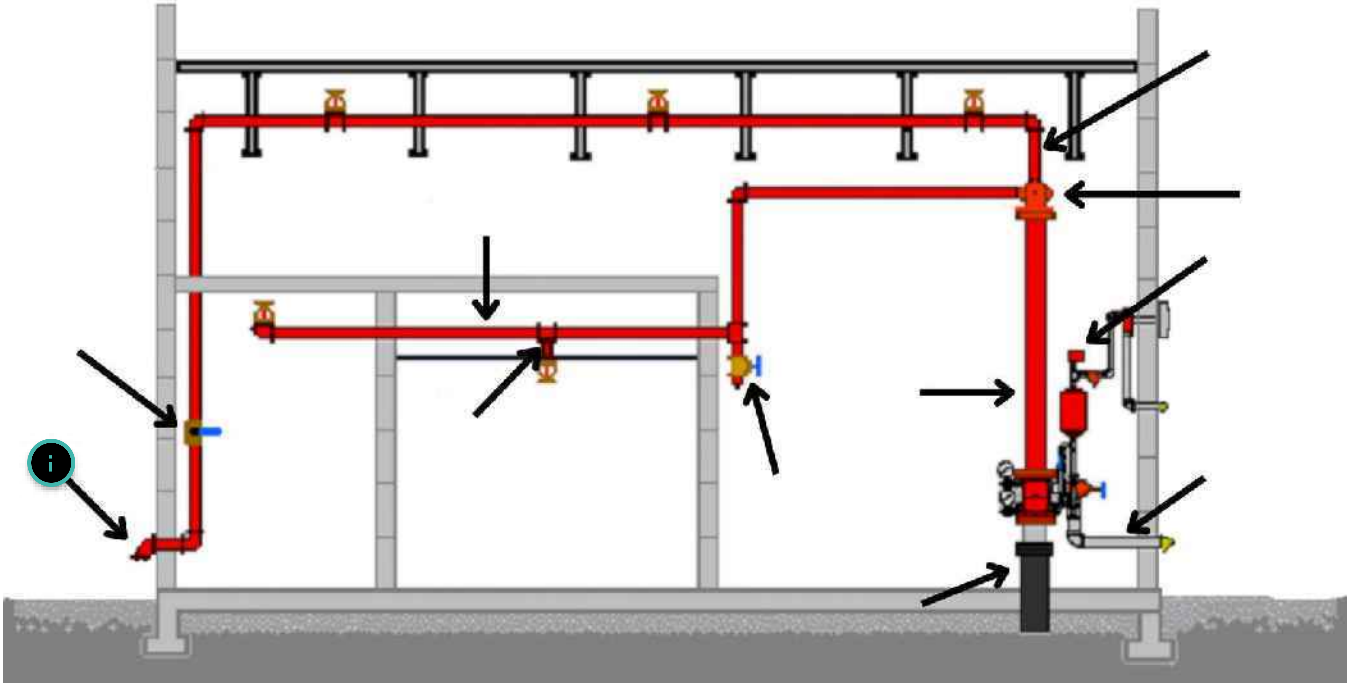
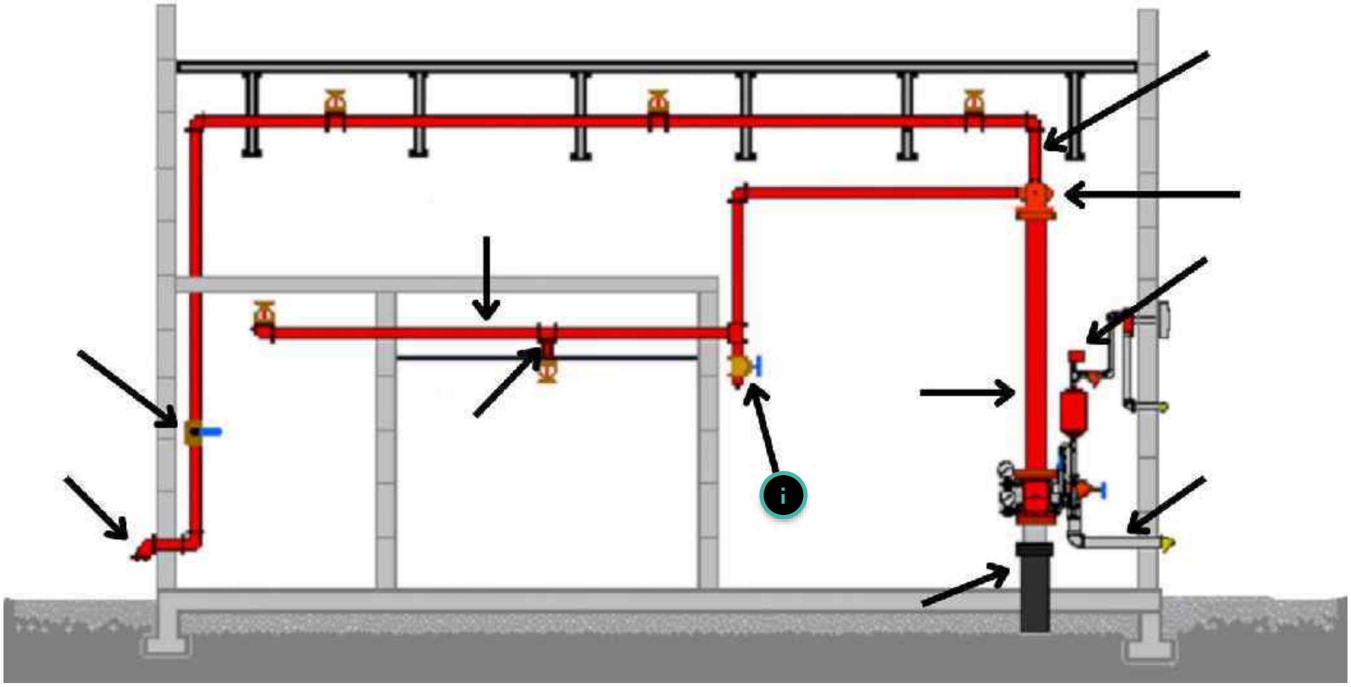


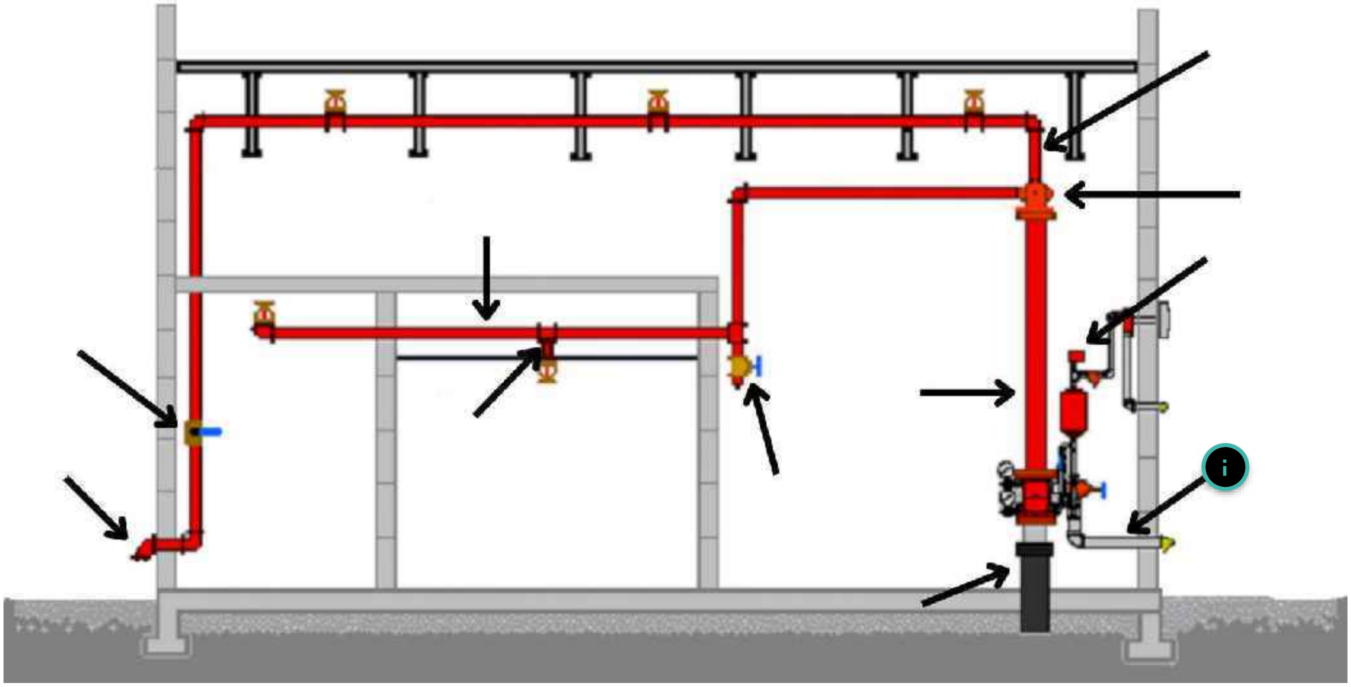
Inspector’s Test Connection

A discharge pipe and orifice from the inspector’s test valve. The orifice placed in the connection is the same as the smallest orifice sprinkler on the system, creating the most demanding waterflow for the waterflow alarm device.



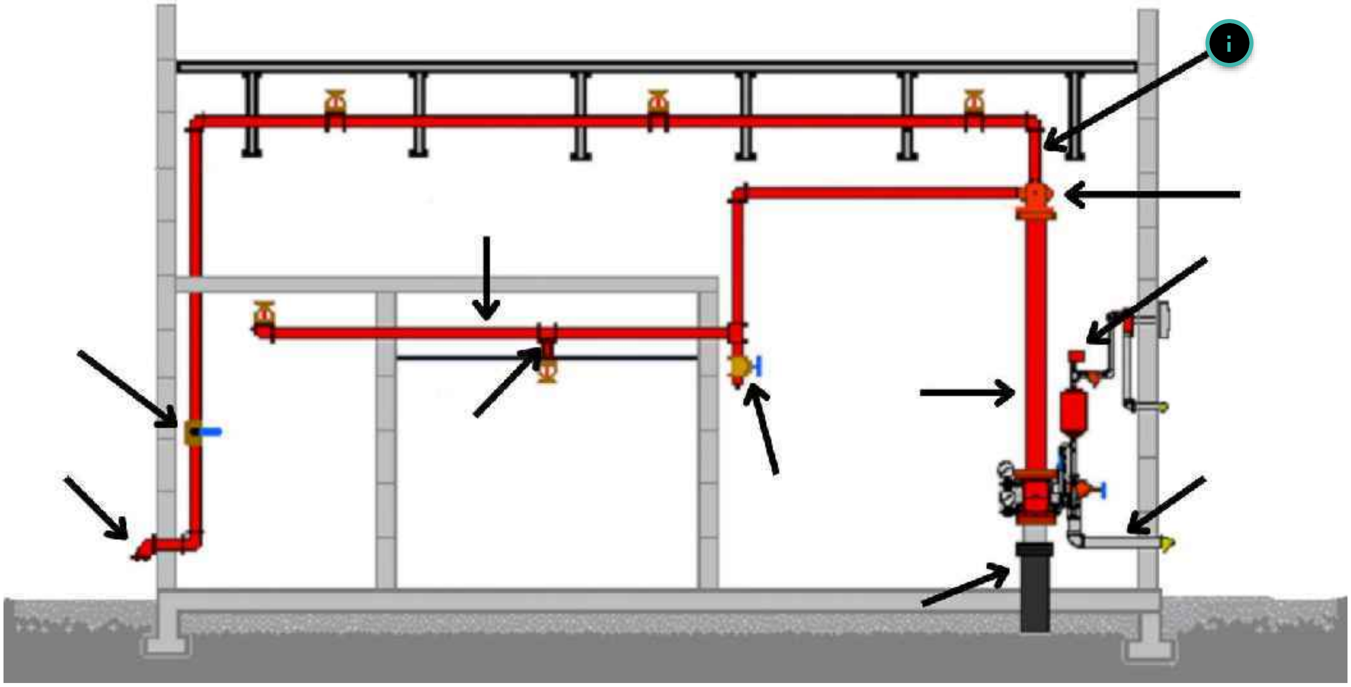
Drain Valve

A valve that allows the release of water in a sprinkler system.



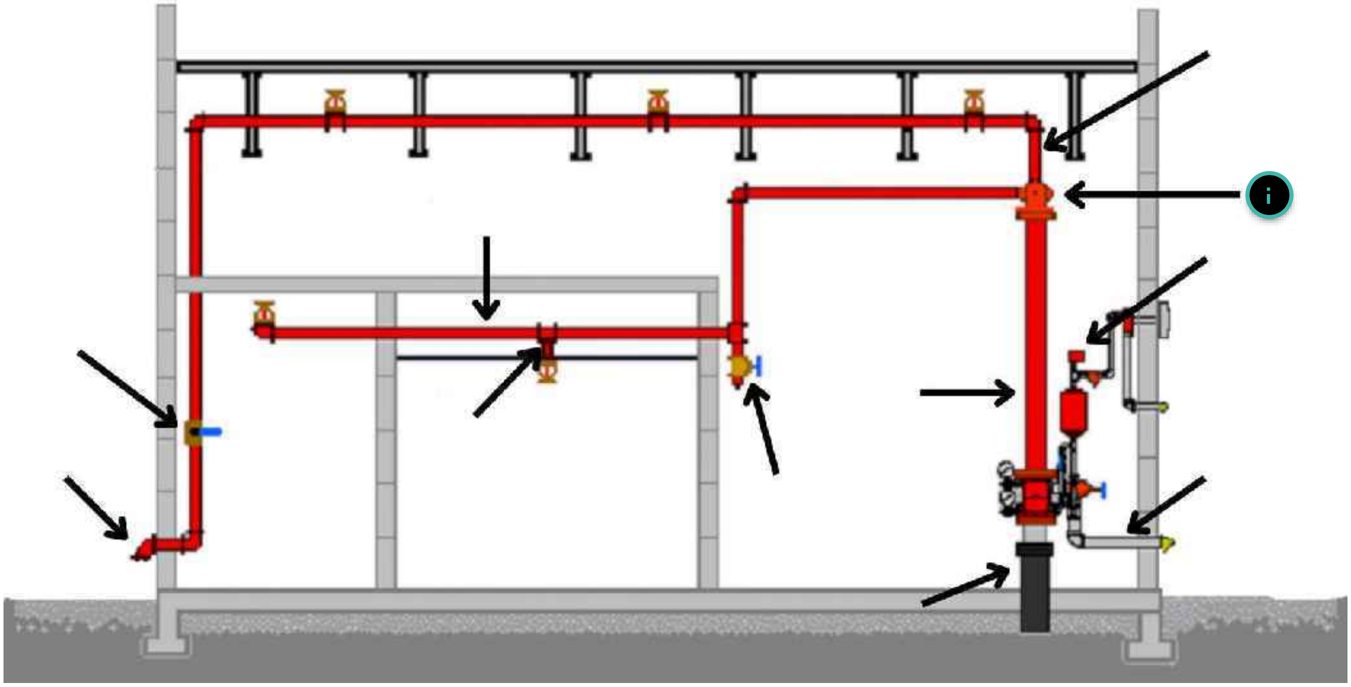
Main Drain

The purpose of the main drain is to allow the sprinkler system to be drained down for maintenance purposes, inspections, repair, or modifications.



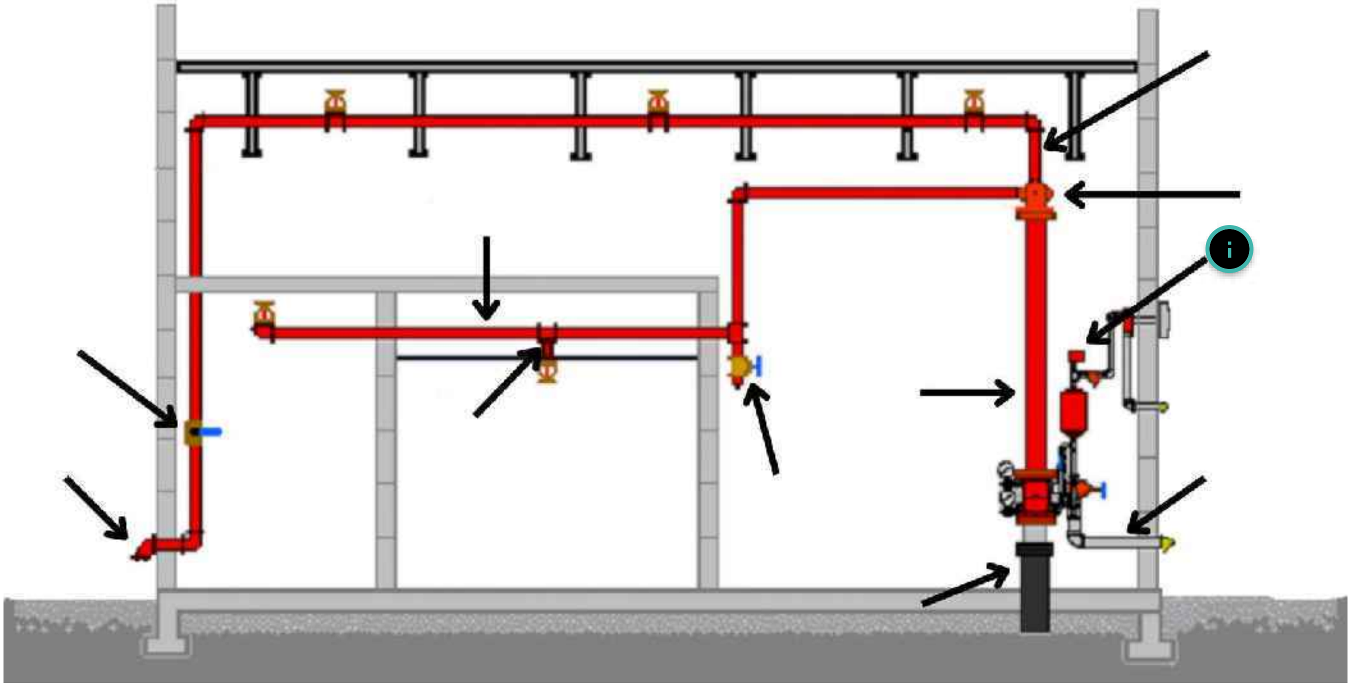
Riser Nipple

A vertical pipe between the main and branch line.



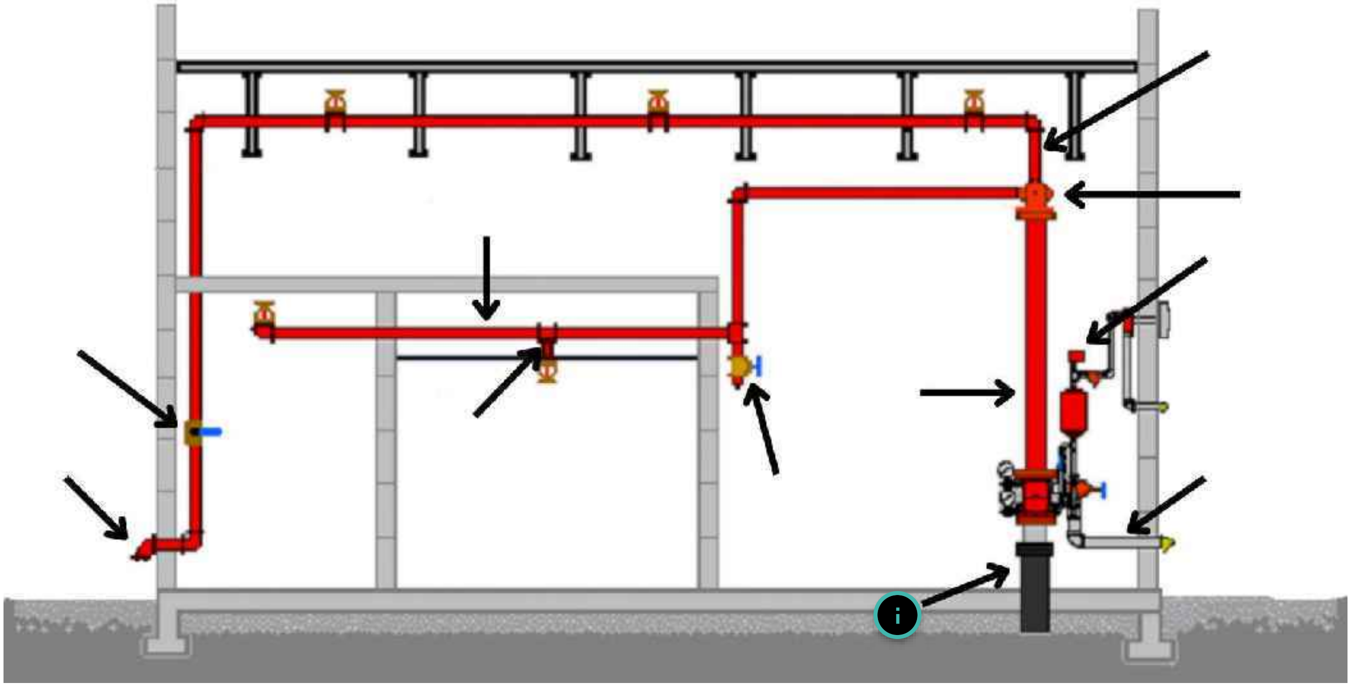
Cross Main

The pipes supplying the branch lines, either directly or through riser nipples. The cross main will generally be installed parallel to the building's roof structure.



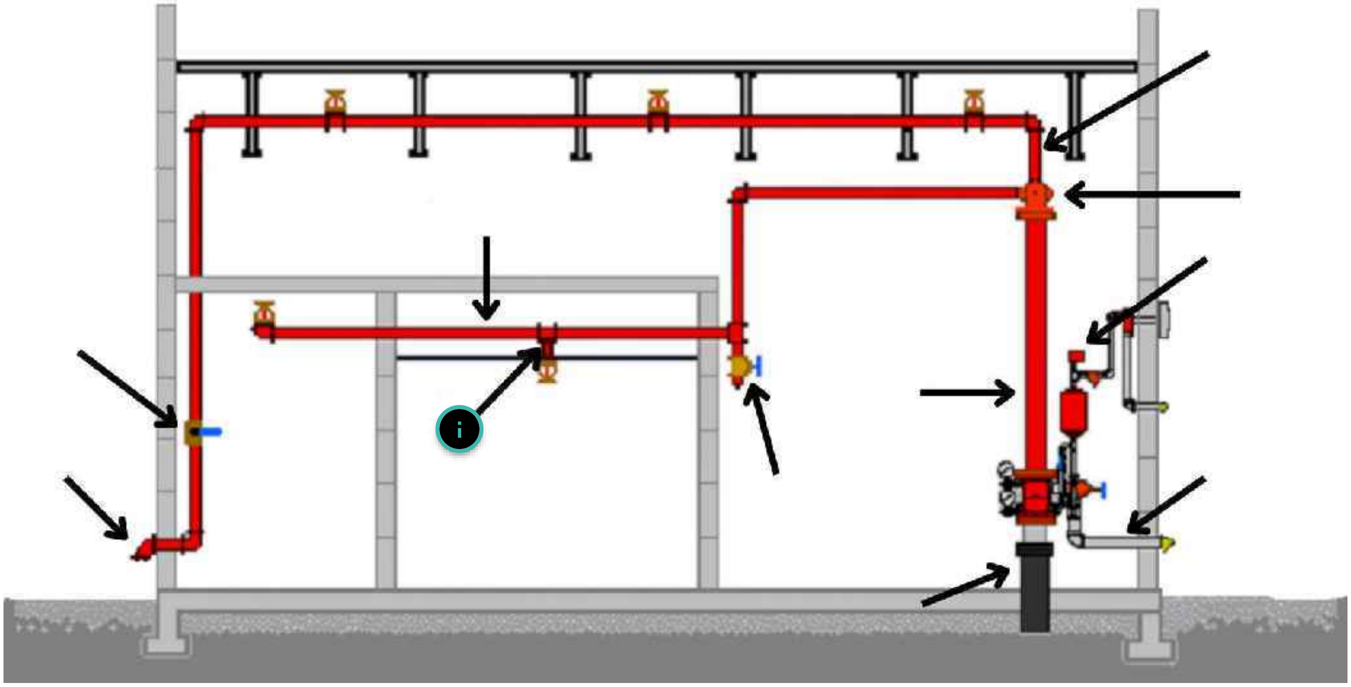
Waterflow Alarm Device

An attachment to the sprinkler system that detects a predetermined water flow and is connected to a fire alarm system to initiate an alarm condition, or is used to mechanically or electrically initiate a fire pump or local audible or visual alarm.



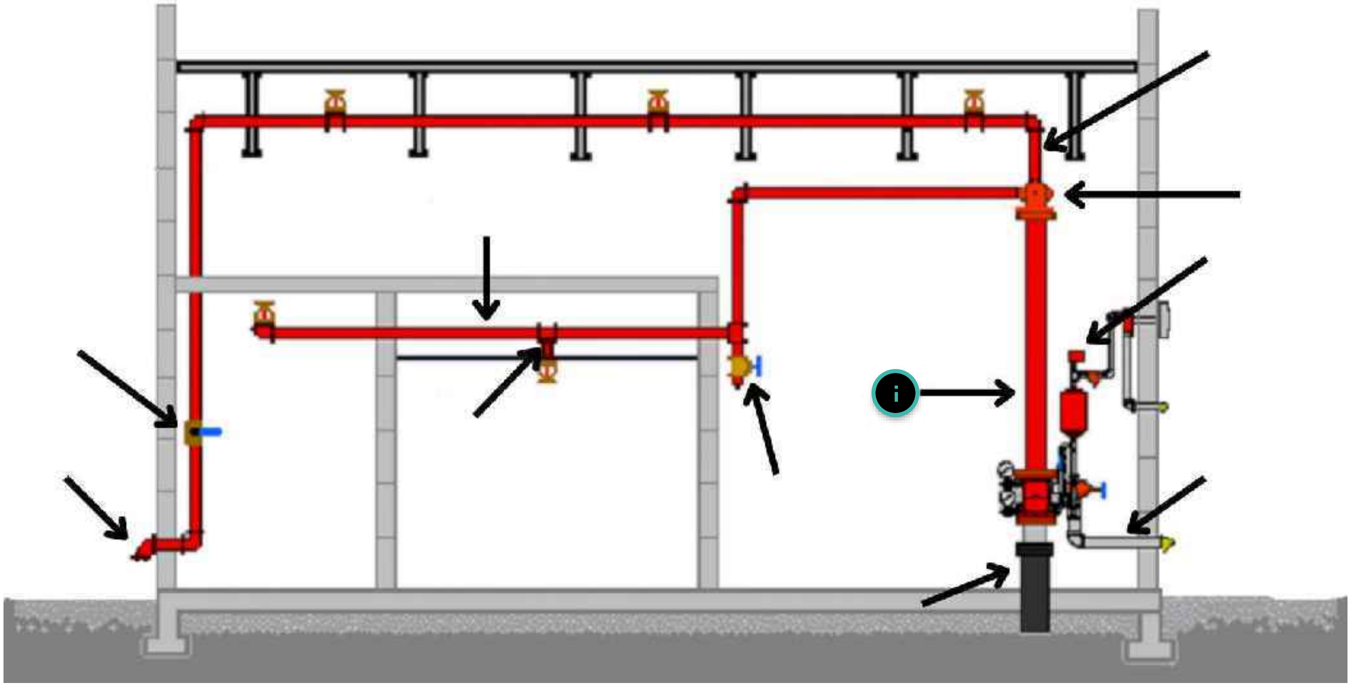
Flange and Spigot

The flanged supply that terminates the underground supply pipe inside the building.



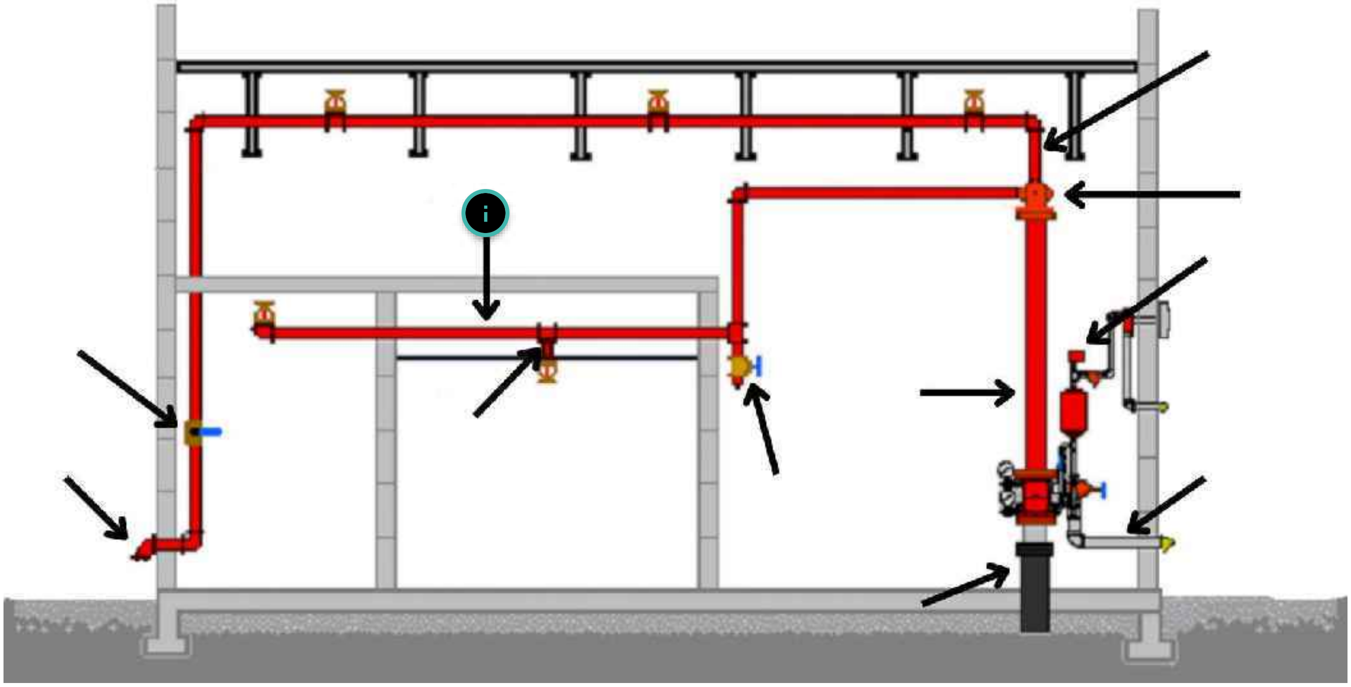
Drop Nipple

A vertical drop from branch line piping to supply a sprinkler. Drop nipples supply sprinklers located in finished ceilings.



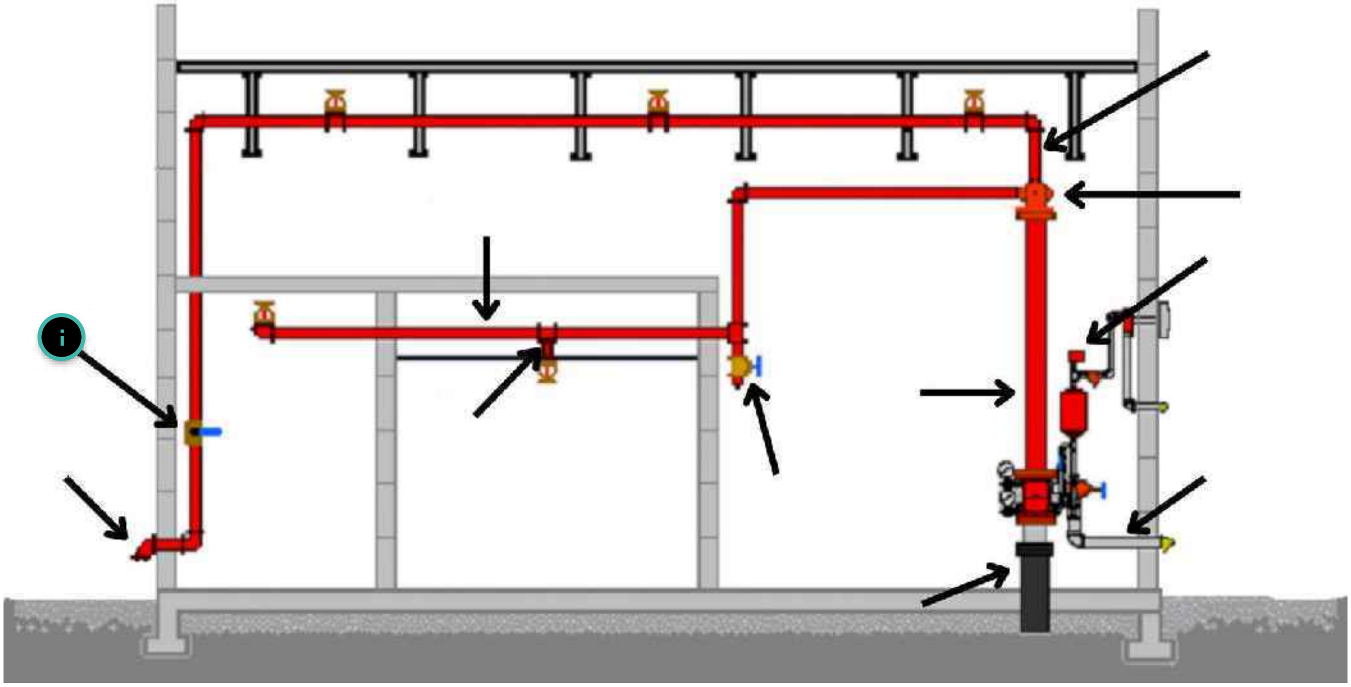
Sprinkler Riser

The vertical supply pipes in a sprinkler system.



Branch Line

The pipes supplying sprinklers, either directly or through sprigs, drops, return bends, or arm-overs.



Inspector’s Test Valve

A valve on the sprinkler system that is opened periodically to simulate a waterflow through the riser, making the waterflow alarm operate.

Image courtesy of Viking.

Paddle-type waterflow alarm indicators shall be used on wet-type systems only. (*NFPA* 13 2016 Section 6.8.2.4)

ANTIFREEZE SYSTEMS

Antifreeze Systems

NFPA 13 2016, Section 3.4.1

An **antifreeze system** is a wet pipe system using automatic sprinklers that contains a liquid solution to prevent freezing of the system, intended to discharge the solution upon sprinkler operation, followed immediately by water from a water supply.

Antifreeze solutions are **required to be listed** for use in sprinkler systems and are limited to premixed solutions of **glycerin or propylene glycol**.

See *NFPA* 13 2016, Section A.7.6.2 for further information.

An **expansion chamber** is required on an antifreeze system having a backflow prevention device.

A **hydrometer** and **refractometer** are used to check the specific gravity of antifreeze.

Hydrometer

Digital Refractometer

Be familiar with the components contained in each of the antifreeze figures, Figures 7.6.3.1, 7.6.3.3, and 7.6.3.4 in *NFPA* 13 2016.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Match the tile to its appropriate sprinkler system.

Wet Pipe System

Most common type of sprinkler system

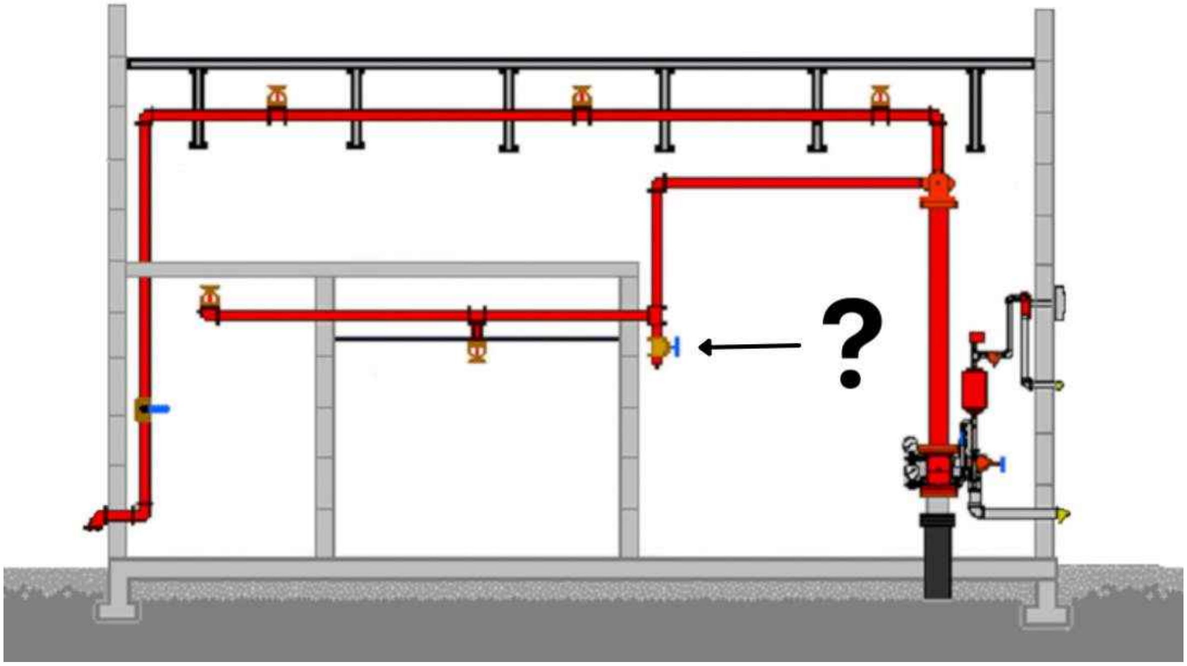
Has an inherently higher degree of reliability

Antifreeze System

Uses a hydrometer and refractometer

Use of listed premixed solutions of glycerine or propylene glycol

What component of the wet pipe diagram is indicated in the image below?



Type your answer here

SUBMIT

Complete the knowledge checks above before moving on.

Dry Pipe Systems

NFPA 13 2016, Sections 3.4.5, 7.2, and 7.2.6

A **dry pipe system** is a sprinkler system employing automatic sprinklers that are attached to a piping system containing air or nitrogen under pressure. The release of these components (as from the opening of a sprinkler) permits the water pressure to open a valve known as a dry pipe valve, and the water then flows into the piping system and out the opened sprinklers.

A dry pipe system is normally used in **areas where freezing is a problem**. It is also used in warehouses and other places that are not normally heated in the wintertime.

Obviously, when water freezes, it expands and it bursts pipes. There cannot be water sitting in our sprinkler pipes under freezing conditions. Clearly, ice does not flow very well from a sprinkler head. The dry pipe system was developed to solve this problem.

Click on the image to enlarge

Click on the image to enlarge

CONTINUE

Watch the video below to learn more about dry pipe systems.

Run time 0:41

CONTINUE

The dry pipe system has **air pressure in the pipes**. The sprinklers and other components are similar in nature to those of the wet system except that, instead of holding back water, they are simply holding back air pressure.

The dry pipe system has to be designed with a certain amount of **slope to the piping** so that it is **easy to drain** after the system has been actuated or tested.

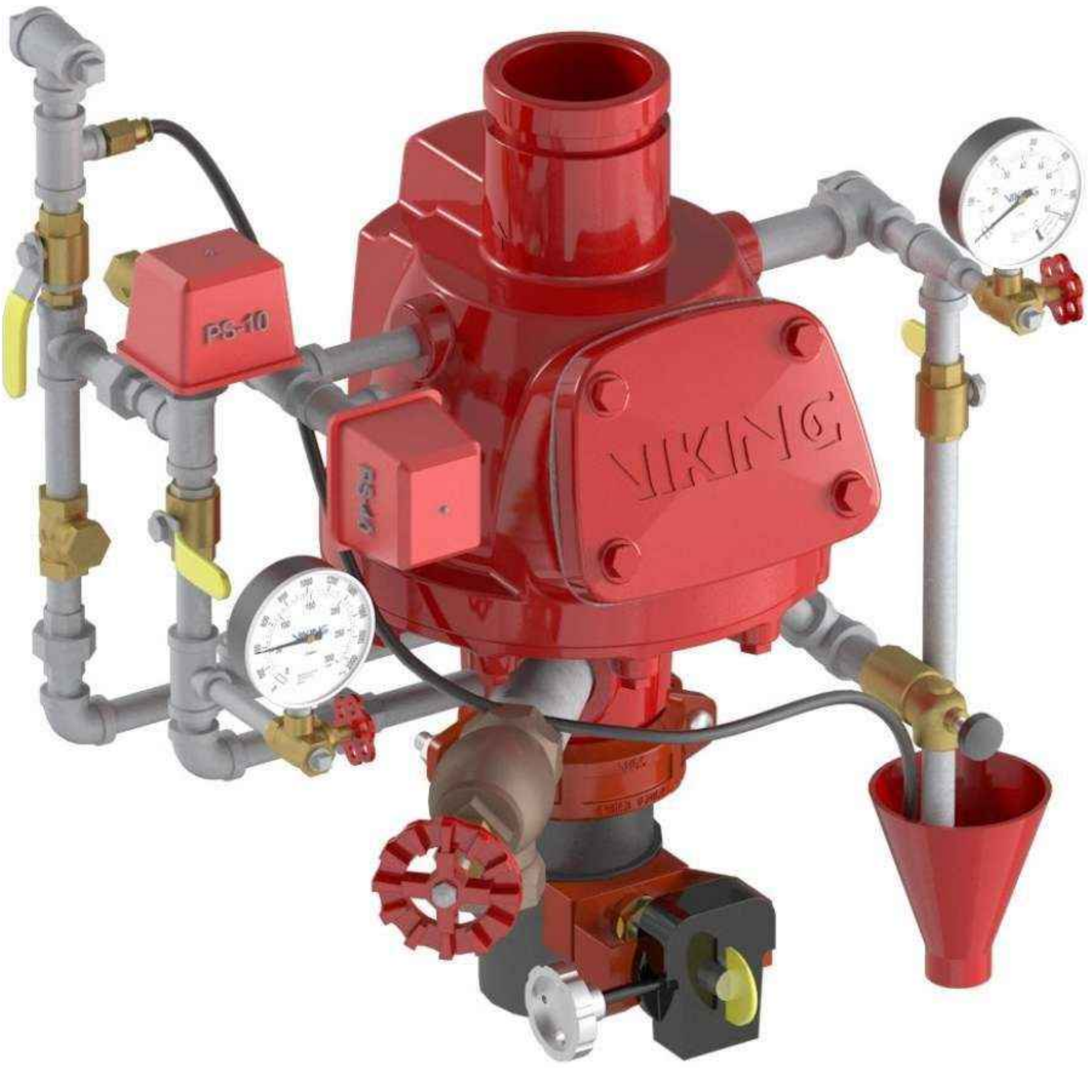


Image courtesy of Viking

ⓘ **The subsections within Section 7.2 of *NFPA* 13 2016 address pressure gauge and relief valve requirements.**

CONTINUE

The following types of sprinklers are permitted in dry pipe systems, as displayed in the flashcards.

Upright sprinkler

1 of 5

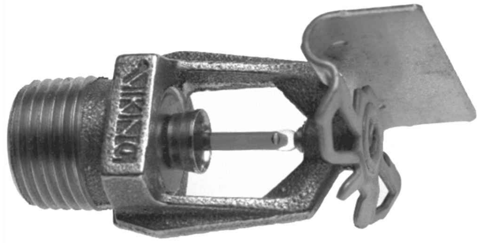
Listed dry sprinklers (dry barrel sprinkler depicted)

Pendent and sidewalls that have:

- area maintained at or above 40°F
- Potable water supply
- copper or CPVC piping

Pendent sprinklers and sidewall sprinklers installed on return bends (40°F temperature minimum)

4 of 5

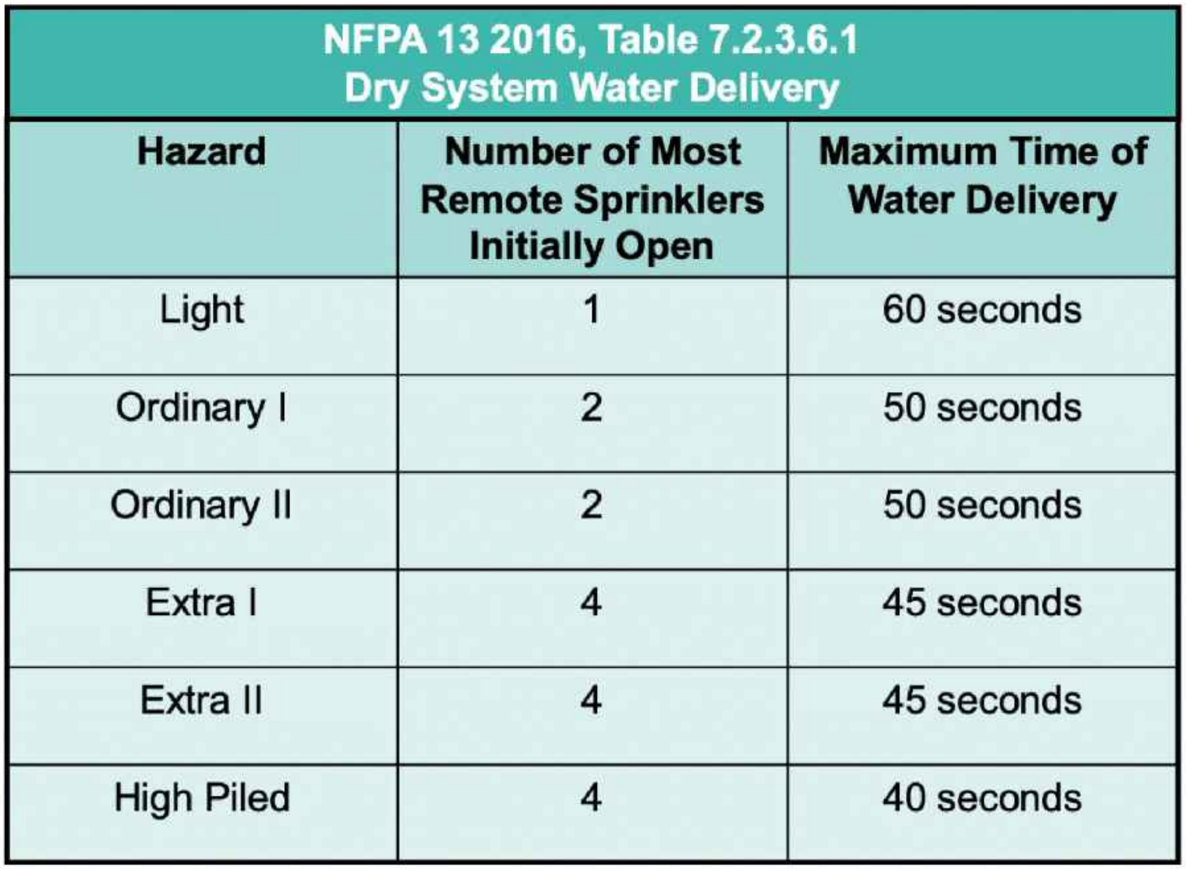


Horizontal sidewall sprinklers, with provisions to prevent water entrapment

5 of 5

CONTINUE

Because a dry pipe system is to be used in areas where freezing can be a problem, the standard recommends the dry pipe system be replaced with a wet pipe system, if and when the low-temperature problem is eliminated.



NFPA 13 2016, Table 7.2.3.6.1
Dry System Water Delivery

Hazard	Number of Most Remote Sprinklers Initially Open	Maximum Time of Water Delivery
Light	1	60 seconds
Ordinary I	2	50 seconds
Ordinary II	2	50 seconds
Extra I	4	45 seconds
Extra II	4	45 seconds
High Piled	4	40 seconds

Click on the image to enlarge.

Due to the fact that the piping in a dry system is filled with air or nitrogen under pressure, that **air must be exhausted** and the **air pressure must be relieved** before the water can enter the pipes.

This delays the water from reaching the fire. It is assumed that since there is a delay in the water reaching the sprinkler, more sprinklers will open in the event of a fire.

Air or nitrogen is required to be **maintained** on dry pipe systems **year-round**.

The air supply is required to be capable of restoring normal air pressure in the system within **30 minutes** (*NFPA* 13 2016 Section 7.2.6).

ⓘ **The dry system needs to be sized so that the initial water is discharged from the system test connection in 60 seconds or less. (*NFPA* 13 2016 Section 7.2.3)**

QUICK OPENING DEVICES

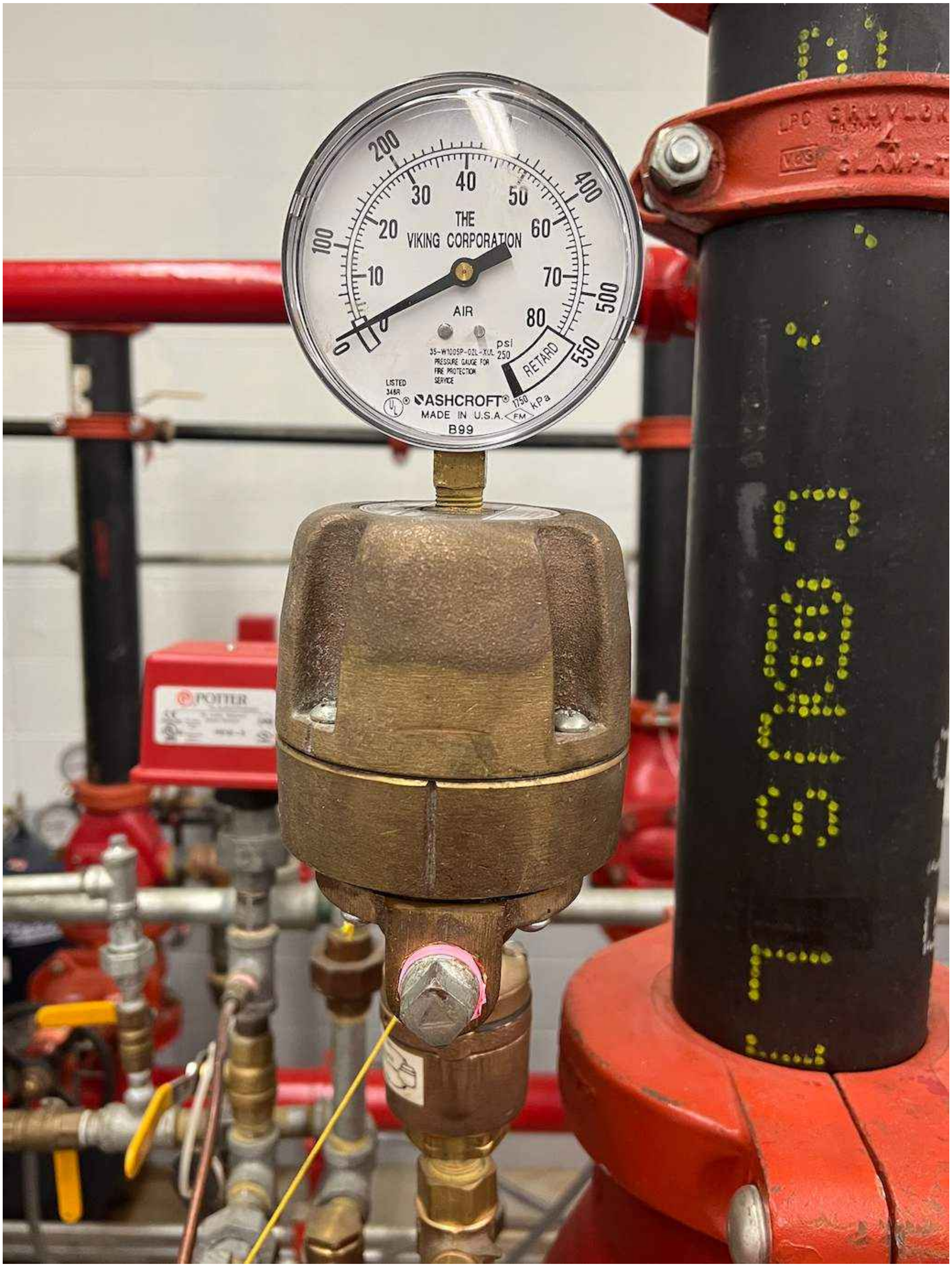
Quick Opening Devices

NFPA 13 2016, Section 7.2

When **quick opening devices** are included in the dry pipe system, they must be installed as near to the dry pipe valve as possible.

- An **indicating valve** must be installed in the connection between the dry pipe system riser and the quick opening device.
- A **check valve** must be installed between the intermediate chamber of the dry pipe valve and the quick opening device.

Check valve for dry pipe system



Quick opening device

For dry pipe systems **not exceeding 500 gallons**, the system capacity is permitted **without** a quick opening device. A system size **not exceeding 750 gallons** is permitted **with** a quick opening device.

- Neither of these system sizes has specific water delivery requirements to the inspection test connection.
- Dry-pipe systems protecting dwelling unit portions of any occupancy **may not** use these options.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Which of the following is a sprinkler type that can be used for a dry pipe system? (Check all that apply)

☐ Any pendent sprinklers and sidewall sprinklers

☐ Upright sprinklers

☐ All Early Suppression Fast Response Sprinklers

☐ Horizontal sidewall sprinklers (with provisions)

SUBMIT

The dry pipe system has air pressure in the pipes.

○ True

○ False

SUBMIT

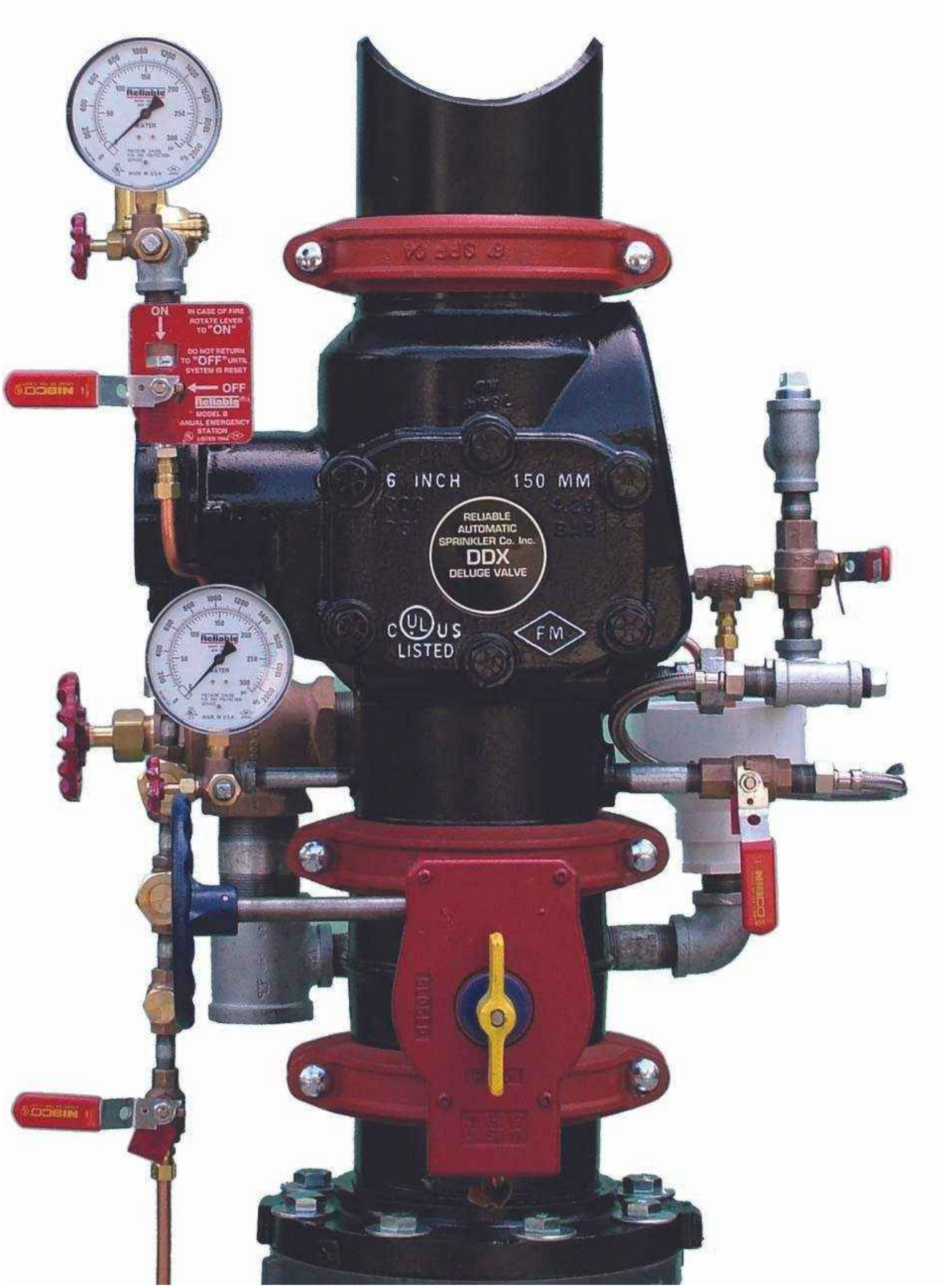
Complete the knowledge checks above before moving on.

Deluge Systems

NFPA 13 2016, Section 3.4.4

A **deluge system** is a sprinkler system employing open sprinklers or nozzles that are attached to a piping system that is connected to a water supply through a valve that is opened by the operation of a detection system installed in the same areas as the sprinklers or nozzles.

This type of system is generally used for **special hazards where rapid fire spread is a concern**, such as near transformers or oil piping systems.


ON
IN CASE OF FIRE ROTATE LEVER TO "ON"
DO NOT RETURN TO "OFF" UNTIL SYSTEM IS RESET
OFF
Reliable
MODEL B
MANUAL EMERGENCY STATION
NIBCO
6 INCH
150 MM
RELIABLE AUTOMATIC SPRINKLER Co. Inc.
DDX
DELUGE VALVE
c UL US
LISTED
FM
Reliable
WATER

When this valve opens, water flows into the piping system and **discharges from all sprinklers or nozzles** attached thereto.

A deluge system is exactly what its name implies. Once actuated, it deluges everything. With a deluge system, there is separate detection because all of the sprinkler heads are open. This would be categorized as an **open type of system**.

When a fire is sensed by the detection system, the main deluge valve opens and all of the heads discharge **simultaneously**. This is the type of system where you would want to be very, very careful in terms of choosing the application. When this type of system actuates, **everything in its proximity will get wet**.

CONTINUE

Watch the video below to learn more about deluge systems.

Run time 1:26

PREACTION SYSTEMS

Preaction Systems

NFPA 13 2016, Section 3.4.10

A **preaction system** is a sprinkler system employing automatic sprinklers that are attached to a piping system that contains air that might or might not be under pressure, with a supplemental detection system installed in the same area as the sprinklers.

Preaction sprinkler systems are a **hybrid of wet, dry, and deluge systems**. They are specialized for use in **areas where accidental activation is undesirable**, such as museums or buildings with rare artworks or manuscripts, libraries, or data centers.

Click on the image to enlarge

Click on the image to enlarge

CONTINUE

Watch the video below to learn more about preaction systems.

Run time 0:50

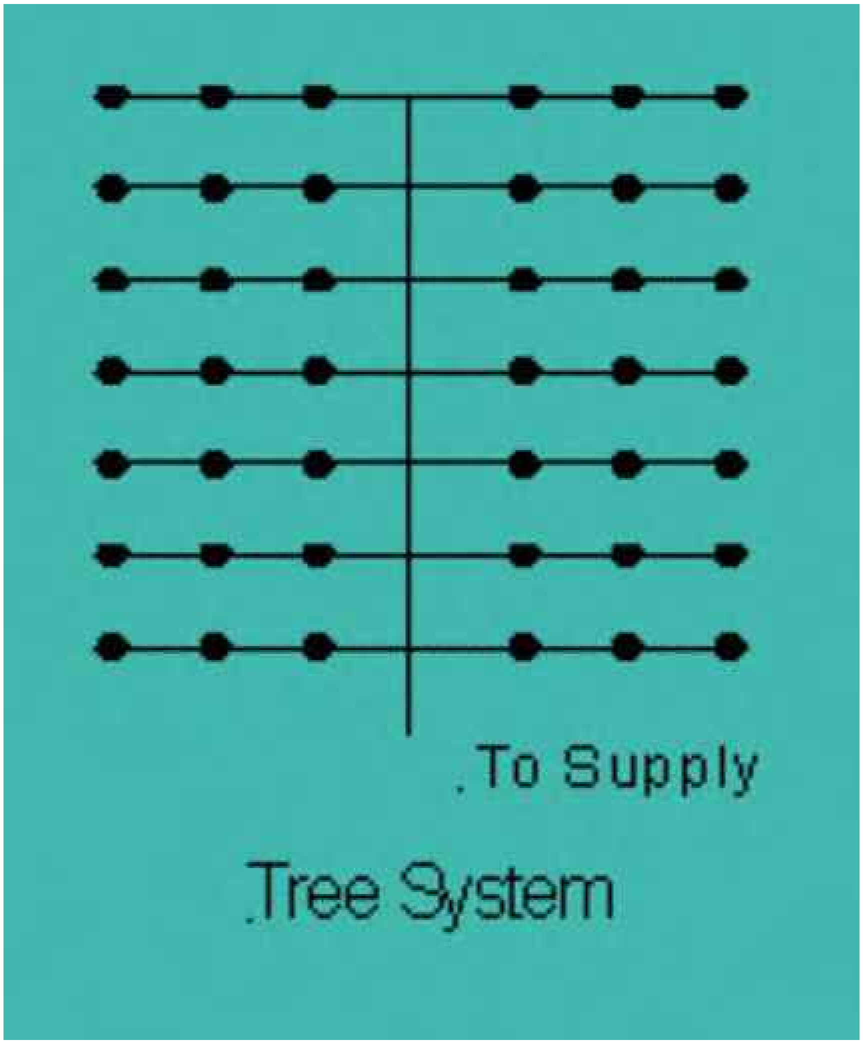
No more than 1000 sprinklers can be controlled by one preaction valve. (*NFPA* 13 2016 Section 7.3.2.2)

SPRINKLER ARRANGEMENTS: TREE OR BASIC SYSTEMS

Tree or Basic System

Automatic Sprinkler Systems Handbook

As defined in the handbook for *NFPA* 13 2016, this system is “the **most basic** system of sprinkler pipe layouts where the **cross mains and the branch lines are not tied together**, providing only one path for the water to flow to an operating sprinkler.”



Click on the image to enlarge.

Advantages

- Easier hydraulic calculations than a gridded system.

Disadvantages

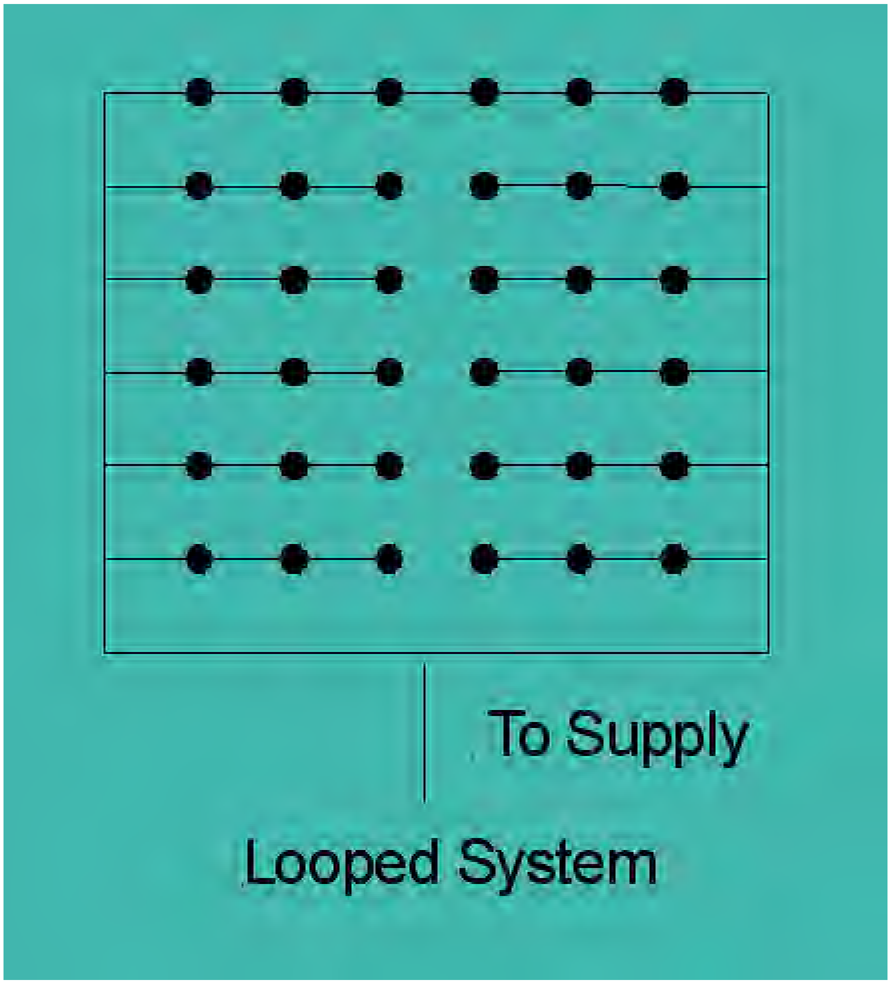
- Does not perform hydraulically as well as a looped or gridded

- Does not have the same limitations and design issues as a gridded system.
- Does not need a relief valve to allow for thermal expansion of water and the related pressure fluctuations, since air can be trapped.

system.

SPRINKLER ARRANGEMENTS: LOOPED SYSTEMS

Looped System



Click on the image to enlarge.

NFPA 13 2016, Section 3.4.6

A sprinkler system in which **multiple cross mains are tied together** so as to provide more than one path for water to flow to an operating sprinkler and branch lines are not tied together.

Advantages	Disadvantages
• Hydraulic performance is better than a tree system design. • Easier hydraulic calculations than a gridded system.	• Does not perform hydraulically as well as a gridded system.

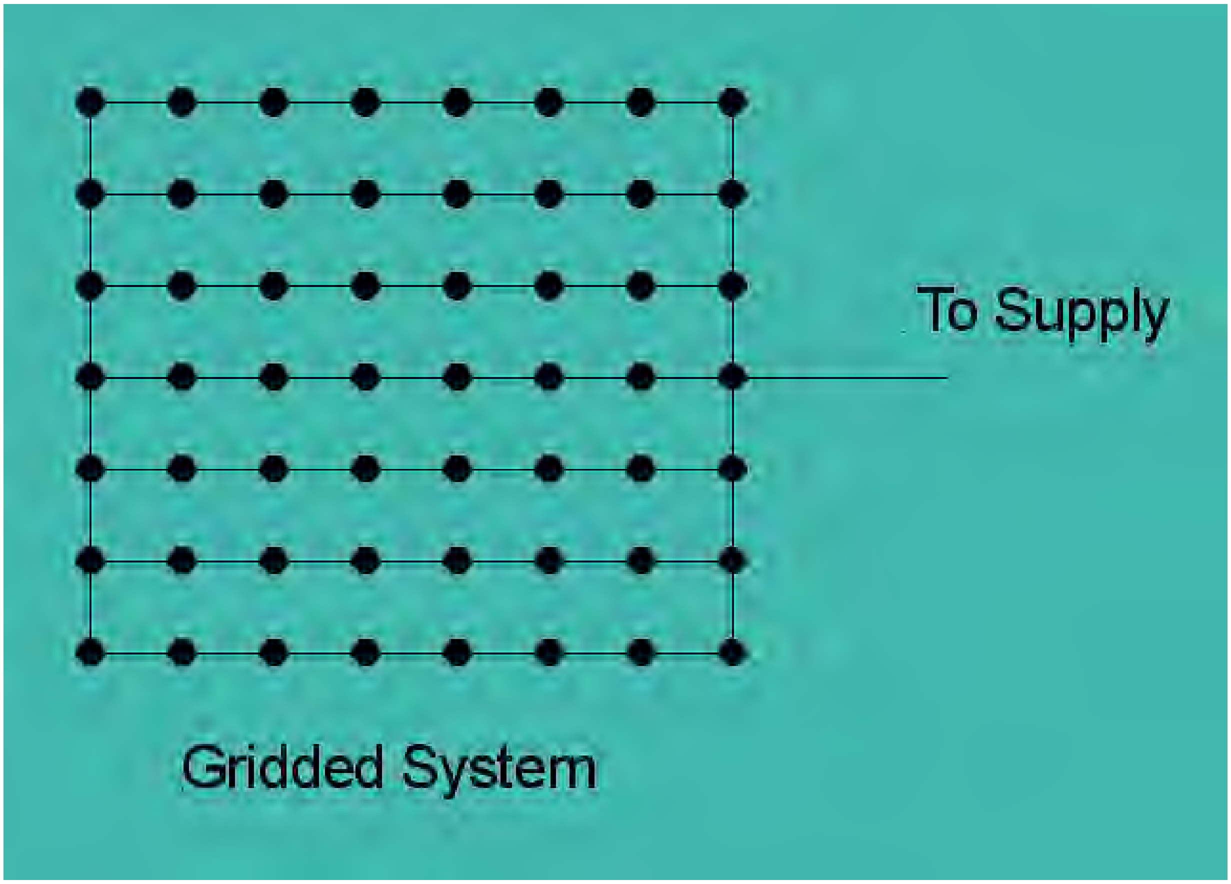
- Does not have the same limitations and design issues as a gridded system.

SPRINKLER ARRANGEMENTS: GRIDDED SYSTEMS

Gridded System

NFPA 13 2016, Section 3.4.7

A sprinkler system in which **parallel cross mains are connected by multiple branch lines**, causing an operating sprinkler to receive water from both ends of its branch line while other branch lines help transfer water between cross mains.



Click on the image to enlarge.

Advantages

- Hydraulic performance is better than looped system designs due to lower pressure drops since there are more flow paths.

Disadvantages

- More difficult hydraulic calculations than tree or looped system designs. A computer program is often needed.
- Must have a relief valve to remove trapped air and allow for thermal expansion of water and the related pressure fluctuations.
- Not permitted for dry pipe systems and some preaction systems.

ⓘ Gridded dry pipe systems are *not* permitted to be installed. (*NFPA* 13 2016 Section 7.2.3.10)

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Match each sprinkler system to its appropriate description.

≡ Wet Pipe System	Most common type of sprinkler system due to its simplicity
≡ Dry Pipe System	The air in the system is pressurized
≡ Preaction System	Hybrid of wet, dry, and deluge systems
≡ Deluge System	When the main valve opens and all of the heads discharge simultaneously

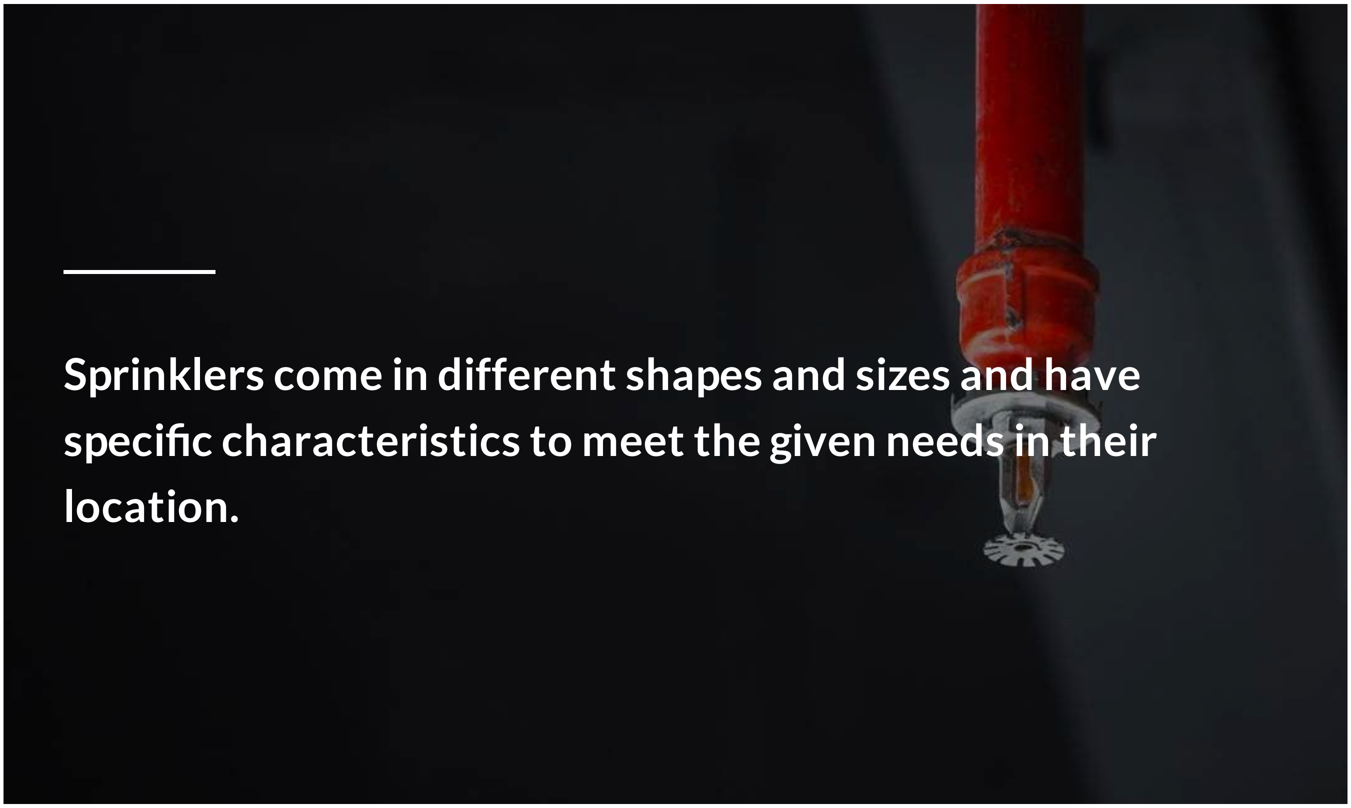
Antifreeze System	Contains a liquid solution to prevent freezing of the system

SUBMIT

Complete the knowledge check above before moving on.

Lesson 2 of 2

Types of Sprinklers



Sprinklers come in different shapes and sizes and have specific characteristics to meet the given needs in their location.

Lesson Goals

By the end of this lesson, you will be able to do the following:

- ☐ Identify sprinkler components, markings, and activation triggers.
- ☐ Recognize different types of sprinklers and explain their functionality.

☐ Describe the relationship between a sprinkler’s k-factor, flow rate, and pressure.

Key References

- *NFPA* 13 - *Standard for the Installation of Sprinkler Systems*, 2016

LET'S BEGIN

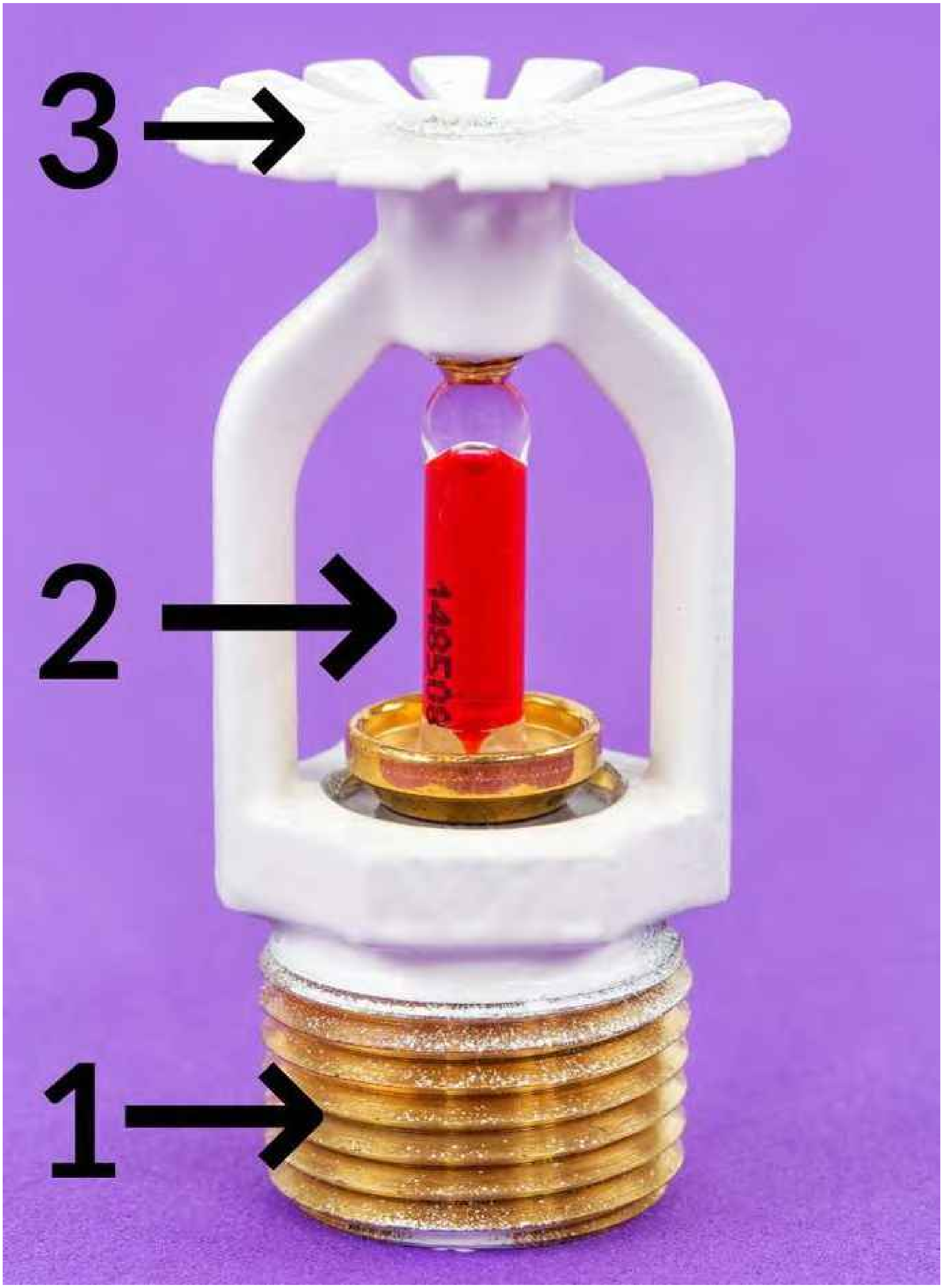
Sprinkler Head Components

A sprinkler head is a pipe fitting with **three main components**:

1. A plugged orifice
2. A temperature trigger
3. A deflector

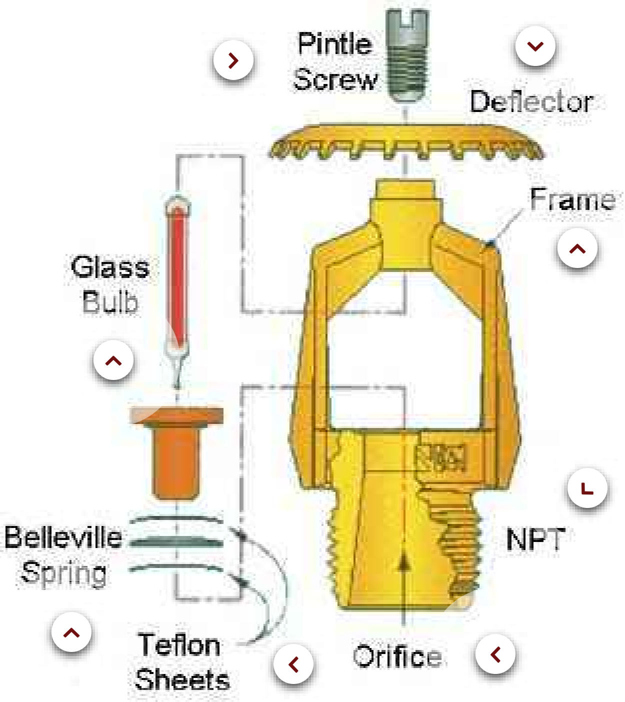
The temperature trigger may be either a liquid-filled glass bulb or a soldered link. On either type, **when the rated temperature is exceeded, the plugged orifice is opened, and water is released**.

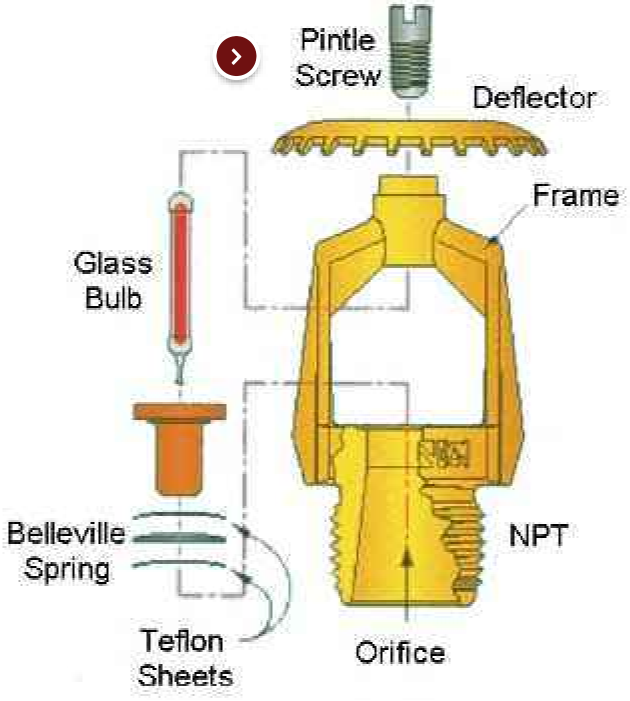
The water impinges on the deflector and sprays uniformly onto the protected area.


3
2
1

CONTINUE

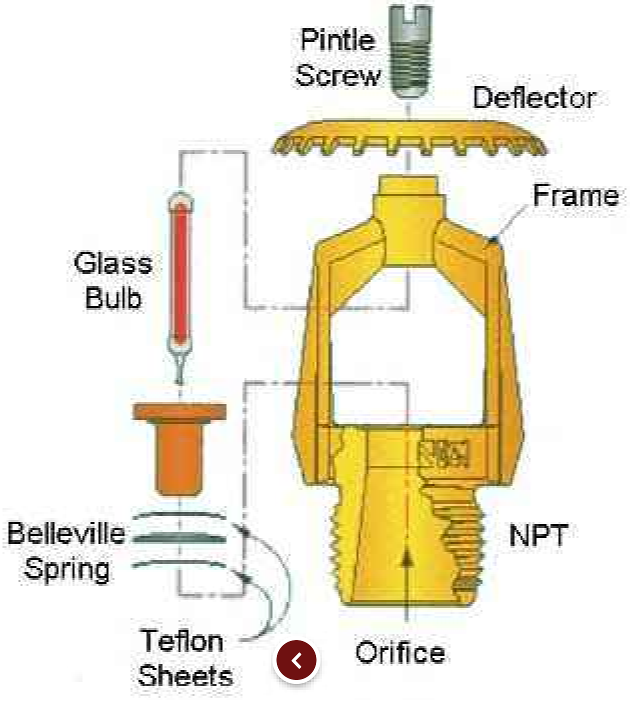
Click on the buttons to learn about the specific components of sprinkler heads.





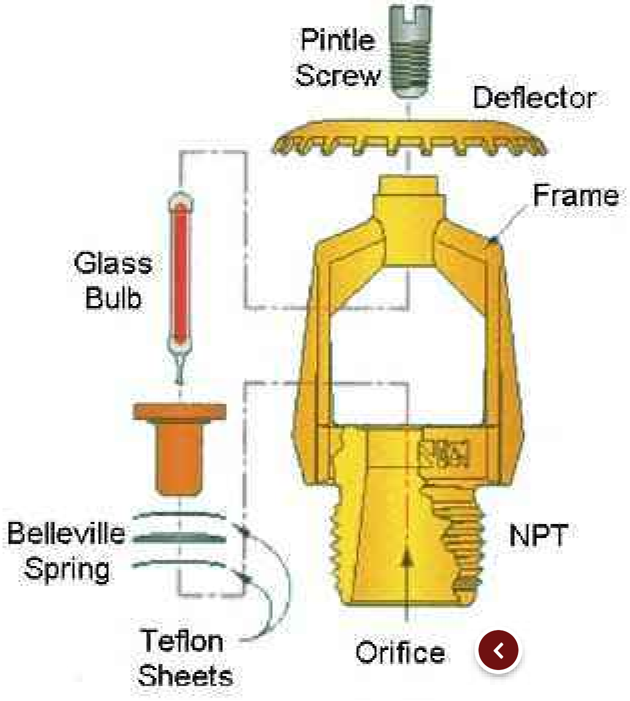
Pintle Screw

Small metal protrusion extending above or beyond the sprinkler deflector.



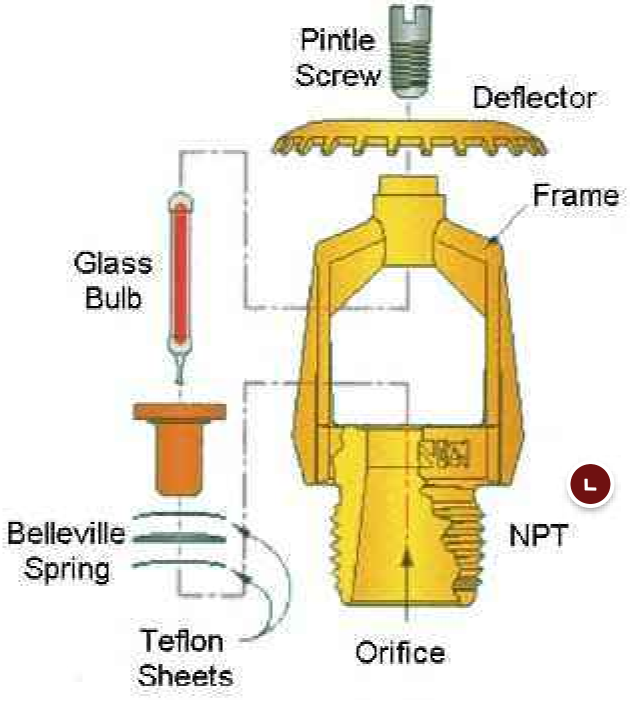
Teflon Sheets

Coats the belleville washer seal.



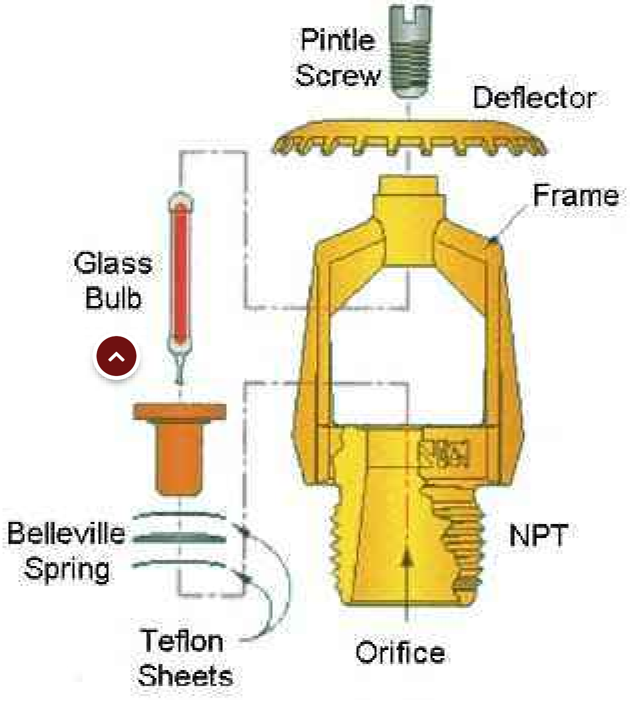
Orifice

The opening of the sprinkler through which liquid flows.



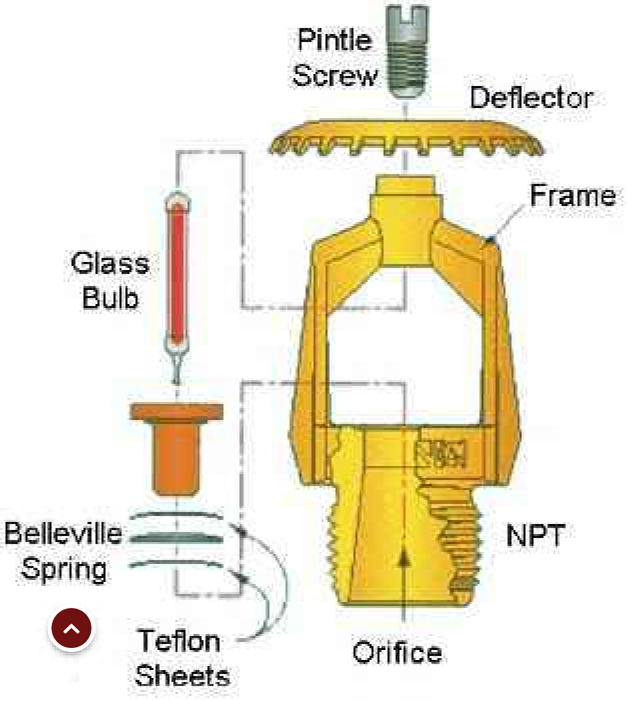
NPT

NPT stands for National Pipe Thead and seals the sprinkler head to pipes for fluid transfer.



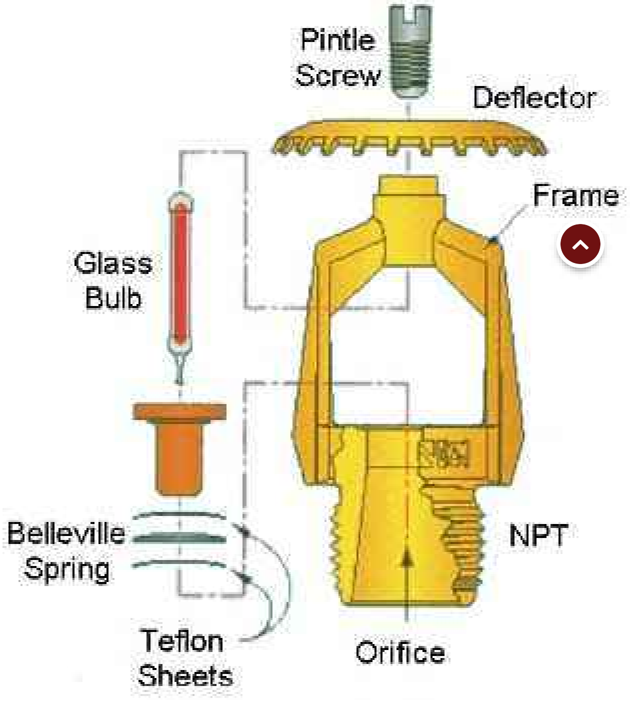
Glass Bulb

It is a heat-sensitive ‘trigger’ that can be adjusted to break and release the seal over the orifice to release water at different temperatures.



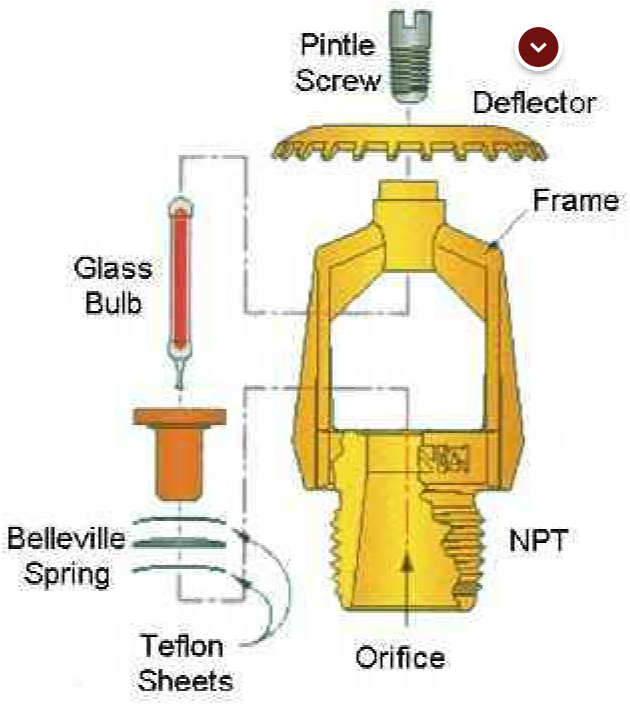
Belleville Spring

Coated on both sides with Teflon sheets, the Belleville spring seals the waterway of the sprinkler. This metal-to-metal sealing mechanism allows the waterway to clear even when no pressure is on the inlet of the sprinkler head.



Frame

The frame, or casting, is the metal housing for the rest of the fire sprinkler head and its connection to the sprinkler pipe.



Deflector

The deflector spreads the water out over the space, and is designed to cover a certain amount of area with a certain amount of water.

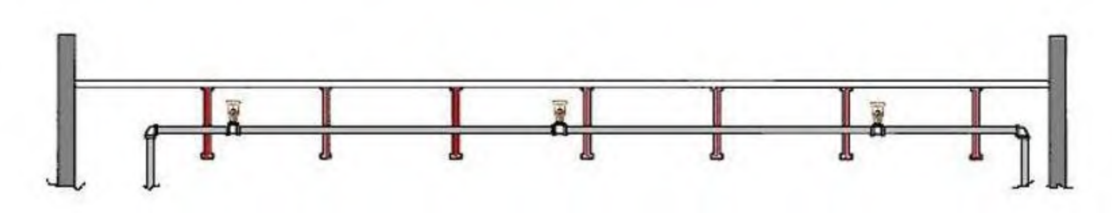
SPRINKLER HEAD TYPES

Sprinkler Head Types

There are different sprinkler head types that serve different purposes depending on the area in which they are located. Scroll through the following sprinkler head types to read their definition and learn more about their purposes.

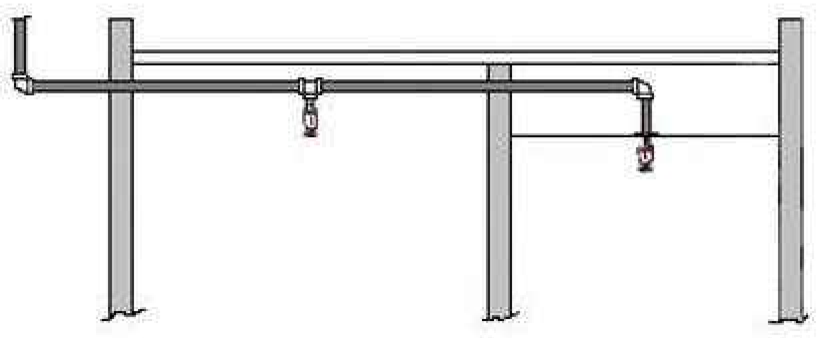
Upright Sprinkler

A sprinkler designed to be installed in such a way that the water spray is directed upwards against the deflector. Upright sprinklers are installed on the top of the sprinkler piping. (*NFPA* 13 2016, Section 3.6.2.6)



Pendent Sprinkler

A sprinkler designed to be installed in such a way that the water stream is directed downward against the deflector. Pendent sprinklers are installed on the bottom of piping or through a ceiling. (*NFPA* 13 2016, Section 3.6.2.3)

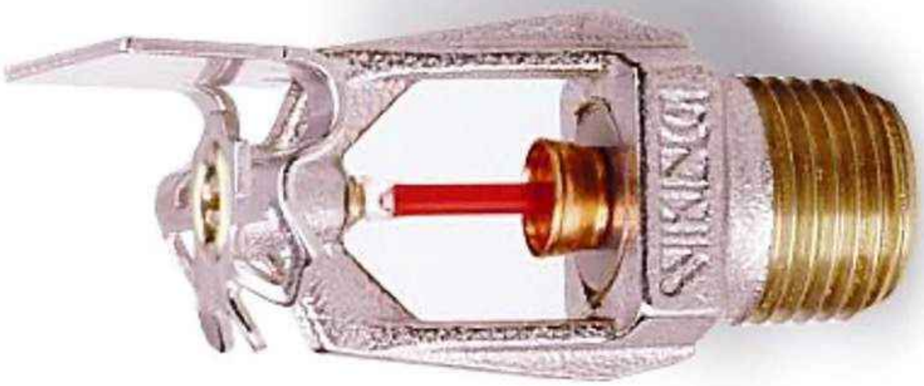


Recessed Sprinkler

A sprinkler in which all or part of the body, other than the shank thread, is mounted within a recessed housing. (*NFPA* 13 2016, Section 3.6.2.4)

Sidewall Sprinkler

A sprinkler having special deflectors that are designed to discharge most of the water away from the nearby wall in a pattern resembling ¼ of a sphere, with a small portion of the discharge directed at the wall behind the sprinkler. (*NFPA* 13 2016, Section 3.6.2.5)



Corrosion-Resistant Sprinkler

A sprinkler fabricated with corrosion-resistant material, or with special coatings or platings, to be used in an atmosphere that would normally corrode sprinklers. (*NFPA* 13 2016, Section 3.6.3.1)

Dry Sprinkler

A sprinkler secured in an extension nipple that has a seal at the inlet end to prevent water from entering the nipple until the sprinkler operates. (*NFPA* 13 2016, Section 3.6.3.2)

Early Suppression Fast-Response (ESFR) Sprinkler

A type of fast-response sprinkler that has the capability to provide fire suppression of specific high-challenge fire hazards. (*NFPA* 13 2016, Section 3.6.4.3)

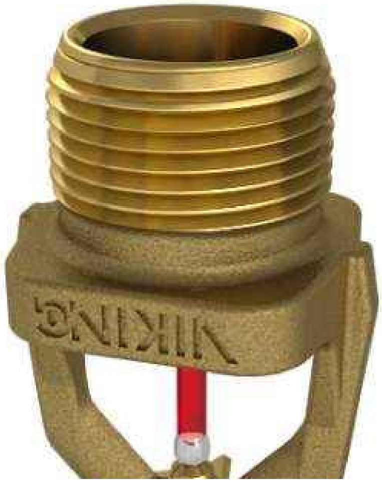
- Shall be used in wet systems, unless listed for dry systems
- Are not permitted to protect storage with open top containers
- **Cannot** be installed on ceilings with a slope that exceeds a pitch of 2 in 12
- Are permitted for use in buildings with unobstructed and noncombustible obstructed construction
- Antifreeze shall **not** be used in ESFR systems unless specifically listed for use with antifreeze systems (*NFPA* 13 2016 Section 7.6.1.2)

Control Mode Specific Application (CMSA) Sprinkler

A type of specific application control mode sprinkler that is capable of producing characteristic large droplets and that is listed for its capability to provide fire control of specific high-challenge fire hazards. (*NFPA* 13 2016, Section 3.6.4.2)

Extended Coverage Sprinkler

A type of spray sprinkler with maximum coverage areas as specified in Sections 8.8 to 8.9 of *NFPA* 13 2016. (*NFPA* 13 2016, Section 3.6.4.4)



Standard Spray Sprinkler

A spray sprinkler with maximum coverage areas as specified in Sections 8.6 to 8.7 of *NFPA* 13 2016. (*NFPA* 13 2016, Section 3.6.4.11.1)

Quick-Response (QR) Sprinkler

A type of spray sprinkler that has a thermal element with an RTI of 50 (meter-seconds)$^{1/2}$ or less and is listed as a quick-response sprinkler for its intended use. (*NFPA* 13 2016, Section 3.6.4.8)

Quick-Response Early Suppression (QRES) Sprinkler

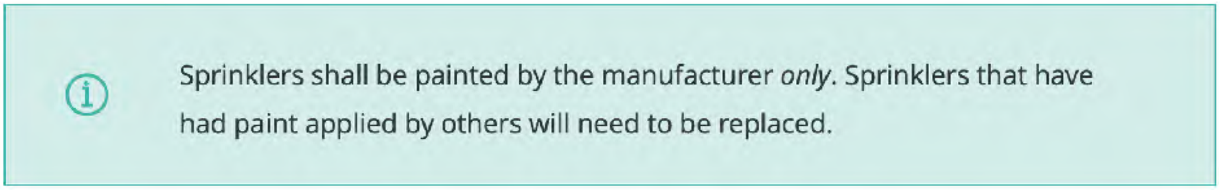
A type of quick-response sprinkler that has a thermal element with an RTI of 50 (meter-seconds)$^{1/2}$ or less and is listed for its capability to provide fire suppression of specific fire hazards. (*NFPA* 13 2016, Section 3.6.4.8.1)

Quick-Response Extended Coverage Sprinkler

A type of quick-response sprinkler that has a thermal element with an RTI of 50 (meter-seconds)^{½} or less and complies with the extended protection areas defined in Chapter 8. (*NFPA* 13 2016, Section 3.6.4.8.2)

Residential Sprinkler

A type of fast-response sprinkler having a thermal element with an RTI of 50 (meter-seconds)^{½} or less, that has been specifically investigated for its ability to enhance survivability in the room of fire origin and is listed for use in the protection of dwelling units. (*NFPA* 13 2016, Section 3.6.4.9)



Sprinklers shall be painted by the manufacturer *only*. Sprinklers that have had paint applied by others will need to be replaced.

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LET'S REVIEW

Let's do a quick check about what has been covered so far.

Match the type of sprinkler to its corresponding definition.

Upright Sprinkler	Installed in such a way that the water spray is directed upward against the deflector
Pendent Sprinkler	Installed in such a way that the water stream is directed downward against the deflector

Sidewall Sprinkler	Has special deflectors that are designed to discharge most of the water away from the wall
Dry Sprinkler	Has a seal at the inlet end to prevent water from entering the nipple until activation
ESFR Sprinkler	Has the capability to provide fire suppression of specific high-challenge fire hazards
CMSA Sprinkler	Sprinkler that is capable of producing characteristic large droplets
Residential Sprinkler	Has been investigated for its ability to enhance survivability in the room of fire origin
Quick-Response Sprinkler	Spray sprinkler that has a thermal element with an RTI of 50 (meter-seconds) ½ or less

SUBMIT

🔒 Complete the knowledge check above before moving on.

Sprinkler Temperature Characteristics

NFPA 13 2016, Section 6.2.5

The temperature trigger of a sprinkler is activated at specific temperatures. The sprinkler temperature rating is **specified by the original building sprinkler drawings**.

Image courtesy of Viking

It is important to compare the temperature rating on the sprinklers versus the rating on the drawings.

- For **newer sprinklers** with glass bulbs, the **color of the liquid in the bulb** will indicate the temperature rating.
- On **older sprinklers** with soldered links, the temperature rating is usually **stamped on the solder element or linkage**.

If the sprinkler has a **protective coating**, such as wax for a corrosive environment, the frame arm or deflector of the sprinkler may be **color-coded**.

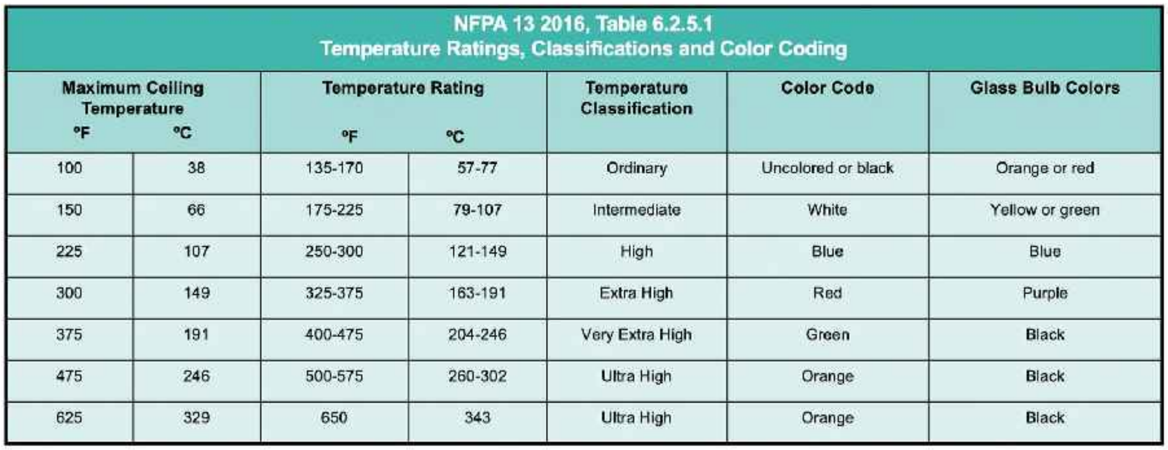
The following is permitted for **color identification of corrosion-resistant sprinklers**:

- A dot on the top of the deflector
- The color of the coating material
- Colored frame arms

Image depicting polyester, stainless steel, and wax-coated corrosive-resistant sprinkler heads. Images courtesy of Viking.

CONTINUE

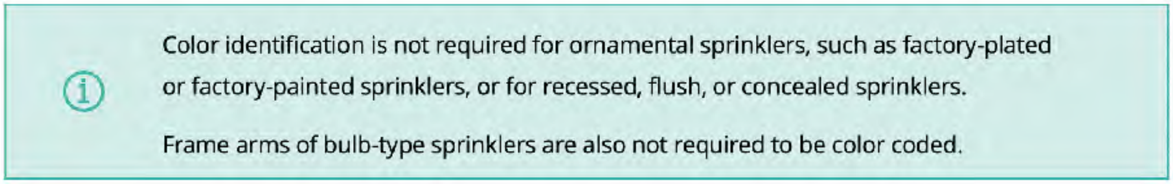
Automatic sprinklers shall have their frame arms, deflector, coating material, or liquid bulb colored in accordance with the requirements of Table 6.2.5.1 (below), or other requirements provided in this Section 6.2.5 of *NFPA* 13 2016.



NFPA 13 2016, Table 6.2.5.1
Temperature Ratings, Classifications and Color Coding

Maximum Ceiling Temperature		Temperature Rating		Temperature Classification	Color Code	Glass Bulb Colors
°F	°C	°F	°C			
100	38	135-170	57-77	Ordinary	Uncolored or black	Orange or red
150	66	175-225	79-107	Intermediate	White	Yellow or green
225	107	250-300	121-149	High	Blue	Blue
300	149	325-375	163-191	Extra High	Red	Purple
375	191	400-475	204-246	Very Extra High	Green	Black
475	246	500-575	260-302	Ultra High	Orange	Black
625	329	650	343	Ultra High	Orange	Black

Click on the image to enlarge.



Color identification is not required for ornamental sprinklers, such as factory-plated or factory-painted sprinklers, or for recessed, flush, or concealed sprinklers.

Frame arms of bulb-type sprinklers are also not required to be color coded.

SPRINKLER IDENTIFICATION NUMBER

Sprinkler Identification

NFPA 13 2016, Section 6.2.2

Prior to 2001, sprinkler manufacturers did not have a common system when utilizing laboratory approval markings (e.g., SSU, SSP, EC, QR, etc.) and various other identification markings on sprinkler heads.

Now, all newer sprinklers are required to be identified with a **Sprinkler Identification Number (SIN)**. The SIN consists of the permanent markings of:

- One or two English **uppercase alphabetic characters** to identify the manufacturer
- **Three or four numbers**, to uniquely identify the sprinkler by:
  - K-factor (orifice size)
  - Orifice shape
  - Deflector characteristic
  - Pressure rating
  - Thermal sensitivity

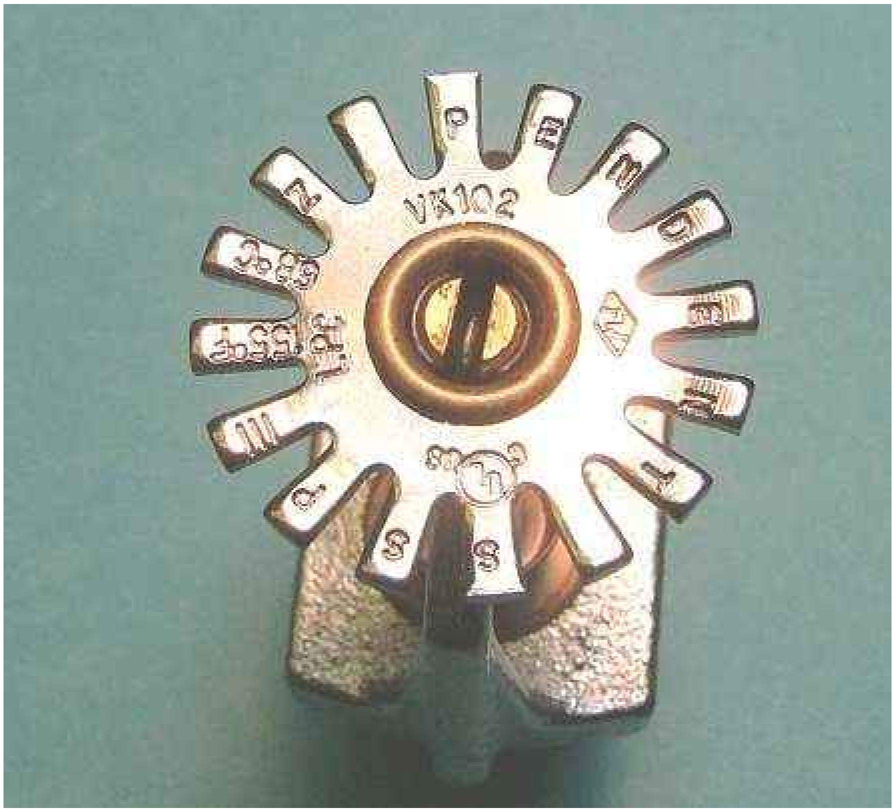


Image courtesy of Viking.

CONTINUE

The three or four numbers are the model numbers and are **set by the manufacturer themselves**. Some manufacturers use each digit to represent a characteristic of the sprinkler, while others use it as a cataloging number.

The number is **marked on the deflector** of most sprinklers and elsewhere on decorative ceiling sprinklers.

For newer sprinklers, use the **manufacturer's catalogs or websites** to determine the characteristics of a particular sprinkler using the SIN.

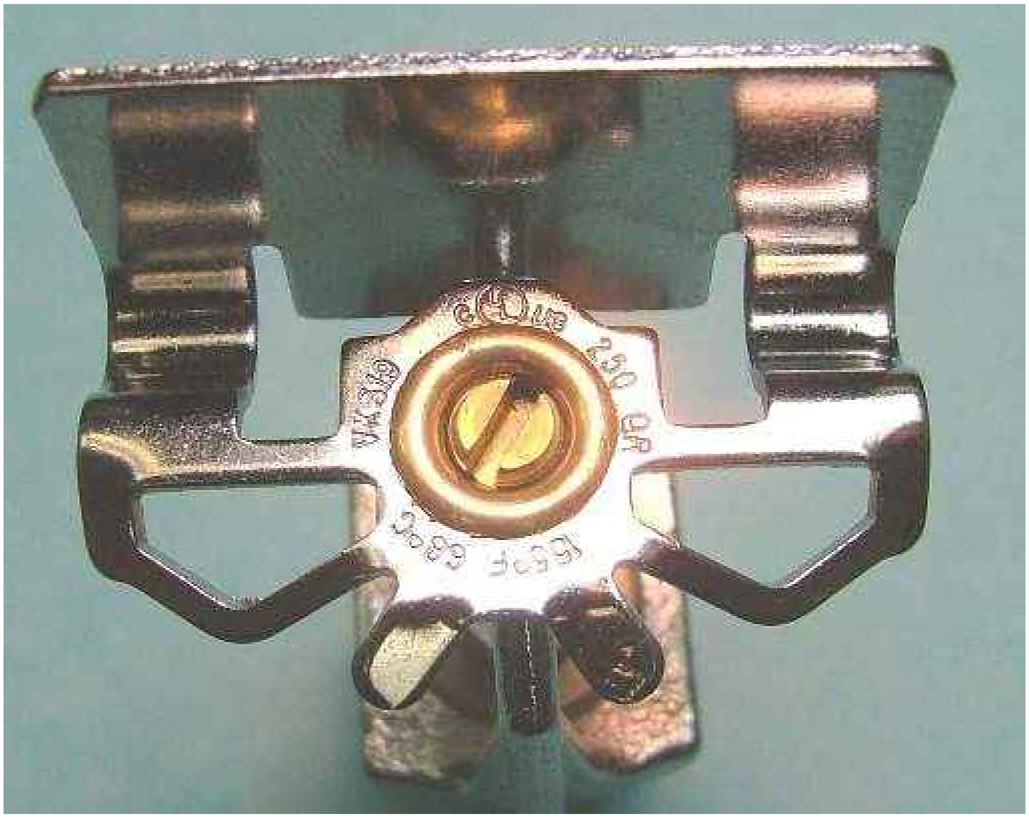


Image courtesy of Viking.

- Underwriters Laboratories (UL) maintains a database for all UL approved manufacturers.
- Field inspections can include spot checks to ensure the model numbers on plans are those that are actually installed.
- The Annex provides the reminder that the SIN should be **checked against a database or the manufacturer's literature** during the plan review to ensure that the sprinklers are being used correctly and within the limitations of their listings.

ⓘ **When a sprinkler is removed from a fitting or welded outlet, it shall not be reinstalled. Only new sprinklers are to be installed. (*NFPA* 13 2016 Section 6.2.1.1)**

LET'S REVIEW

Let's do a quick check about what has been covered so far.

The SIN consists of the permanent markings of (check all that apply)

☐ UL approved shape symbols

☐ Uppercase alphabetic characters

☐ Colored lines

☐ Numbers

SUBMIT

🔒 Complete the knowledge check above before moving on.

K-Factor and Discharge Characteristics

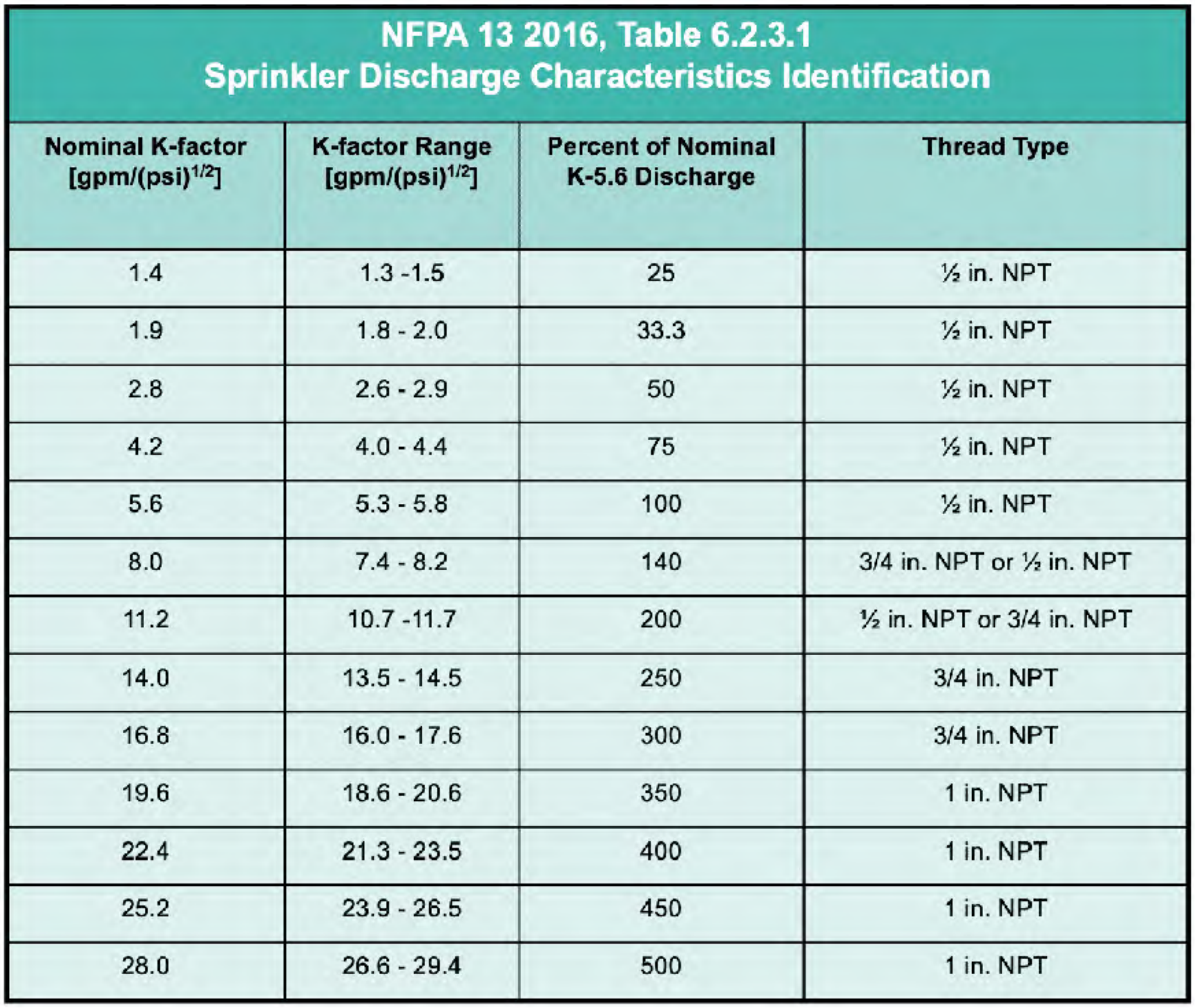
NFPA 13 2016, Sections 6.2.3 and 8.3.4

The **k-factor** is the discharge coefficient of a sprinkler's given orifice. The **larger the k-factor, the greater the flow rate** (at the same sprinkler system pressure). As sprinkler system pressure changes, the flow rate through the sprinkler also changes.

There are thirteen different k-factors that are determined in the design. It is important to **ensure the k-factor and temperature ratings are correct on any spare sprinklers**.

CONTINUE

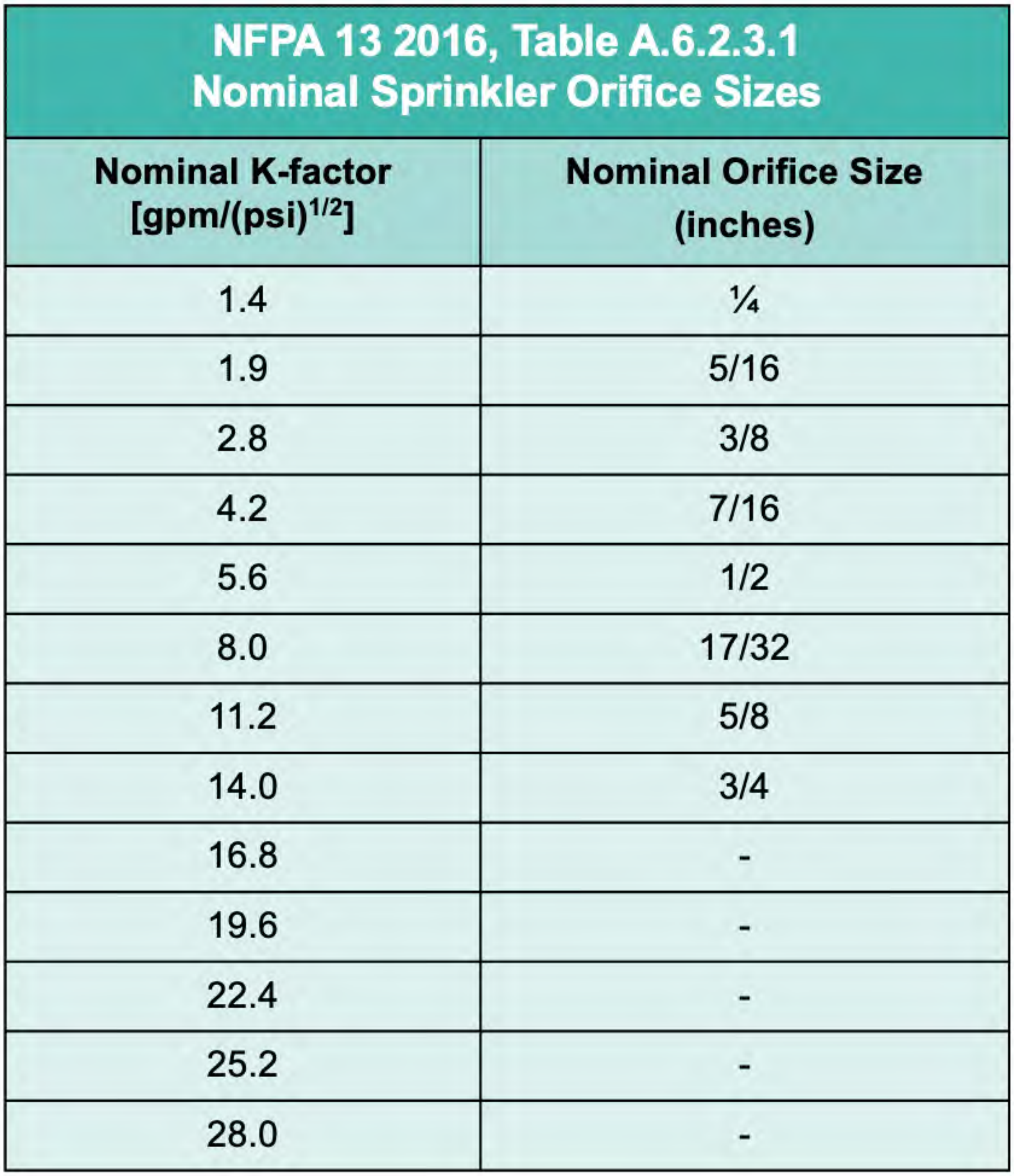
Table 6.2.3.1 identifies sprinkler discharge characteristics.



NFPA 13 2016, Table 6.2.3.1
Sprinkler Discharge Characteristics Identification

Nominal K-factor [gpm/(psi)$^{1/2}$]	K-factor Range [gpm/(psi)$^{1/2}$]	Percent of Nominal K-5.6 Discharge	Thread Type
1.4	1.3 -1.5	25	½ in. NPT
1.9	1.8 - 2.0	33.3	½ in. NPT
2.8	2.6 - 2.9	50	½ in. NPT
4.2	4.0 - 4.4	75	½ in. NPT
5.6	5.3 - 5.8	100	½ in. NPT
8.0	7.4 - 8.2	140	3/4 in. NPT or ½ in. NPT
11.2	10.7 -11.7	200	½ in. NPT or 3/4 in. NPT
14.0	13.5 - 14.5	250	3/4 in. NPT
16.8	16.0 - 17.6	300	3/4 in. NPT
19.6	18.6 - 20.6	350	1 in. NPT
22.4	21.3 - 23.5	400	1 in. NPT
25.2	23.9 - 26.5	450	1 in. NPT
28.0	26.6 - 29.4	500	1 in. NPT

CONTINUE



NFPA 13 2016, Table A.6.2.3.1
Nominal Sprinkler Orifice Sizes

Nominal K-factor [gpm/(psi)$^{1/2}$]	Nominal Orifice Size (inches)
1.4	¼
1.9	5/16
2.8	3/8
4.2	7/16
5.6	1/2
8.0	17/32
11.2	5/8
14.0	3/4
16.8	-
19.6	-
22.4	-
25.2	-
28.0	-

Click on the image to enlarge.

Small orifice sprinklers are those with k-factors **less than 5.6** and can be used when the application doesn't require as much water as a 5.6 k-factor sprinkler at 7 psi.

Small orifice sprinklers are only allowed to be used in conjunction with Light Hazard occupancies. Further limitations on small orifice sprinklers include the following:

- They must be part of a hydraulically designed system.
- The system must be a wet system.
- A listed strainer must protect any sprinklers having a k-factor less than 2.8.

Small orifice sprinklers are **restricted to wet systems**, as there is a concern with scale plugging the orifice. There is an **exception** for dry and preaction systems with a k-factor of 4.2, if the pipe is corrosion-resistant or internally galvanized.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

The discharge coefficient of a sprinkler's given orifice is known as ___________.

○ SIN

○ z-factor

○ k-factor

○ CMSA

SUBMIT

Complete the knowledge check above before moving on.

Spare Sprinklers Stock

NFPA 13 2016, Section 6.2.9

A supply of **at least six spare sprinklers** has to be maintained on the premises so that any sprinklers that have operated or been damaged in any way can be promptly replaced.

Spare sprinkler cabinets are **checked for the number and type of sprinklers** in the cabinet and the head wrench.

To maintain consistency of the building's sprinkler plan, the spare sprinklers must **correspond to the types and temperature ratings** of the sprinklers in the property.

The stock of spare sprinklers include all types and ratings installed and are as follows:

- For protected facilities having under 300 sprinklers — **no fewer than 6 sprinklers**
- For protected facilities having 300 to 1000 sprinklers — **no fewer than 12 sprinklers**
- For protected facilities having over 1000 sprinklers — **no fewer than 24 sprinklers**

CONTINUE

A **list of the sprinklers** installed on the property is posted in the sprinkler cabinet. The list should be permanently attached and include the following information:

- ☐ Sprinkler Identification Number (SIN) if equipped; or the manufacturer, model, orifice, deflector type, thermal sensitivity, and pressure rating
- ☐ General description
- ☐ Quantity of each type to be contained in the cabinet
- ☐ Issue or revision date of the list

LET'S REVIEW

Let's do a quick check about what has been covered so far.

A protected facility with 530 sprinklers must have no fewer than _____ spare sprinklers.

Type your answer here

SUBMIT

🔒 Complete the knowledge check above before moving on.

After completing this module, you should now have a better understanding of the different types of sprinklers and sprinkler systems.

Click on the “Next” arrow up on the right-hand corner of the screen to continue to the quiz.

Automatic Sprinkler & Standpipe Systems - Sprinkler System Components

By the end of this module, you will be able to do the following:

- Identify the purpose and function of various sprinkler system components.
- Explain the role of and design requirements for a fire department connection.
- Recognize working pressure limitations for sprinklers system components.

Key References:

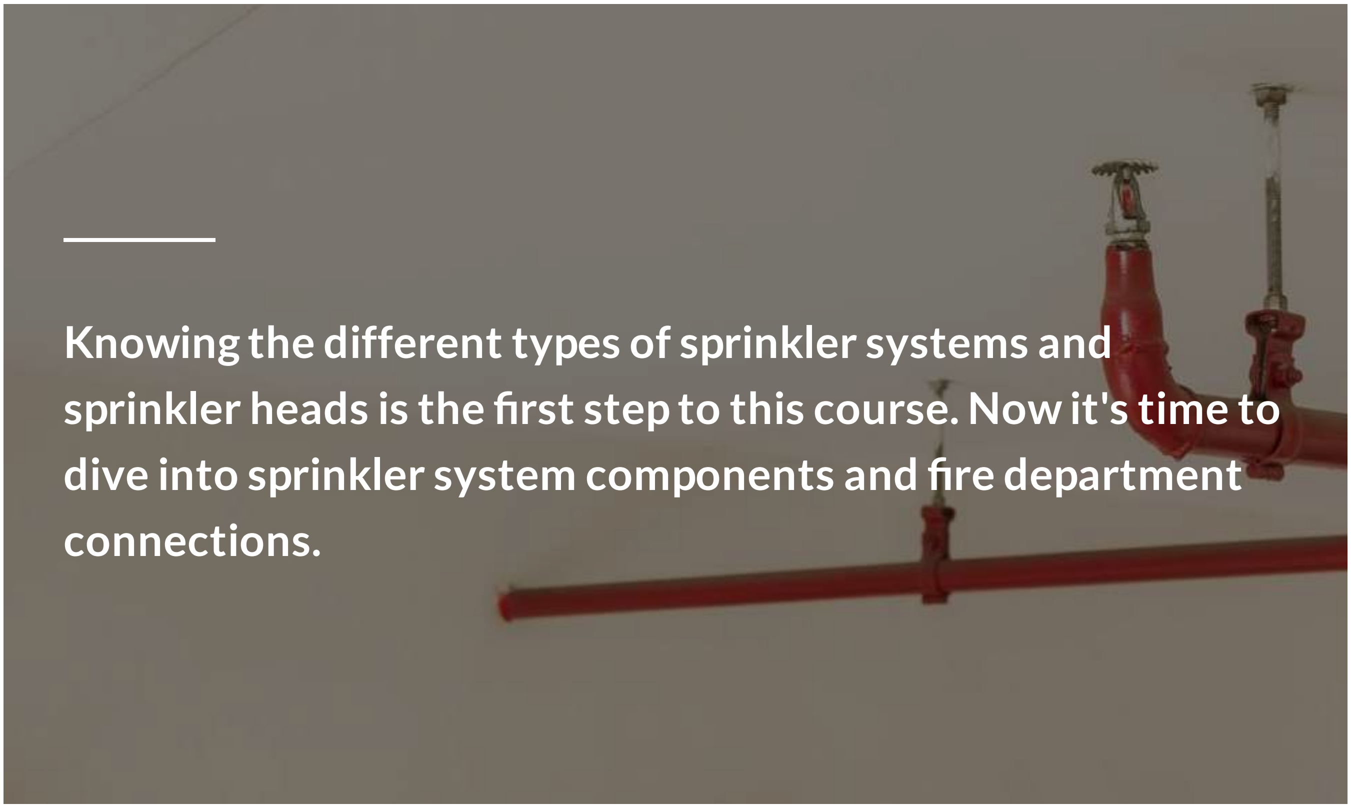
- *NFPA* 13 - *Standard for the Installation of Sprinkler Systems*, 2016

When you are ready to begin, click on the button above to start the course.

Sprinkler System Components

Lesson 1 of 1

Sprinkler System Components



Knowing the different types of sprinkler systems and sprinkler heads is the first step to this course. Now it's time to dive into sprinkler system components and fire department connections.

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Identify the purpose and function of various sprinkler system components.

☐ Explain the role of and design requirements for a fire department connection.

☐ Recognize working pressure limitations for sprinklers system components.

Key References

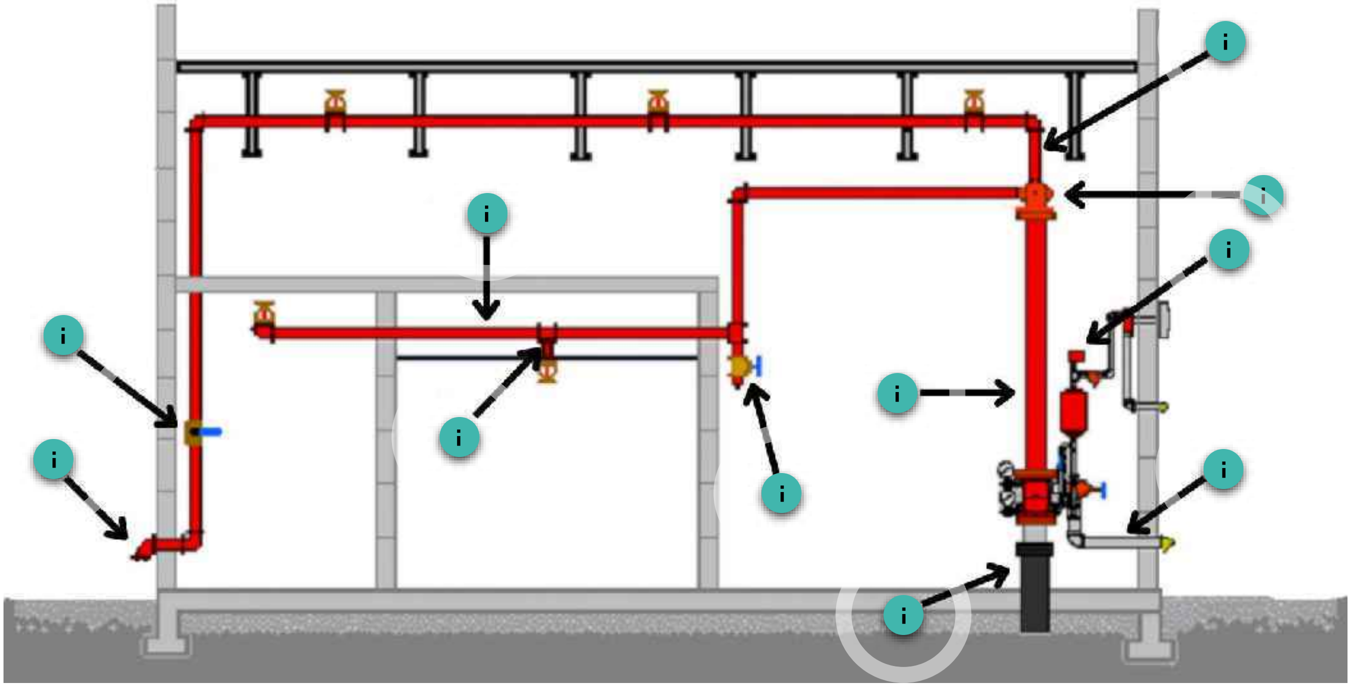
- *NFPA* 13 - *Standard for the Installation of Sprinkler Systems*, 2016

LET'S BEGIN

Sprinkler System Components

As featured in the sprinkler systems lesson, let's first review the components of the wet pipe sprinkler system again.

Click on the buttons of the diagram to view each component's definition.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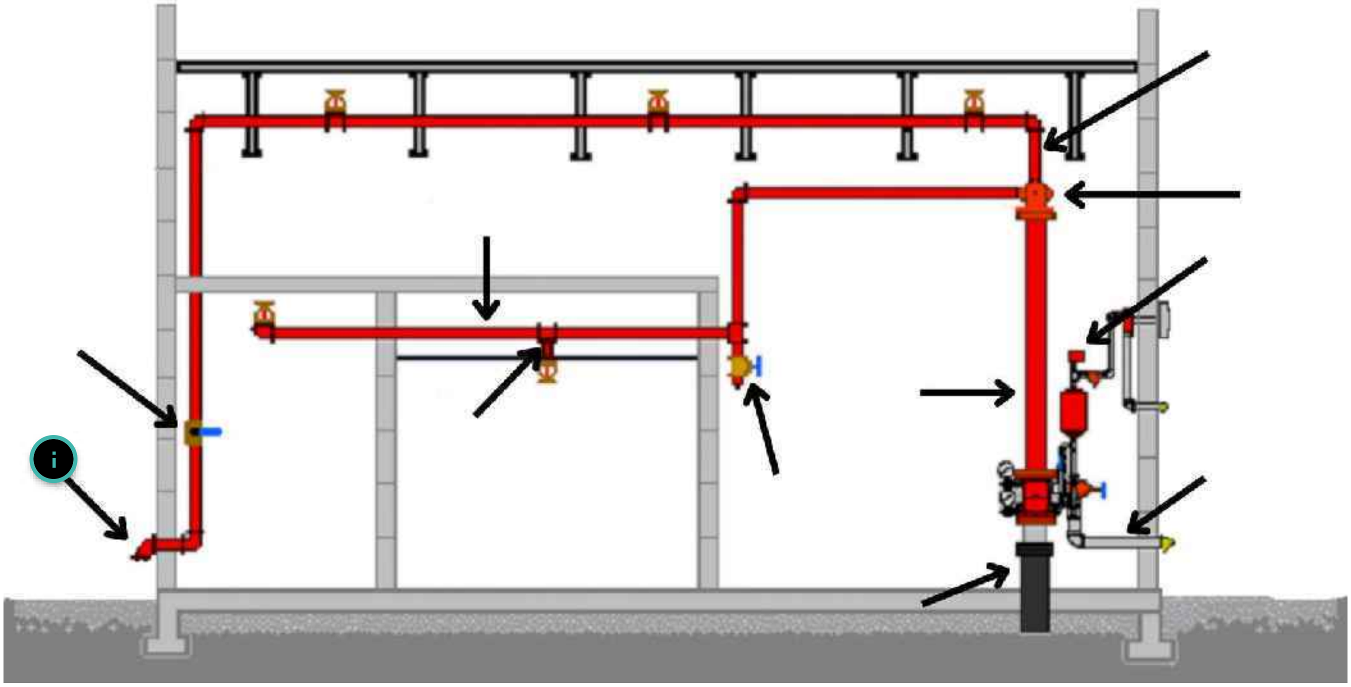
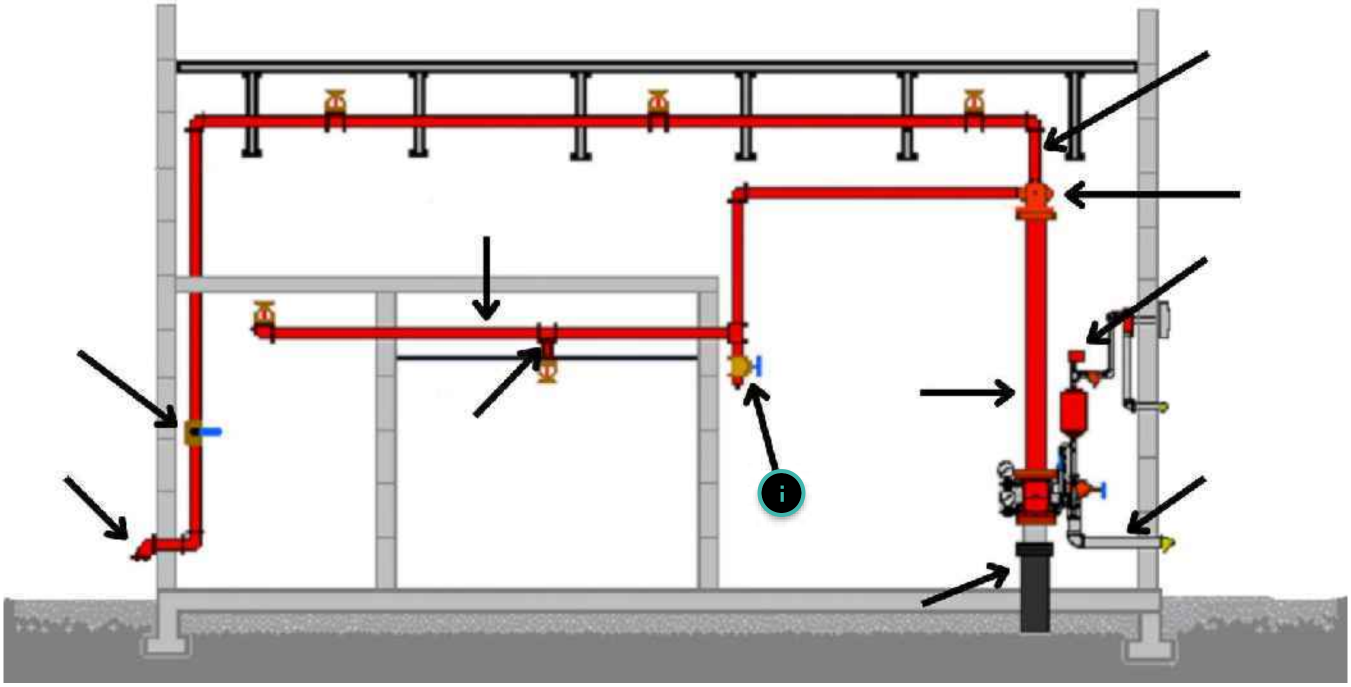


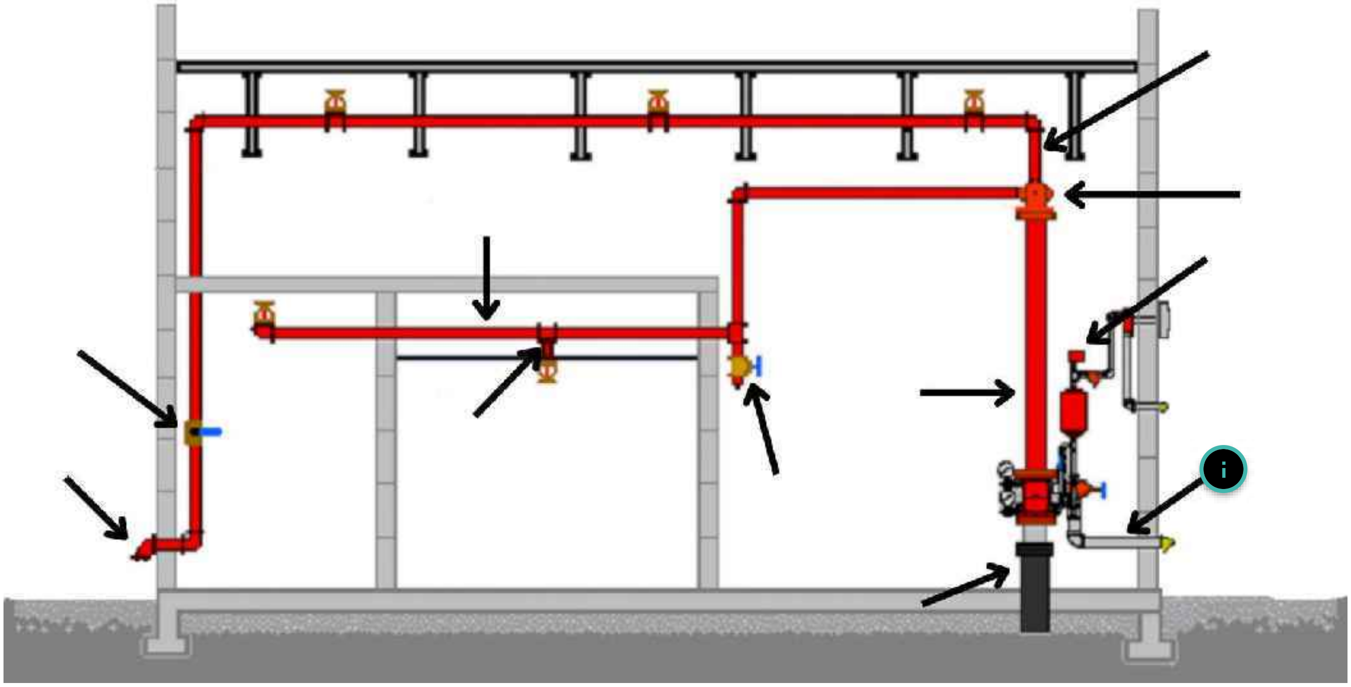
Inspector’s Test Connection

A discharge pipe and orifice from the inspector’s test valve. The orifice placed in the connection is the same as the smallest orifice sprinkler on the system, creating the most demanding waterflow for the waterflow alarm device.



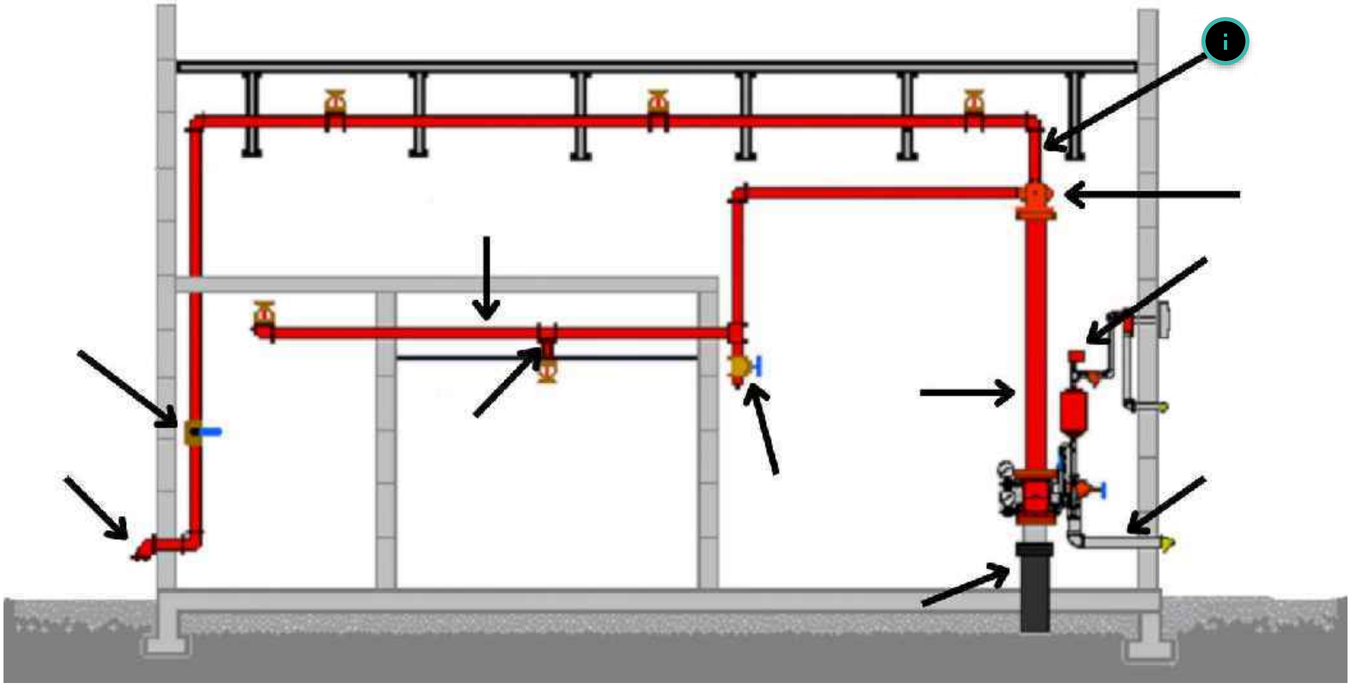
Drain Valve

A valve that allows the release of water in a sprinkler system.



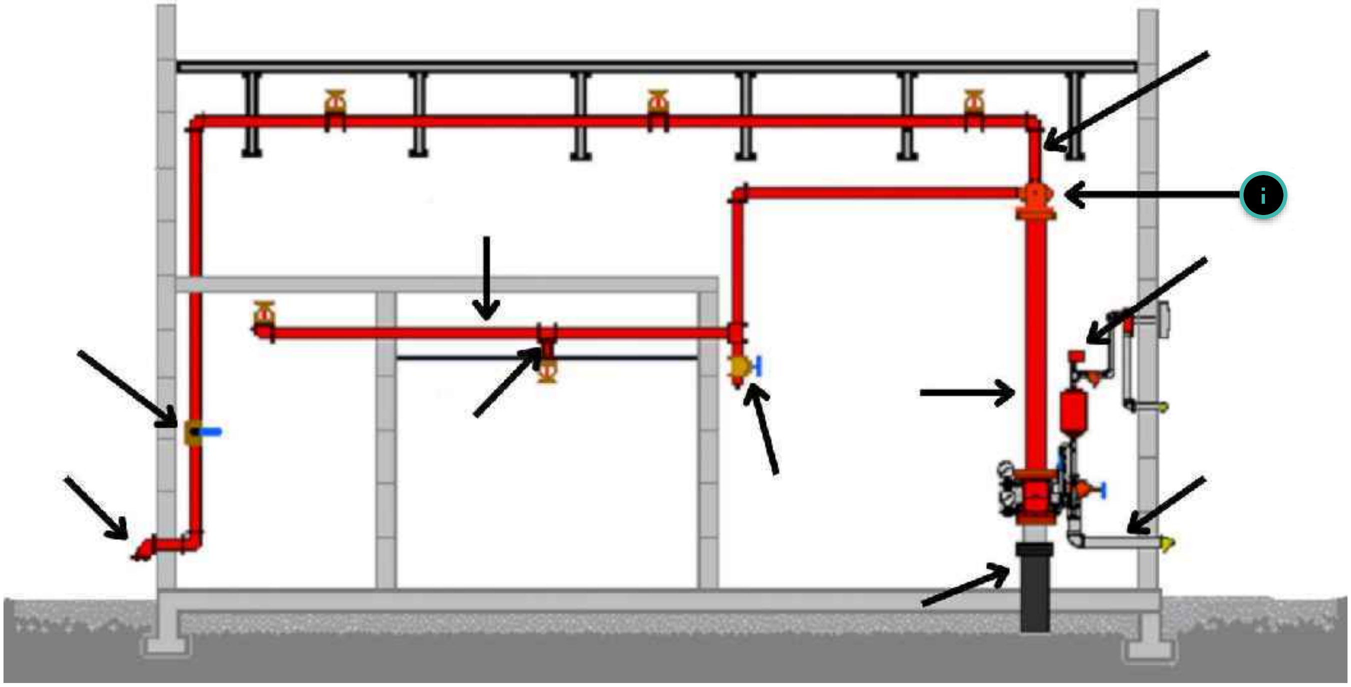
Main Drain

The purpose of the main drain is to allow the sprinkler system to be drained down for maintenance purposes, inspections, repair, or modifications.



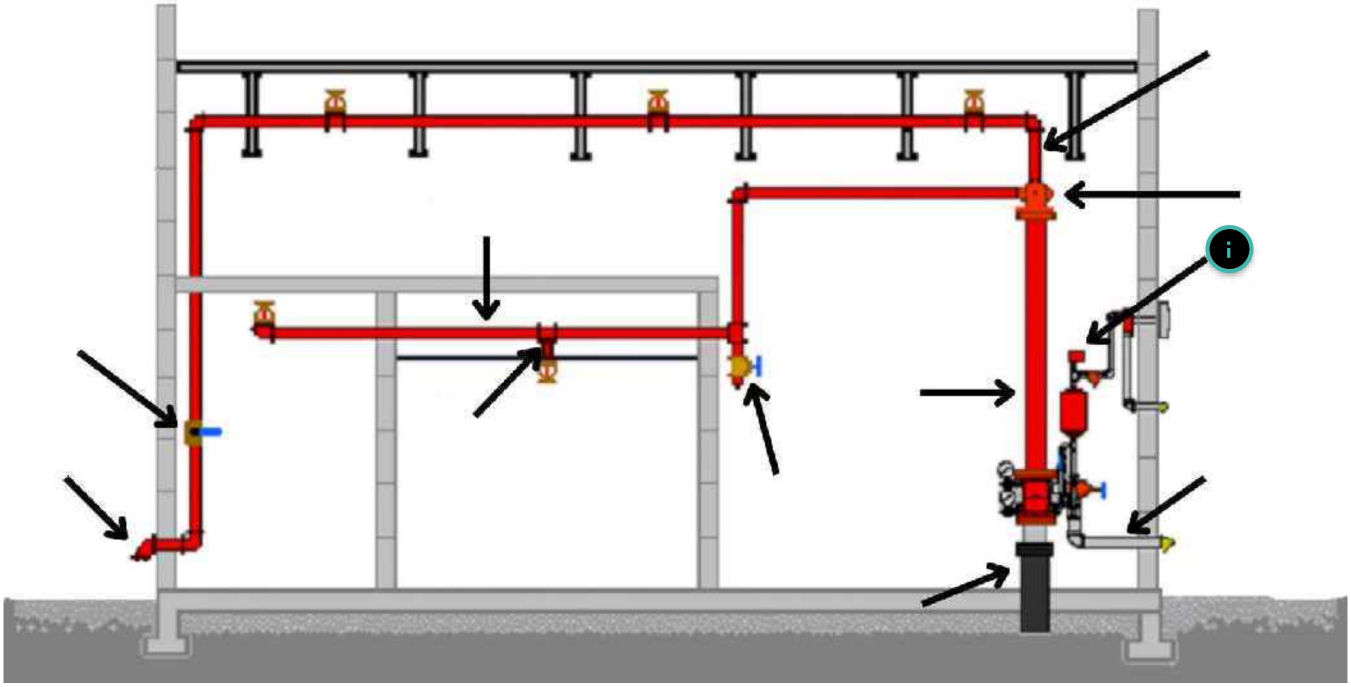
Riser Nipple

A vertical pipe between the main and branch line.



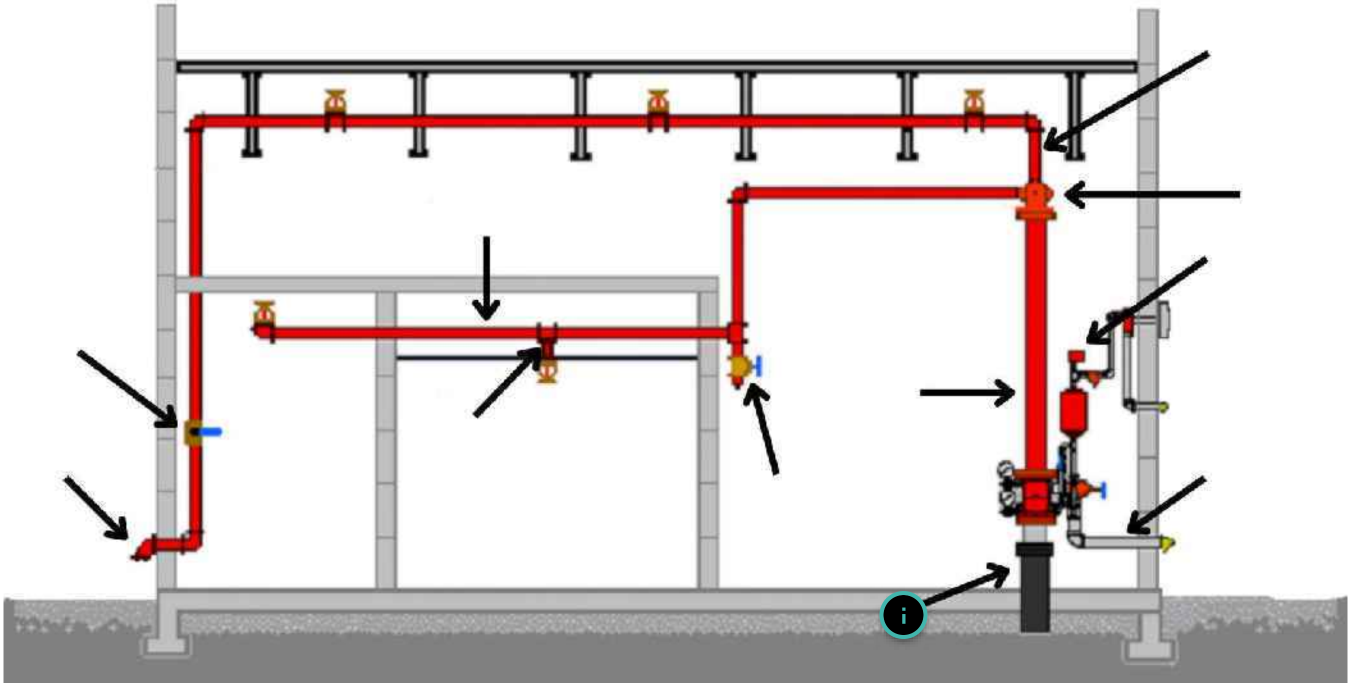
Cross Main

The pipes supplying the branch lines, either directly or through riser nipples. The cross main will generally be installed parallel to the building’s roof structure.



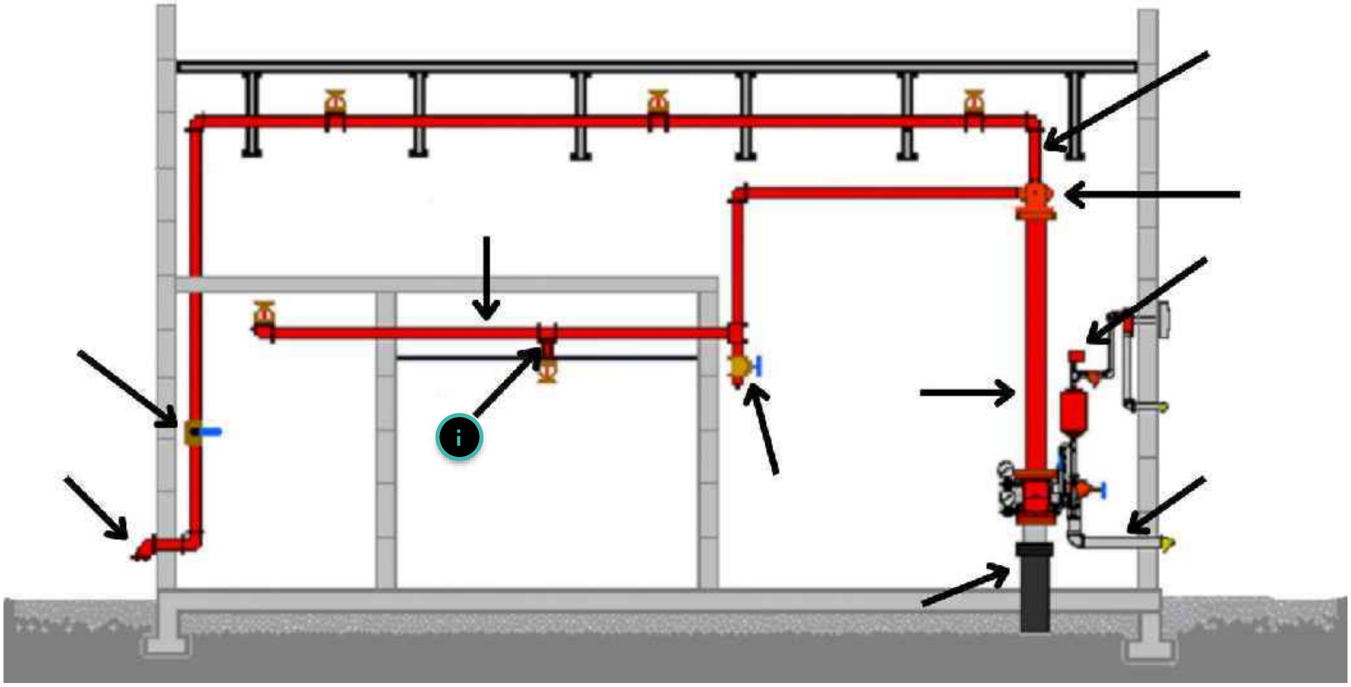
Waterflow Alarm Device

An attachment to the sprinkler system that detects a predetermined water flow and is connected to a fire alarm system to initiate an alarm condition, or is used to mechanically or electrically initiate a fire pump or local audible or visual alarm.



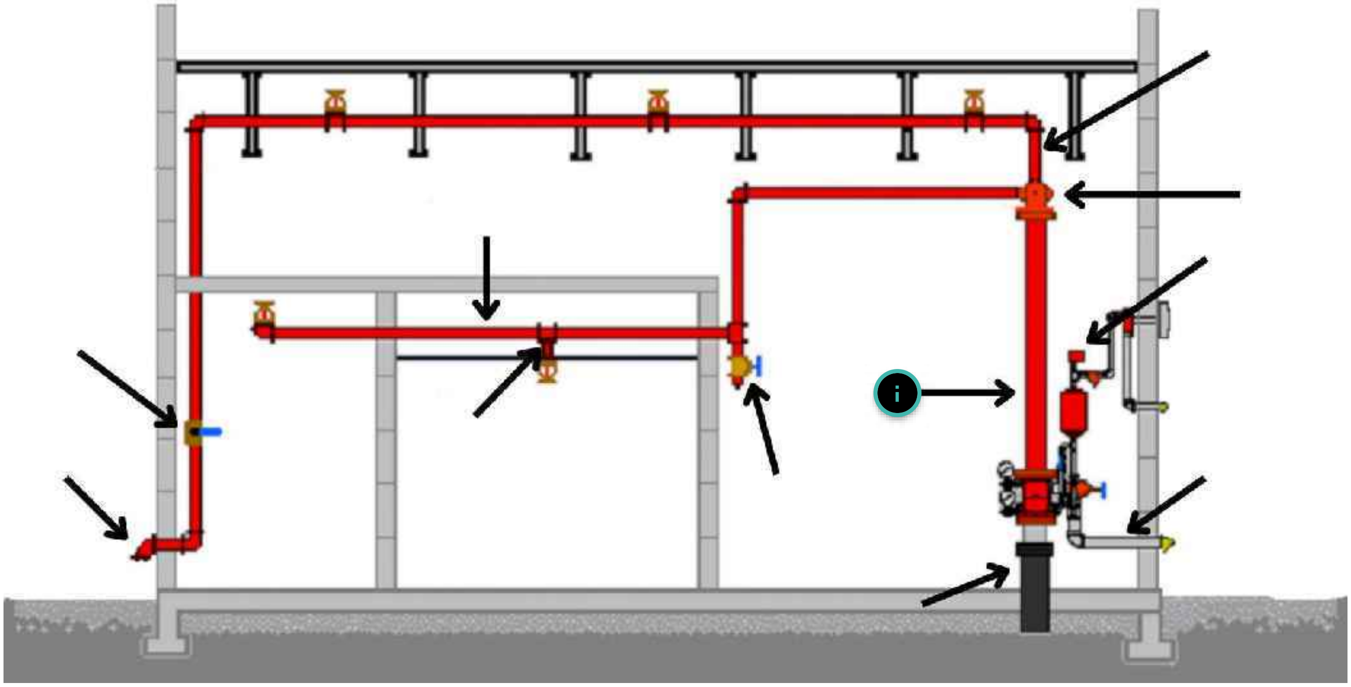
Flange and Spigot

The flanged supply that terminates the underground supply pipe inside the building.



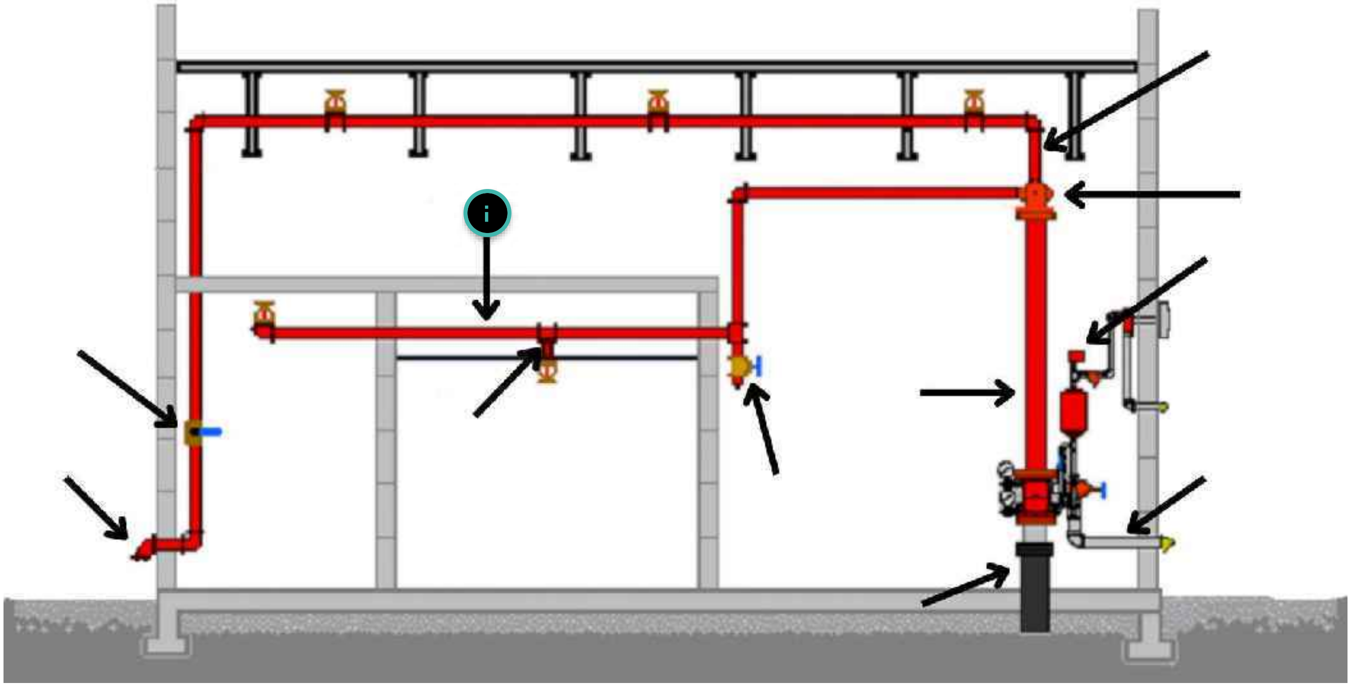
Drop Nipple

A vertical drop from branch line piping to supply a sprinkler. Drop nipples supply sprinklers located in finished ceilings.



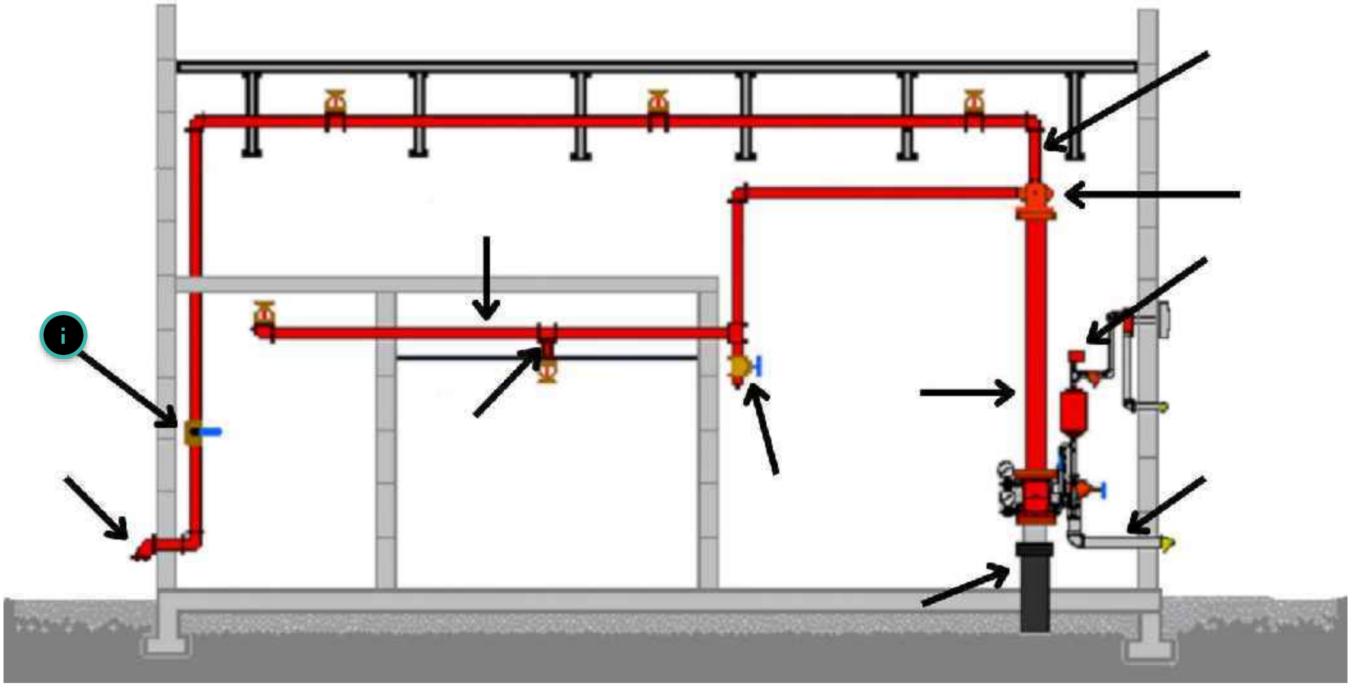
Sprinkler Riser

The vertical supply pipes in a sprinkler system.



Branch Line

The pipes supplying sprinklers, either directly or through sprigs, drops, return bends, or arm-overs.



Inspector’s Test Valve

A valve on the sprinkler system that is opened periodically to simulate a waterflow through the riser, making the waterflow alarm operate.

Image courtesy of Viking.

CONTINUE

Click through the tabs below to view the definitions of other sprinkler system components

CHECK VALVE | INDICATING VALVE | WATER GAUGE | MANIFOLD | ES

Allows flow in one direction only. (*NFPA* 13 2016, Section 3.8.1.15.1)

CHECK VALVE | **INDICATING VALVE** | WATER GAUGE | MANIFOLD | ES

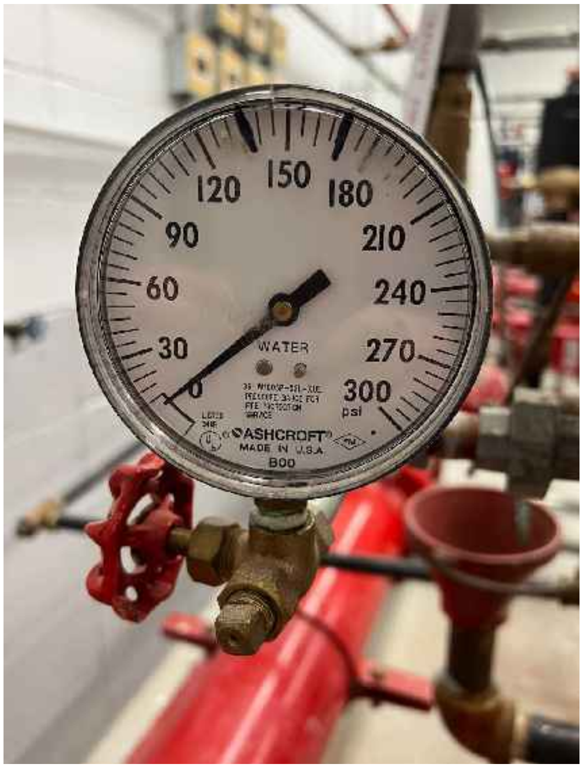
A valve that has components that provide the valve’s operating position: open or closed. (*NFPA* 13 2016, Section 3.8.1.15.2)

Examples are outside screw and yoke (OS&Y) gate valves, butterfly valves, and underground gate valves with indicator posts.

Based on *NFPA* 13 2016, Section 6.6.1.2, listed indicating valves shall not close in less than 5 seconds when operated at maximum possible speed from the fully open position.

CHECK VALVE | INDICATING VALVE | **WATER GAUGE** | MANIFOLD | ES

A device for measuring the pressure of a system.



CHECK VALVE

INDICATING VALVE

WATER GAUGE

MANIFOLD

ES

A pipe that branches into several openings.

A riser manifold is depicted below.

CHECK VALVE | INDICATING VALVE | WATER GAUGE | MANIFOLD | ES

An accessory to a sprinkler system that is used to surround the base of the sprinkler and cover the cut-out in the ceiling or wall. (*NFPA* 13 2016, Section 6.7.2)

Escutcheons used with recessed, flush-type, or concealed sprinklers are required to be part of a listed sprinkler assembly.

The Annex explains the use of an incorrect type of escutcheon with recessed or flush-type sprinklers can impede the spray pattern, which will impact the effectiveness of the sprinkler.

CHECK VALVE	INDICATING VALVE	WATER GAUGE	MANIFOLD	ES

A visual and audible alarm signal given at the central safety station to indicate when the system is in operation, or when a condition that would impair the satisfactory operation of the system exists. Supervisory alarms must give a distinct indication for each individual system component that is monitored. (*NFPA* 13 2016, Section 3.10.11)

CHECK VALVE
INDICATING VALVE
WATER GAUGE
MANIFOLD
ES

A device arranged to supervise the operative condition of automatic sprinkler systems. (*NFPA* 13 2016, Section 3.5.12)

CHECK VALVE

INDICATING VALVE

WATER GAUGE

MANIFOLD

ES

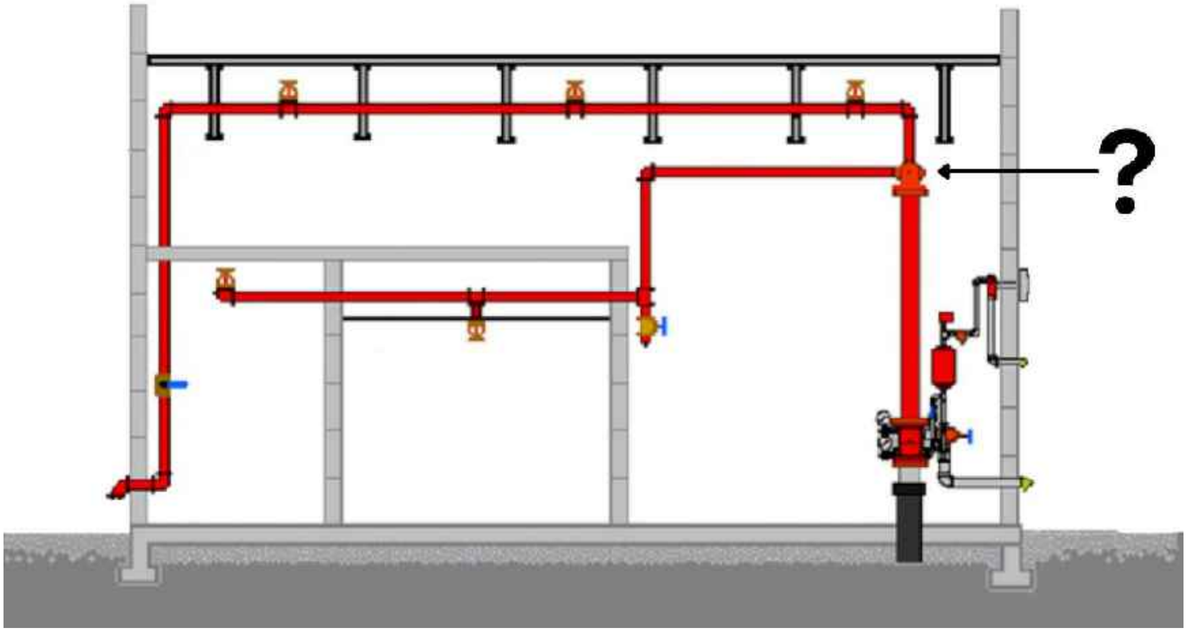
A device for use in applications requiring special water discharge patterns, directional spray, or other unusual discharge characteristics. (*NFPA* 13 2016, Section 3.6.4.5)

Images courtesy of Viking.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

What component of the diagram is indicated below?



Type your answer here

SUBMIT

What is a valve on the sprinkler system that is opened periodically to simulate a waterflow through the riser, making the waterflow alarm operate?

○ Inspector's Test Connection

○ Inspector's Test Valve

○ Indicating Valve

○ Drain Valve

SUBMIT

What is depicted in the image shown below?

Type your answer here

SUBMIT

Complete the knowledge checks above before moving on.

Fire Department Connection

NFPA 13 2016, Sections 3.8.1.4, 6.7, and 8.17.2

As defined in NFPA 13 2016 Section 3.8.1.4, a **fire department connection (FDC)** is a connection through which the fire department can pump supplemental water into the sprinkler system, standpipe, or other sprinkler systems, furnishing water for fire extinguishment to supplement existing water supplies.

The purpose of the FDC is to **supplement the water supply,** rather than provide enough water to meet the system demand.

The FDC is required to be on the system side of the water supply check valve, and the connection shall not be less than 18 in. and not greater than 4 ft.

ⓘ **Refer to *NFPA* 13 2016, Figure 8.17.2(a) Fire Department Connection**

CONTINUE

The following systems **do not** require an FDC:

- Buildings located in remote areas that are inaccessible for fire department support
- Large deluge systems that exceed the pumping capacity of the fire department
- Single-story buildings that do not exceed 2000 ft^2 in area

According to Section 8.17.2.3 of *NFPA* 13 2016, the **pipe size** for an FDC shall be one of the following:

- For fire engine connections – **4 in. minimum**
- For fireboat connections – **6 in. minimum**
- For hydraulically calculated systems – **less than 4 in., but not less than the largest riser being served by that connection**

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RECONDITIONING AND PRESSURE

Reconditioning and Rated Pressure

NFPA 13 2016, Sections 6.1.2 and 6.1.3

Reconditioned valves and devices are permitted to be used as **replacement equipment** in existing systems.

However, reconditioned sprinklers are **not allowed** on any new or existing systems.

System components are required to be rated for the **maximum** **system working pressure** to which they are exposed but shall **not be rated at less than 175 psi** for components installed **aboveground**, and **150 psi** for components installed **underground**.

CONTINUE

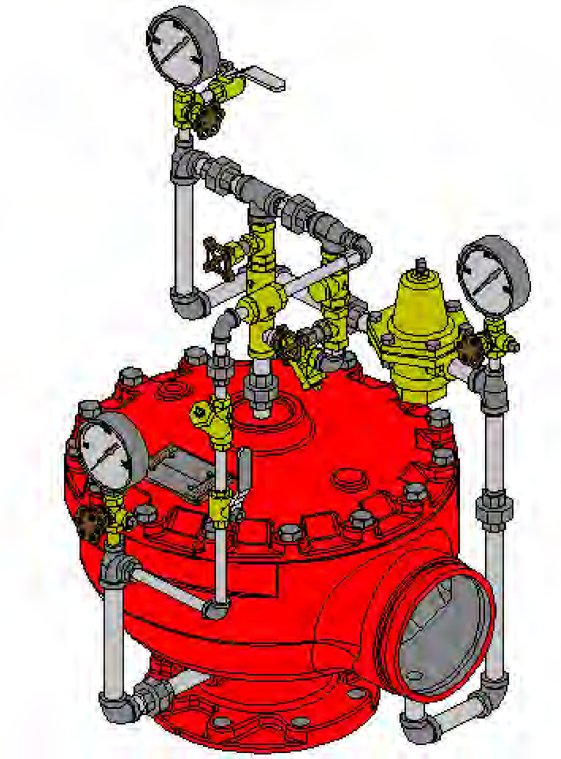
Pressure Definitions

NFPA 13 2016, Chapter 3

Pressure Regulating Device

A device designed for the purpose of reducing, regulating, controlling, or restricting water pressure. Examples include pressure-reducing valves, pressure-control valves, and pressure-restricting devices. (*NFPA* 13 2016, Section 3.8.1.10)

Images depicts Pilot Operated Pressure Control Valve; courtesy of Viking.



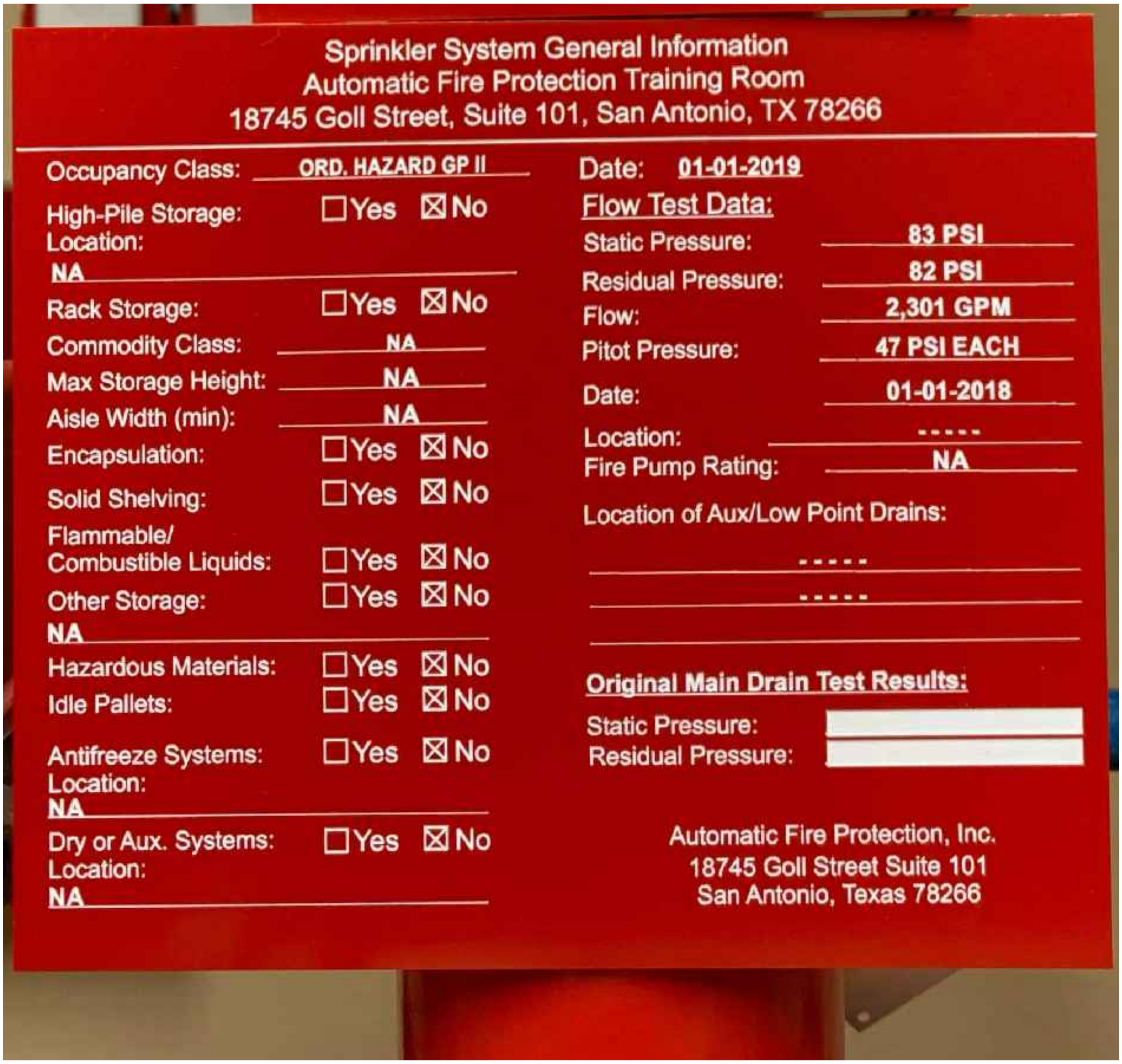
Residual Pressure

The pressure that exists in the distribution system, measured at the residual hydrant at the time the flow readings are taken at the flow hydrants. (*NFPA* 13 2016, Section 3.8.1.9.1)

Static Pressure

The pressure that exists at a given point under normal distribution system conditions measured at the residual hydrant with no hydrants flowing. (*NFPA* 13 2016, Section 3.8.1.9.2)

In the following general information palcard, you can see the data for the sprinkler system's static pressure and residual pressure displayed along with additional information.



Sprinkler System General Information
Automatic Fire Protection Training Room
18745 Goll Street, Suite 101, San Antonio, TX 78266

Occupancy Class: ORD. HAZARD GP II
High-Pile Storage: ☐Yes ☒No
Location:
NA
Rack Storage: ☐Yes ☒No
Commodity Class: NA
Max Storage Height: NA
Aisle Width (min): NA
Encapsulation: ☐Yes ☒No
Solid Shelving: ☐Yes ☒No
Flammable/ Combustible Liquids: ☐Yes ☒No
Other Storage: ☐Yes ☒No
NA
Hazardous Materials: ☐Yes ☒No
Idle Pallets: ☐Yes ☒No
Antifreeze Systems: ☐Yes ☒No
Location:
NA
Dry or Aux. Systems: ☐Yes ☒No
Location:
NA

Date: 01-01-2019
Flow Test Data:
Static Pressure: 83 PSI
Residual Pressure: 82 PSI
Flow: 2,301 GPM
Pitot Pressure: 47 PSI EACH
Date: 01-01-2018
Location: -----
Fire Pump Rating: NA
Location of Aux/Low Point Drains:

Original Main Drain Test Results:
Static Pressure:
Residual Pressure:

Automatic Fire Protection, Inc.
18745 Goll Street Suite 101
San Antonio, Texas 78266

LET'S REVIEW

Let's do a quick check about what has been covered so far.

The purpose of the FDC is to provide enough water to meet the system's demand.

○ True

○ False

SUBMIT

Reconditioned sprinklers are not allowed on any new or existing systems.

○ True

○ False

SUBMIT

Complete the knowledge checks above before moving on.

After completing this module, you should now have a better understanding of the purpose and function of various sprinkler system components.

Click on the “Next” arrow up on the right-hand corner of the screen to continue to the quiz.

Automatic Sprinkler & Standpipe Systems - Sprinkler Installation

By the end of this module, you will be able to do the following:

- Select the correct sprinkler for various applications, considering temperature ratings based on:
    - Proximity to heat sources
    - Specific building locations
    - Residential areas
- Apply sprinkler location and spacing rules to installations.
- Identify various characteristics of pipe, tube, and fittings.
- Recognize hanger components and types of hangers.
- Properly space hangers.
- Recall riser support requirements.

Key References:

- *NFPA* 13 - *Standard for Installation of Sprinkler Systems*, 2016

When you are ready to begin, click on the button above to start the course.

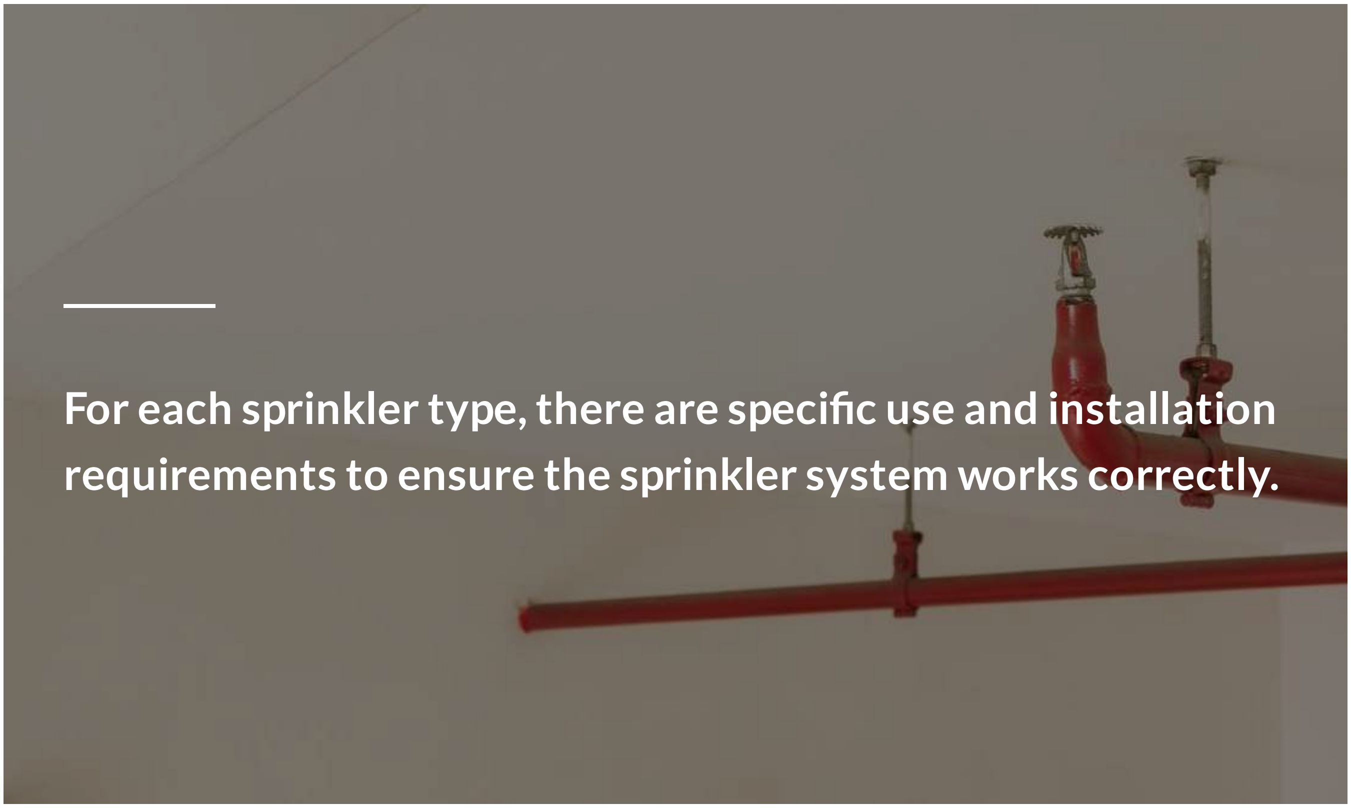
Sprinkler Installation

Pipe and Tube

Hangers and Bracing

Lesson 1 of 3

Sprinkler Installation



For each sprinkler type, there are specific use and installation requirements to ensure the sprinkler system works correctly.

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Select the correct sprinkler for various applications, considering temperature ratings based on:

- Proximity to heat sources

- Specific building locations
- Residential areas

☐ Apply sprinkler location and spacing rules to installations.

Key References

- *NFPA* 13 - *Standard for the Installation of Sprinkler Systems*, 2016

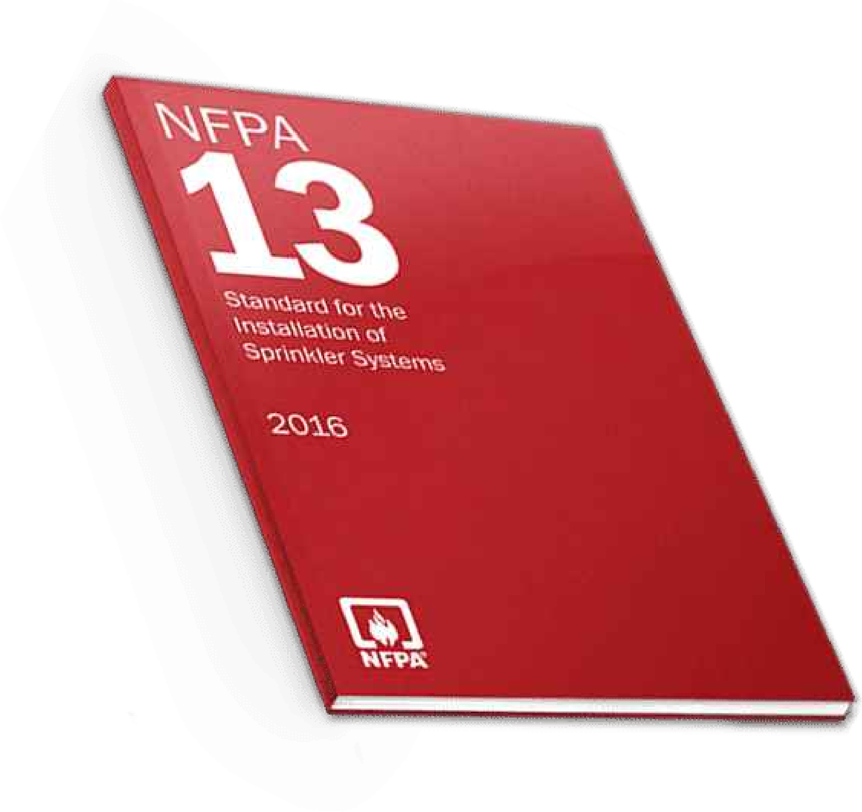
LET'S BEGIN

Sprinkler Limitations

NFPA 13 2016, Chapter 8

Although numerous types of sprinklers are currently available, sprinkler technology continues to evolve, especially with regard to thermal sensitivity, spray pattern distribution characteristics, and droplet size. As a result, new types and styles of sprinklers with specific applications and installation requirements continue to be developed.

The requirements in Chapter 8 of *NFPA* 13 2016 are **organized by sprinkler types** to better address their use and installation requirements. This standard provides use and installation requirements for the most common types of sprinklers.



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NFPA 13 2016, Section 8.3

Since the numerous types of sprinklers available have specific usage and installation requirements, this section reviews the limitations for each. These limitations include:

- Temperature ratings
- Hazard classification
- Location
- Orientation

Below are a few of the general limitations listed in the section:

Section 8.3.1.1

Only listed sprinklers can be used, and these sprinklers must be installed according to their listing.

Section 8.3.1.3

Upright sprinklers must be installed with their frames parallel to the branch lines. This is to minimize interference with the spray pattern of the sprinkler.

Section 8.3.1.4

When solvent cement is used as a bonding agent for the pipe and fittings, the sprinklers cannot be installed in the fittings before the fittings are cemented in place.

TEMPERATURE RATINGS

Temperature Ratings for Sprinklers

NFPA 13 2016, Section 8.3

In terms of installations involving heat-producing devices or other areas where high temperatures can create problems, there are temperature ratings set in place for sprinklers. More specifically, ordinary temperature sprinklers are to be used **exclusively**, except where conditions fall within the exceptions of Section 8.3 of *NFPA* 13 2016, which is when the temperature **exceeds 100°F**.

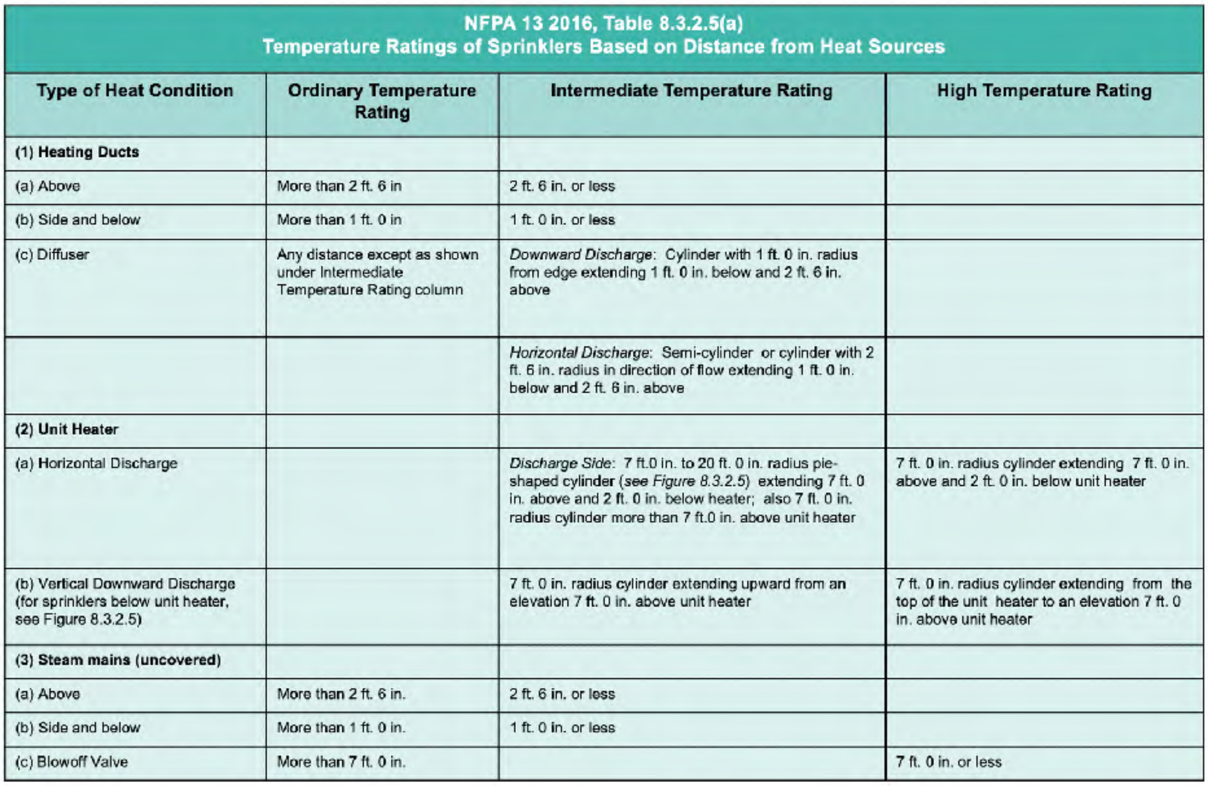
In addition, there are certain spacing requirements based on heat sources. There are **distances which have to be maintained**.

These requirements are contained in the text and two tables within our reference.

1. The first table summarizes the various requirements for different types of heating devices and the spacing, location, and rating requirements for sprinkler heads.
2. The second table shows the requirements for the ratings of sprinklers in specified locations such as under skylights, in attics, under flat roofs, and in show windows.

CONTINUE

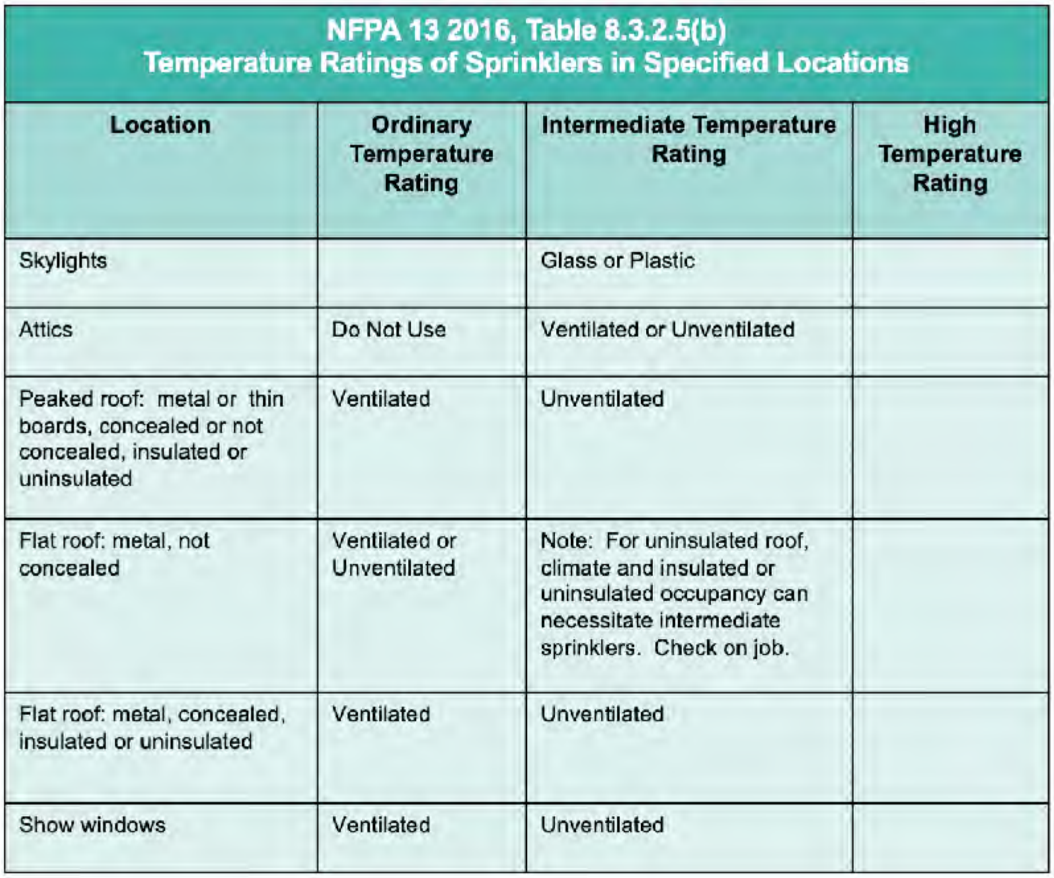
Tables 8.3.2.5(a) and (b) outline the temperature ratings for sprinklers based on spacing and location.



NFPA 13 2016, Table 8.3.2.5(a)
Temperature Ratings of Sprinklers Based on Distance from Heat Sources

Type of Heat Condition	Ordinary Temperature Rating	Intermediate Temperature Rating	High Temperature Rating
(1) Heating Ducts			
(a) Above	More than 2 ft. 6 in	2 ft. 6 in. or less	
(b) Side and below	More than 1 ft. 0 in	1 ft. 0 in. or less	
(c) Diffuser	Any distance except as shown under Intermediate Temperature Rating column	*Downward Discharge*: Cylinder with 1 ft. 0 in. radius from edge extending 1 ft. 0 in. below and 2 ft. 6 in. above	
		Horizontal Discharge: Semi-cylinder or cylinder with 2 ft. 6 in. radius in direction of flow extending 1 ft. 0 in. below and 2 ft. 6 in. above	
(2) Unit Heater			
(a) Horizontal Discharge		*Discharge Side*: 7 ft.0 in. to 20 ft. 0 in. radius pie-shaped cylinder (*see Figure 8.3.2.5*) extending 7 ft. 0 in. above and 2 ft. 0 in. below heater; also 7 ft. 0 in. radius cylinder more than 7 ft.0 in. above unit heater	7 ft. 0 in. radius cylinder extending 7 ft. 0 in. above and 2 ft. 0 in. below unit heater
(b) Vertical Downward Discharge (for sprinklers below unit heater, see Figure 8.3.2.5)		7 ft. 0 in. radius cylinder extending upward from an elevation 7 ft. 0 in. above unit heater	7 ft. 0 in. radius cylinder extending from the top of the unit heater to an elevation 7 ft. 0 in. above unit heater
(3) Steam mains (uncovered)			
(a) Above	More than 2 ft. 6 in.	2 ft. 6 in. or less	
(b) Side and below	More than 1 ft. 0 in.	1 ft. 0 in. or less	
(c) Blowoff Valve	More than 7 ft. 0 in.		7 ft. 0 in. or less

Click on the image to enlarge.

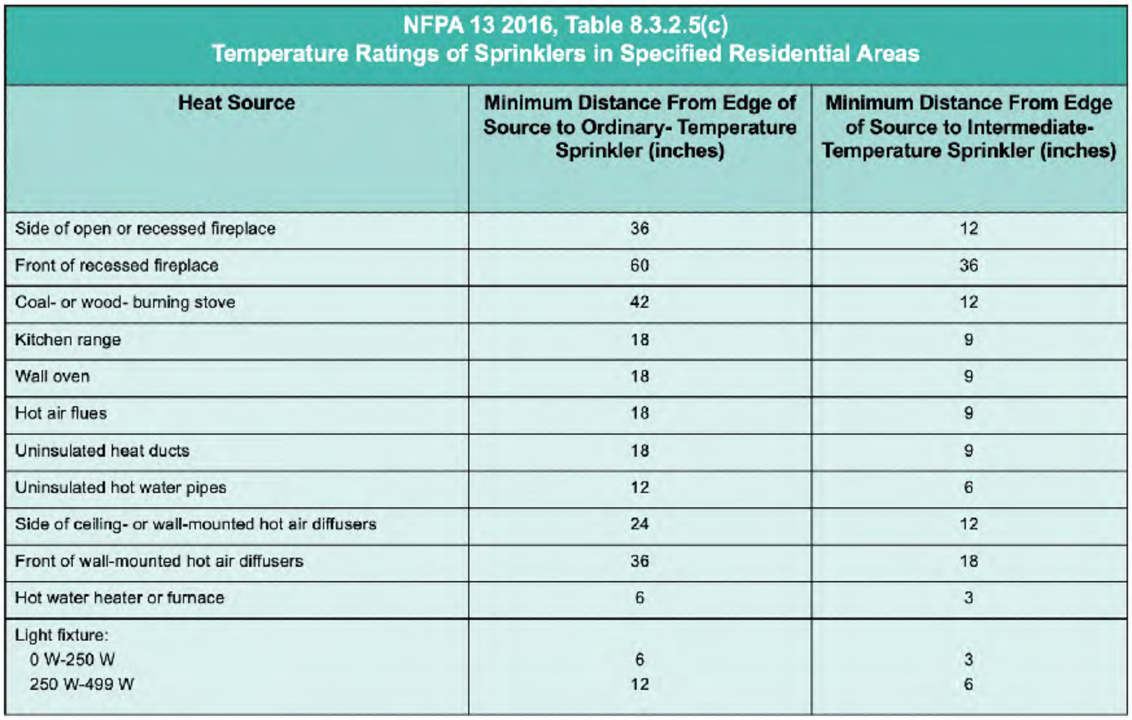


NFPA 13 2016, Table 8.3.2.5(b)
Temperature Ratings of Sprinklers in Specified Locations

Location	Ordinary Temperature Rating	Intermediate Temperature Rating	High Temperature Rating
Skylights		Glass or Plastic	
Attics	Do Not Use	Ventilated or Unventilated	
Peaked roof: metal or thin boards, concealed or not concealed, insulated or uninsulated	Ventilated	Unventilated	
Flat roof: metal, not concealed	Ventilated or Unventilated	Note: For uninsulated roof, climate and insulated or uninsulated occupancy can necessitate intermediate sprinklers. Check on job.	
Flat roof: metal, concealed, insulated or uninsulated	Ventilated	Unventilated	
Show windows	Ventilated	Unventilated	

CONTINUE

Table 8.3.2.5(c) lists the minimum distances for different temperature ratings of sprinklers in specified residential areas.



NFPA 13 2016, Table 8.3.2.5(c)
Temperature Ratings of Sprinklers in Specified Residential Areas

Heat Source	Minimum Distance From Edge of Source to Ordinary- Temperature Sprinkler (inches)	Minimum Distance From Edge of Source to Intermediate-Temperature Sprinkler (inches)
Side of open or recessed fireplace	36	12
Front of recessed fireplace	60	36
Coal- or wood- burning stove	42	12
Kitchen range	18	9
Wall oven	18	9
Hot air flues	18	9
Uninsulated heat ducts	18	9
Uninsulated hot water pipes	12	6
Side of ceiling- or wall-mounted hot air diffusers	24	12
Front of wall-mounted hot air diffusers	36	18
Hot water heater or furnace	6	3
Light fixture:		
0 W-250 W	6	3
250 W-499 W	12	6

Click on the image to enlarge.

Do not overlook Figure 8.3.2.5, as it illustrates high and intermediate temperature zones for unit heaters.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Upright sprinklers must be installed with their frames _____ to the branch lines.

○ Parallel

○ Perpendicular

○ Adjacent

SUBMIT

Determine the temperature rating for a sprinkler located on a flat, metal, ventilated roof. The sprinkler is not concealed.

○ Ordinary

○ Intermediate

○ High

SUBMIT

Complete the knowledge checks above before moving on.

Application of Sprinkler Types

NFPA 13 2016, Section 8.4

This section outlines how each sprinkler type is to be selected for its particular use. Many sprinkler types are covered in this section, of which we only highlight a few below. **The key point is the types of sprinklers must be spaced and positioned according to this standard**.

It is important to note that the type of sprinkler used is **dependent on the construction type and occupancy hazard**. Generally, a sprinkler sensitivity rating must be consistent in a compartment to have a uniform response by the system.

Review the application of the following sprinkler types based on construction type and occupancy hazard.

Upright and pendent spray sprinklers

Unless Section 8.15.1.6 requirements apply, upright and pendent spray sprinklers are permitted in **all** occupancy hazard classifications and building construction types. (*NFPA* 13 2016, Section 8.4.1.1)

Sidewall sprinklers

Since the discharge characteristics of sidewall sprinklers are not as effective as those of upright and pendent sprinklers, their application is limited to light hazard occupancies, ordinary hazards with smooth, flat ceilings, and below overhead doors. (*NFPA* 13 2016, Section 8.4.2)

Open sprinklers

Open sprinklers are spray sprinklers with their operating elements removed. Given this characteristic, they can be used in a deluge system to protect against special hazards, exposures, and other special situations. (*NFPA* 13 2016, Section 8.4.4.1)

Residential sprinklers

Residential sprinklers are limited to wet system installations and, in general, their location and spacing are dictated by residential standards *NFPA* 13D and *NFPA* 13R. Because residential sprinklers are tested and listed using a residential fire scenario, they are permitted only in residential portions of all occupancies. In other portions of such occupancies, sprinklers must be listed for general usage and must be installed in accordance with the requirements of NFPA 13. (*NFPA* 13 2016, Section 8.4.5)

Early Suppression Fast Response (ESFR) sprinklers –

Early Suppression Fast Response (ESFR) sprinklers are restricted typically to wet systems and structures with flat roofs (i.e. buildings with roofs having a slope of 2 in. per foot or less). ESFR sprinklers use fast-response operating elements and are designed to respond very quickly to a fire. Because fires in the spaces typically protected with ESFR sprinklers can grow extremely fast with large increases in heat release rates over a short period of time, the speed with which water is applied is critical. (*NFPA* 13 2016, Section 8.4.6)

Control Mode Specific Application (CMSA) sprinklers –

Control Mode Specific Application (CMSA) sprinklers are permitted in wet, dry, or preaction systems. (*NFPA* 13 2016, Section 8.4.7.1)

INSTALLATION REQUIREMENTS

Installation Requirements

NFPA 13 2016, Section 8.5

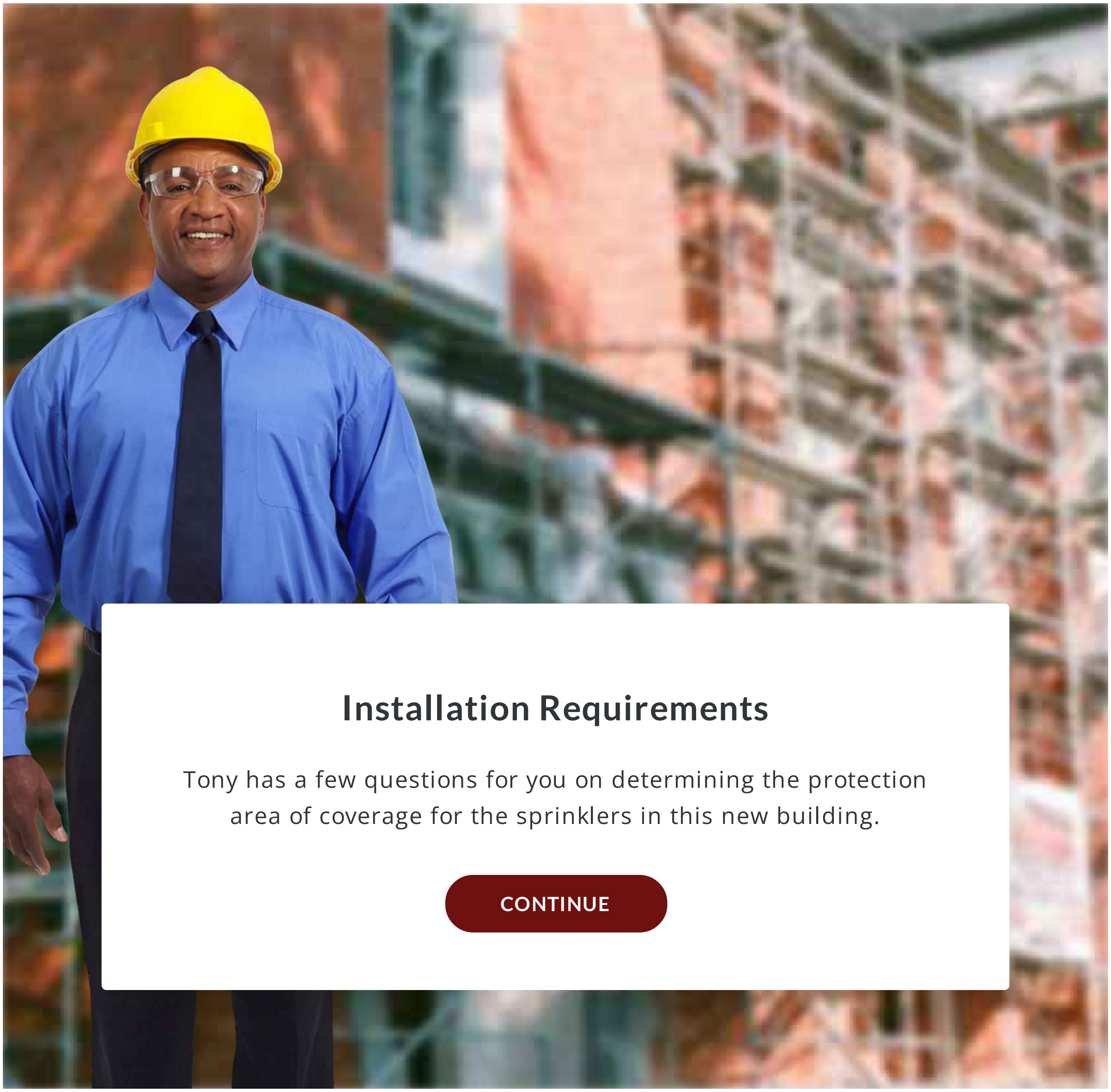
Proper positioning and spacing of sprinklers are important to ensure that sprinklers operate promptly and that obstructions to sprinkler distribution patterns do not adversely affect the performance of the sprinkler.

This portion of *NFPA* 13 2016 discusses the actual requirements for sprinkler spacing and clearances between sprinklers and structural members, with respect to sprinkler location and position. **There is a great deal of information contained in this area of the standard,** divided as follows:

- **Section 8.6** – Standard pendant and upright spray sprinklers
- **Section 8.7** – Sidewall standard spray sprinklers
- **Section 8.8** – Extended coverage upright and pendent spray sprinklers
- **Section 8.9** – Extended coverage sidewall spray sprinklers
- **Section 8.10** – Residential sprinklers
- **Section 8.11** – CMSA sprinklers
- **Section 8.12** – ESFR sprinklers
- **Section 8.13** – In-rack sprinklers

CONTINUE

In order to get more familiar with this section's requirements for sprinkler spacing and clearances, utilize Section 8.5 in your *NFPA* 13 2016 standard to work through the scenario below.

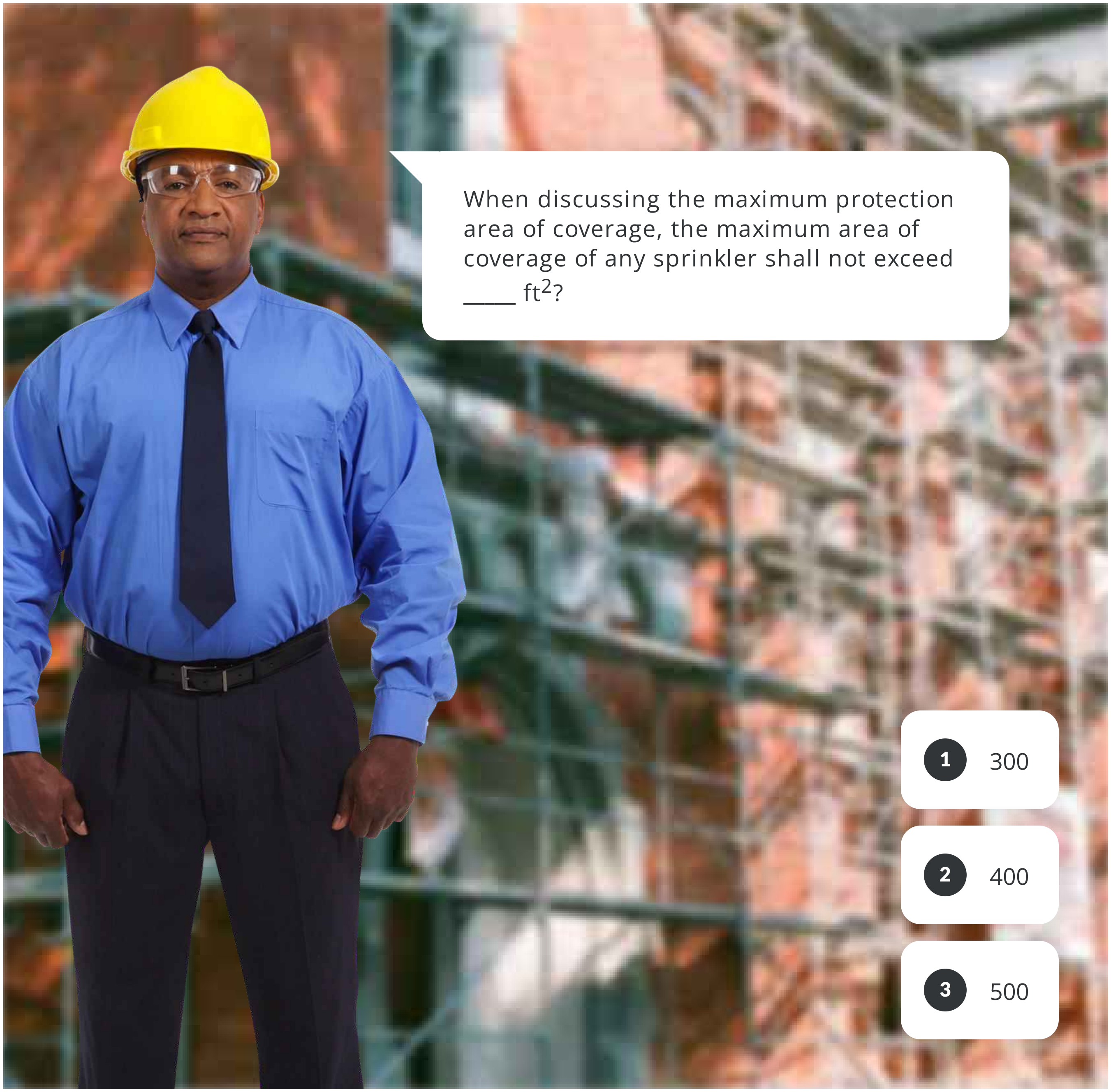


Installation Requirements

Tony has a few questions for you on determining the protection area of coverage for the sprinklers in this new building.

Scene 1 Slide 1

Continue → Next Slide



When discussing the maximum protection area of coverage, the maximum area of coverage of any sprinkler shall not exceed ____ ft^2?

1 300

2 400

3 500

Scene 1 Slide 2

0 → Next Slide

1 → Next Slide

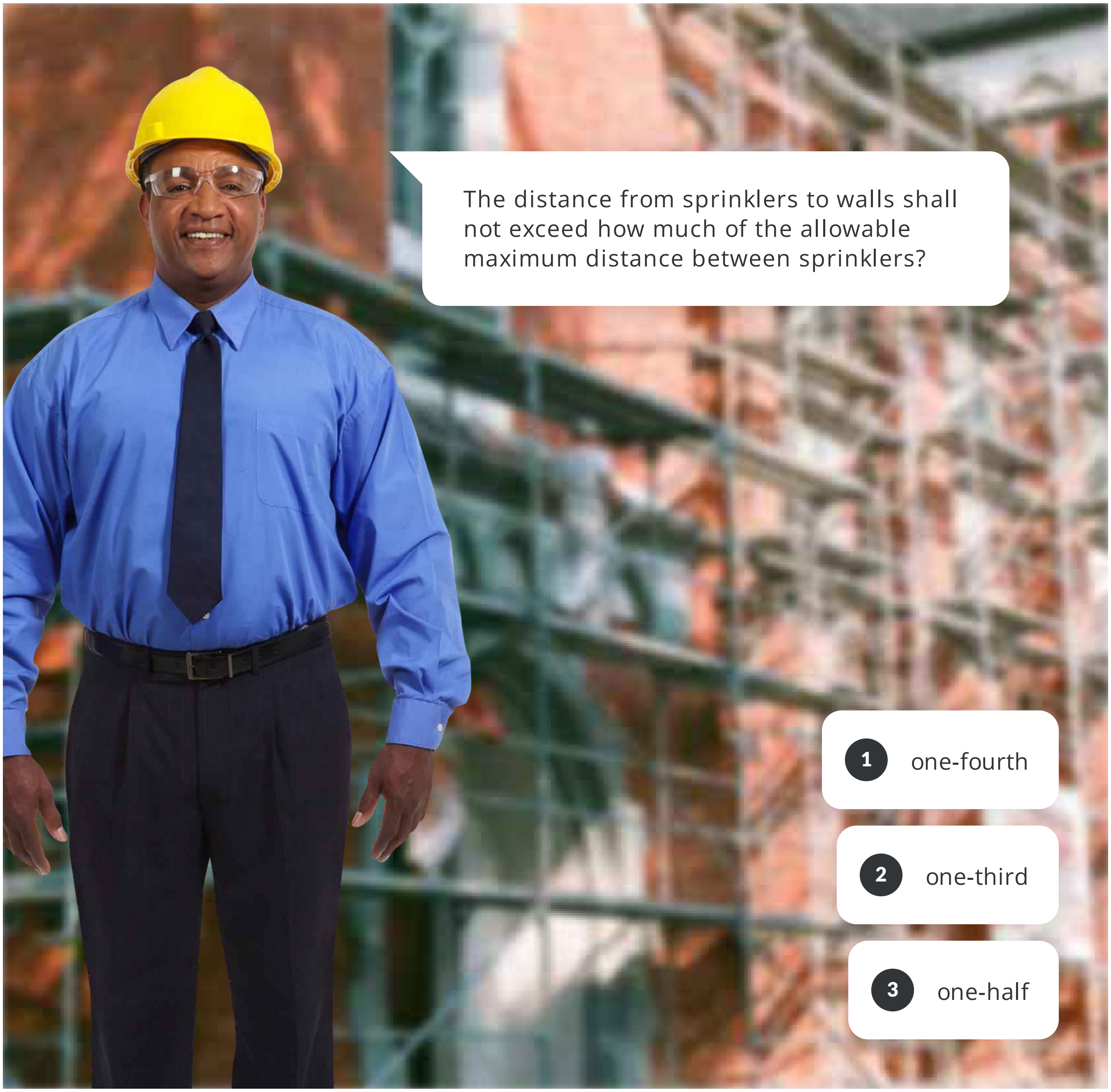
2 → Next Slide

The maximum distance between sprinklers is to be based on the centerline distance between adjacent sprinklers and is to be measured ______?

1. along the slope of the ceiling
2. from the floor to the ceiling
3. perpendicular to the wall

Scene 1 Slide 3

0 → Next Slide
1 → Next Slide
2 → Scene 1 Slide 1



The distance from sprinklers to walls shall not exceed how much of the allowable maximum distance between sprinklers?

1 one-fourth

2 one-third

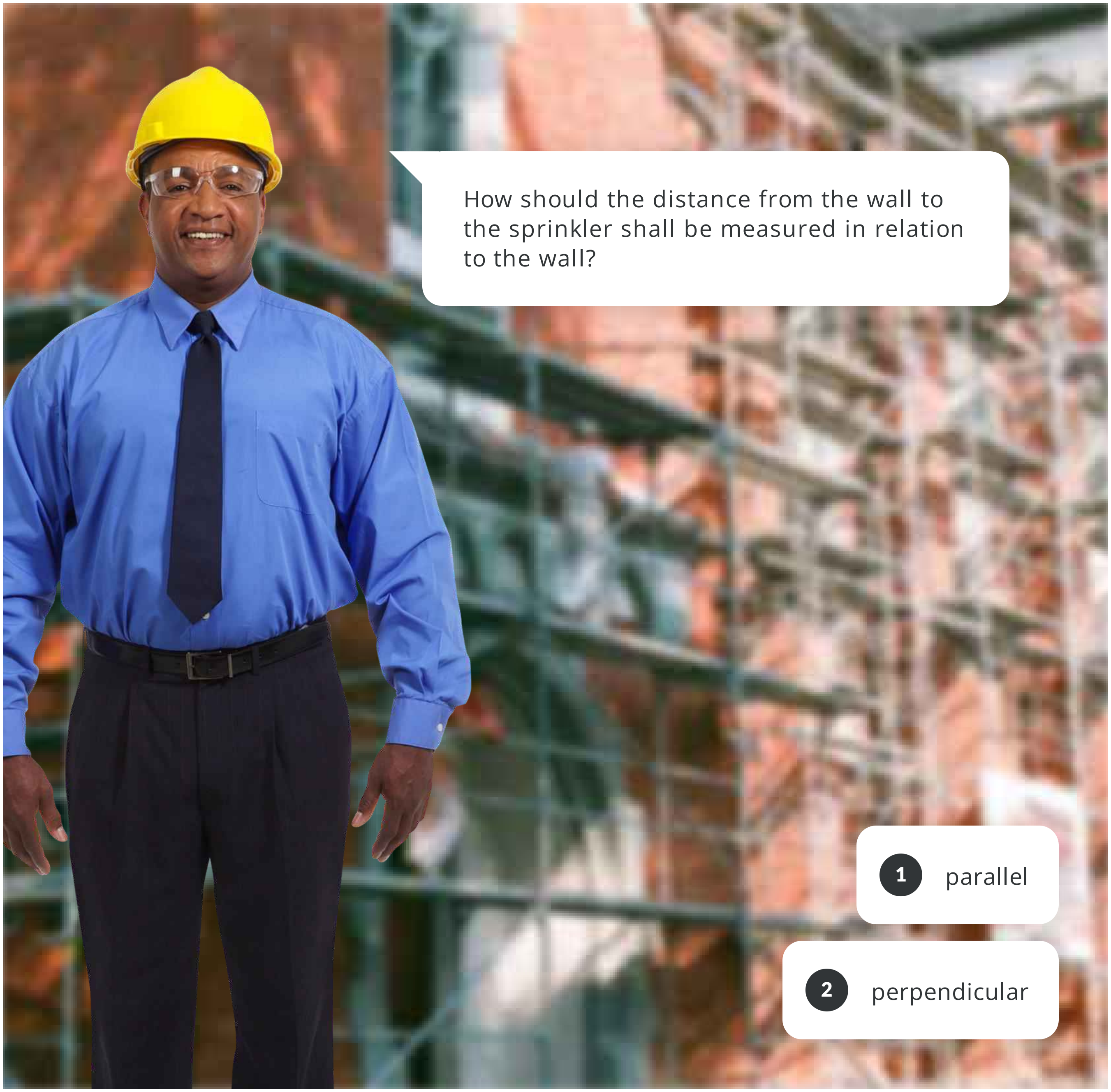
3 one-half

Scene 1 Slide 4

0 → Scene 1 Slide 1

1 → Next Slide

2 → Next Slide



How should the distance from the wall to the sprinkler shall be measured in relation to the wall?

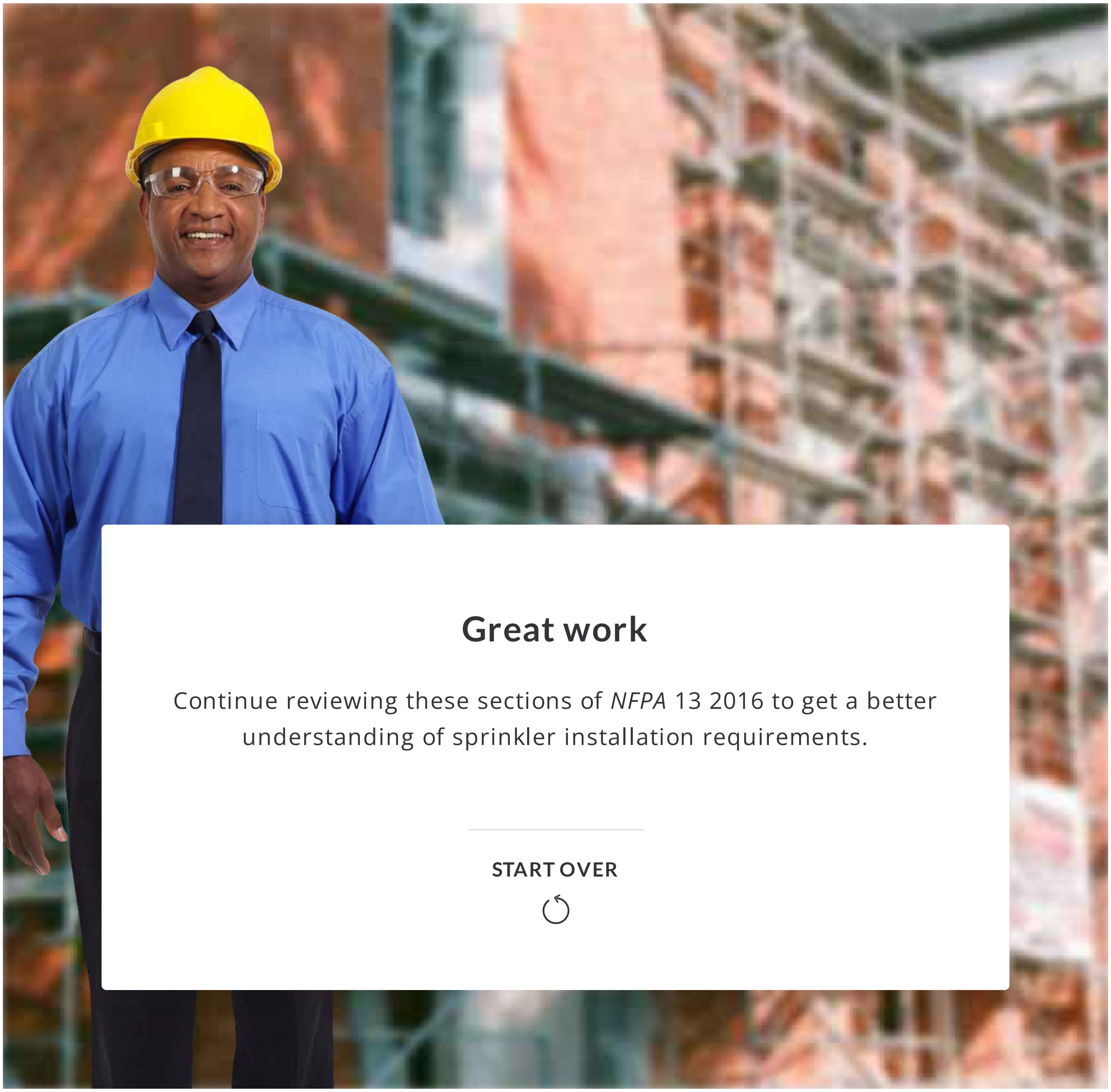
1 parallel

2 perpendicular

Scene 1 Slide 5

0 → Scene 1 Slide 1

1 → Next Slide



Great work

Continue reviewing these sections of *NFPA* 13 2016 to get a better understanding of sprinkler installation requirements.

START OVER

Scene 1 Slide 6

Continue → End of Scenario

Complete the scenario above before moving on.

Installation for Occupancy Categories

NFPA 13 2016, Section 8.5.3

For light and ordinary hazard occupancies, the maximum spacing between branch lines and between sprinklers on branch lines is 15 ft. This spacing is reduced to 12 ft. for extra hazard occupancies and high-piled storage applications. The 12 ft. limitation is increased to 12 ft. 6 in. for bays which are 25 ft. wide and to 15 ft. for hydraulically calculated densities below 0.25 gpm per ft^2.

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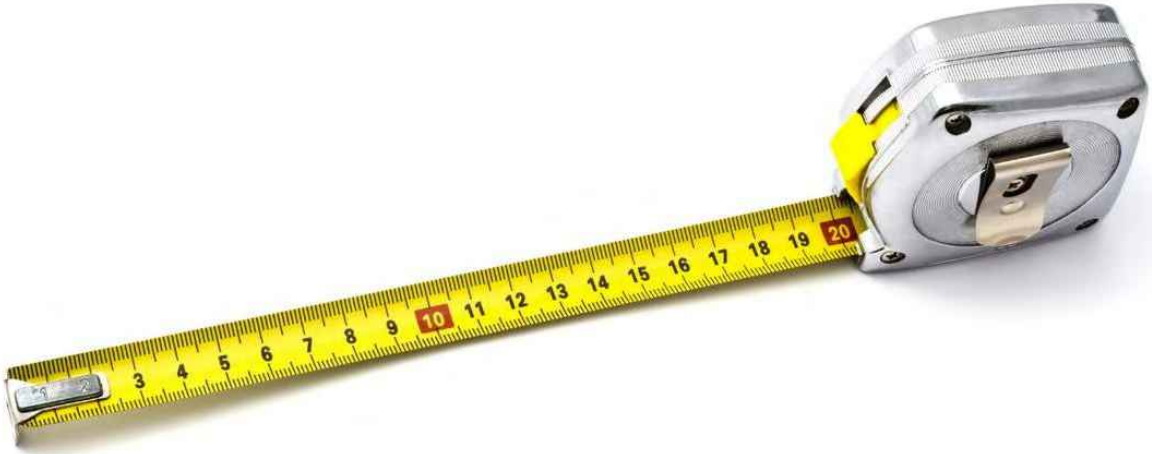


NFPA 13 2016, Section 8.6.3.2

In all occupancy categories, the distance from a sprinkler to a wall **must not exceed one-half the maximum sprinkler spacing**.

This distance is increased to 9 ft. for small rooms where the standard recognizes the potential for clutter at the ceiling level and therefore, allows another one to one-half feet of flexibility to the layout designer.

Annex figures in this section illustrate typical utilizations of this exception.

The standard defines the **minimum distance** from a wall for each type of sprinkler. Typically, upright sprinklers can be located **no closer than 4 in.** from a wall unless otherwise listed. This is an attempt to **minimize interference with the spray pattern** of the sprinkler.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Unless Section 8.15.1.6 requirements apply, upright and pendent spray sprinklers are permitted in ____ Hazard occupancy classifications and building construction types.

○ only Light

○ only Extra

○ all

SUBMIT

For extra hazard occupancies and high-piled storage applications, the maximum spacing between branch lines and between sprinklers on branch lines is ____?

○ 12 ft

○ 13 in

○ 14 ft

○ 15 ft

SUBMIT

Complete the knowledge checks above before moving on.

Installation Requirements for Obstructions to Sprinkler Discharge

We will review the obstructions to sprinkler discharge pattern development and obstructions that prevent sprinkler discharge from reaching the hazard.

CONTINUE

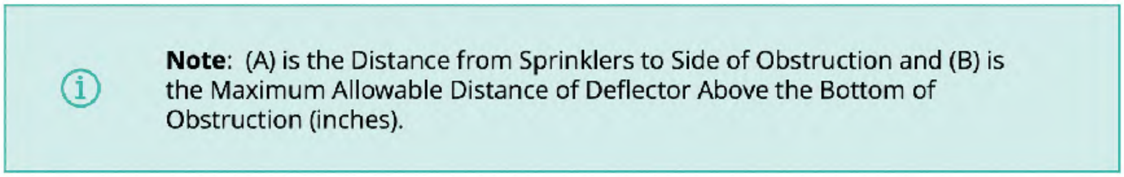
Standard Pendent and Upright Spray Sprinklers

NFPA 13 2016, Section 8.6.5

This section covers this topic in more detail for the standard pendent and upright spray sprinklers to get a sense of the standard.

> **Remember, it is important to know the specific language for each of the sprinkler types, and there are exceptions that are beyond the scope of this discussion.**

There are several key points in this area. The first deals with **obstructions that are hung from the ceiling**. These can be beams, ducts, etc. This was formerly known as the "**Beam Rule,**" which allows the discharge spray to go under the obstruction, rather than a significant portion of the spray being blocked by the obstruction.



Note: (A) is the Distance from Sprinklers to Side of Obstruction and (B) is the Maximum Allowable Distance of Deflector Above the Bottom of Obstruction (inches).

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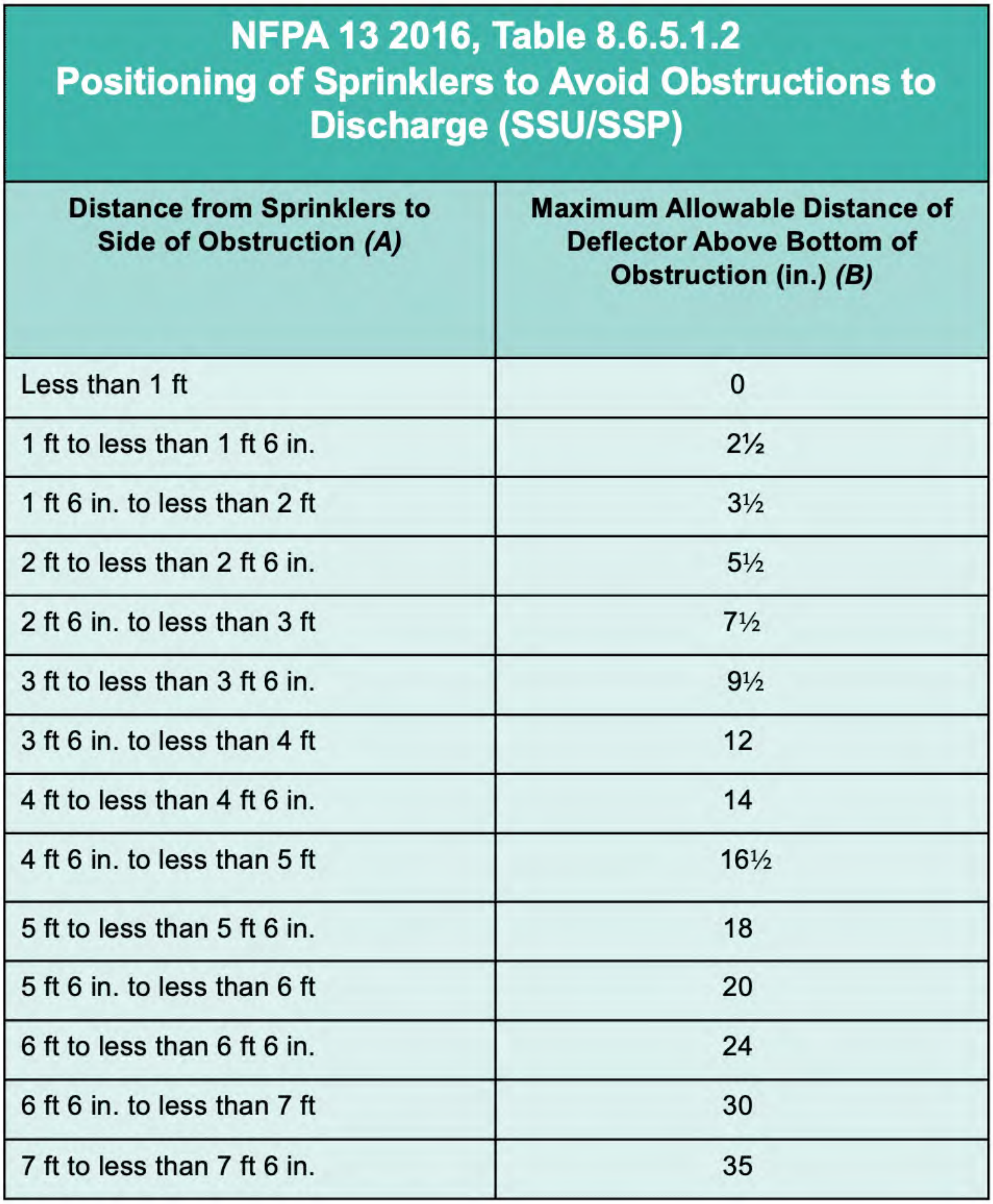
Table 8.6.5.1.2 lists the maximum allowable distance for SSU and SSP sprinkler detectors to avoid obstructions



NFPA 13 2016, Table 8.6.5.1.2
Positioning of Sprinklers to Avoid Obstructions to Discharge (SSU/SSP)

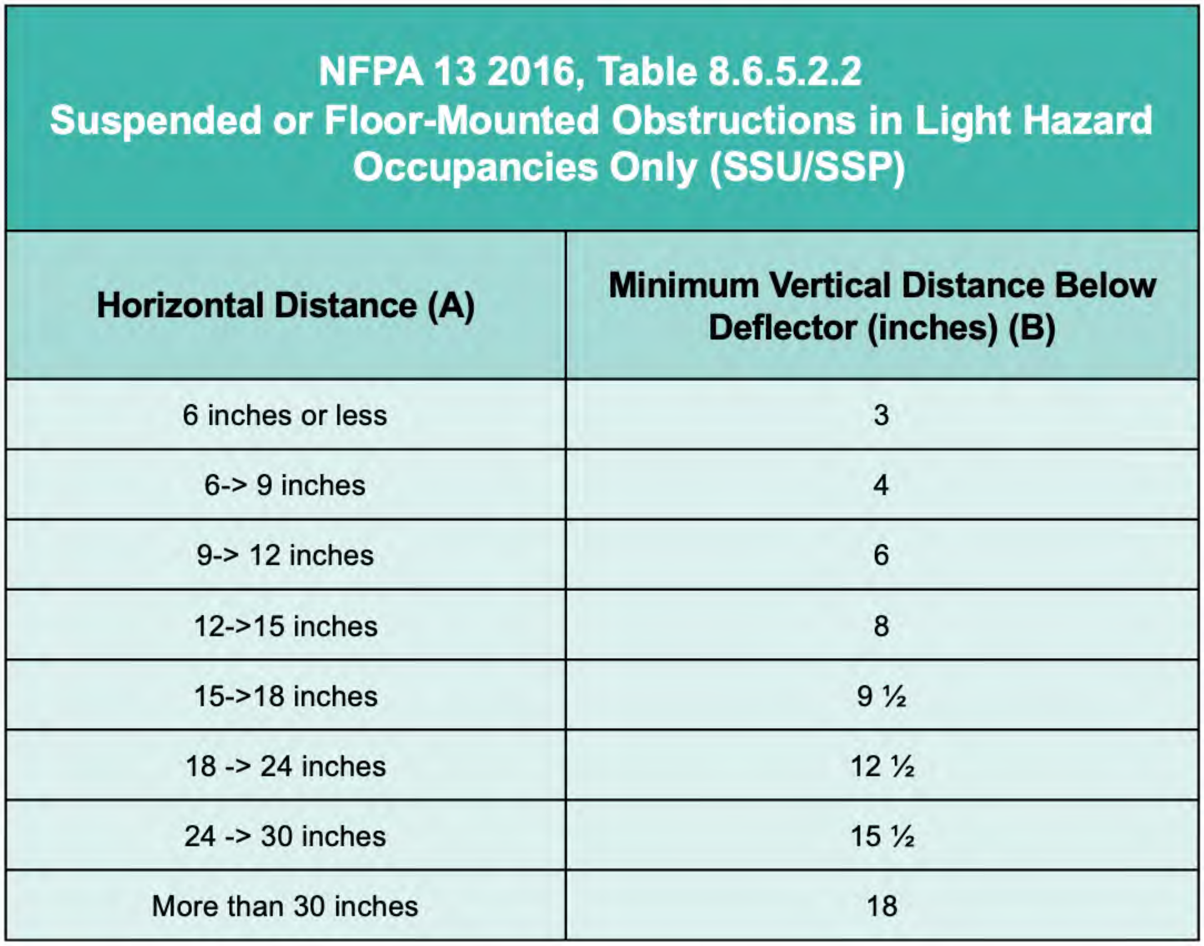
Distance from Sprinklers to Side of Obstruction *(A)*	**Maximum Allowable Distance of Deflector Above Bottom of Obstruction (in.) *(B)***
Less than 1 ft	0
1 ft to less than 1 ft 6 in.	2½
1 ft 6 in. to less than 2 ft	3½
2 ft to less than 2 ft 6 in.	5½
2 ft 6 in. to less than 3 ft	7½
3 ft to less than 3 ft 6 in.	9½
3 ft 6 in. to less than 4 ft	12
4 ft to less than 4 ft 6 in.	14
4 ft 6 in. to less than 5 ft	16½
5 ft to less than 5 ft 6 in.	18
5 ft 6 in. to less than 6 ft	20
6 ft to less than 6 ft 6 in.	24
6 ft 6 in. to less than 7 ft	30
7 ft to less than 7 ft 6 in.	35

ⓘ Refer to ***NFPA*** 13 2016, Figure 8.6.5.1.2(a), Positioning of Sprinklers to Avoid Obstructions to Discharge (SSU/SSP).

CONTINUE

Another point explains that obstructions located against a wall that **do not exceed 30 inches in width** are permitted. These are typically soffits but can be ductwork or other construction arrangements. The distance away from the obstruction is calculated per the formula in the illustration below. It is a function of the obstruction width (D) and the sprinkler deflector height above the obstacle (B). This is shown in *NFPA* 13 2016, Figure 8.6.5.1.2(b), Obstructions Against Walls (SSU/SSP).

Table 8.6.5.2.2 refers to suspended or floor-mounted obstructions. Also, refer to *NFPA* 13 2016, Figure 8.6.5.2.2, Suspended or Floor-Mounted Obstructions in Light Hazard Occupancies Only (SSU/SSP).



NFPA 13 2016, Table 8.6.5.2.2
Suspended or Floor-Mounted Obstructions in Light Hazard Occupancies Only (SSU/SSP)

Horizontal Distance (A)	Minimum Vertical Distance Below Deflector (inches) (B)
6 inches or less	3
6-> 9 inches	4
9-> 12 inches	6
12->15 inches	8
15->18 inches	9 ½
18 -> 24 inches	12 ½
24 -> 30 inches	15 ½
More than 30 inches	18

ⓘ The minimum clearance to the top of storage for standard sprinklers is 18 inches. (*NFPA* 13 2016, Section 8.5.6.1)

LET'S REVIEW

Let's do a quick check about what has been covered so far.

For standard pendent and upright spray sprinklers, if the distance from a sprinkler to the side of an obstruction is 4 ft. 2 in., what is the maximum allowable distance the deflector can be above the bottom of the obstruction?

○ 9 ½ in

○ 14 in

○ 16 ½ in

○ 20 in

SUBMIT

Complete the knowledge check above before moving on.

Sidewall Sprinklers

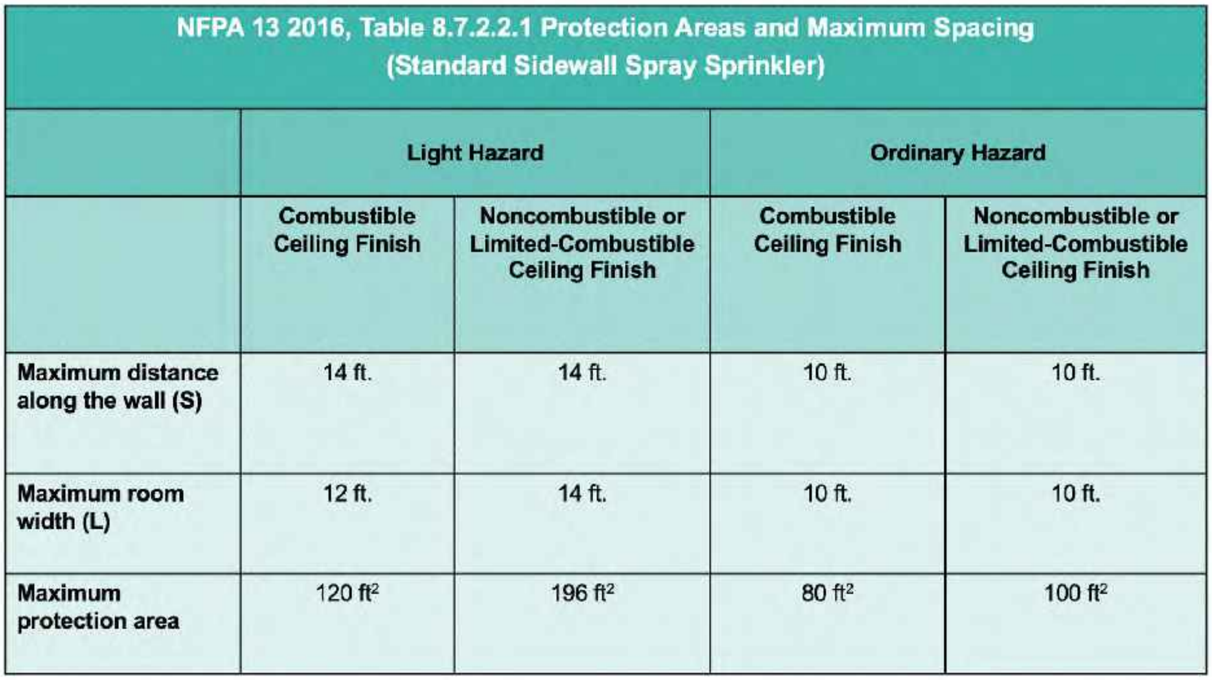
NFPA 13 2016, Section 8.7

This section provides requirements pertaining to the protection area of coverage, both along a wall and across a room. The maximum allowable protection area of coverage for a sprinkler is found in Table 8.7.2.2.1, shown below. **Note that the maximum area of coverage of a sprinkler is 196 ft^2.**

Sidewall sprinklers are not to be installed back-to-back without separation by a continuous lintel or soffit. The maximum permitted width of the lintel or soffit is 16 inches. Requirements for minimum distance from walls and minimum distance between sprinklers are found in this part of the standard as well.

Sidewall sprinklers are to be installed **no closer than 4 ft.** from light fixtures or similar obstructions.

Table 8.7.2.2.1 refers to the protected areas and maximum spacing of standard sidewall spray sprinklers based on occupancy classification.



NFPA 13 2016, Table 8.7.2.2.1 Protection Areas and Maximum Spacing (Standard Sidewall Spray Sprinkler)	Light Hazard		Ordinary Hazard	
	Combustible Ceiling Finish	Noncombustible or Limited-Combustible Ceiling Finish	Combustible Ceiling Finish	Noncombustible or Limited-Combustible Ceiling Finish
Maximum distance along the wall (S)	14 ft.	14 ft.	10 ft.	10 ft.
Maximum room width (L)	12 ft.	14 ft.	10 ft.	10 ft.
Maximum protection area	120 ft²	196 ft²	80 ft²	100 ft²

Click on the image to enlarge.

The deflector of a sidewall sprinkler is to be aligned parallel to the ceiling or roof. (*NFPA* 13 2016, Section 8.7.4.2.1)

CONTINUE

Extended Coverage Sidewall Sprinklers

NFPA 13 2016, Section 8.9

Most of the provisions in Section 8.9 are similar to those found in Section 8.7. The main difference is that extended coverage sidewall sprinklers have **larger protection areas** and **flatter distribution patterns** than standard spray sidewall sprinklers and, therefore, require **greater separation distances** from obstructions.

- The maximum allowable protection area of coverage for a sprinkler can **not** exceed 400 ft^2.
- Sidewall sprinklers can **not** be installed back-to-back without being separated by a continuous lintel, soffit, or baffle.
- Requirements for minimum distances from walls and between sprinklers are located in this section of the standard. **Note there are differences in requirements for sidewall sprinkler deflectors and horizontal sidewall sprinkler deflectors.**
- Sidewall sprinklers are to be installed **no closer than 8 ft**. from light fixtures or other similar obstructions.

CONTINUE

Early Suppression Fast-Response (ESFR) Sprinklers

NFPA 13 2016, Section 8.12

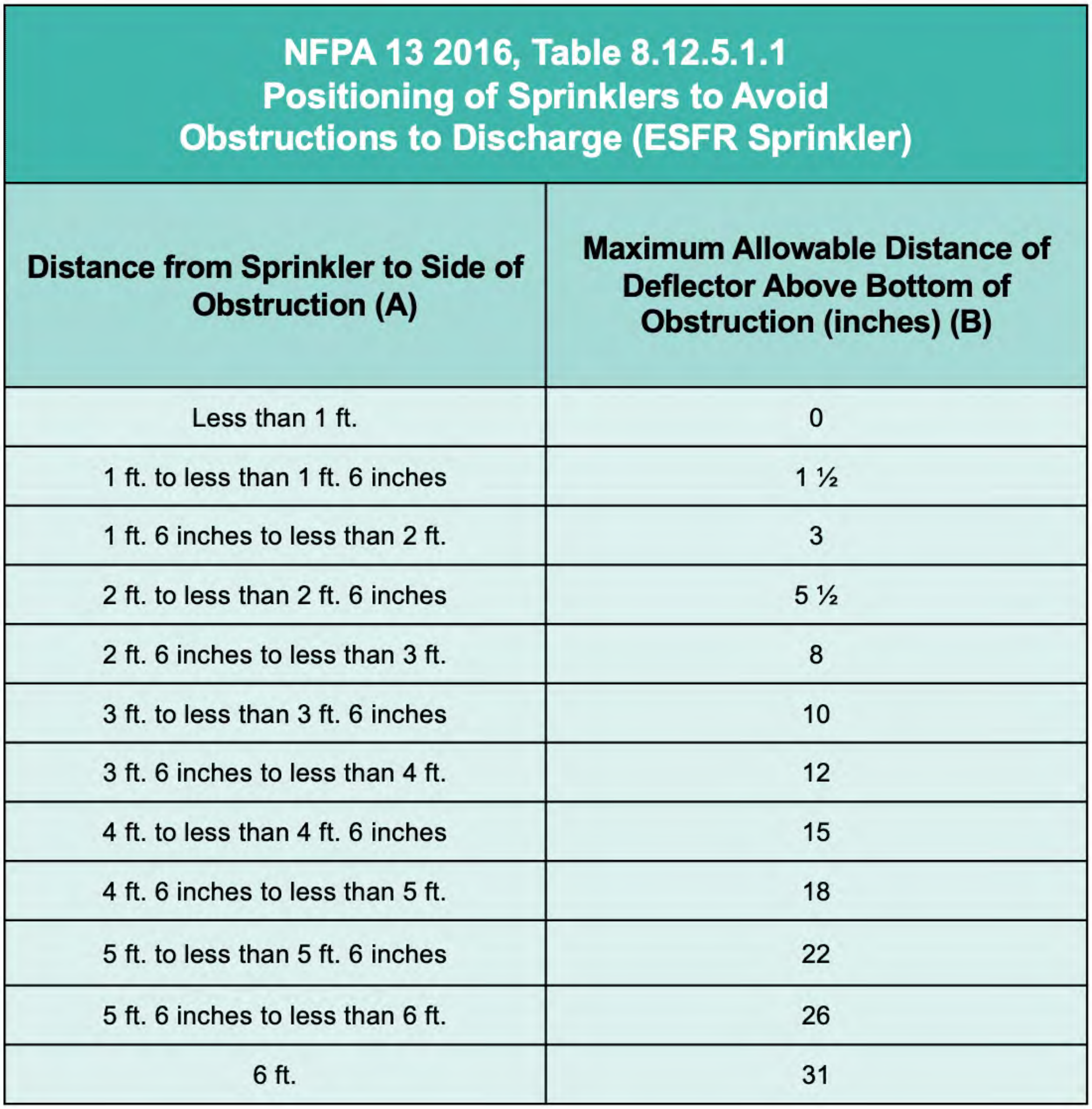
The spacing and location requirements of ESFR sprinklers are designed to ensure that the sprinklers operate while the fire size is sufficiently small so that the fire can be suppressed. ESFR sprinklers are also designed to **minimize the impact of obstructions** so that the sprinkler discharge can reach the seat of the fire.

- Early Suppression Fast-Response (ESFR) sprinklers are required to be located a **minimum of 4 in.** from a wall.

- The minimum distance between sprinklers requires a spacing **no less than 8 ft.** on centers and the minimum allowable protection area of coverage for a sprinkler shall **not be less than 64 ft^2**.

- For clearance, the clearance between the deflector and the top of the storage shall be **at least 36 in**.

Table 8.12.5.1.1 lists the maximum allowable distance for ESFR sprinkler deflectors to avoid obstructions.



NFPA 13 2016, Table 8.12.5.1.1
Positioning of Sprinklers to Avoid
Obstructions to Discharge (ESFR Sprinkler)

Distance from Sprinkler to Side of Obstruction (A)	Maximum Allowable Distance of Deflector Above Bottom of Obstruction (inches) (B)
Less than 1 ft.	0
1 ft. to less than 1 ft. 6 inches	1 ½
1 ft. 6 inches to less than 2 ft.	3
2 ft. to less than 2 ft. 6 inches	5 ½
2 ft. 6 inches to less than 3 ft.	8
3 ft. to less than 3 ft. 6 inches	10
3 ft. 6 inches to less than 4 ft.	12
4 ft. to less than 4 ft. 6 inches	15
4 ft. 6 inches to less than 5 ft.	18
5 ft. to less than 5 ft. 6 inches	22
5 ft. 6 inches to less than 6 ft.	26
6 ft.	31

ⓘ Refer to *NFPA* 13 2016, Figure 8.12.5.1.1, Positioning of Sprinkler to Avoid Obstructions to Discharge (ESFR Sprinkler).

LET'S REVIEW

Let's do a quick check about what has been covered so far.

If sidewall sprinklers are installed back-to-back, there needs to be separation by a continuous lintel or soffit.

○ True

○ False

SUBMIT

Early Suppression Fast-Response (ESFR) sprinklers are required to be located at least ___ from a wall.

○ 4 in.

○ 6 in.

○ 4 ft.

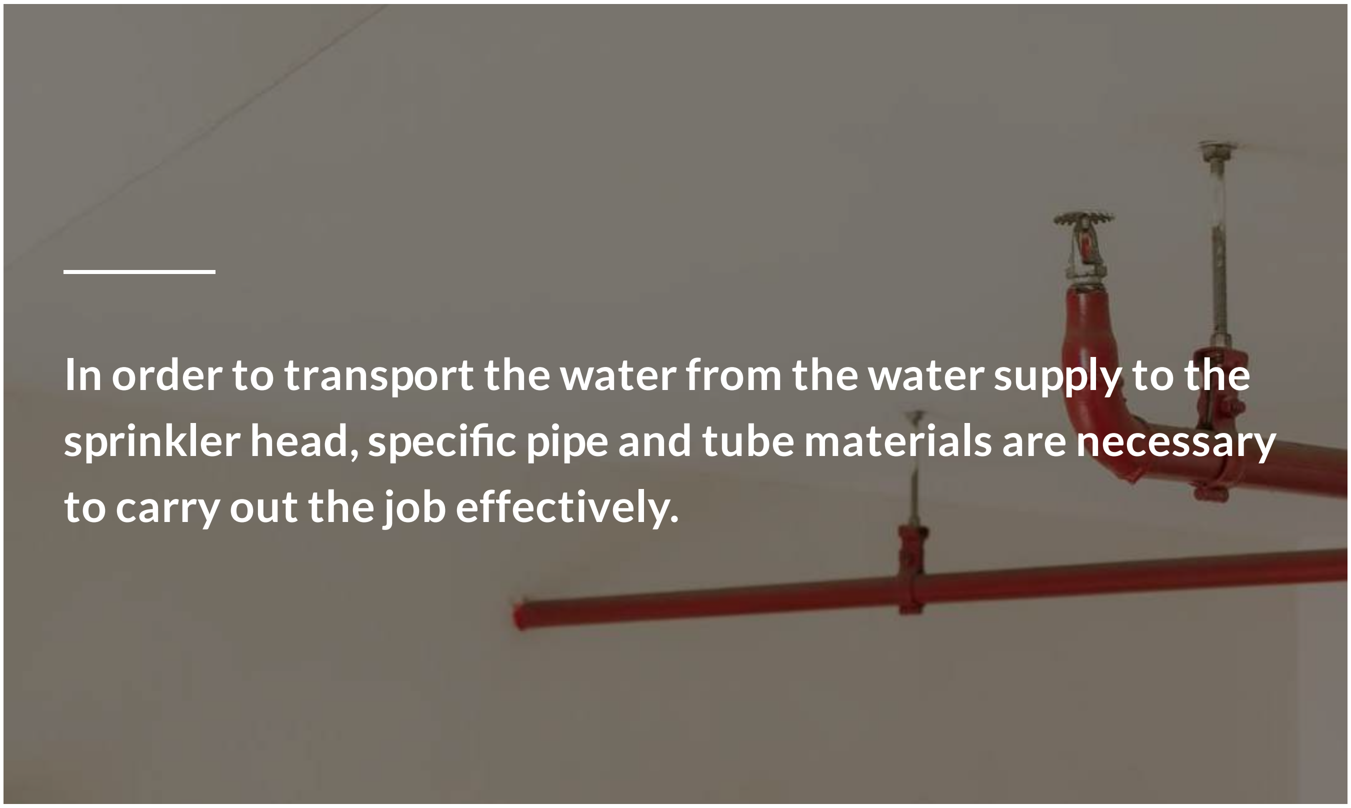
○ 6 ft.

SUBMIT

Complete the knowledge checks above before moving on.

Lesson 2 of 3

Pipe and Tube



In order to transport the water from the water supply to the sprinkler head, specific pipe and tube materials are necessary to carry out the job effectively.

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Identify various characteristics of pipe, tube, and fittings.

Key References

- *NFPA* 13 - *Standard for the Installation of Sprinkler Systems*, 2016

LET'S BEGIN

Pipe and Tube Identification

NFPA 13 2016, Section 6.3

The use of new pipe materials and the development of new methods for installing and joining pipe continue to grow. Section 6.3 provides details on the applications of various pipe materials used in aboveground applications. *NFPA* 13 currently allows for various types of steel, copper, and nonmetallic pipe to be used.

Copper Tube –

Have a wall thickness of Type K, Type L, or Type M where used in a sprinkler system.

Manufacturer’s Pipe and Tube Identification –

All pipes are marked continuously along their length, and the marking is required to be visible on every piece of pipe over 2 ft. long. Pipe identification shall include the manufacturer’s name, model designation, or schedule.

Steel Pipe - Threaded

Joined by threaded fittings used with pipe having cut grooves.

Steel Pipe - Welded and Grooved

Used and joined by welding as referenced, or by roll grooved pipe and fittings as referenced.

ⓘ **When steel pipe referenced in Table 6.3.1 is joined by threaded fittings or by fittings used with pipe having cut grooves, the minimum wall thickness shall be in accordance with**

Schedule 30 pipe (8 in. or larger size) or Schedule 40 pipe (less than 8 in. size) for pressures up to 300 psi. (*NFPA* 13 2016, Section 6.3.3)

CHARACTERISTICS OF PIPE AND TUBE

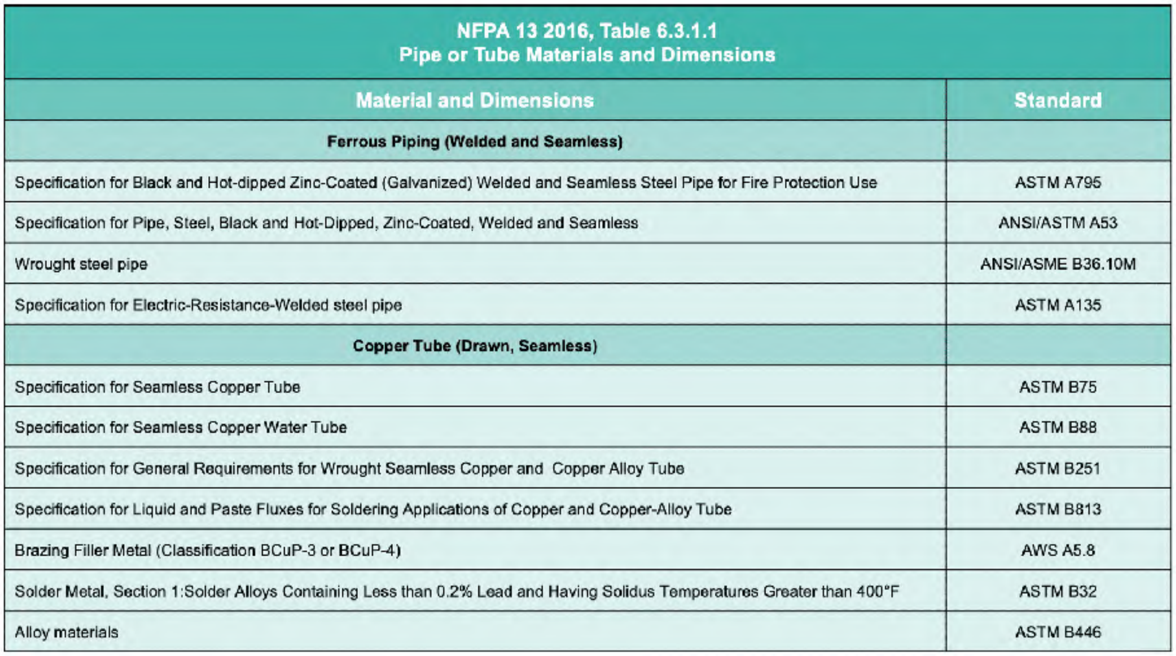
Characteristics of Pipe and Tube

NFPA 13 2016, Section 6.3

This portion of the standard references numerous tables that are important to understand when reviewing the characteristics of pipe and tube. Chapter 2 contains a list of publications referenced throughout the standard. Chapter 6 provides tables that specifically show the materials and dimensions of pipe, tube, and fittings and the various standards which apply to them.

In Table 6.3.1.1, you will see the specifications for ferrous piping, both welded and seamless, and also for copper tubing which is drawn or seamless. This table lists the ANSI Standards, ASTM Standards, or AWS Standards which must be followed for the different materials.

- **Ferrous (welded and seamless)**: Ferrous piping can be galvanized, black, or wrought
- **Copper Tube (drawn or seamless)**: Copper tubing, which must be either drawn or seamless, is limited to types K, L, and M.



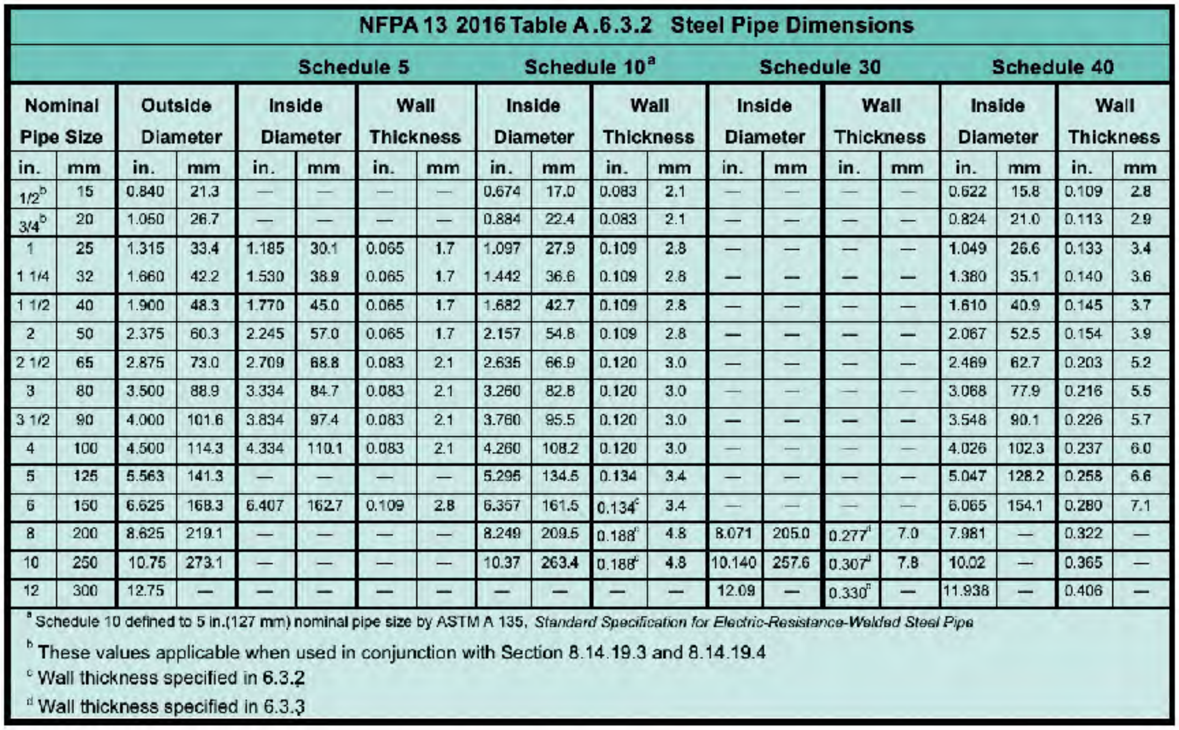
NFPA 13 2016, Table 6.3.1.1
Pipe or Tube Materials and Dimensions

Material and Dimensions	Standard
Ferrous Piping (Welded and Seamless)	
Specification for Black and Hot-dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use	ASTM A795
Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless	ANSI/ASTM A53
Wrought steel pipe	ANSI/ASME B36.10M
Specification for Electric-Resistance-Welded steel pipe	ASTM A135
Copper Tube (Drawn, Seamless)	
Specification for Seamless Copper Tube	ASTM B75
Specification for Seamless Copper Water Tube	ASTM B88
Specification for General Requirements for Wrought Seamless Copper and Copper Alloy Tube	ASTM B251
Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper-Alloy Tube	ASTM B813
Brazing Filler Metal (Classification BCuP-3 or BCuP-4)	AWS A5.8
Solder Metal, Section 1:Solder Alloys Containing Less than 0.2% Lead and Having Solidus Temperatures Greater than 400°F	ASTM B32
Alloy materials	ASTM B446

Click on the image to enlarge.

CONTINUE

Table A.6.3.2 outlines the dimensions for different Schedules of steel pipe.



NFPA 13 2016 Table A.6.3.2 Steel Pipe Dimensions

Nominal Pipe Size		Outside Diameter		Schedule 5				Schedule 10[a]				Schedule 30				Schedule 40			
				Inside Diameter		Wall Thickness		Inside Diameter		Wall Thickness		Inside Diameter		Wall Thickness		Inside Diameter		Wall Thickness	
in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
1/2[b]	15	0.840	21.3	—	—	—	—	0.674	17.0	0.083	2.1	—	—	—	—	0.622	15.8	0.109	2.8
3/4[b]	20	1.050	26.7	—	—	—	—	0.884	22.4	0.083	2.1	—	—	—	—	0.824	21.0	0.113	2.9
1	25	1.315	33.4	1.185	30.1	0.065	1.7	1.097	27.9	0.109	2.8	—	—	—	—	1.049	26.6	0.133	3.4
1 1/4	32	1.660	42.2	1.530	38.9	0.065	1.7	1.442	36.6	0.109	2.8	—	—	—	—	1.380	35.1	0.140	3.6
1 1/2	40	1.900	48.3	1.770	45.0	0.065	1.7	1.682	42.7	0.109	2.8	—	—	—	—	1.610	40.9	0.145	3.7
2	50	2.375	60.3	2.245	57.0	0.065	1.7	2.157	54.8	0.109	2.8	—	—	—	—	2.067	52.5	0.154	3.9
2 1/2	65	2.875	73.0	2.709	68.8	0.083	2.1	2.635	66.9	0.120	3.0	—	—	—	—	2.469	62.7	0.203	5.2
3	80	3.500	88.9	3.334	84.7	0.083	2.1	3.260	82.8	0.120	3.0	—	—	—	—	3.068	77.9	0.216	5.5
3 1/2	90	4.000	101.6	3.834	97.4	0.083	2.1	3.760	95.5	0.120	3.0	—	—	—	—	3.548	90.1	0.226	5.7
4	100	4.500	114.3	4.334	110.1	0.083	2.1	4.260	108.2	0.120	3.0	—	—	—	—	4.026	102.3	0.237	6.0
5	125	5.563	141.3	—	—	—	—	5.295	134.5	0.134	3.4	—	—	—	—	5.047	128.2	0.258	6.6
6	150	6.625	168.3	6.407	162.7	0.109	2.8	6.357	161.5	0.134[c]	3.4	—	—	—	—	6.065	154.1	0.280	7.1
8	200	8.625	219.1	—	—	—	—	8.249	209.5	0.188[c]	4.8	8.071	205.0	0.277[d]	7.0	7.981	—	0.322	—
10	250	10.75	273.1	—	—	—	—	10.37	263.4	0.188[c]	4.8	10.140	257.6	0.307[d]	7.8	10.02	—	0.365	—
12	300	12.75	—	—	—	—	—	—	—	—	—	12.09	—	0.330[d]	—	11.938	—	0.406	—

[a] Schedule 10 defined to 5 in.(127 mm) nominal pipe size by ASTM A 135, *Standard Specification for Electric-Resistance-Welded Steel Pipe*

[b] These values applicable when used in conjunction with Section 8.14.19.3 and 8.14.19.4

[c] Wall thickness specified in 6.3.2

[d] Wall thickness specified in 6.3.3

Click on the image to enlarge.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Ferrous piping can be galvanized, black, or wrought.

○ True

○ False

SUBMIT

🔒 Complete the knowledge check above before moving on.

Pipe and Tube Bending

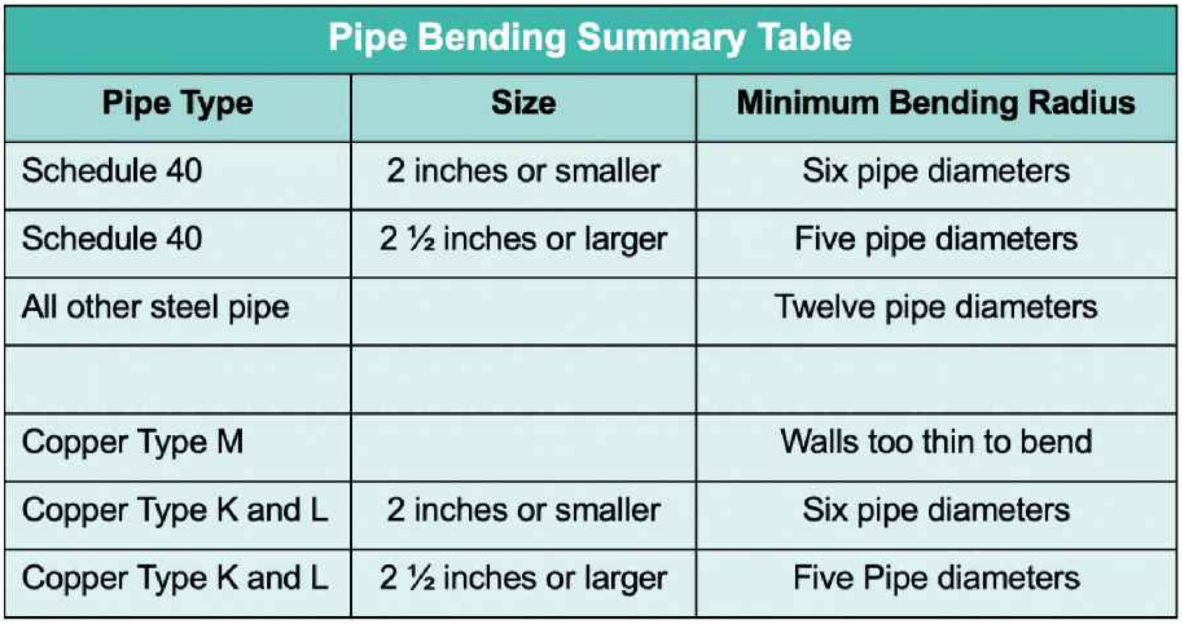
NFPA 13 2016, Section 6.3.8

Bending for Schedule 10 steel pipe, or any steel pipe of wall thickness equal to or greater than Schedule 10 and Types K and L copper tube, is permitted when bends are made with **no kinks, ripples, distortions, or reductions in diameter or any noticeable deviations** from round.

Bending for Schedule 40 and Copper Tubing

The **minimum radius of a bend** shall be six pipe diameters for pipe sizes 2 in. and smaller, and five pipe diameters for pipe sizes 2 ½ in. and larger.

For all other steel pipe, the **minimum radius of a bend** shall be 12 pipe diameters for all sizes.



Pipe Bending Summary Table		
Pipe Type	**Size**	**Minimum Bending Radius**
Schedule 40	2 inches or smaller	Six pipe diameters
Schedule 40	2 ½ inches or larger	Five pipe diameters
All other steel pipe		Twelve pipe diameters
Copper Type M		Walls too thin to bend
Copper Type K and L	2 inches or smaller	Six pipe diameters
Copper Type K and L	2 ½ inches or larger	Five Pipe diameters

Click on the image to enlarge

LET'S REVIEW

Let's do a quick check about what has been covered so far.

For a Schedule 40 pipe 2 ½ in. or larger, what is the minimum bending radius?

○ Six pipe diameters

○ Five pipe diameters

○ Tweleve pipe diameters

SUBMIT

Complete the knowledge check above before moving on.

Joining of Pipe

NFPA 13 2016, Section 6.4

This section outlines the fittings used in sprinkler systems for the joining of pipe. Subsection 6.4.1 specifies the types of fittings permitted to be used in sprinkler systems.

Image of pipe cap, reducer coupling, and union

Fittings: Are not limited to polybutylene, CPVC, and steel in accordance with regulations.

Couplings and Unions: Screwed unions shall not be used on pipe larger than 2 in. Couplings and unions other than screwed-type shall be of a type listed specifically for use in sprinkler systems.

Reducers and Bushings: A one-piece reducing fitting shall be used wherever a change is made in the size of the pipe. Hexagonal or face bushing shall be permitted in reducing the size of the opening of fittings when standard fittings of the required size are not available.

ⓘ **Joint compound or tape is required to be applied to male threads only. (*NFPA* 13 2016, Sections 6.5.1.3)**

WELDED PIPE AND FITTINGS

Welded Pipe and Fittings

NFPA 13 2016, Sections 6.5.2

Welding is permitted to join sprinkler piping. The pipe is required to be **shop welded**, although the standard does permit exceptions.

- Welding is **not** permitted if there is rain, snow, sleet, or high winds that can impact the weld on the pipe.
- Torch cutting and welding are **not** permitted when modifying or repairing sprinkler systems.

Brazed and Soldered Joints

NFPA 13 2016, Sections 6.5.4

Solder joints, where permitted, shall be fabricated in accordance with the methods and procedures listed in *ASTM* B828, Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.

- Unless requirements are met, joints for the connection of copper tube shall be **brazed**.
- Solder joints shall be permitted for exposed wet pipe systems in **Light Hazard occupancies** where the temperature classification of the installed sprinklers is of the **ordinary-** or **intermediate-temperature** classification.
- Solder joints shall be permitted for wet pipe systems in **Light Hazard** and **Ordinary Hazard (Group 1) occupancies** where the piping is concealed, irrespective of sprinkler temperature ratings.
- Brazing fluxes, if used, shall **not** be of a highly corrosive type.

ⓘ After cutting a pipe, all burrs and fins are required to be removed. (*NFPA* 13 2016, Section 6.5.6.1)

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Screwed unions shall not be used on pipe larger than ___ inch(es).

○ One

○ Two

○ Three

SUBMIT

Brazed Joints

For the connection of copper tube

Fluxes, if used, shall not be of a highly corrosive type

Soldered Joints

For exposed wet pipe systems in Light Hazard with ordinary temp. class.

For wet pipe systems (concealed) in Light Hazard and OH1

Complete the knowledge checks above before moving on.

Piping Material

NFPA 13 2016, Section 10.1

The pipe and fittings must be listed for fire protection purposes and comply with *AWWA* (American Water Works Association) standards. Numerous piping choices are available including cast iron, asbestos-cement, copper, steel, fiberglass, polyethylene, and PVC.

Steel piping is currently **prohibited** from underground use **except for FDCs**.

Per Section A.10.1.1, the selection of the type of piping should be based on:

- Maximum system working pressure
- Maximum pressure from pressure surges and anticipated frequency of surges
- Depth at which the pipe is to be installed
- Soil conditions
- Corrosion
- Susceptibility of pipe to other external loads, including earth loads, installation beneath buildings, and traffic or vehicle loads

A **150 psi minimum working pressure** rating is required for this pipe.

ⓘ **All piping used in private fire service mains shall be rated for the maximum system working pressure to which the piping is exposed to but shall not be rated at less than 150 psi. (*NFPA* 13 2016, Section 10.1.2)**

CONTINUE

Fittings and Joining of Pipe and Fittings

NFPA 13 2016, Sections 10.2 and 10.3

All fittings should meet the approved standards (*ASME*, *ASTM*) described in *NFPA* 24 and *NFPA* 13. There are many materials that can be used, and they must be installed per their listing limitations.

- A 150 psi minimum working pressure rating is required for the fittings.
- The joints which are used must be approved.
- There are several different methods for putting the pipe together, and these methods must be observed per *NFPA* 13 requirements.

CONTINUE

Depth of Cover

NFPA 13 2016, Section 10.4

For depth of cover, the pipe must be laid **at least 1 ft. below the frost line** in a given area.

- If frost is not a factor, a **30 in. minimum coverage** of the underground pipe is required.
- If you're going under driveways, you must go down a **minimum of 3 ft**.

- If you're locating under railroad tracks, the minimum requirement for coverage is **4 ft**.
- If installed under large piles of heavy commodities or in areas subject to heavy shock and vibrations, the minimum requirement for coverage is **4 ft**.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Steel piping is allowed for underground use and for FDCs.

○ True

○ False

SUBMIT

Complete the knowledge check above before moving on.

Protection against Freezing or Damage

NFPA 13 2016, Section 10.4

If it's impossible to locate the pipe underground, the standard allows it to be located above ground. However, there must be **satisfactory protection against freezing and mechanical damage**, and this protection additionally must be approved by the Authority Having Jurisdiction (AHJ).

The protection should be based on the **lowest mean temperature day**. A chart for this is provided in the Annex.

Pipe shall **not** be run under buildings unless special precautions are taken and with prior approval from your AHJ. Leaks in pipe under a building would be difficult to detect and repair.

In the event this cannot be avoided, special precautions are identified, allowing the private fire service main to extend **no more than 10 ft**. under the building to the riser location (measured from the outside of the building).

- Pipe joints shall not be located directly under foundation fittings.
- Piping is required to be installed at least 12 in. below the bottom of the building foundation or footers.

CONTINUE

Grounding and Bonding

NFPA 13 2016, Section 10.5

Underground piping may **not** be a grounding device for any electrical system. However, bonding the underground piping to a lightning protection grounding system is **not prohibited**.

NFPA 780 is cited as the reference for these requirements.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

If frost is not a factor, how many inches minimum coverage of the underground pipe is required?

○ 5

○ 10

○ 20

○ 30

SUBMIT

Pipe is not permitted to be run under buildings, unless special precautions are taken, with approval from the ___.

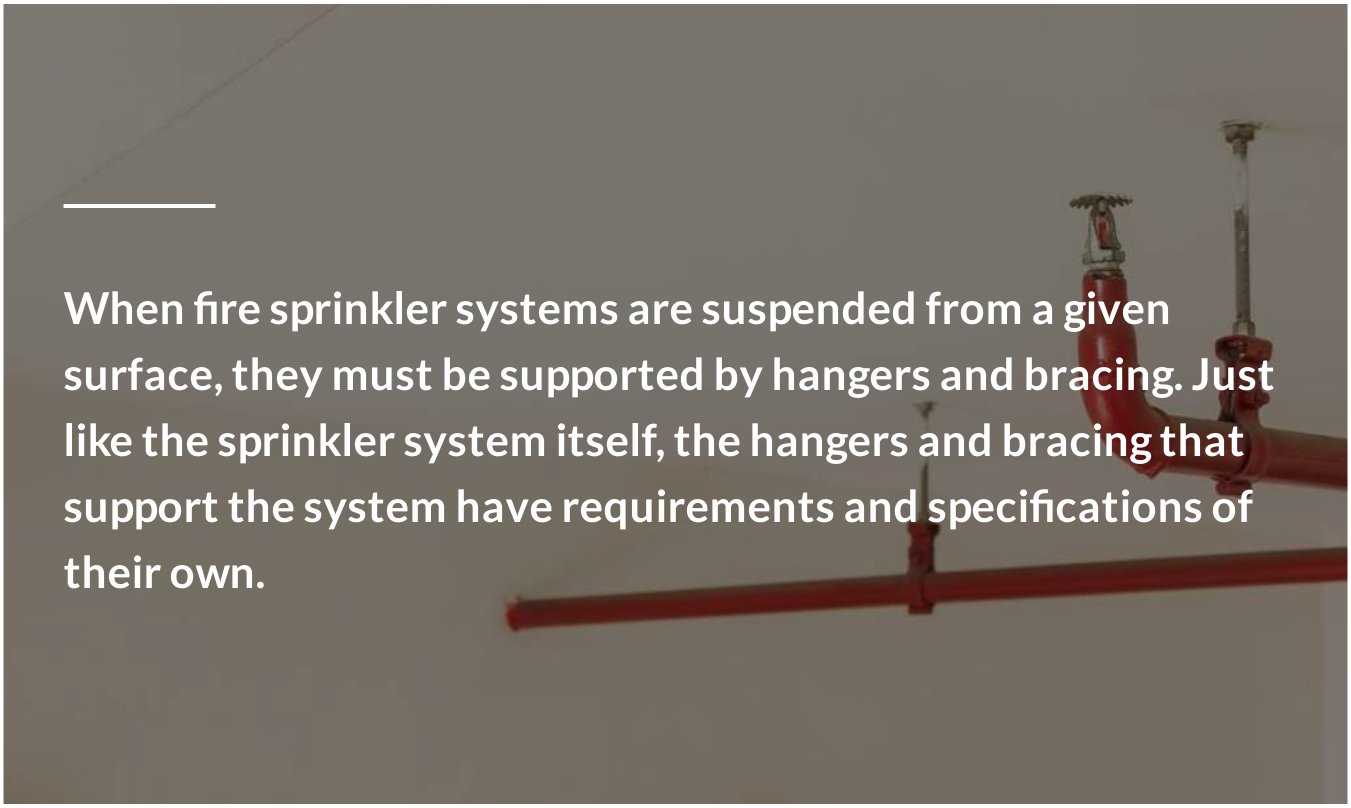
Type your answer here

SUBMIT

Complete the knowledge checks above before moving on.

Lesson 3 of 3

Hangers and Bracing



When fire sprinkler systems are suspended from a given surface, they must be supported by hangers and bracing. Just like the sprinkler system itself, the hangers and bracing that support the system have requirements and specifications of their own.

Lesson Goals

By the end of this lesson, you will be able to do the following:

- ☐ Recognize hanger components and types of hangers.
- ☐ Properly space hangers.

☐ Recall riser support requirements.

Key References

- *NFPA* 13 - *Standard for the Installation of Sprinkler Systems*, 2016

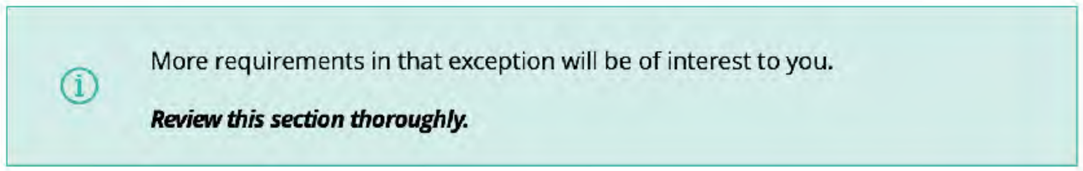
LET'S BEGIN

Hangers

NFPA 13 2016, Section 9.1

Hangers are designed to support five times the weight of the water-filled pipe plus 250 lbs. at each point of piping support. The points of support are required to adequately support the system. (*NFPA* 13 2016, Section 9.1.1.2)

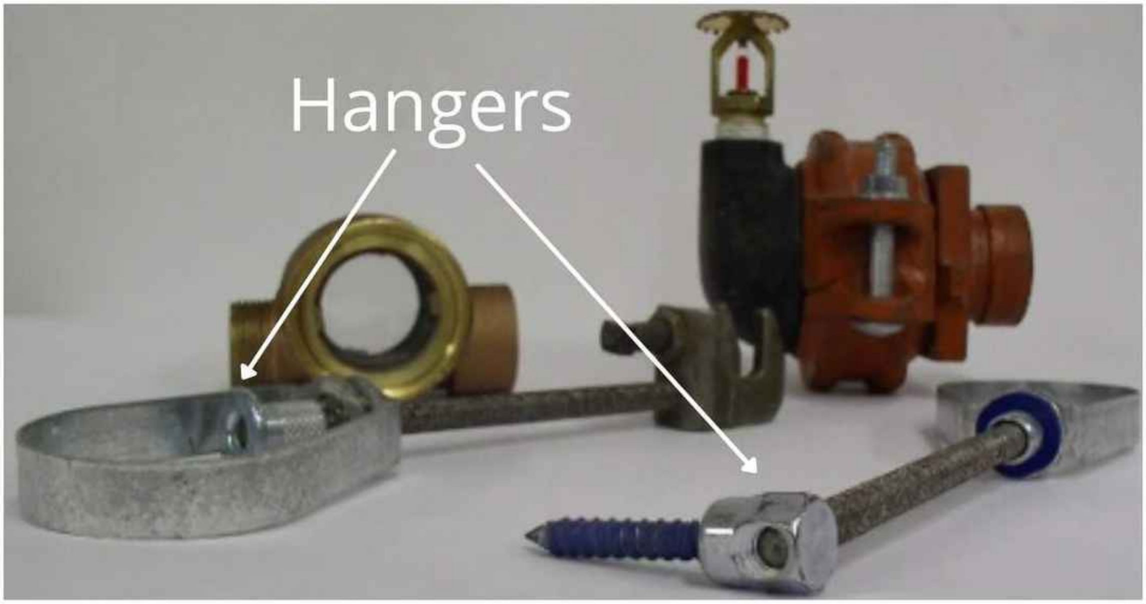
The general requirements of pipe hangers and hanging are contained in our referenced section. There is an exception to these requirements which allows for the design of the hangers by a registered professional engineer. To comply with this exception, the design must be able to **support five times the weight of the water-filled pipe plus 250 lbs**.



ⓘ More requirements in that exception will be of interest to you.

Review this section thoroughly.

CONTINUE



The hanger is composed of **three parts**:

1. The components attaching to the building structure
2. The components attaching to the sprinkler piping
3. The component attaching these two

Hanger assemblies attaching **directly** to the building structure must be listed, except for those fabricated from mild steel rods.

The hangers must be **ferrous** or must be made of materials that have been **subjected to actual fire tests**. These materials must also be listed.

NFPA 13 2016, Figure A.9.1.1 depicts a number of different hanger designs. Take time to review these designs.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Pipe hangers must be _____ or must be made of materials that have been subjected to actual fire tests.

○ Copper

○ Ferrous

○ Brazed

○ Soldered

SUBMIT

Complete the knowledge check above before moving on.

Maximum Distance between Hangers

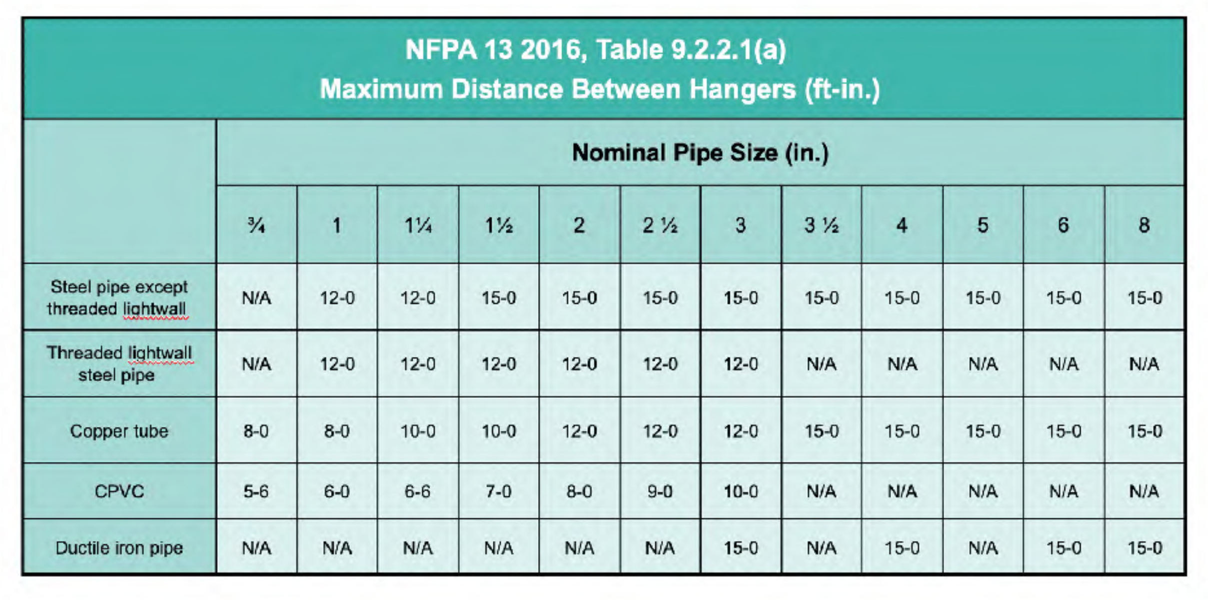
NFPA 13 2016, Section 9.2.2

The maximum distance between hangers depends on the **type of pipe** you are using in your network.

- In terms of steel pipe, the maximum distance between hangers is 15 ft. for 1 ½ in. pipe and larger, and is 12 ft. for pipe which is less than 1 ½ in.
- Threaded lightwall steel pipe can only be used for pipe sizes 1 - 3 in. and its spacing is a constant 12 ft.
- In terms of copper pipe, the spacing between hangers ranges between 8 ft. and 15 ft. depending on nominal tube size.

CONTINUE

Table 9.2.2.1(a) provides hanger spacing requirements for various types of pipe.



NFPA 13 2016, Table 9.2.2.1(a)
Maximum Distance Between Hangers (ft-in.)

	Nominal Pipe Size (in.)											
	¾	1	1¼	1½	2	2 ½	3	3 ½	4	5	6	8
Steel pipe except threaded lightwall	N/A	12-0	12-0	15-0	15-0	15-0	15-0	15-0	15-0	15-0	15-0	15-0
Threaded lightwall steel pipe	N/A	12-0	12-0	12-0	12-0	12-0	12-0	N/A	N/A	N/A	N/A	N/A
Copper tube	8-0	8-0	10-0	10-0	12-0	12-0	12-0	15-0	15-0	15-0	15-0	15-0
CPVC	5-6	6-0	6-6	7-0	8-0	9-0	10-0	N/A	N/A	N/A	N/A	N/A
Ductile iron pipe	N/A	N/A	N/A	N/A	N/A	N/A	15-0	N/A	15-0	N/A	15-0	15-0

Click on the image to enlarge.

SUPPORT OF RISERS

Support of Risers

NFPA 13 2016, Section 9.2.5

Risers are required to be **supported by riser clamps or by hangers** located on the horizontal connections within 24 in. of the riser centerline.

Riser clamps supporting risers using set screws are **not** permitted.

For multistory buildings, riser supports are required at the **lowest level, at each alternate level above, above and below offsets, and at the top of the riser**.

The distance between supports for risers in multistory buildings shall **not** exceed 25 ft.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

In terms of steel pipe, the maximum distance between hangers is ___ ft. for 1 ½ in. pipe and larger, and is ___ ft. for pipe which is less than 1 ½ in.

○ 15; 8

○ 10; 6

○ 15; 12

○ 8; 6

SUBMIT

🔒 Complete the knowledge check above before moving on.

After completing this module, you should now have a better understanding of the rules for sprinkler system installation and the requirements of pipe, tube, fittings, and hangers.

Click on the “Next” arrow up on the right-hand corner of the screen to continue to the quiz.

Automatic Sprinkler & Standpipe Systems - Sprinkler System Design and Acceptance

By the end of this module, you will be able to do the following:

- Compare and contrast design approaches for sprinkler systems.
- Identify the water supply requirements for sprinkler systems.
- Recognize the importance of sprinkler system acceptance tests.
- Compare acceptance tests for sprinkler systems and valves.

Key References:

- *NFPA* 13 - *Standard for the Installation of Sprinkler Systems*, 2016

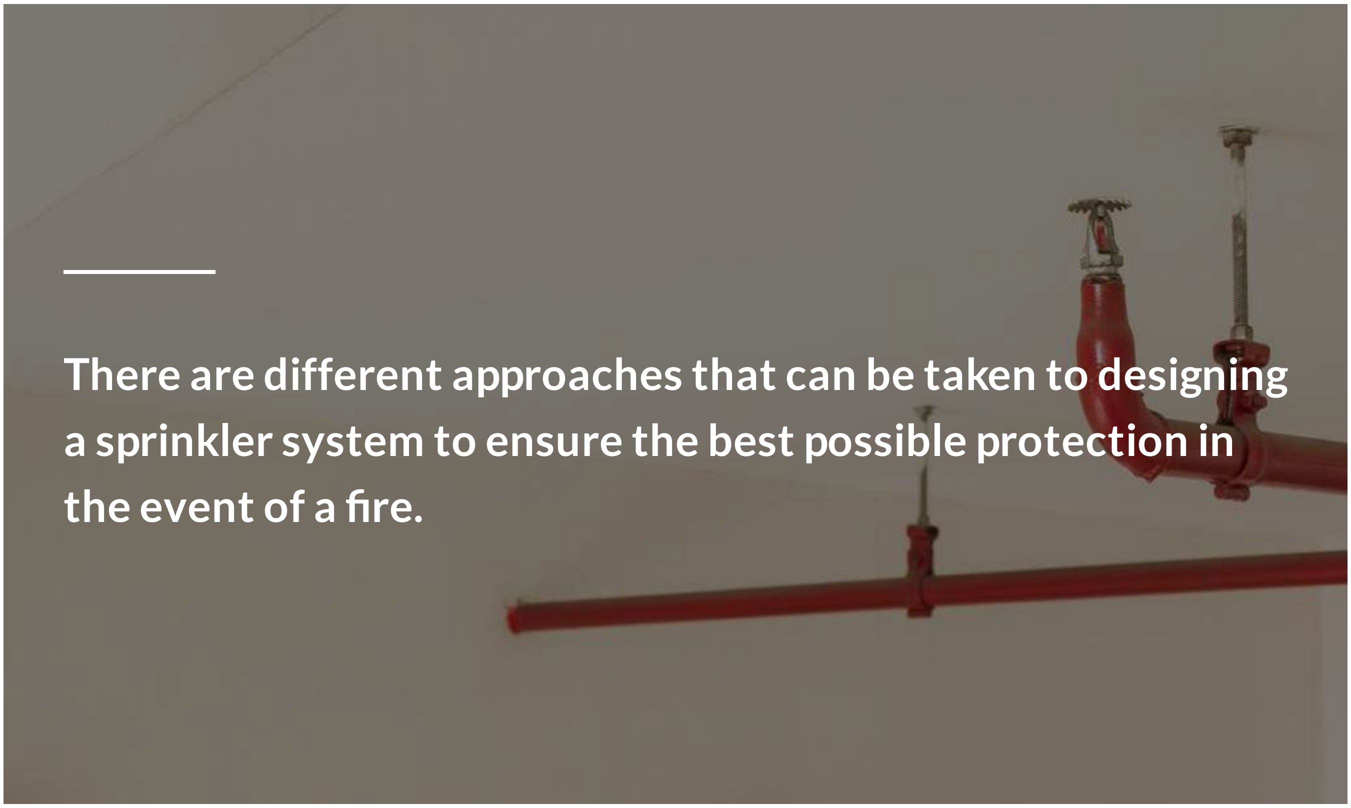
When you are ready to begin, click on the button above to start the course.

Sprinkler Design Requirements

Sprinkler System Acceptance

Lesson 1 of 2

Sprinkler Design Requirements



There are different approaches that can be taken to designing a sprinkler system to ensure the best possible protection in the event of a fire.

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Compare and contrast design approaches for sprinkler systems.

☐ Identify the water supply requirements for sprinkler systems.

Key References

- *NFPA* 13 - *Standard for the Installation of Sprinkler Systems*, 2016

LET'S BEGIN

Design Approaches

NFPA 13 2016, Chapters 11 and 23

There are two approaches that can be taken when designing a sprinkler system:

1. Pipe schedule system
2. Hydraulically designed system

Pipe schedule system

A sprinkler system in which the pipe sizing is selected from a schedule that is determined by the occupancy classification and in which a given number of sprinklers are allowed to be supplied from specific sizes of pipe.

Hydraulically designed systems

A calculated sprinkler system in which pipe sizes are selected on a pressure loss basis to provide a prescribed water density, in gallons per minute per square foot, or a prescribed minimum discharge pressure or flow per sprinkler, distributed with a reasonable degree of uniformity over a specified area.


Typically, the calculations for **hydraulically designed systems** are completed by **computer programs**.

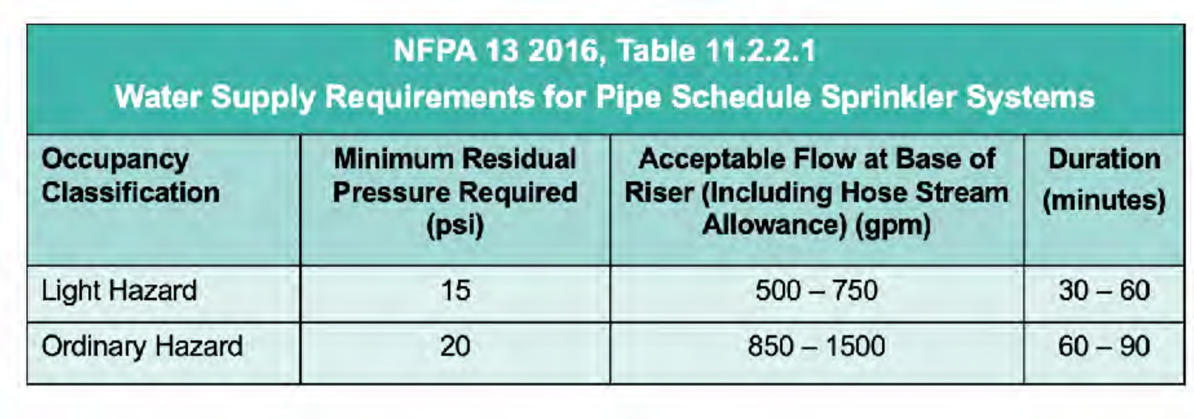
PIPE SCHEDULE SYSTEM

Pipe Schedule System

The pipe schedule method is permitted to be used for the following circumstances:

- Additions or modifications to existing pipe schedule systems sized according to the requirements found in Section 23.7
- Additions or modifications to existing Extra Hazard pipe schedule systems
- New systems of 5000 ft^2 or less
- New systems exceeding 5000 ft^2 if the available flow rate meets a minimum residual pressure of 50 psi at the highest elevation of the sprinkler.

Table 11.2.2.1 shows the water supply requirements when using the pipe schedule method.



NFPA 13 2016, Table 11.2.2.1
Water Supply Requirements for Pipe Schedule Sprinkler Systems

Occupancy Classification	Minimum Residual Pressure Required (psi)	Acceptable Flow at Base of Riser (Including Hose Stream Allowance) (gpm)	Duration (minutes)
Light Hazard	15	500 – 750	30 – 60
Ordinary Hazard	20	850 – 1500	60 – 90

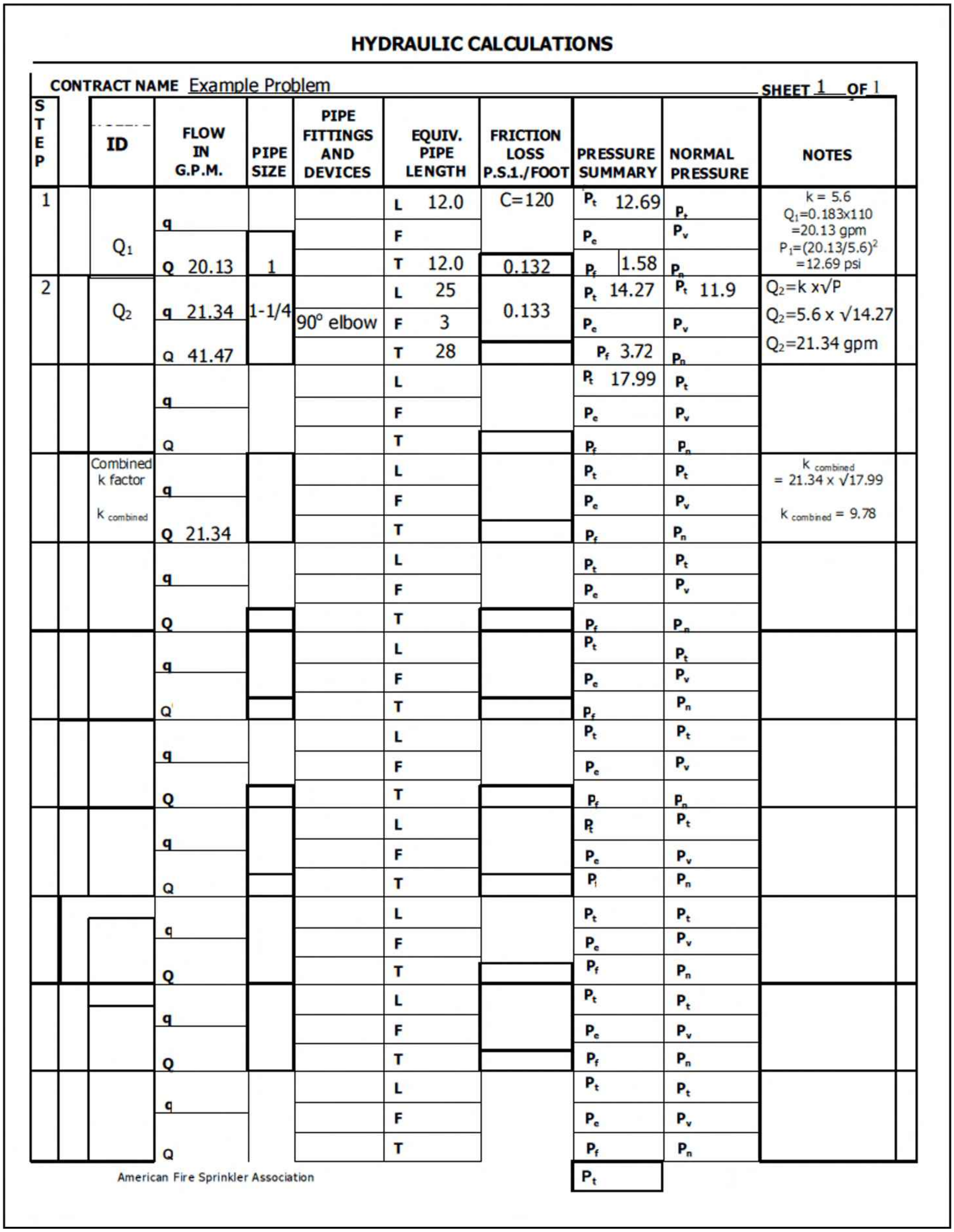
Click on the image to enlarge.

HYDRAULICALLY CALCULATED SYSTEMS

Hydraulically Calculated Systems

Water supply requirements differ for hydraulically calculated systems.

This approach takes pipe size, the number of sprinklers per branch line, and the number of branch lines per cross main into the calculations, all of which are driven by the available water supply.



HYDRAULIC CALCULATIONS

CONTRACT NAME Example Problem **SHEET** 1 **OF** 1

STEP		ID	FLOW IN G.P.M.	PIPE SIZE	PIPE FITTINGS AND DEVICES	EQUIV. PIPE LENGTH	FRICTION LOSS P.S.1./FOOT	PRESSURE SUMMARY	NORMAL PRESSURE	NOTES
1		Q_1				L 12.0	C=120	P_t 12.69	P_t	k = 5.6 Q_1=0.183x110 =20.13 gpm $P_1=(20.13/5.6)^2$ =12.69 psi
			q			F		P_e	P_v	
			Q 20.13	1		T 12.0	0.132	P_f 1.58	P_n	
2		Q_2				L 25	0.133	P_t 14.27	P_t 11.9	$Q_2=k \times \sqrt{P}$
			q 21.34	1-1/4	90° elbow	F 3		P_e	P_v	$Q_2=5.6 \times \sqrt{14.27}$
			Q 41.47			T 28		P_f 3.72	P_n	Q_2=21.34 gpm
						L		P_t 17.99	P_t	
			q			F		P_e	P_v	
			Q			T		P_f	P_n	
		Combined k factor				L		P_t	P_t	$k_{combined} = 21.34 \times \sqrt{17.99}$
		$k_{combined}$	q			F		P_e	P_v	$k_{combined}$ = 9.78
			Q 21.34			T		P_f	P_n	
						L		P_t	P_t	
			q			F		P_e	P_v	
			Q			T		P_f	P_n	
						L		P_t	P_t	
			q			F		P_e	P_v	
			Q			T		P_f	P_n	
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			q			F		P_e	P_v	
			Q			T		P_f	P_n	
								P_t		

American Fire Sprinkler Association

Sample of a Hydraulic Calculation Form.

CONTINUE

NFPA 13 2016, Section 11.2.3

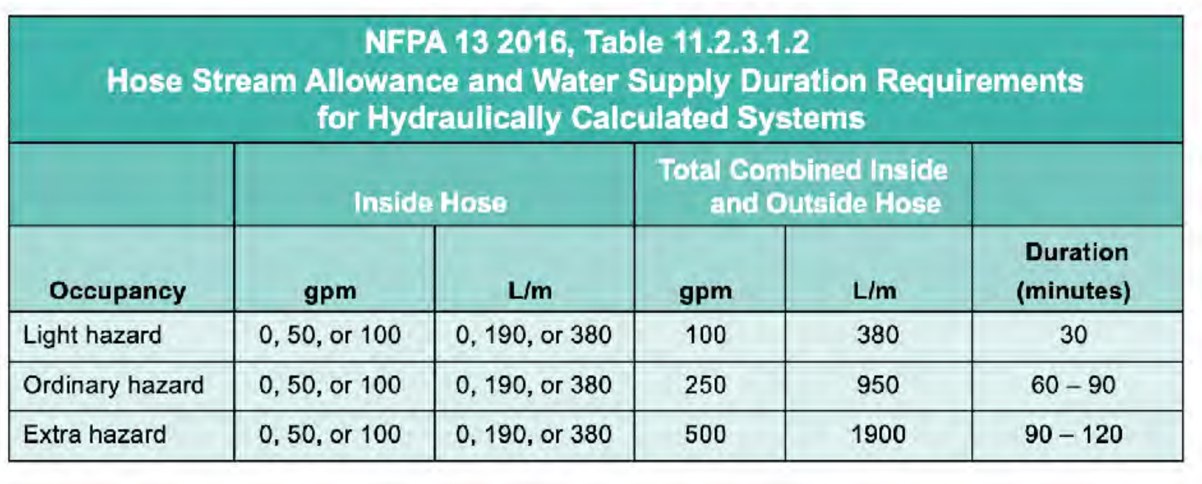
Hydraulically calculated systems are required to meet one of the following water demand requirements:

- Density/area curves found in Figure 11.2.3.1.1
- The room that creates the greatest demand per the room design method
- Special design areas that comply with requirements found in Section 11.2.3.4

The minimum operating pressure of any sprinkler shall be 7 psi. (*NFPA* 13 2016, Section 23.4.4.11.1)

CONTINUE

Table 11.2.3.1.2 provides water supply duration requirements for hydraulically calculated systems.



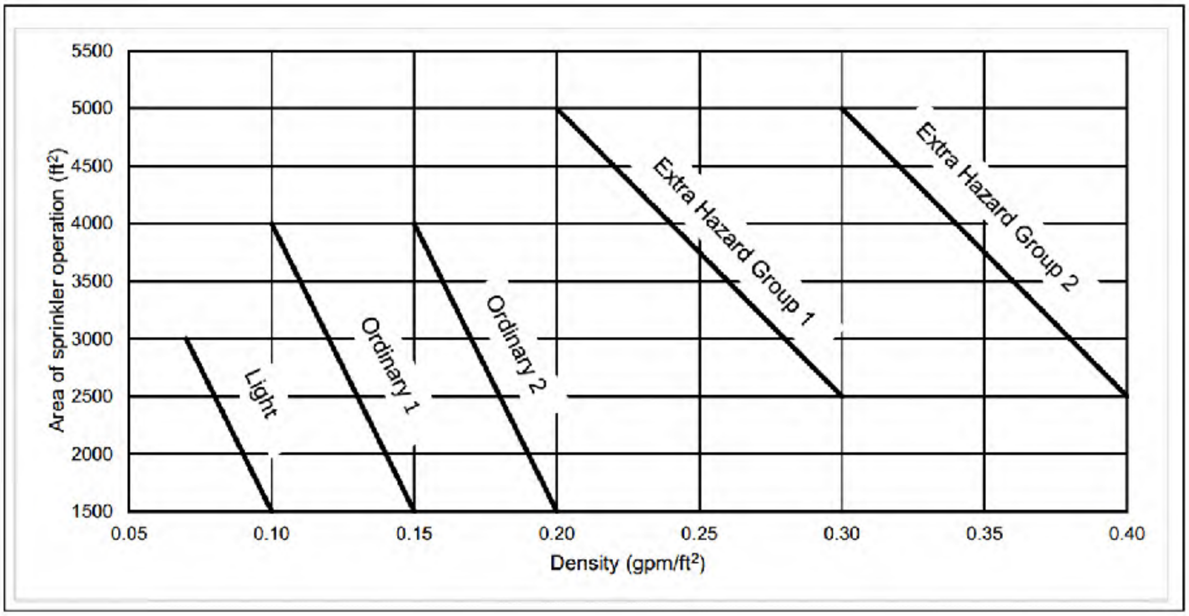
NFPA 13 2016, Table 11.2.3.1.2
Hose Stream Allowance and Water Supply Duration Requirements for Hydraulically Calculated Systems

	Inside Hose		Total Combined Inside and Outside Hose		
Occupancy	**gpm**	**L/m**	**gpm**	**L/m**	**Duration (minutes)**
Light hazard	0, 50, or 100	0, 190, or 380	100	380	30
Ordinary hazard	0, 50, or 100	0, 190, or 380	250	950	60 – 90
Extra hazard	0, 50, or 100	0, 190, or 380	500	1900	90 – 120

Click on the image to enlarge.

CONTINUE

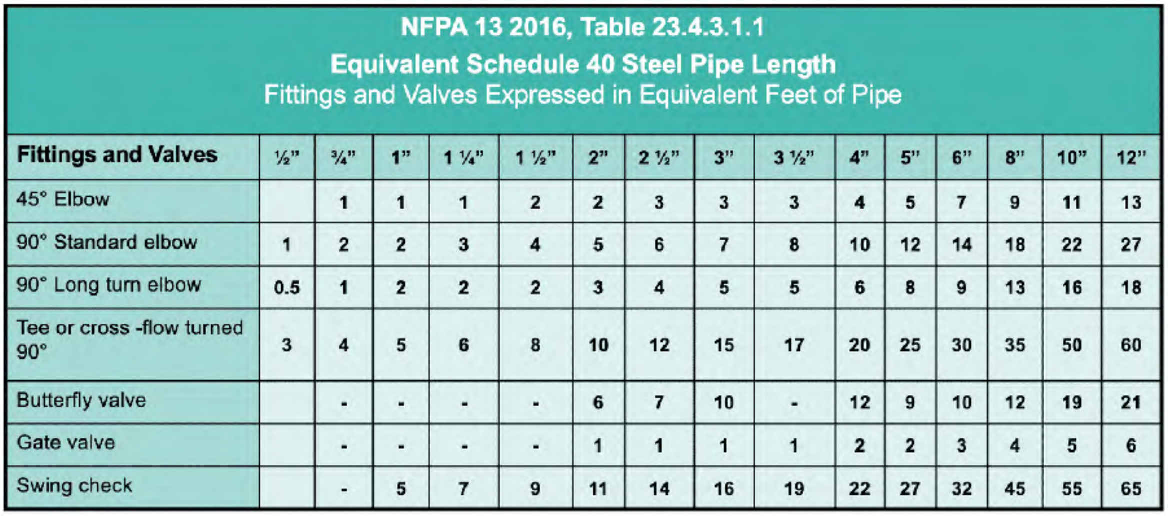
Below is an example of density/area curves for each type of occupancy.



Click on the image to enlarge.

CONTINUE

Table 23.4.3.1.1 provides equivalent length values for Schedule 40 Steel pipe.



NFPA 13 2016, Table 23.4.3.1.1
Equivalent Schedule 40 Steel Pipe Length
Fittings and Valves Expressed in Equivalent Feet of Pipe

Fittings and Valves	½"	¾"	1"	1 ¼"	1 ½"	2"	2 ½"	3"	3 ½"	4"	5"	6"	8"	10"	12"
45° Elbow		1	1	1	2	2	3	3	3	4	5	7	9	11	13
90° Standard elbow	1	2	2	3	4	5	6	7	8	10	12	14	18	22	27
90° Long turn elbow	0.5	1	2	2	2	3	4	5	5	6	8	9	13	16	18
Tee or cross -flow turned 90°	3	4	5	6	8	10	12	15	17	20	25	30	35	50	60
Butterfly valve		-	-	-	-	6	7	10	-	12	9	10	12	19	21
Gate valve		-	-	-	-	1	1	1	1	2	2	3	4	5	6
Swing check		-	5	7	9	11	14	16	19	22	27	32	45	55	65

Click on the image to enlarge.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Pipe Schedule System

Pipe size is determined by the occupancy classification

A given number of sprinklers are allowed to be supplied from specific pipe sizes

Hydraulically Designed Systems

Pipe size is based on pressure loss basis to provide a prescribed water density

Calculations are completed by computer programs

Complete the card matching above before moving on.

Water Supply Requirements

NFPA 13 2016, Section 24.1

Every automatic sprinkler system is required to have **at least one automatic water supply**.

The water supply must meet the needed **flow** and **pressure** for the remote design area. This includes where the hose stream allowance is needed for the required duration.

NFPA 13 2016, Section 24.1.3

No pipe less than 6 in. in diameter is permitted to be installed as a private fire service main.

If the main does not supply a hydrant, then sizes less than 6 in. are permitted, per restrictions defined in this section of the standard.

For pipe schedule systems, the underground supply pipe is required to be at least as large as the system riser.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Every automatic sprinkler system is required to have at least one automatic water supply.

○ True

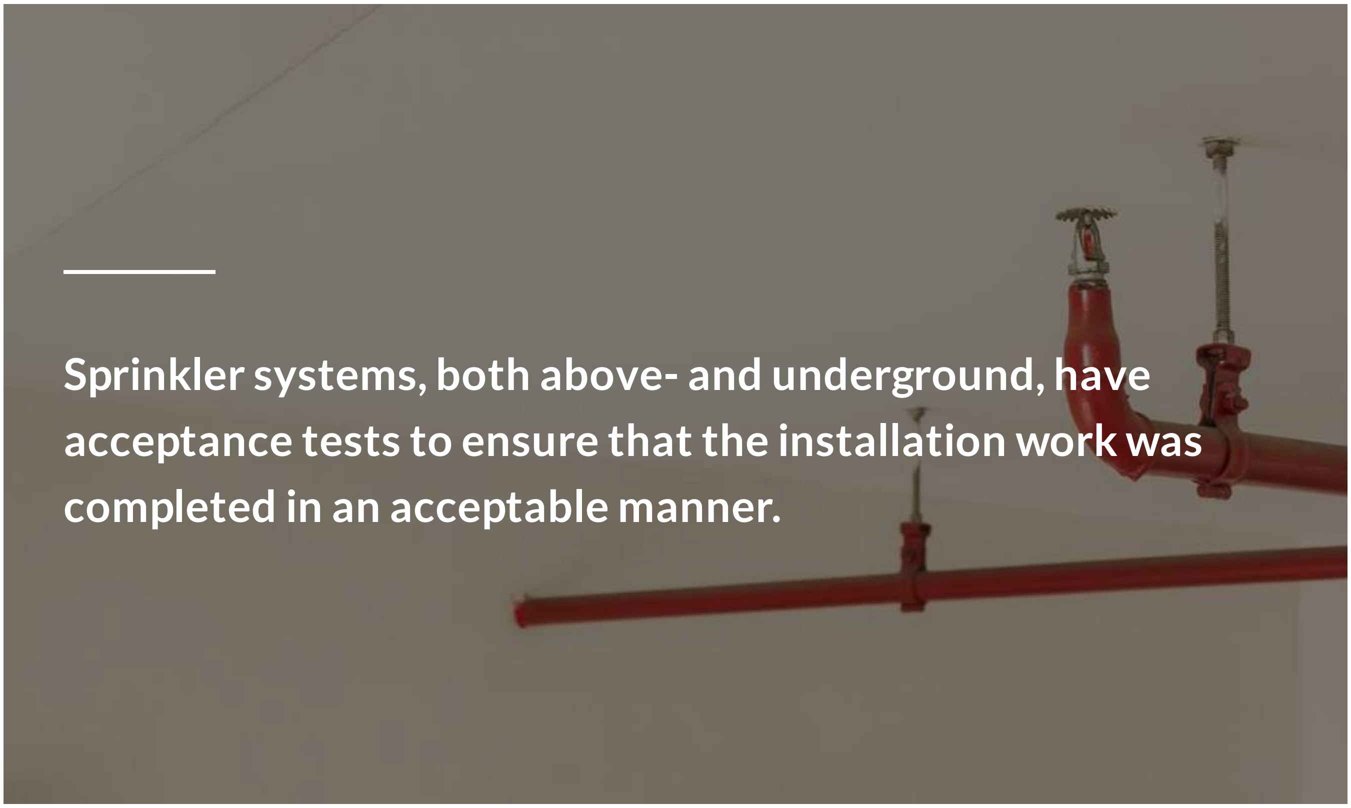
○ False

SUBMIT

Complete the knowledge check above before moving on.

Lesson 2 of 2

Sprinkler System Acceptance



Sprinkler systems, both above- and underground, have acceptance tests to ensure that the installation work was completed in an acceptable manner.

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Recognize the importance of sprinkler system acceptance tests.

☐ Compare acceptance tests for sprinkler systems and valves.

Key References

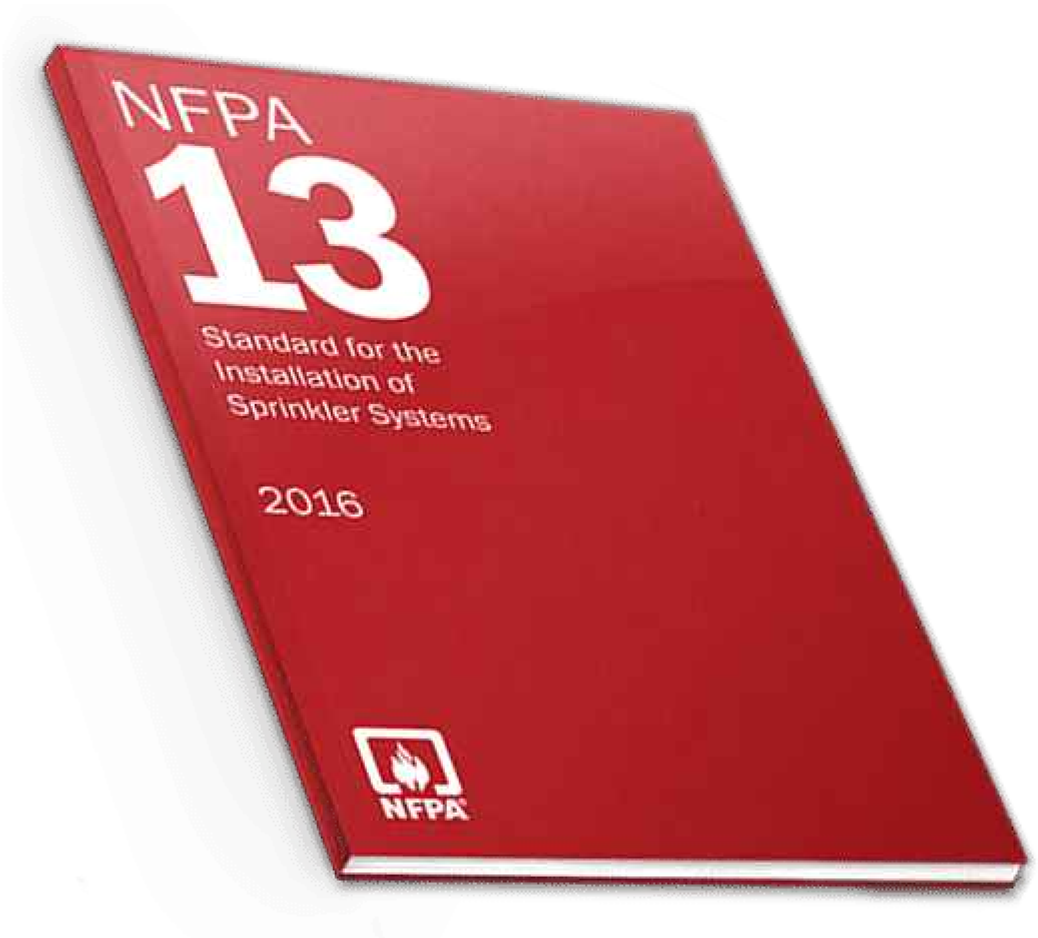
- *NFPA* 13 - *Standard for the Installation of Sprinkler Systems*, 2016

LET'S BEGIN

Sprinkler System Acceptance Tests

Chapter 25 of *NFPA* 13 2016 contains information concerning systems acceptance for the **aboveground** portions of sprinkler systems. All requirements for the testing and acceptance of **underground** piping are found in Section 10.10.

The approval process for system acceptance is important in verifying the design and installation of the system and should receive **top priority**.



These final steps in the design and installation of a sprinkler system confirm:

- The basic requirements of *NFPA* 13 are satisfied.
- The work was completed in an acceptable manner.
- The customer is receiving a system that performs as intended.

Failure to comply with system acceptance requirements will likely delay the issuance of the building's certificate of occupancy. To remedy any deficiency in the sprinkler system design or installation discovered after the building is occupied is likely to be **extremely costly**.

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LET'S REVIEW

Let's do a quick check about what has been covered so far.

The final steps in the design and installation of a sprinkler system confirm...

(Check all that apply)

☐ *NFPA* 25 requirements are met

☐ *NFPA* 13 requirements are met

☐ The work was completed in an acceptable manner

☐ The aboveground and underground piping are identical

☐ The cost matches the quote given to the customer

☐ The system performs as intended

SUBMIT

Complete the knowledge check above before moving on.

Acceptance Requirements

NFPA 13 2016, Section 25.2

All piping shall be **hydrostatically tested at 200 psi for 2 hours without loss of pressure**, except in cold weather when an interim air test is acceptable. The **air test shall be at 40 psi for 24 hours with a maximum loss of 1.5 psi**. The interim air test **does not replace** the hydrostatic test, which must still be conducted when the weather permits.

Any **modifications** to existing systems are required to be tested at system working pressure.

Modifications to an existing system that affect more than 20 sprinklers are required to be **isolated and tested at 200 psi for 2 hours**.

CONTINUE

Test pressure is required to be measured at a gauge at the **low elevation point of the system**, or the portion of the system that is being tested. The pressures in piping at **higher elevations** are allowed to be less than 200 psi, after taking elevation loss into account.

The following are **not** permitted to be used during hydrostatic tests:

- Additives
- Corrosive chemicals such as sodium silicate, brine, or similar acting chemicals

Take the time to review the Contractor's Material and Test Certificate for Aboveground Piping, found in *NFPA* 13 2016, Figure 25.1.

After completion of the acceptance tests, the following are to be **left on the premises**:

- System component instructions
- Care and maintenance instructions
- A copy of NFPA 25

LET'S REVIEW

Let's do a quick check about what has been covered so far.

During acceptance testing, all piping shall be hydrostatically tested at 200 psi for _____ hour(s) without pressure loss.

○ 1

○ 2

○ 12

○ 24

SUBMIT

Complete the knowledge check above before moving on.

Main Drain Valves

NFPA 13 2016, Section 25.2.3.4

The main drain is required to be opened and **remain open during a system operational test** until the system pressure stabilizes.

The static and residual pressures are to be documented on the Contractor’s Test Certificate and the sprinkler system general information placard.

Control Valves

NFPA 13 2016, Section 25.2.3.5

Control valves are required to be fully closed and opened under system water pressure to **ensure proper operation**.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

After completion of the acceptance tests, what is/are to be left on the premises? (Check all that apply).

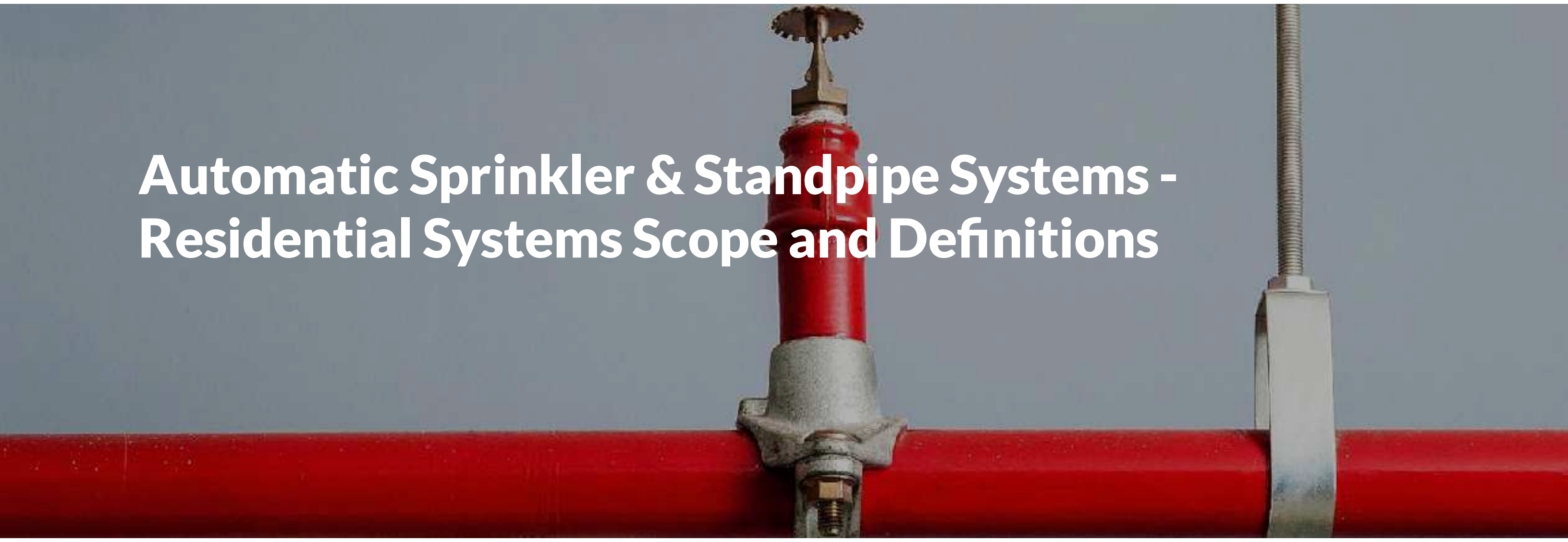
- ☐ System Component instructions
- ☐ Caution sign
- ☐ Care and maintenance instructions
- ☐ A copy of NFPA 13
- ☐ A copy of NFPA 25

SUBMIT

Complete the knowledge check above before moving on.

After completing this module, you should now have a better understanding of the different design approaches for sprinkler system and the importance of acceptance tests.

Click on the “Next” arrow up on the right-hand corner of the screen to continue to the quiz.



Automatic Sprinkler & Standpipe Systems - Residential Systems Scope and Definitions

By the end of this module, you will be able to do the following:

- Compare the purposes of *NFPA* 13D and *NFPA* 13R.
- Define key terms found in *NFPA* 13D and *NFPA* 13R.

Key References:

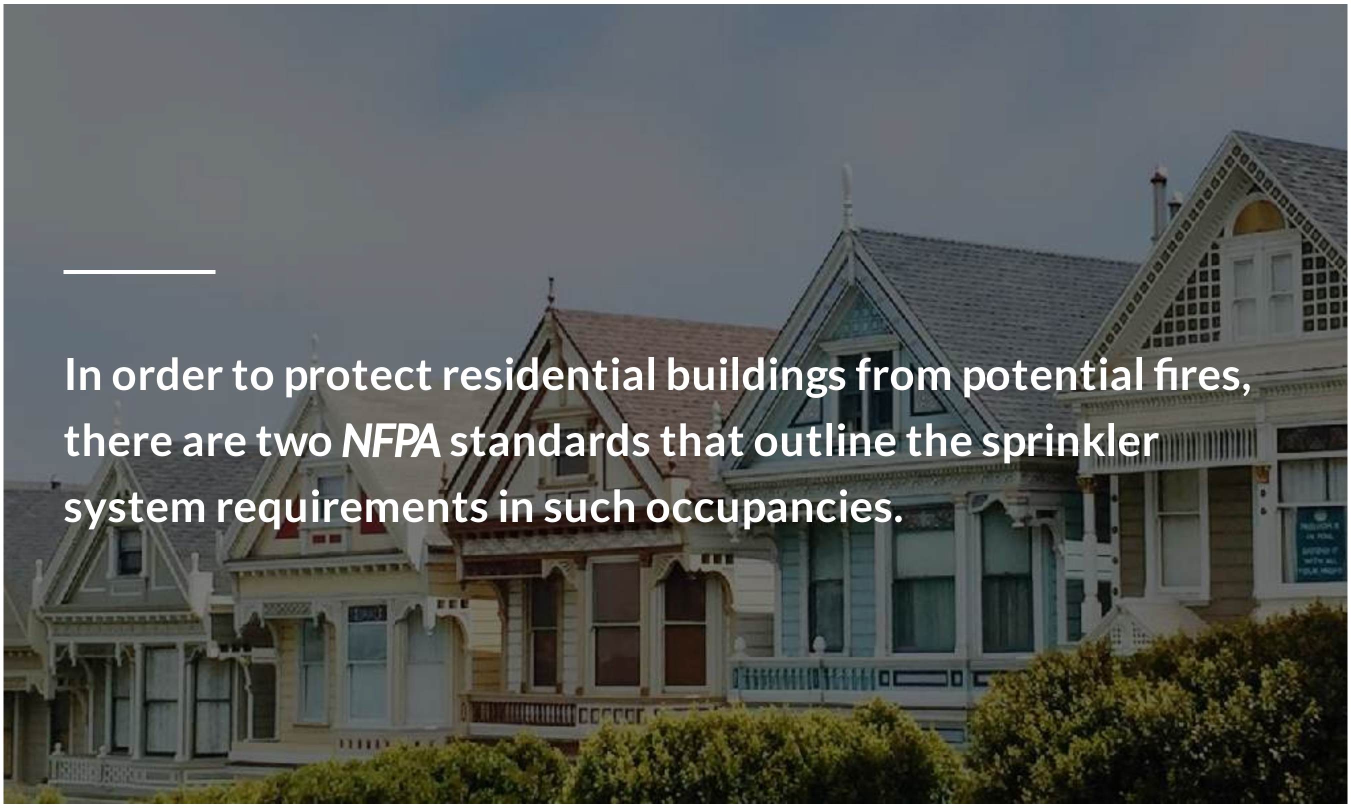
- *NFPA* 13D - *Standard for the Installation of Sprinkler Systems in One-and Two-Family Dwellings and Manufactured Homes*, 2016
- *NFPA* 13R - *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, 2016

When you are ready to begin, click on the button above to start the course.

Residential Scope and Definitions

Lesson 1 of 1

Residential Scope and Definitions



In order to protect residential buildings from potential fires, there are two *NFPA* standards that outline the sprinkler system requirements in such occupancies.

Lesson Goals

By the end of this lesson, you will be able to do the following:

- ☐ Compare the purposes of *NFPA* 13D and *NFPA* 13R.
- ☐ Define key terms found in *NFPA* 13D and *NFPA* 13R.

Key References

- *NFPA* 13D - *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, 2016
- *NFPA* 13R - *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, 2016

LET'S BEGIN

Overview

The focus of this module is to review the requirements for sprinkler systems in residential occupancies as they are outlined in *NFPA* 13D and *NFPA* 13R (2016 editions).

As with *NFPA* 13, start by becoming very familiar with the Table of Contents.

When responding to a question, **look up the keywords** in either the Table of Contents or in the Index in the back of the standard. These will enable you to find the appropriate section of the standard in the quickest possible time.

NFPA 13D 2016

NFPA 13D 2016

Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes

The standard provides requirements for the design, installation, and maintenance of automatic sprinkler systems for protection against fire hazards in one- and two-family dwellings and manufactured homes.

The requirements in *NFPA* 13D pertain to sprinkler systems designed to **protect a residence against a fire that originates from a single ignition location**.

The intent of *NFPA* 13D is to provide a sprinkler system that **improves protection of life** by detecting and controlling residential fires.

The **number one goal of the *NFPA* 13D is preventing flashover** in the room of origin where sprinklered, thereby allowing occupants to escape.

NFPA 13R 2016

NFPA 13R 2016

Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies

NFPA 13R provides requirements for the design and installation of automatic sprinkler systems for protection against the fire hazards in residential occupancies up to and including four stories in height, in buildings not exceeding 60 ft. in height above grade plane.

Like *NFPA* 13D, the requirements found in *NFPA* 13R pertain to sprinkler systems designed to protect against a fire originating from a single ignition location.

Buildings that have multiple occupancies (either separated or non-separated), accessory occupancies, or incidental uses may have **special rules** that limit the use of *NFPA* 13R. In these instances, the **adopted building code** must be consulted to determine which restrictions apply.

In cases where *NFPA* 13R references *NFPA* 13 requirements, such as for hanging and bracing, design densities, and welding, *NFPA* 13 is intended to be used as a helpful resource, not as required compliance. In such instances, the Authority Having Jurisdiction (AHJ) needs to be consulted for approval.

CONTINUE

NFPA 13R 2016, Section 3.3.9

This section defines residential occupancies as occupancies that include the following (as defined in *NFPA* 101):

- Apartment buildings
- Lodging and rooming houses
- Board and care facilities
- Hotels, motels, and dormitories

LET'S REVIEW

Let's do a quick check about what has been covered so far.

NFPA 13D

Protection in one- and two-family dwellings and manufactured homes

Number one goal is preventing flashover in the room of origin

NFPA 13R

Four stories in height, in buildings not exceeding 60 ft. in height above plane

Adopted building code must be consulted to determine restrictions

Examples of residential occupancies include apartment buildings and hotels

Complete the card matching above before moving on.

Residential Sprinkler Terms

The following are key terms regarding residential sprinkler systems highlighted in this course:

NFPA 13R 2016, Section 3.3

Bathroom —

Within a dwelling unit, any room or compartment containing a lavatory dedicated to personal hygiene, or a water closet, or bathing capability such as a shower or tub, or any combination of facilities thereof. (*NFPA* 13R 2016, Section 3.3.1)

Compartment —

A space completely enclosed by walls and a ceiling. Each wall in the compartment is permitted to have openings to an adjoining space if the openings have a minimum lintel depth of 8 in. from the ceiling, and the total width of the openings in each wall does not exceed 8 ft. in width. A single opening of 36 in. or less in width without a lintel is permitted when there are no other openings to adjoining spaces. (*NFPA* 13R 2016, Section 3.3.2)

Dwelling Unit —

One or more rooms arranged for the use of one or more individuals living together, as in a single housekeeping unit normally having cooking, living, sanitary, and sleeping facilities. (*NFPA* 13R 2016, Section 3.3.4)

ⓘ Review the terms and definitions from *NFPA* 13, found in the Automatic Sprinkler modules. Additionally, be familiar with these terms defined in *NFPA* 13D and *NFPA* 13R.

CONTINUE

NFPA 13D 2016, Chapter 3

Multipurpose Piping System –

A piping system intended to serve both domestic needs in excess of a single fixture and fire protection needs from one common piping system throughout the dwelling unit(s). (*NFPA* 13D 2016, Section 3.3.11.3)

Network System –

A type of multipurpose system utilizing a common piping system supplying domestic fixtures and fire sprinklers where each sprinkler is supplied by a minimum of three separate paths. (*NFPA* 13D 2016, Section 3.3.11.4)

Passive Purge Sprinkler System –

A type of sprinkler system that serves a single toilet in addition to the fire sprinklers. (*NFPA* 13D 2016, Section 3.3.11.5)

Stand-Alone Sprinkler System –

A sprinkler system where the aboveground piping serves only fire sprinklers. (*NFPA* 13D 2016, Section 3.3.11.9)

CONTINUE

After completing this module, you should now have a better understanding of the purpose of *NFPA* 13D and *NFPA* 13R.

Click on the "Next" arrow up on the right-hand corner of the screen to continue to the quiz.

Automatic Sprinkler & Standpipe Systems - Residential Systems NFPA 13D Requirements

By the end of this module, you will be able to do the following:

- Recognize the objectives and general requirements of *NFPA* 13D.
- Identify the sprinkler system requirements for dwellings as outlined in *NFPA* 13D.
- Calculate the minimum pressure and flow requirements of a given network.
- Apply protection, maintenance, and design requirements for residential sprinkler systems.

Key References:

- *NFPA* 13D - *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, 2016

When you are ready to begin, click on the button above to start the course.

Lesson 1 of 2

NFPA 13D Requirements

In order to protect residents from fire hazards, sprinkler systems for one- and two-family dwellings and manufactured homes follow a standard of their own: *NFPA* 13D.

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Recognize the objectives and general requirements of *NFPA* 13D.

☐ Identify the sprinkler system requirements for dwellings as outlined in *NFPA* 13D.

Key References

- *NFPA* 13D - *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, 2016

LET'S BEGIN

Dwelling Sprinklers

The intent of *NFPA* 13D is to provide additional life and property protection in **one- and two-family dwellings and in mobile homes**.

The standard assumes that appropriate smoke detectors are used in conjunction with properly installed operational smoke detectors.

Here, we have an important **early warning device** that must be installed according to the manufacturer's instructions and must also be maintained accordingly.

CONTINUE

Residential Sprinklers

Residential sprinklers are permitted in residences, but their coverage and spacing must be in accordance with:

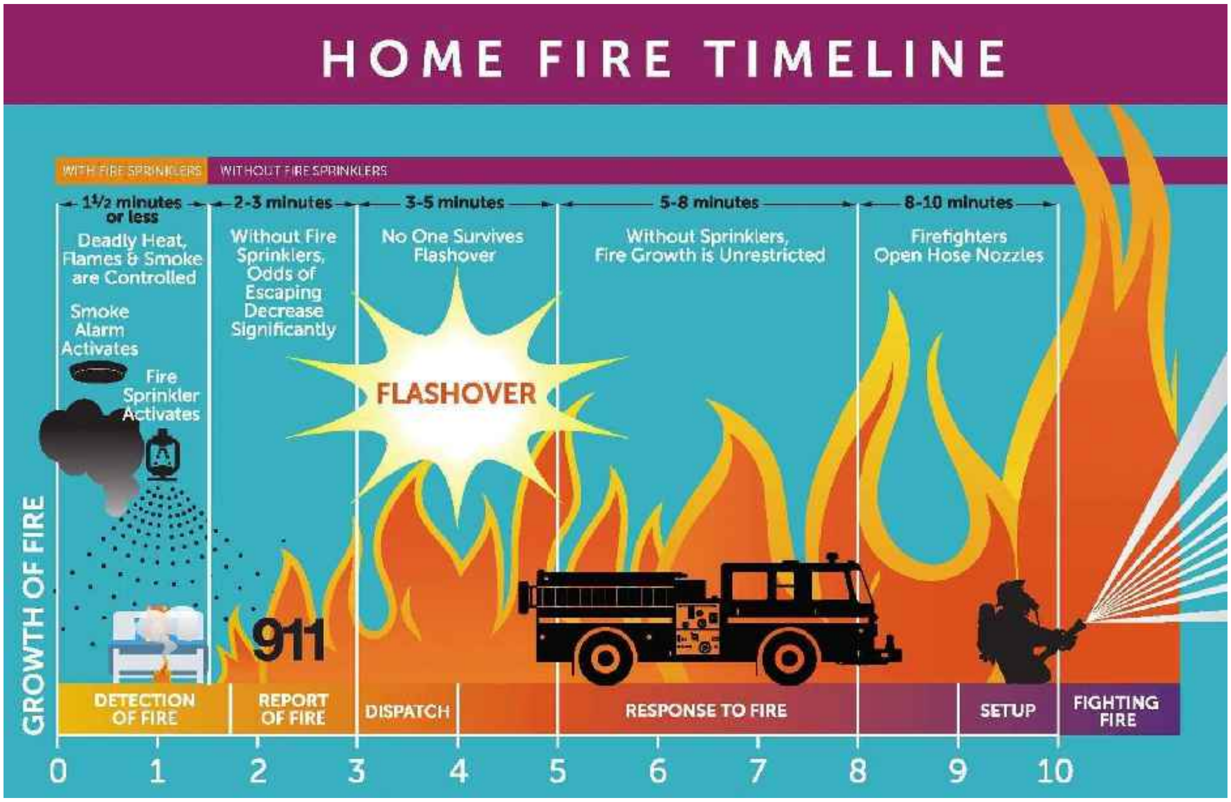
- ***NFPA* 13** - Standard for the Installation of Sprinkler Systems
- ***NFPA* 13D** - One- or Two-Family Dwellings and Manufactured Homes
- ***NFPA* 13R** - Low-Rise Residential Occupancies

These last two standards cover residential properties ranging from **mobile homes to four-story apartment buildings**. They are also referenced in *NFPA* 13 for applications that are not covered in *NFPA* 13D or *NFPA* 13R.

NFPA 13D OBJECTIVES

Objectives of *NFPA* 13D

One objective of *NFPA* 13D is to **minimize the cost of installing a sprinkler system** for the individual family, while **providing an acceptable degree of protection against fire hazards**. New homes are expensive and their cost is escalating rapidly. While residential sprinkler system installation is important, the more provisions which can be made to minimize the cost, the greater the incentive to install the system.



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The number one goal of the NFPA 13D is **preventing flashover** in the room of origin where sprinklered, thereby allowing occupants to escape.

Property conservation is number two. This is not to say that dwelling sprinklers are gimmicks because sprinkler systems save lives and property. However, if there was a decision to be made in terms of a balance factor between life protection and property protection, the standard makers decided in favor of the life protection goal.

CONTINUE

General Requirements

NFPA 13D 2016, Chapter 4

Chapter 4 contains the general requirements that apply to all fire sprinkler systems designed and installed in accordance with *NFPA* 13D.

Temperature Ratings

Sprinklers can be:

- **Ordinary rated** (i.e. 135°F to 170°F) or
- **Intermediate rated** (i.e. 175°F to 225°F)

LET'S REVIEW

Let's do a quick check about what has been covered so far.

What is the number one goal of the *NFPA* 13D?

○ Minimizing cost

○ Preventing flashover

○ Property conservation

SUBMIT

🔒 Complete the knowledge check above before moving on.

System Components

NFPA 13D 2016, Section 5.1

Chapter 5 covers system components. Only **new** sprinklers are permitted to be installed in sprinkler systems.

There is **no** requirement for spare sprinklers in *NFPA* 13D. This differs from *NFPA* 13R requirements, which calls for six spares (a minimum of two sprinklers of each type and rating). Spares are required in *NFPA* 13 as well.

NFPA 13 Spare Sprinkler Requirements

The minimum stock of spare sprinklers for the following system sizes are:

- 0 to 300 sprinklers – **6**
- 300 to 1000 sprinklers – **12**
- Over 1000 sprinklers – **24**

Sprinkler system components must be listed. However, while tanks, pumps, hangers, waterflow detection devices, and valves are not required to be listed, their mechanical integrity must be proven.

CONTINUE

NFPA 13D 2016, Section 5.2

Similar to *NFPA* 13 requirements, pipe and fittings used in these systems must be in accordance with the specifications of the tables contained in this reference.

Review those tables and other paragraphs in terms of the acceptability of the pipe and fittings, which can be used in dwelling sprinkler systems.

Pipe and fittings must withstand a working pressure greater than **175 psi**.

One exception is for non-metallic piping or fittings used in a multi-purpose system with no fire department connection (FDC). These may be designed to withstand a minimum working pressure of **130 psi**.

An interesting note concerning fittings - copper must be brazed for **dry** **or** **preaction systems** but can be soldered or brazed for **wet** **or** **antifreeze systems**.

Nonmetallic pipe used in wet pipe sprinkler systems not equipped with an FDC and provided with a pressure-reducing valve set no higher than 80 psi, must be able to withstand a working pressure of not less than 130 psi at 120°F and 100 psi at 180°F.

If the **maximum static pressure** from the water supply is less than or equal to 80 psi, pipe designed to withstand a working pressure of not less than 130 psi at 120°F and 100 psi at 180°F is permitted to be used without a pressure-reducing valve.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Non-metallic piping or fittings used in a multi-purpose system with no fire department connection (FDC) are designed to withstand a minimum working pressure of ___ psi.

○ 80

○ 100

○ 130

○ 175

SUBMIT

Ordinary rated sprinklers are set for what temperature range?

○ 100^{O}F to 135^{O}F

○ 135^{O}F to 170^{O}F

○ 175^{O}F to 200^{O}F

○ 175^{O}F to 225^{O}F

SUBMIT

Complete the knowledge checks above before moving on.

Water Supplies for Dwellings

NFPA 13D 2016, Section 6.1

Chapter 6 of *NFPA* 13D defines the requirements for the system water supply.

At least one automatic supply must have at least a **10-minute** duration capability at the calculated system demand flow. This 10-minute flow requirement is to allow escape.

Keep in mind that the purpose of a sprinkler system is not necessarily to extinguish fires. **It's to control a fire until other appropriate means can be taken to extinguish the fire**. In this particular instance, it was felt that 10 minutes is adequate time for people to escape from a dwelling.

Because the standard is intended for use in one- and two-family dwellings and mobile homes only, not apartment buildings or other larger residences, this minimum **10-minute waterflow** requirement in *NFPA* 13D should be sufficient to **prevent flashover** and allow the residents of the dwelling to escape.

NFPA 13 2016 states that wet systems in residential sprinklers shall only be used in the following situations:

- Unless specifically listed for use in dry systems or preaction systems
- If the minimum operating pressure exceeds 7 psi
- When the piping is maintained above 40°F

CONTINUE

NFPA 13D 2016, Section 6.2

Acceptable water supplies include a **city main, a gravity tank, a pressure tank, or an automatic pump**. This is similar to the allowable water supplies in other *NFPA* standards.

An additional acceptable water supply is a **well with a pump** of sufficient capacity and pressure to meet the sprinkler system demand. The stored water can be a combination of water in a well and the water in a holding tank, provided that the tank can supply the sprinkler system.

When determining the water supply requirements, the domestic demand, including any lawn sprinkler operations, water softeners, etc. **must be taken into consideration** for the fire protection system.

If a pump is the water supply source for a sprinkler system, but is not a portion of the domestic water supply, the following is required:

- A test connection downstream of the pump to create a flow of water equal to the smallest sprinkler on the system returning water to the tank.
- Pump motors using AC power connected to a 240V normal circuit and wired per *NFPA* 70 requirements.
- Any disconnecting means for the pump shall be approved.
- The pump is not permitted to sit directly on the floor and must be located at least 1 ½ in. off the floor.

Figure A.6.2(a) provides an acceptable arrangement for sprinkler systems for residential occupancies. Other arrangements are provided in the Annex section as well.

CONTINUE

It is interesting to note that the requirements for fire pumps installed in a residential occupancy differ between *NFPA* 13D and *NFPA* 13R.

Fire pump

If a fire pump is used as a part of the sprinkler system per *NFPA* 13D requirements, then this pump does **not** need to satisfy *NFPA* 20 requirements. Per *NFPA* 20, the pump and power supply arrangement for the pump must meet *NFPA* 70 requirements.

However, if the sprinkler system is installed in accordance with *NFPA* 13R requirements, then conformance with *NFPA* 20 is necessary.

ⓘ ***NFPA* 20 - *Standard for the Installation of Stationary Pumps for Fire Protection***

NFPA* 70 - *National Electric Code

LET'S REVIEW

Let's do a quick check about what has been covered so far.

At least one automatic water supply for a residential sprinkler system must have at least a ____-minute duration capability at the calculated system demand flow.

Type your answer here

SUBMIT

Acceptable water supplies include: (check all that apply)

☐ Gravity tank

☐ Pressure tank

☐ Lawn sprinkler

☐ Well with a pump

SUBMIT

🔒 Complete the knowledge checks above before moving on.

Installation

NFPA 13D 2016, Sections 7.1 – 7.3

A single control valve is involved for the entire system, which includes both the domestic system and the sprinkler system. There must be a separate valve for the domestic water.

There are exceptions for formally supervised system control valves. **Review these exceptions!**

☐ A drain valve on the system side of the control valve is **required**. A drain is also required in trapped sections of dry systems.

☐ The size of the inspector's test connection orifice will be **equal to or smaller than** the smallest sprinkler.

☐ Gauges are **required** on dry systems and on pressure tanks. Pressure tanks are **acceptable** per *NFPA* 13D.

CONTINUE

NFPA 13D 2016, Sections 7.5

When residential sprinklers were introduced, there was concern that homeowners would not find them visually appealing when installed in their homes. Sprinkler manufacturers have responded by developing residential sprinklers that are aesthetically pleasing in appearance or concealed entirely.

The following practices are to be followed when installing residential sprinklers unless higher ambient temperatures require a higher temperature rating:

Sprinklers under glass or plastic skylights exposed to direct rays of sun are to be **intermediate temperature-rated** sprinklers.

Sprinklers in an unventilated concealed space under an uninsulated roof or in an unventilated attic are to be **intermediate temperature-rated** sprinklers.

Sprinklers installed **near specific heat sources** shown in Table 7.5.6.3 shall follow the ratings in the table unless the sprinklers are listed for positioning closer to the heat source.

Sprinklers installed in saunas and steam rooms with ambient ceiling temperatures 151 - 225^{o}F are to be **high temperature-rated** spray sprinklers.

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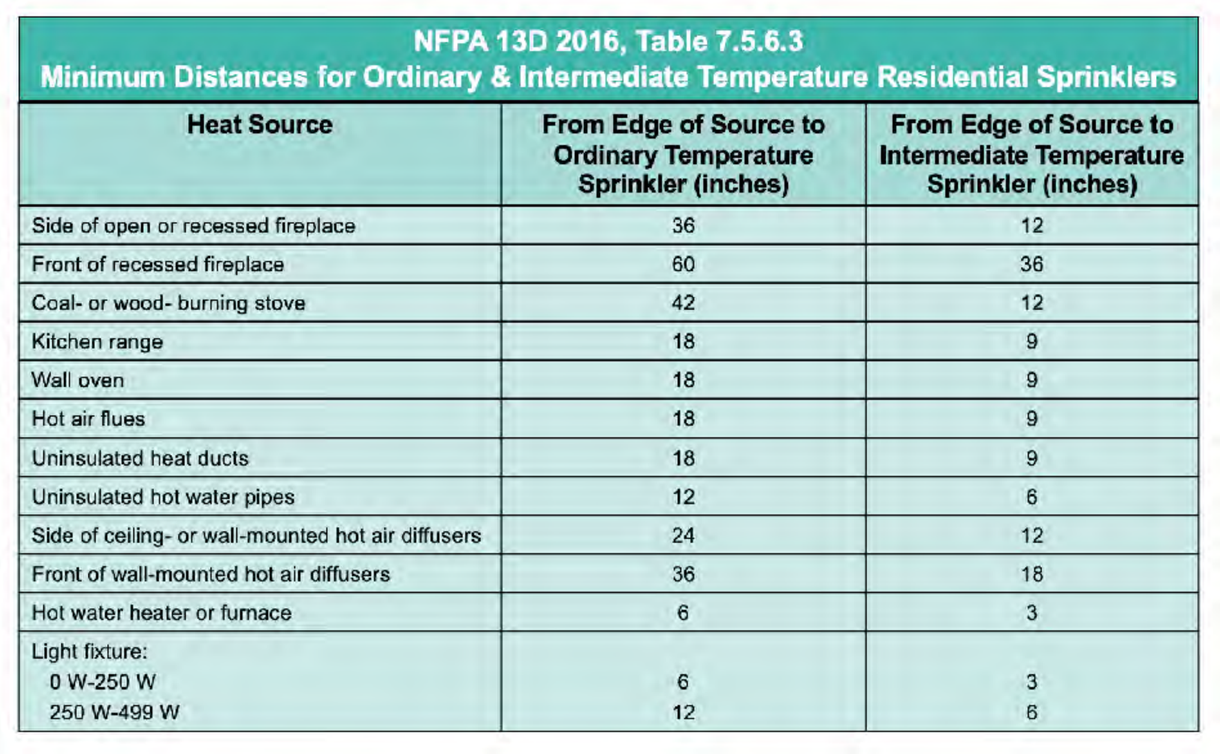
CONTINUE

The subsection of 7.5.4 permits the use of **quick-response** **rather than residential sprinklers in mechanical closets** — spaces where temperatures can often exceed the normal temperatures in the rest of the dwelling.

If the temperature exceeds 100°F (38°C), *NFPA* 13D prohibits the use of an **ordinary temperature-rated** sprinkler (see 7.5.6.1), and either **intermediate or high temperature–rated** sprinklers are to be used.

Table 7.5.6.3 is a good table to know and understand as it provides minimum distances from a heat source to ordinary and intermediate temperature sprinklers.

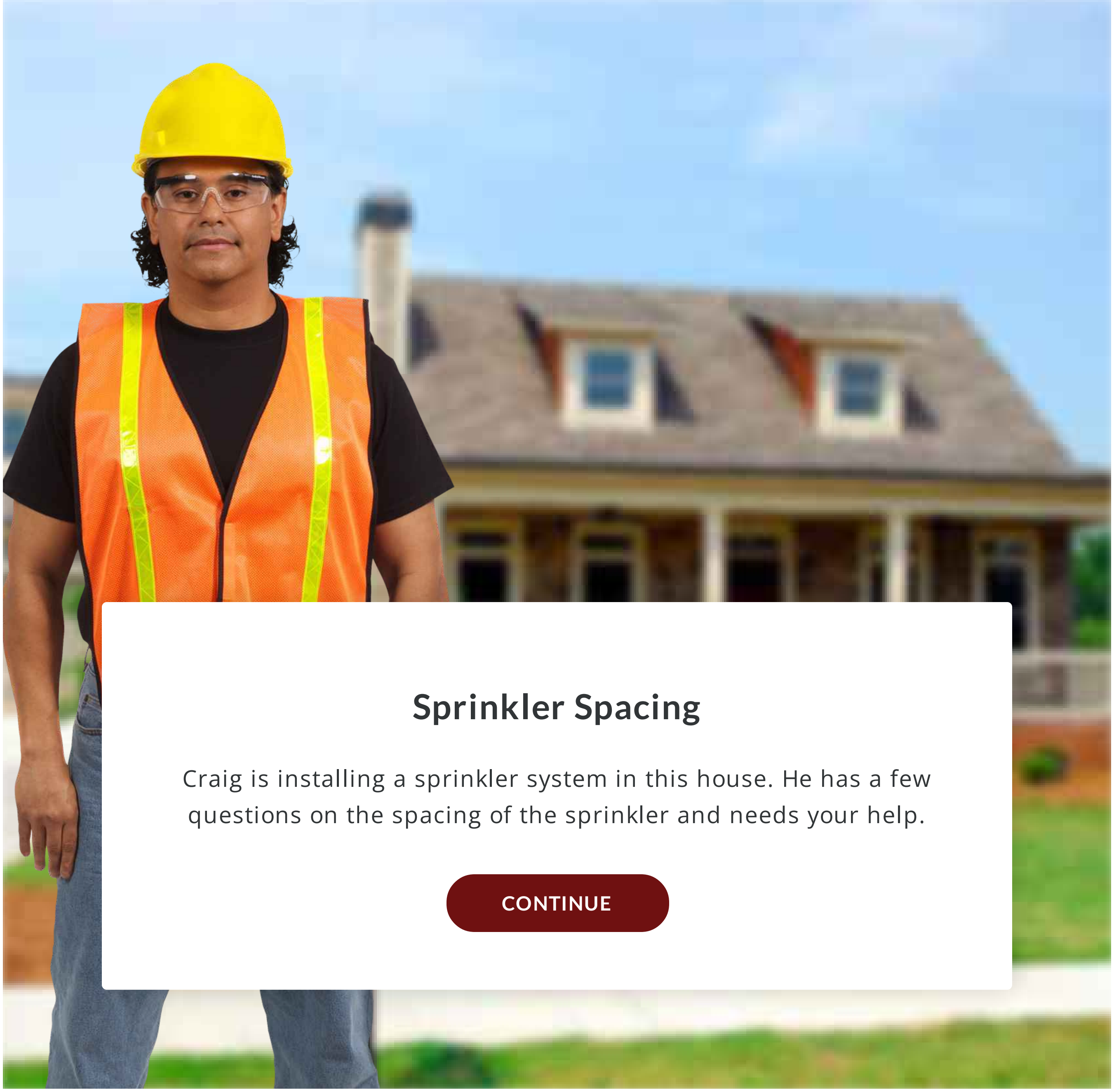


NFPA 13D 2016, Table 7.5.6.3
Minimum Distances for Ordinary & Intermediate Temperature Residential Sprinklers

Heat Source	From Edge of Source to Ordinary Temperature Sprinkler (inches)	From Edge of Source to Intermediate Temperature Sprinkler (inches)
Side of open or recessed fireplace	36	12
Front of recessed fireplace	60	36
Coal- or wood- burning stove	42	12
Kitchen range	18	9
Wall oven	18	9
Hot air flues	18	9
Uninsulated heat ducts	18	9
Uninsulated hot water pipes	12	6
Side of ceiling- or wall-mounted hot air diffusers	24	12
Front of wall-mounted hot air diffusers	36	18
Hot water heater or furnace	6	3
Light fixture: 0 W-250 W 250 W-499 W	 6 12	 3 6

CONTINUE

Let's utilize the information in Table 7.5.6.3 to answer the questions in the following scenario.



Sprinkler Spacing

Craig is installing a sprinkler system in this house. He has a few questions on the spacing of the sprinkler and needs your help.

Scene 1 Slide 1

Continue → Next Slide

A sprinkler (225^{o}F rating) is to be installed in a room with a recessed fireplace. You need to determine the minimum distance from the sprinkler to the front of the fireplace. What’s the first step?

1 Determine whether the sprinkler system requires ordinary or intermediate temperature-rated sprinklers for this area.

2 Determine whether the sprinkler system requires an upright or a standard pendent sprinkler head.

3 Determine if there are additional heat sources that can affect the sprinkler distance.

Scene 1 Slide 2

0 → Next Slide
1 → Next Slide
2 → Next Slide

Based on NFPA 13D 2016, Section 4.1.2, are ordinary or intermediate temperature-rated sprinklers used for the 225^{o}F temperature rating?

1 Ordinary

2 Intermediate

3 High

Scene 1 Slide 3

0 → Next Slide

1 → Next Slide

2 → Next Slide

Based on NFPA 13D 2016, Table 7.5.6.3, what is the distance required from the heat source (front of the recessed fireplace) based on the temperature rating of the sprinkler?

1. 12 in.
2. 36 in.
3. 60 in.

Scene 1 Slide 4

0 → Next Slide

1 → Next Slide

2 → Next Slide

Great work.

Now you have a better understanding of how to use Table 7.5.6.3 and how to determine the minimum distances from a heat source to ordinary and intermediate temperature sprinklers.

START OVER

Scene 1 Slide 5

Continue → End of Scenario

Complete the scenario above before moving on.

The sprinklers themselves must be listed as residential units.

- The fusing elements of these sprinklers must be of the **ordinary rated** variety (i.e., 135°F to 170°F) when ceiling temperatures do not exceed 100°F.
- **Intermediate rated** sprinklers (i.e., 175°F to 225°F) are required where ceiling temperatures may range as high as 150°F.

Furthermore, sprinklers with **ornamental finishes** are also discussed in this section. They should **never** be painted unless by the manufacturer.

NFPA 13D 2016, Section 7.6

Local waterflow alarms are **required** except when smoke detectors are provided. The smoke alarms must be installed per *NFPA* 72 - The National Fire Alarm Code. Therefore, unless you have smoke detectors, which you should anyway, a local flow alarm is **required**.


POTTER
The Symbol of Protection
St. Louis, Missouri
Model Number
VSR
CE
SIGNALING
Fire Alarm Equipment 354L
c UL us LISTED
Extinguishing System Attachment
LPCB
FM APPROVED
WARNING
Hazardous Voltage May Be Present. Disconnect Power Before Servicing.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

For ceiling temperatures that may range as high as 150°F, _____ sprinklers are required.

○ Dry

○ ESFR

○ Ordinary rated

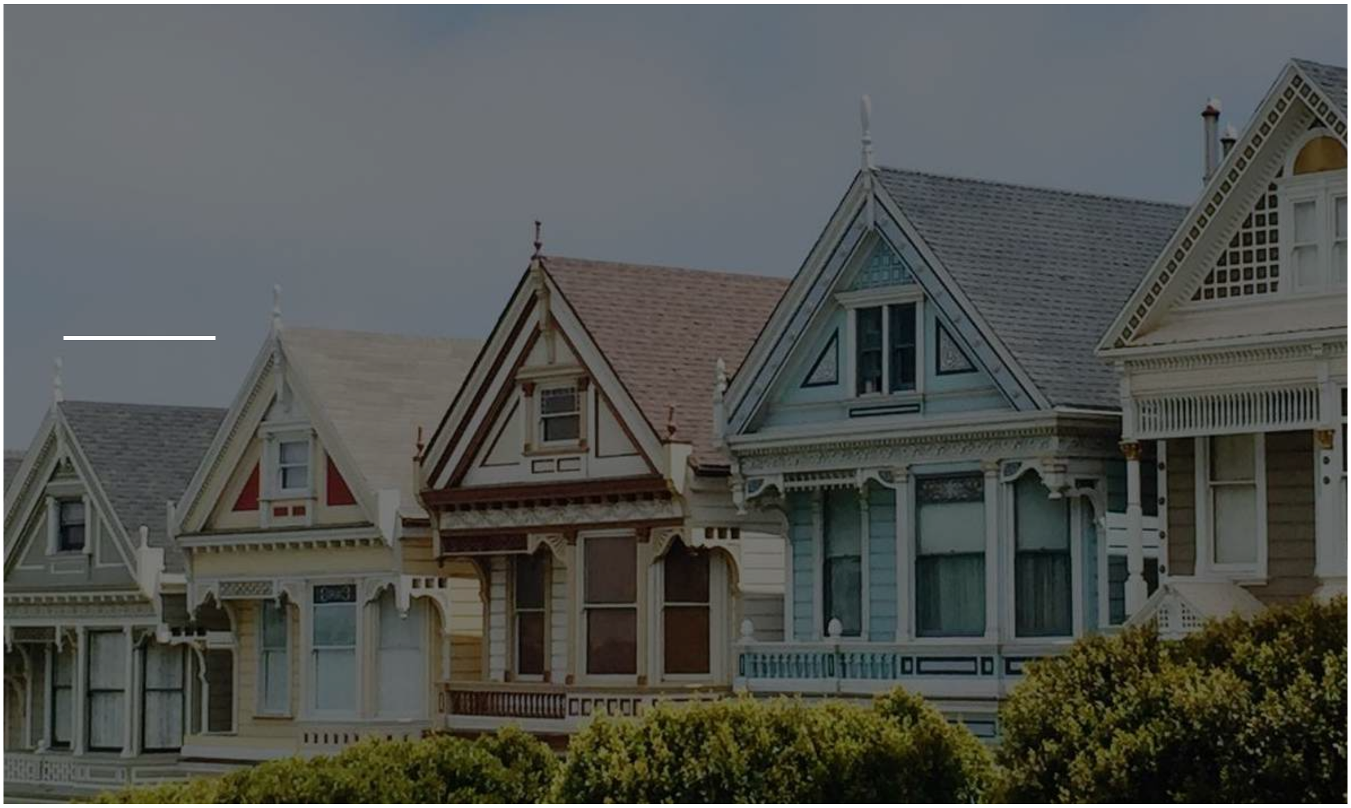
○ Intermediate rated

SUBMIT

Complete the knowledge check above before moving on.

Lesson 2 of 2

NFPA 13D Location and Design



Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Calculate the minimum pressure and flow requirements of a given network.

☐ Apply protection, maintenance, and design requirements for residential sprinkler systems.

Key References

- *NFPA* 13D - *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, 2016

LET'S BEGIN

Sprinkler Position and Location

Chapter 8 addresses the following subjects:

- **System design criteria**, which includes the number of design sprinklers, the floor area to be covered by each sprinkler, and the minimum operating pressure required for each sprinkler**.**
- The **position of sprinklers**, which includes the location of sprinklers in relation to ceilings and walls with respect to building elements and other objects that could affect sprinkler discharge (i.e., obstructions to water discharge).
- The **location of sprinklers**, which identifies those spaces and areas that do not require sprinkler coverage.

CONTINUE

NFPA 13D 2016, Section 8.1

If the ceiling is sloped, the **maximum S dimension** is to be measured **along the slope** of the ceiling to the next sprinkler. The **minimum distance** between sprinklers in a compartment is 8 ft.

Similar to *NFPA* 13, the **minimum operating pressure** requirement in *NFPA* 13D is 7 psi.

ⓘ **Refer to *NFPA* 13D 2016, Figure 8.1.1.1, Measuring S Dimension**

CONTINUE

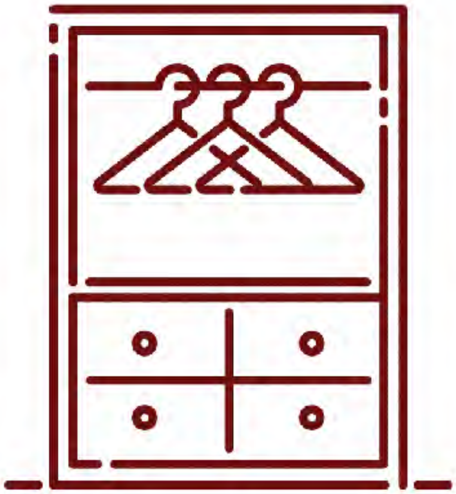
Exceptions

Sprinklers are required in all areas **except** those identified in the Location of Sprinklers section of Chapter 8. Click on the "Start" button below to view these exceptions.

1

Bathrooms - less than 55 ft^2.

2



Closets and pantries - less than 24 ft^2, with walls and ceilings surfaced with noncombustible or limited-combustible materials per *NFPA* 220 requirements.

3

Open attached porches, garages, carports, or similar structures.

4

Attics, penthouse equipment rooms, elevator machine rooms, concealed spaces dedicated exclusively to and containing only dwelling unit ventilation equipment, floor/ceiling spaces, elevator shafts, crawl spaces, and other concealed spaces that are not used or intended for living purposes.

5

Covered, unheated areas at entrances/exits where other egress is available.

6

Certain ceiling pockets as identified in the standard.

Review the exceptions noted in this section of *NFPA* 13D.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Sprinklers in an unventilated concealed space under an uninsulated roof or in an unventilated attic are to be ______ temperature-rated sprinklers.

Type your answer here

SUBMIT

Local waterflow alarms are required except when _____ is/are provided.

○ control valves

○ a control panel

○ smoke detectors

○ residential sprinklers

SUBMIT

Complete the knowledge checks above before moving on.

Protection from Freezing

NFPA 13D 2016, Section 9.1

Chapter 9 addresses antifreeze requirements for residential systems.

Wet, dry, and preaction systems are **permitted**. Wet systems should be installed in areas above 40°F, or in areas where freezing is not a concern.

In areas where freezing is a concern, unheated attic spaces need to have **sprinkler piping insulated**. The insulation can be laid over the pipe so that the heat from below can be trapped, rather than placing the insulation under the pipe, which would only stop the heat from reaching the system piping.

Figures A.9.1.1(a) through A.9.1.1(e) show several methods that can be used to protect piping from freezing. Two assumptions are made for these situations:

1. The home is heated
2. The temperature setting is warm enough to keep the pipe from freezing.

CONTINUE

Blown-in insulation can also be used to protect wet pipe sprinkler systems. However, as discussed previously, the insulation cannot be blown between the sprinkler pipe and the heated space below.

The *Automatic Sprinkler Systems for Residential Occupancies Handbook* suggests protecting the piping by **covering it with thick plastic sheets** before the insulation is blown over the pipe. The blown-in insulation will then rest on top of these plastic sheets, which will surround the pipe with a heated air pocket.

A combination of **batt insulation** over the sprinkler piping and **blown-in insulation** in adjacent areas is another suggested method to consider when protecting the pipe from freezing.

ⓘ **Refer to *NFPA* 13D 2016, Figures 9.1.1(a) – 9.1.1(e), Insulation Recommendations**

LET'S REVIEW

Let's do a quick check about what has been covered so far.

The *Automatic Sprinkler Systems for Residential Occupancies Handbook* suggests protecting sprinkler piping by covering it with _____ before the insulation is blown over the pipe.

○ blown-in insullation

○ foam

○ aluminum

○ plastic sheets

SUBMIT

Complete the knowledge check above before moving on.

NFPA 13D 2016, Section 9.1.2

If the piping is located in areas that are subject to freezing, the following methods are permitted to protect the pipe:

- Dry pipe and preaction systems.
- Antifreeze systems (antifreeze solutions are recommended only for systems not exceeding 40 gal).
- Dry pendent or dry sidewall sprinklers extending from the pipe in heated areas into unheated areas not used for living purposes.
- Heat tracing - This is a system that can maintain or raise the temperature of the sprinkler pipe, using an electrical heating element that remains in contact with the sprinkler pipe along the length of the pipe. The heat generated by this element can maintain or raise the pipe temperature.
- Residential dry pendent or dry sidewall sprinklers extending from the pipe in heated areas into unheated areas not used for living purposes.

CONTINUE

NFPA 13D 2016, Section 9.2.3

NFPA 13D provides two choices for arranging an antifreeze system:

1. One with a backflow preventer
2. One without

Backflow Preventer

Keep in mind that **local health codes** may still require a backflow preventer anyway, regardless of whether an antifreeze system is used, and may require additional backflow prevention measures to be taken to isolate the antifreeze system.

☐ If a **backflow preventer is installed** as part of an antifreeze system, *NFPA* 13D provides requirements for arranging the rest of the system, which includes an expansion chamber.

☐ For antifreeze systems **without a backflow preventer**, the antifreeze loop needs to be installed with a minimum of a 5 ft. elevation drop. The purpose of this drop is to **keep the antifreeze from mixing with the water**: the vertical pipe keeps the antifreeze at the bottom and the water at the top.

☐ If a backflow preventer is required by the Authority Having Jurisdiction (AHJ), then these devices are usually located where the rubber-faced check valve is located.

CONTINUE

Recall that both backflow preventers and meters have **large friction losses** associated with them. If either of these devices is required by the AHJ for a residential system, then this must be taken into consideration in the system's **hydraulic calculations**.

As shown in **Figure 9.2.3.1.1**, the purpose for the 1/32 in. hole in the clapper is to allow the antifreeze to expand out of the antifreeze portion of the system and into the vertical portion of the loop separating the antifreeze from the water-filled piping, if it is warmed. This helps to keep the proper concentration of antifreeze to provide protection from freezing.

As shown in **Figure 9.2.3.2.1**, an expansion chamber is required if a backflow prevention assembly is utilized as part of an antifreeze system to take care of antifreeze solution expansion and contraction. Because a hole cannot be drilled in the clapper of the backflow preventer, a properly sized expansion chamber is required to provide the antifreeze solution a place to go when it expands.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

If a backflow preventer is installed as part of an antifreeze system, *NFPA* 13D provides requirements for arranging the rest of the system, which includes a(n) __________________.

Type your answer here

SUBMIT

Complete the knowledge check above before moving on.

NFPA 13D 2016, Section 5.1.2.1 and 9.2.3

Interestingly, expansion chambers are **not required** to be listed by *NFPA* 13D, but they are required to be approved, as stated in Section 5.1.2.1.

The intent is to help **decrease the costs** associated with the installation of a residential fire protection system.

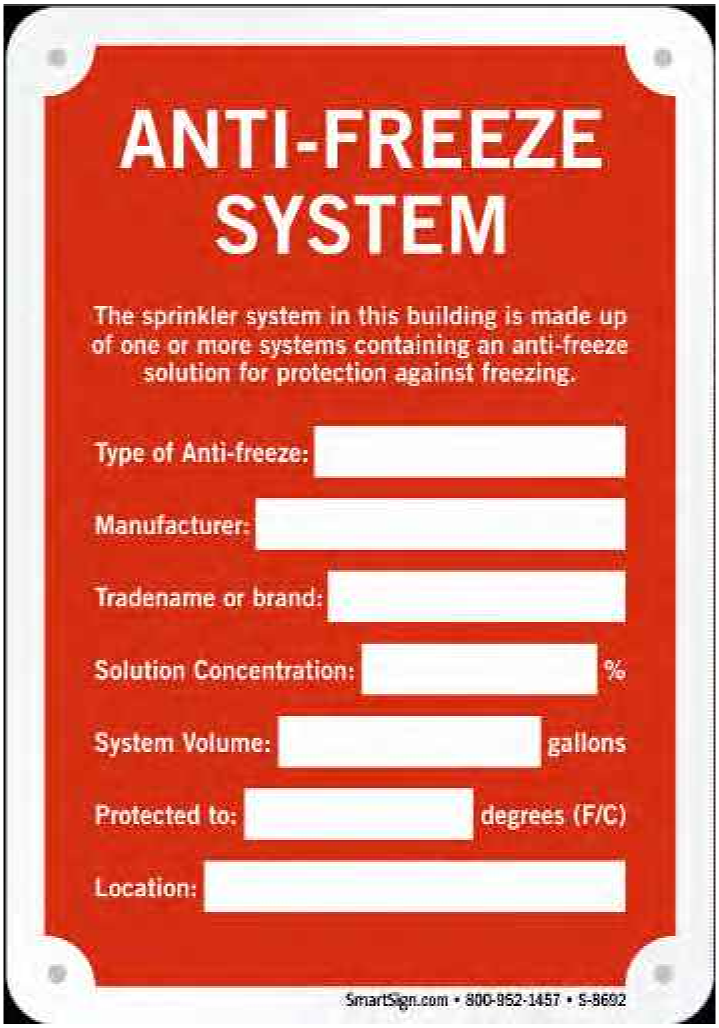
Note that this **differs from *NFPA* 13** requirements, where expansion chambers are required to be listed. Keep in mind that the expansion chamber must still be sized correctly and rated for the maximum system pressure as the antifreeze expands.

CONTINUE

NFPA 13D 2016, Section 9.2.5

A placard is required on the antifreeze system main valve that shows the following:

- The **manufacturer type and brand** of antifreeze solution
- The **concentration** of antifreeze solution used
- The **volume** of the antifreeze solution used in the system



ANTI-FREEZE SYSTEM

The sprinkler system in this building is made up of one or more systems containing an anti-freeze solution for protection against freezing.

Type of Anti-freeze:
Manufacturer:
Tradename or brand:
Solution Concentration: %
System Volume: gallons
Protected to: degrees (F/C)
Location:

SmartSign.com • 800-952-1457 • S-8692

CONTINUE

NFPA 13D 2016, Section 9.3.1.2

The following sprinklers and arrangements are permitted for dry pipe and preaction systems:

- Residential upright sprinklers
- Residential dry sprinklers
- Residential pendent and sidewall sprinklers installed on return bends, where the sprinklers, return bends, and branchline piping are in an area maintained at or above 40°F.
- Residential horizontal sidewall sprinklers, installed so that water is not trapped

CONTINUE

NFPA 13D 2016, Section 9.3.2

Preaction systems are permitted to be one of the following:

Double-Interlock System –

A double-interlock system, which admits water to sprinkler piping upon operation of both detection devices and automatic sprinklers.

Non-Interlock System —

A non-interlock system, which admits water to sprinkler piping upon operation of the detection devices or automatic sprinklers.

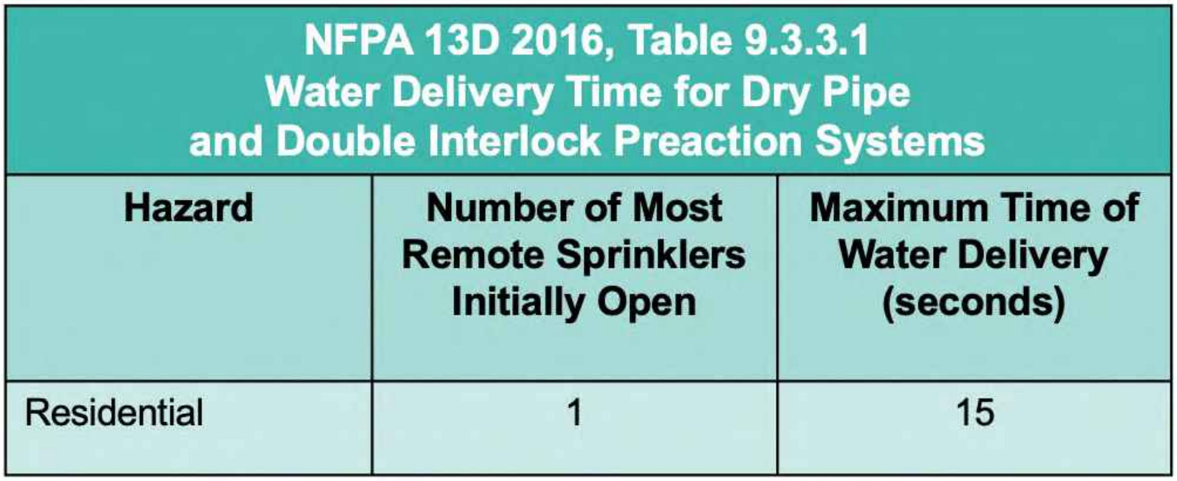
Single Interlock System —

A single interlock system, which admits water to sprinkler piping upon operation of the detection devices.

CONTINUE

NFPA 13D 2016, Section 9.3.3

Table 9.3.3.1 shows the water delivery time requirements for dry pipe and double interlock preaction systems in a residential system.



NFPA 13D 2016, Table 9.3.3.1
Water Delivery Time for Dry Pipe
and Double Interlock Preaction Systems

Hazard	Number of Most Remote Sprinklers Initially Open	Maximum Time of Water Delivery (seconds)
Residential	1	15

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Which preaction system admits water to sprinkler piping upon operation of the detection devices?

○ Non-interlock system

○ Single interlock system

○ Double interlock system

SUBMIT

🔒 Complete the knowledge check above before moving on.

Hydraulic Calculations

NFPA 13D 2016, Chapter 10

At a minimum, the system is required to provide **sufficient flow** to produce a discharge density of 0.05 gpm/ft^2 or the sprinkler listing (whichever is greater). **This criterion may vary**, depending upon the area to be covered, the type of ceiling, and the distance from the ceiling.

CONTINUE

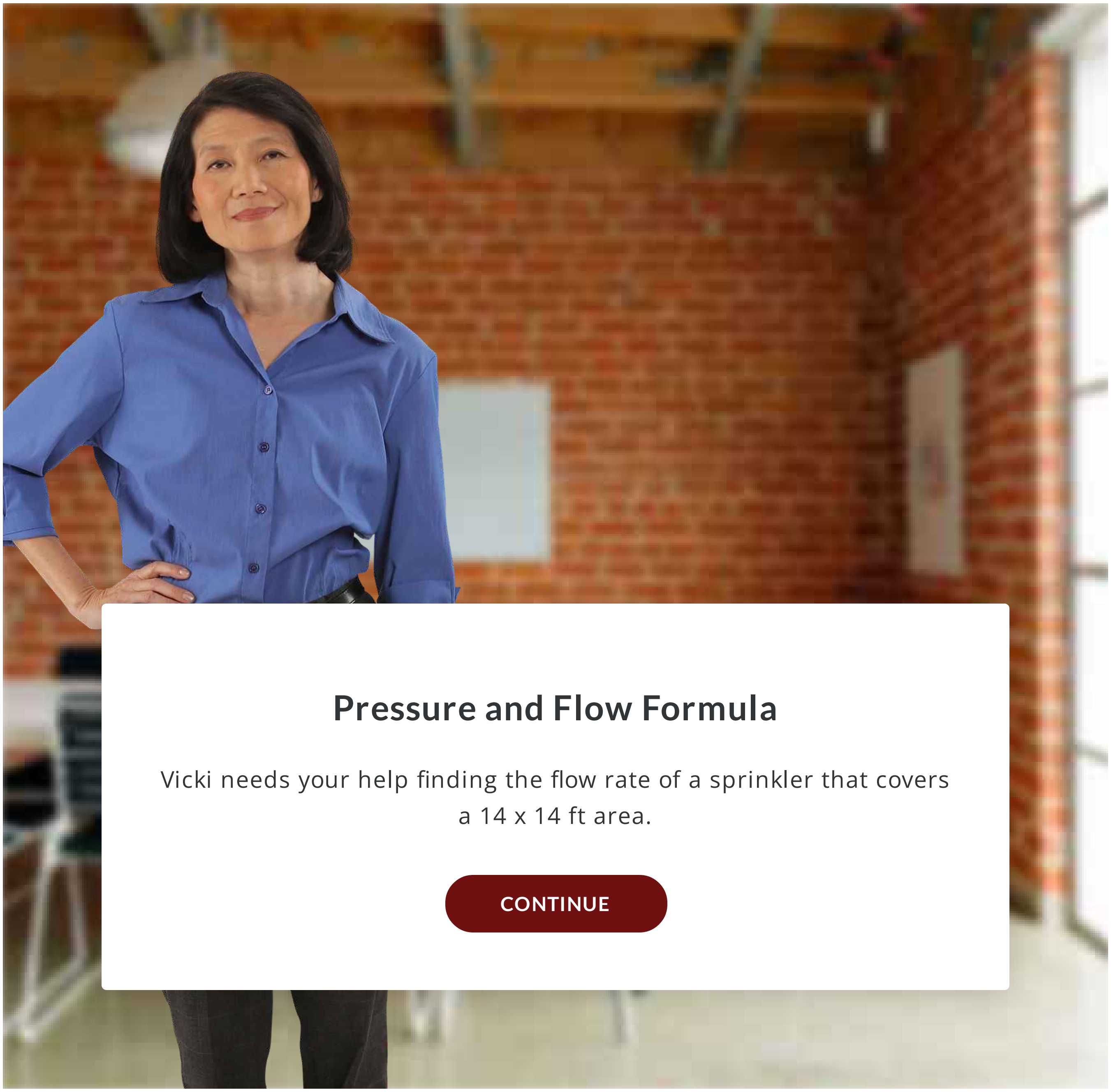
NFPA 13D 2016, Section A.10.1

The minimum pressure and flow requirements need to follow our **pressure and flow formula**:

$$Q = k\sqrt{P}$$

- **Q** = Flow rate (gpm)
- **k** = Discharge coefficient
- √**P** = Pressure (psi)

The following scenario will help you become more familiar with hydraulic calculations and utilizing the above formula.

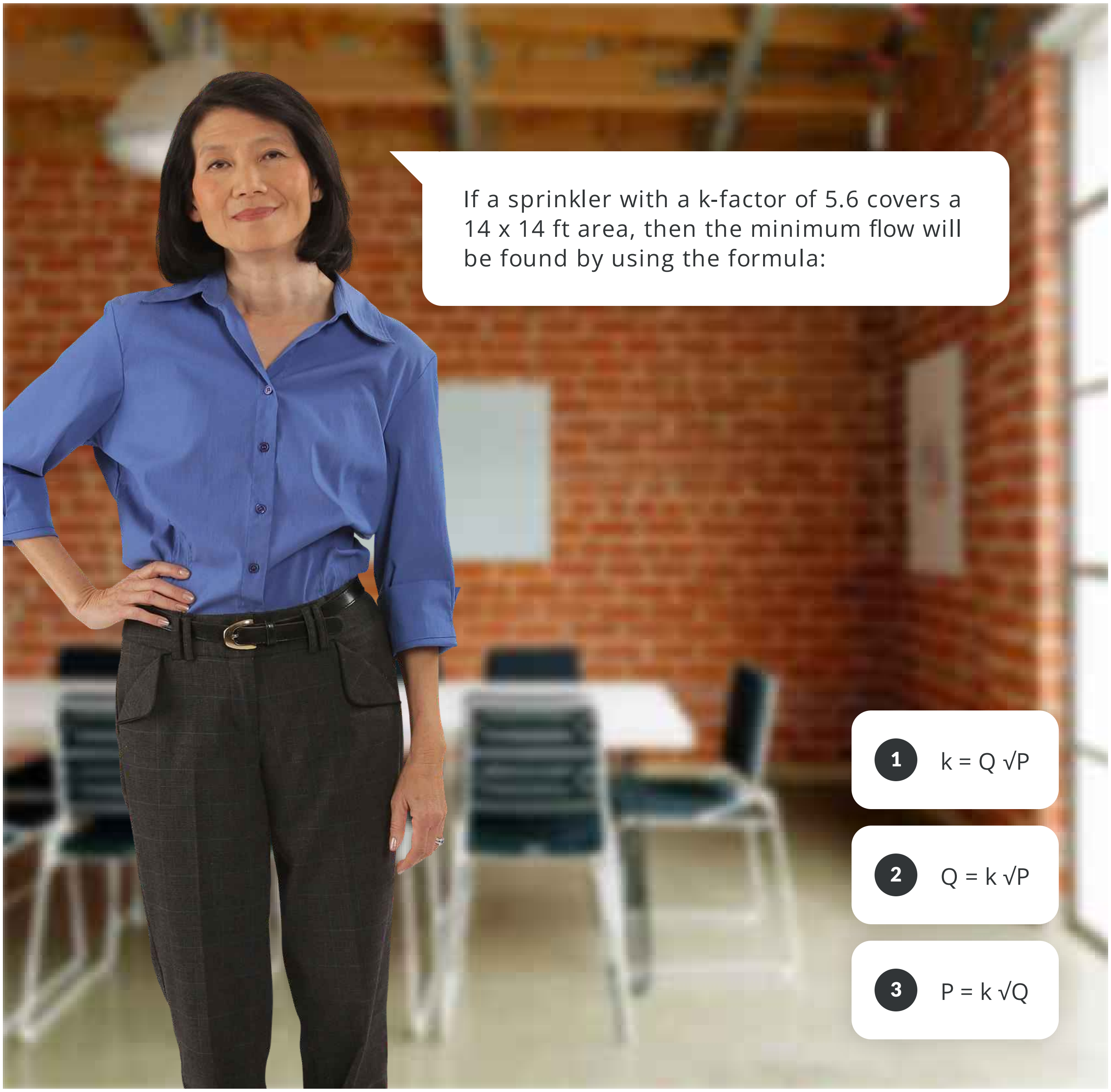


Pressure and Flow Formula

Vicki needs your help finding the flow rate of a sprinkler that covers a 14 x 14 ft area.

Scene 1 Slide 1

Continue → Next Slide



If a sprinkler with a k-factor of 5.6 covers a 14 x 14 ft area, then the minimum flow will be found by using the formula:

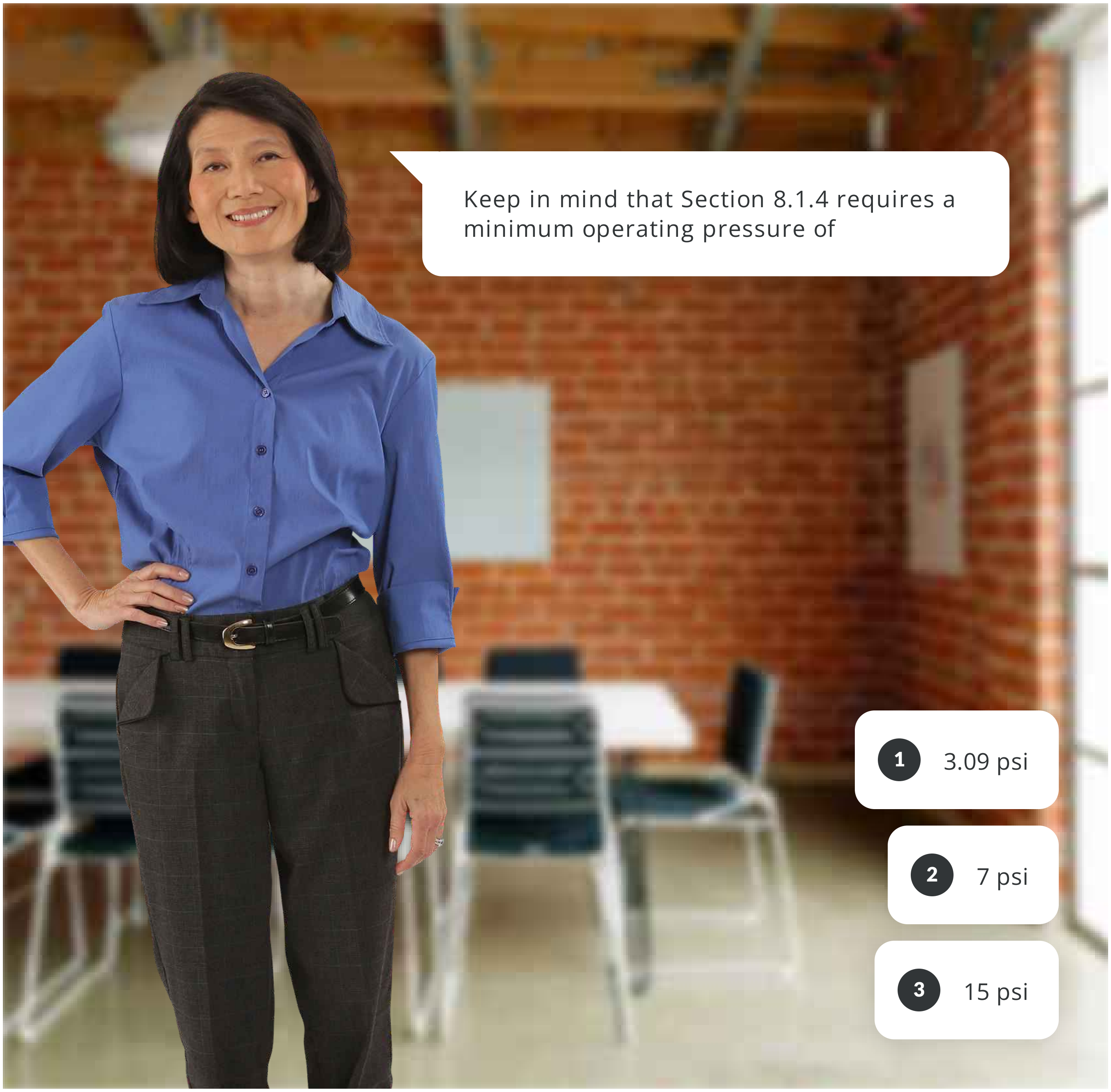
① $k = Q \sqrt{P}$

② $Q = k \sqrt{P}$

③ $P = k \sqrt{Q}$

Scene 1 Slide 2

0 → Next Slide
1 → Next Slide
2 → Next Slide



Keep in mind that Section 8.1.4 requires a minimum operating pressure of

1 3.09 psi

2 7 psi

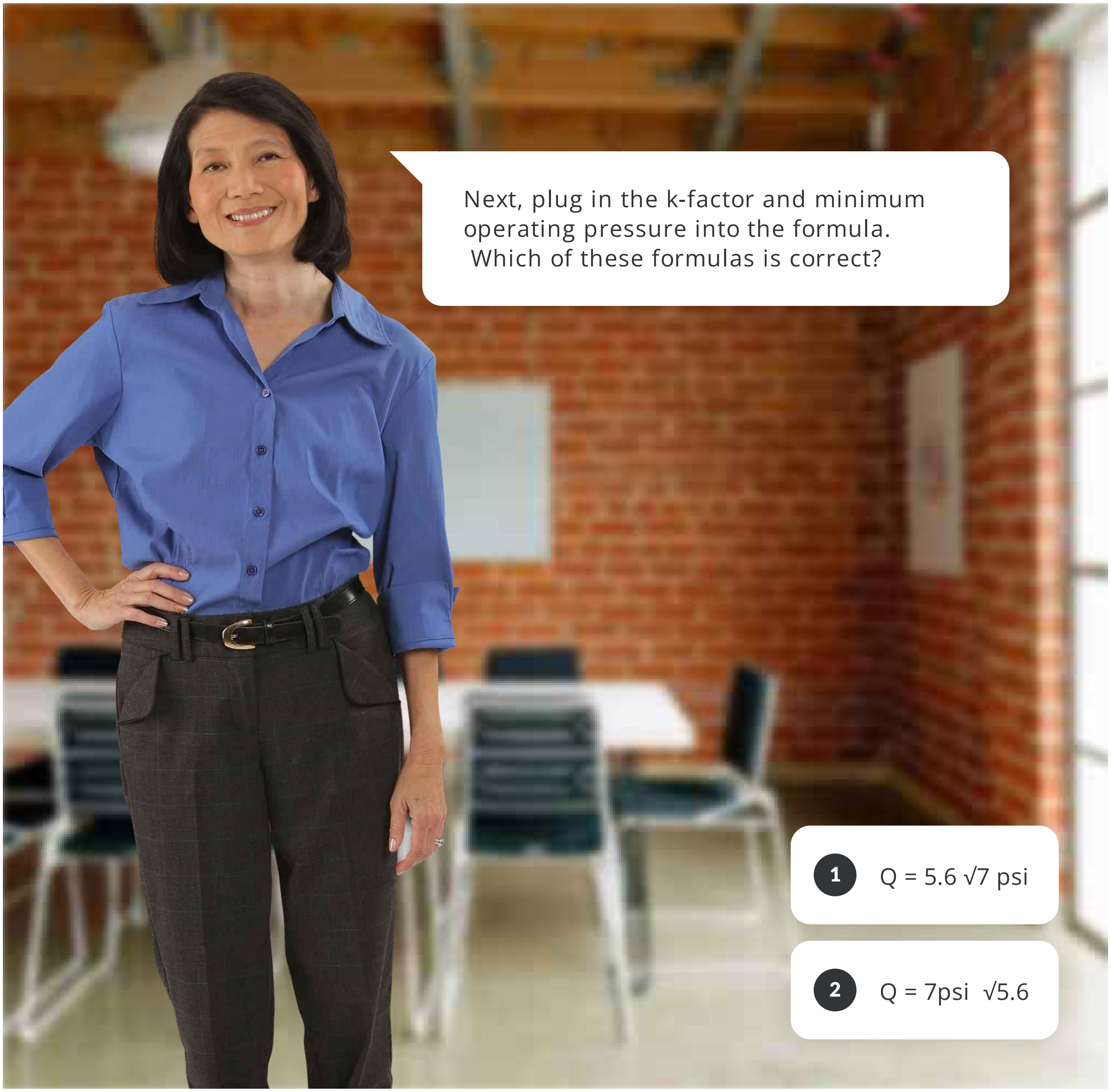
3 15 psi

Scene 1 Slide 3

0 → Next Slide

1 → Next Slide

2 → Next Slide



Next, plug in the k-factor and minimum operating pressure into the formula.
Which of these formulas is correct?

1 $Q = 5.6 \sqrt{7}$ psi

2 $Q = 7\text{psi}\ \sqrt{5.6}$

Scene 1 Slide 4

0 → Next Slide

1 → End of Scenario

Complete the scenario above before moving on.

You can choose to calculate the flow based on the area (14 ft x 14 ft = 196 ft^2) and the minimum density for a residential system (0.05 gpm/ft^2).

196 ft^2 x 0.05 gpm/ft^2 = 9.8 gpm

However, you need to be aware that even though a flow of 9.8 gpm satisfies the design density criteria, the minimum pressure requirement of 7 psi **would not be met**.

9.8 gpm = 5.6 $\sqrt{P}$

P = 3.06 psi

Since you need to meet both the minimum density and pressure requirements, **be aware of this when you perform your calculations.**

SYSTEM DESIGN

System Design

NFPA 13D 2016, Section 10.2

Chapter 3 defines a compartment as a space completely enclosed by walls and a ceiling. Each wall in the compartment is permitted to have openings to an adjoining space if the openings have a minimum lintel depth of 8 in. from the ceiling and the total width of the openings in a single wall does not exceed

8 ft. in width. A single opening of 36 in. or less in width without a lintel is permitted when there are no other openings to adjoining spaces.

A **lintel** is the distance between the ceiling and the top of the door.

Section 10.2 defines the number of design sprinklers required within a compartment, under five different conditions. Review these situations in this section, as their intent is to assure that sufficient heat is trapped in the compartment to actuate the sprinkler head(s).

Refer to *NFPA* 13D 2016, Figures A.10.2(a) and A.10.2(b), Sprinkler Design Areas for Typical Residential Occupancy — With and Without Lintel

CONTINUE

NFPA 13D 2016, Section 10.3

The Annex explains that this is a type of multipurpose system that often uses ½ in. piping to serve both domestic and fire protection needs, providing an equivalent level of suppression capability as found with larger piping systems.

To accomplish this protection, each sprinkler is supplied by water flowing to it from **at least three paths**.

Piping systems may be either:

- Straight
- Looped

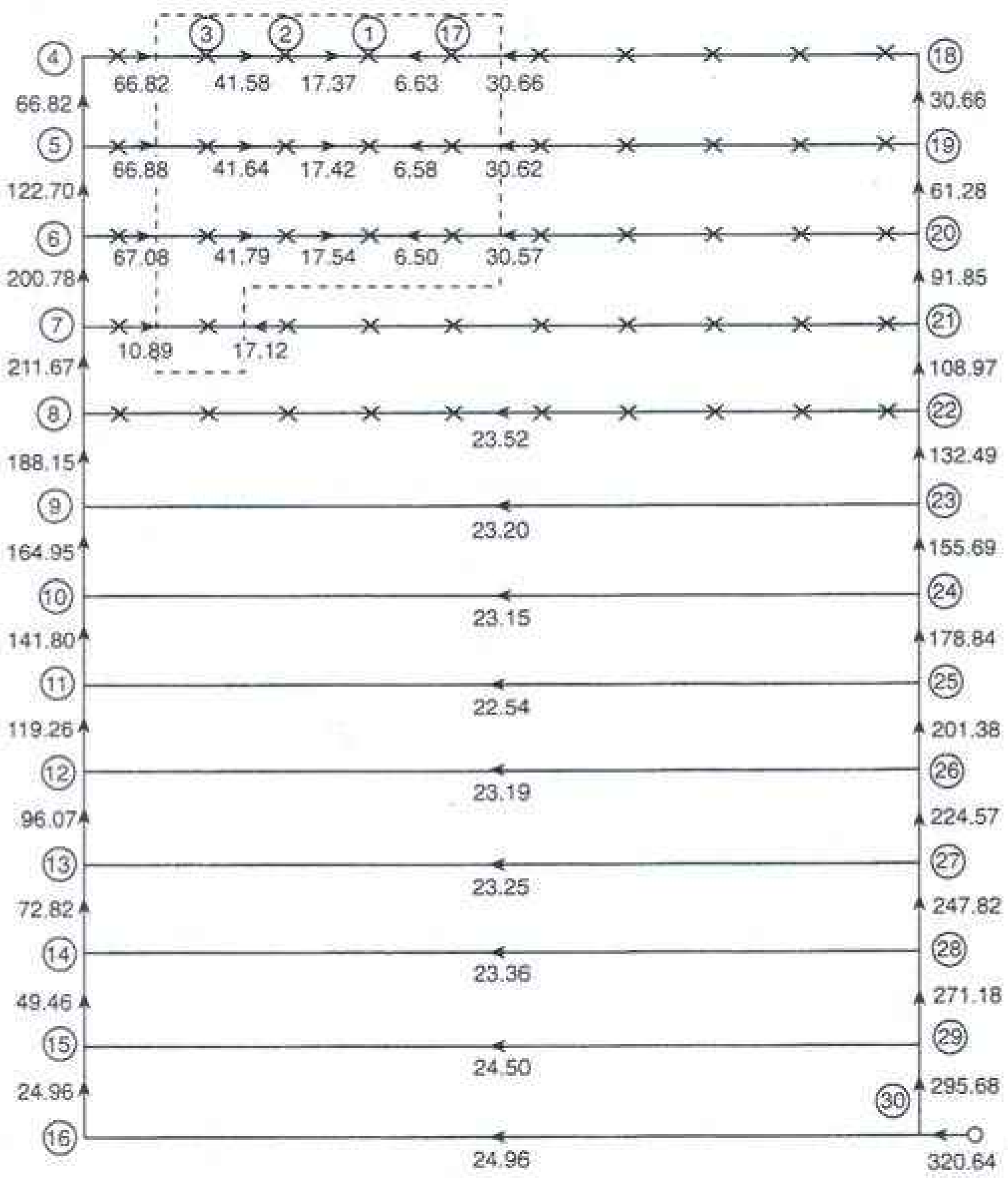
- Gridded
- A combination of these configurations

CONTINUE

NFPA 13D 2016, Section 10.4

The minimum piping requirements are 3/4 in. for copper and 1 in. for steel. Either ½ in. nonmetallic pipe or copper pipe can be used in network systems under certain conditions.

There are tables in Chapter 10 which provide friction loss information for Schedule 40 pipe, copper tubing, valves and fittings, and water meters. **Take a look at these tables and understand how to use them correctly.**



NFPA 13D defines a network system as a type of multipurpose system utilizing a common piping system supplying domestic fixtures and fire sprinklers, where each sprinkler is supplied by a minimum of three separate paths.

NFPA 13D gives the designer latitude in terms of deciding which is the **most advantageous**, which is the **most efficient**, and which will be the **most cost-effective** design configuration.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

A ______ is the distance between the ceiling and the top of the door.

Type your answer here

SUBMIT

🔒 Complete the knowledge check above before moving on.

Acceptance Testing

NFPA 13D 2016, Section 11.2.2

Before a formal system acceptance test is conducted, a system with a pump must be tested by opening the drain/test connection. During this test, the pump must:

- Sense the water flow
- Turn on
- Run for the required duration without interruption or tripping the circuit breaker

The use of a timer to keep the pump operating is discouraged, since the timer would permit the pump to continue running even with no water flow.

MAINTENANCE

Sprinkler Maintenance

NFPA 13D 2016, Chapter 12

Chapter 12 defines the general requirements of the inspection, testing, and maintenance of the system, which is the responsibility of the owner or the manager of the property.

NFPA 13D 2016, Section 12.3.2

If a sprinkler needs to be replaced, it is required to be replaced with a **new listed sprinkler of the same characteristics** once it is:

- Operated
- Damaged
- Corroded
- Covered with foreign materials
- Showing signs of leakage

CONTINUE

NFPA 13D 2016, Section 12.3.3

Sprinklers are **not** permitted to be painted, **unless they are factory painted** by the manufacturer.

Sprinklers that were painted outside of the factory are required to be replaced.

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LET'S REVIEW

Let's do a quick check about what has been covered so far.

During acceptance testing, the use of a timer to keep the pump operating is encouraged.

○ True

○ False

SUBMIT

🔒 Complete the knowledge check above before moving on.

After completing this module, you should now have a better understanding of the requirements outlined in *NFPA* 13D.

Click on the “Next” arrow up on the right-hand corner of the screen to continue to the quiz.

Automatic Sprinkler & Standpipe Systems - Residential Systems NFPA 13R Requirements

By the end of this module, you will be able to do the following:

- Recognize the objectives and purpose of *NFPA* 13R.
- Identify the characteristics of sprinkler systems in residential occupancies as outlined in *NFPA* 13R.
- Explore the installation and design requirements for given networks.
- Calculate the domestic demand and water supply needed for the sprinkler system.
- Recall acceptance test requirements for *NFPA* 13R sprinkler systems.

Key References:

- *NFPA* 13R - *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, 2016

When you are ready to begin, click on the button above to start the course.

Lesson 1 of 2

NFPA 13R Requirements

Similar to *NFPA* 13D, low-rise residential occupancies must follow a standard of their own to protect residents from fire hazards.

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Recognize the objectives and purpose of *NFPA* 13R.

☐ Identify the characteristics of sprinkler systems in residential occupancies as outlined in *NFPA* 13R.

☐ Explore the installation requirements for given networks.

Key References

- *NFPA* 13R - *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, 2016

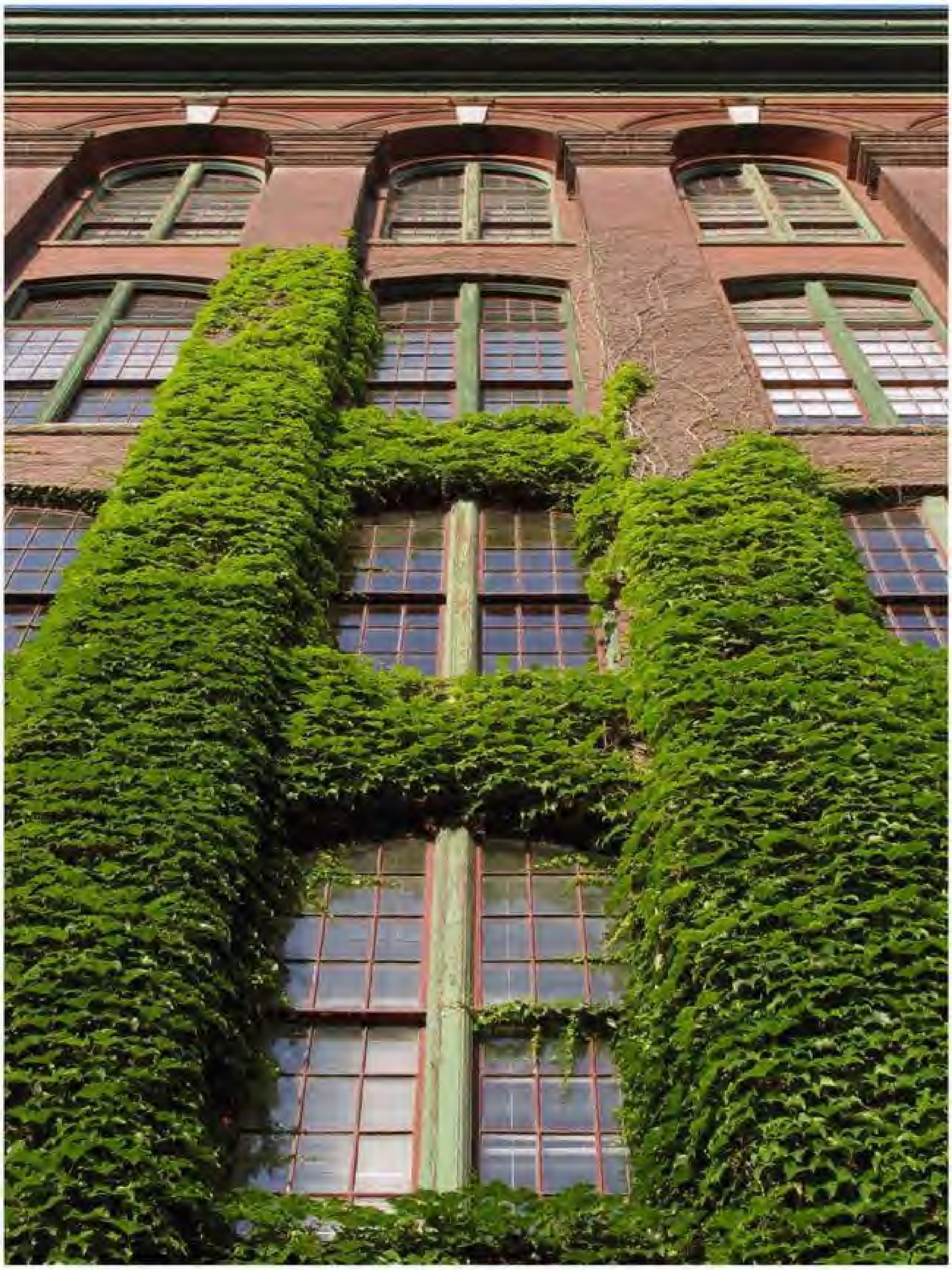
LET'S BEGIN

NFPA 13R 2016

NFPA 13R covers the design and installation of sprinkler systems for residential occupancies up to and including four stories in height.

The intent of the standard is to provide a **higher degree of life safety and property protection** for inhabitants of low-rise, residential facilities.

Like *NFPA* 13D, the goal of *NFPA* 13R is **preventing flashover in the room of origin** where sprinklered; thereby **allowing occupants to escape**.



SYSTEM COMPONENTS

System Components

NFPA 13R 2016, Section 5.1

NFPA 13R requires the same criteria as *NFPA* 13 for sprinklers, namely in the following areas:

☐ Identification

☐ Discharge characteristics

☐ Pipe threads

☐ Use of residential or special sprinklers

☐ Temperature characteristics

☐ Use of escutcheons and cover plates

☐ Painting and finish

☐ Use of protective caps and straps

ⓘ **Table 5.1.1.4.1 shows sprinkler discharge characteristics identification and is identical to *NFPA* 13 2016 Table 6.2.3.1.**

Residential sprinklers are not limited to only k-factors found in the referenced table.

CONTINUE

NFPA **13R 2016, Section 5.1.1.5.2**

Special Sprinklers

Similar to *NFPA* 13, *NFPA* 13R **requires** special sprinklers to maintain characteristics as follows:

- Orifice size
- Temperature ratings

- Protection area of coverage to not exceed 400 ft^2 for Light Hazard and Ordinary Hazard occupancies

CONTINUE

NFPA 13R 2016, Section 5.2.3.6

Pipe

Pipe or tube listed for Light Hazard occupancies is permitted in Ordinary Hazard rooms of otherwise Light Hazard occupancies, where the room does not exceed 400 ft^2.

This **allows the use of nonmetallic pipe in small rooms** such as closets and mechanical rooms.

CONTINUE

NFPA 13R 2016, Section 5.2.15

Pressure Gauges

A pressure gauge with a connection no smaller than ¼ in. is **required** in the following locations:

- At the system main drain
- At each main drain associated with a floor control valve
- On the inlet and outlet side of each pressure-reducing valve

Each gauge connection is required to have a **shut-off valve** and **provisions for draining**.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Section 5.2.3.6 allows the use of nonmetallic pipe in small rooms such as closets and mechanical rooms.

○ True

○ False

SUBMIT

Complete the knowledge check above before moving on.

Installation Requirements

Chapter 6 of *NFPA* 13R 2016 provides the requirements for the installation of *NFPA* 13R systems, including the specific provisions relating to **general system requirements, area limits, and protection of piping**.

NFPA 13R 2016, Section 6.1

Section 6.1 establishes the **maximum size of a sprinkler system** on a single floor of a building as 52,000 ft^2.

The purpose of having a maximum area at all is to **limit the amount of space that would be unprotected** if a valve needed to be closed to perform maintenance or repair on a system.

The maximum floor area on any one floor to be protected by sprinklers supplied by any one sprinkler system riser or combined system riser can **not exceed** 52,000 ft^2.

Any additional floor area occupied by mezzanines is not to be included in this area limitation.

CONTINUE

NFPA 13R 2016, Section 6.4.6.3.2

Obstructions

In all closets and compartments no greater than 400 ft^3, including those closets housing mechanical equipment, a **single sprinkler at the highest ceiling space is sufficient**.

The Annex explains that for these small closets, one single sprinkler installed at the highest point will help to keep the fire contained.

Additionally, the Annex notes that there can be many **different types of obstructions** that could potentially prevent water from reaching all portions of a closet. Some common examples include:

- Heating and air-conditioning closets where the plenum totally blocks the spray pattern, and in some cases only 4 in. or less exists between the wall and the plenum for the sprinkler
- Globe or fluorescent lights in closets that hang down obstructing the sprinkler
- Closets under stairs that switchback where the spray pattern will not reach the low side

CONTINUE

NFPA 13R 2016, Sections 3.3.10 and 6.4.6.3.3

NFPA 13R defines a shadow area as the dry floor area within the protection area of a sprinkler created by the portion of sprinkler discharge that is blocked by a wall or partition.

The Annex explains the shadow area concept is not intended to replace existing obstruction requirements. Rather, it is meant to eliminate any confusion surrounding conditions where walls form non-rectangular-shaped rooms. **Figure A.3.3.10 provides an example of this concept.**

Shadow areas are permitted in the protection area of a sprinkler if the cumulative dry areas **do not exceed 15 ft^2 per sprinkler**.

Shadow areas in corridors up to 2 ft. in depth and up to 9 ft. in length behind sidewall sprinklers are permitted as shown in **Figure 6.4.6.3.3.2**.

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LET'S REVIEW

Let's do a quick check about what has been covered so far.

In all closets and compartments no greater than 400 ft^3, how many sprinklers must be installed at the highest point to help to keep the fire contained?

○ One

○ Two

○ Three

SUBMIT

Complete the knowledge check above before moving on.

NFPA 13R 2016, Section 6.6

Review the requirements for the **location of sprinklers** found in this section. Similar to *NFPA* 13D, there are numerous requirements and exceptions contained in this section.

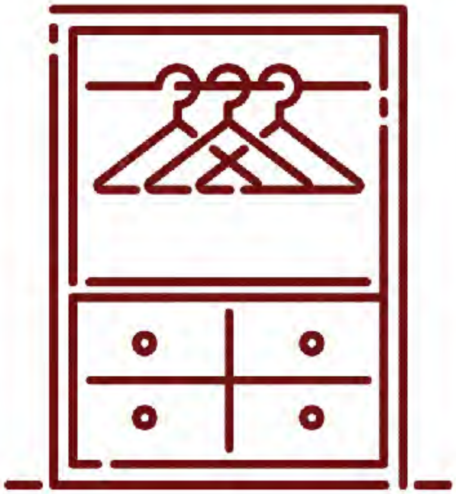
Sprinkler Omission

Similar to *NFPA* 13D, there are some instances where **sprinkler omission** is permitted by *NFPA* 13R. Click on the "Start" button below to view these situations.

1

In bathrooms less than or equal to 55 ft^2

2



In clothes closets, linen closets, and pantries with the following criteria:

- The area of space does not exceed 24 ft^2
- The walls and ceilings are surfaced with noncombustible or limited-combustible materials as defined in *NFPA* 220, *Standard on Types of Building Construction*

3

In attics, penthouse equipment rooms, elevator machine rooms, concealed spaces dedicated exclusively to and containing only dwelling unit ventilation equipment, crawl spaces, floor/ceiling spaces

A room is still considered a bathroom if it contains just a toilet. Two bathrooms can be adjacent to each other and are considered separate rooms, provided they are enclosed with the required level of construction. (*NFPA* 13R 2016, Section A.6.6.2)

CONTINUE

Differing from *NFPA* 13D, some instances where **sprinkler omission** is permitted by *NFPA* 13R include the following situations:

- Noncombustible elevator shafts where the elevator shafts comply with ANSI A17.1, Safety Code for Elevators and Escalators, and other concealed spaces that are not used or intended for living purposes or storage, and do not contain fuel-fired equipment. Spaces with fuel-fired equipment are required to have at least one quick-response intermediate temperature sprinkler installed above the equipment.

- In closets on exterior balconies, regardless of size, as long as there are no doors or unprotected penetrations from the closet directly into the dwelling unit.

The Annex material points out that concealed spaces are permitted to have small openings, such as grilles for return air when the space is being used as a plenum.

Such small openings do not disqualify the space from being considered as a concealed space, and sprinklers are **still permitted to be omitted**.

ⓘ **Closets with washers and dryers, and other heat-producing mechanical equipment, are not considered clothes closets, linen closets, or pantries and require sprinklers. (*NFPA* 13R 2016, Section A.6.6.4)**

LET'S REVIEW

Let's do a quick check about what has been covered so far.

____ is the dry floor area within a protection area of a sprinkler created by the blocked portion of the sprinkler discharge.

Type your answer here

SUBMIT

Complete the knowledge check above before moving on.

Lesson 2 of 2

NFPA 13R Design and Demand

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Explore the design requirements for given networks.

☐ Calculate the domestic demand and water supply needed for the sprinkler system.

☐ Recall acceptance test requirements for *NFPA* 13R sprinkler systems.

Key References

- *NFPA* 13R - *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, 2016

LET'S BEGIN

Discharge Criteria

NFPA 13R 2016, Chapter 7

The *Automatic Sprinkler Systems for Residential Occupancies Handbook* provides some insight on the requirements found in Chapter 7, reminding us that sprinkler systems installed in accordance with *NFPA* 13R must be hydraulically calculated, following the calculation procedure spelled out in *NFPA* 13.

The **discharge criteria** for *NFPA* 13R sprinkler systems usually consist of **two separate calculations**:

1. One for the areas within the dwelling unit and
2. A second for the areas outside of the dwelling unit.

> The water supply must meet both of these demands separately, as the demands do not need to be added together.

For protection inside the dwelling unit, two sprinkler types are allowed. **Residential sprinklers are preferred**, but **quick-response sprinklers are permitted,** if there are four or fewer sprinklers located in the entire dwelling unit.

CONTINUE

NFPA 13R 2016, Section 7.1

Inside the Dwelling Unit

The sprinkler system is required to provide **sufficient flow to produce a minimum discharge density** of 0.05 gpm/ft^2 or the sprinkler listing, whichever is greater.

NFPA 13R requires **up to four sprinklers** within a compartment, depending upon the situation, placing restrictions on compartment features such as ceiling heights, ceiling slopes, ceiling beam dimensions, and compartment size.

Review the specific requirements found in Section 7.1.1.3.

CONTINUE

NFPA 13R 2016, Section 7.2

Outside the Dwelling Unit

NFPA 13R considers areas outside the dwelling unit to include:

- Lobbies, corridors, halls, and foyers that are not a part of the actual dwelling unit
- Basements and storage areas
- Inside stairwells
- Equipment, furnace, trash, laundry, and linen rooms

NFPA 13R permits the **design area to be limited to the number of sprinklers in the compartment** (not to exceed four sprinklers) for compartments that are 500 ft^2 or less, protected with quick response sprinklers, and satisfying all of the conditions listed below:

☐ The area is protected with 30 minute–rated construction.

☐ The sprinklers are spaced at 225 ft^2 maximum for Light Hazard, 130 ft^2 maximum for Ordinary Hazard, or in accordance with their listing.

☐ Openings have a lintel depth at least 8 in. in depth.

☐ The total area of openings, excluding any overhead doors that open to the exterior, does not exceed 50 ft^2 for each compartment.

☐ Discharge densities are in accordance with *NFPA* 13.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

For protection inside the dwelling unit, which two sprinkler types are allowed? (Check all that apply)

☐ Concealed sprinklers

☐ Residential sprinklers

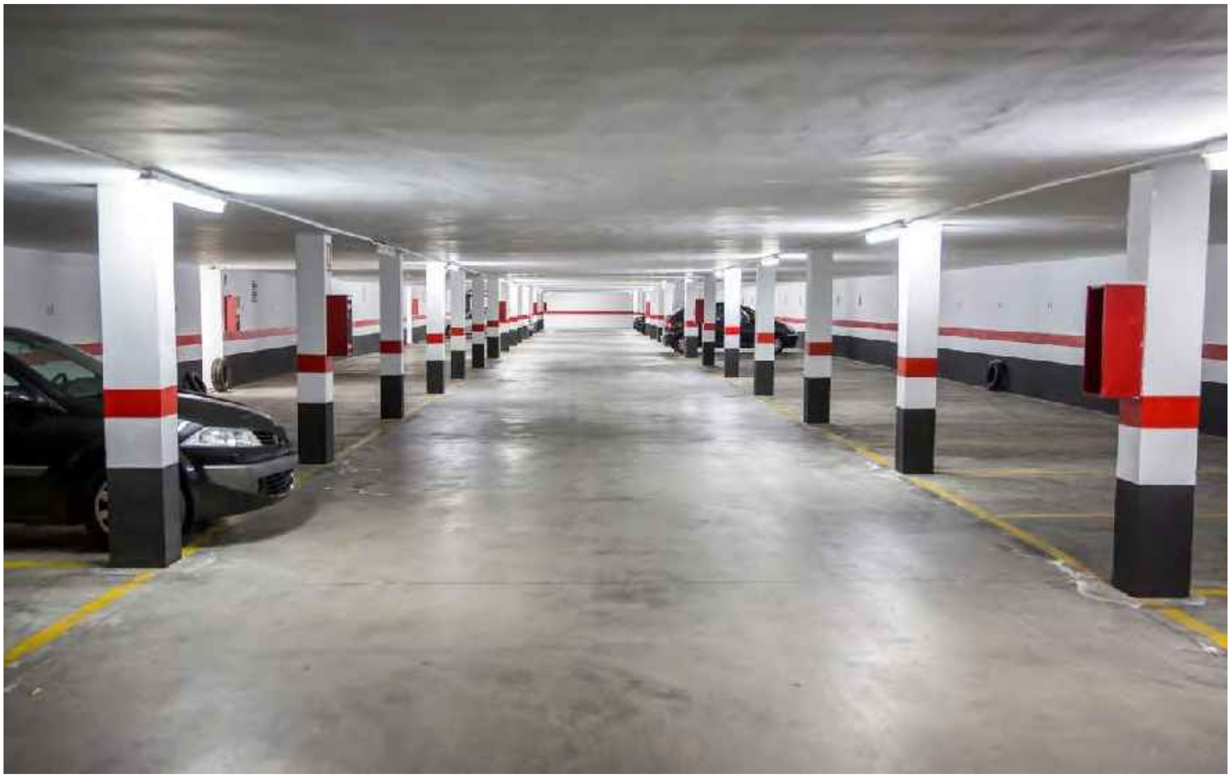
☐ ESFR sprinklers

☐ Quick-response sprinklers

SUBMIT

Complete the knowledge check above before moving on.

NFPA 13R 2016, Section 7.3



Garages

Garages completely separated from the residential portion of the building by fire-resistive construction and considered to be separate buildings are **required** to meet *NFPA* 13 requirements.

Garage doors are **not considered obstructions** and do not need to be taken into consideration for hydraulic calculations.

However, garages that serve only a single dwelling unit are considered to be part of that unit. In addition, garages that are accessible only from a single dwelling unit are also considered to be part of that dwelling unit. If that is the case, then the garage must be protected with one of the following:

- A residential sprinkler per Section 7.1 requirements
- An extended coverage sprinkler discharging water not less than its listed flow rate for Light Hazard
- A quick-response spray sprinkler at Light Hazard spacing in accordance with *NFPA* 13 designed to discharge at 0.05 gpm/ft^2 density

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Garage doors are considered obstructions and need to be taken into consideration for hydraulic calculations.

○ True

○ False

SUBMIT

Complete the knowledge check above before moving on.

Water Supplies

Chapter 9 contains the **minimum requirements for the water supply** for an *NFPA* 13R sprinkler system. The rules are very similar to those of *NFPA* 13 in terms of what is permitted to serve as a water supply and how the water supply is required to be arranged. If fire pumps are used as a part of the water supply, they need to comply with *NFPA* 20. The rules of Chapter 9 used to be integrated with the installation rules and other rules of Chapter 6.

NFPA 13R 2016, Sections 9.1 – 9.5

Each sprinkler system is required to have **at least one automatic water supply**, supplying the system demand for a **minimum of 30 minutes**.

Sources of water supplies include the following:

- A connection to a reliable waterworks system with or without a pump
- An elevated or gravity tank

- A pressure tank
- A stored water source with an automatic pump

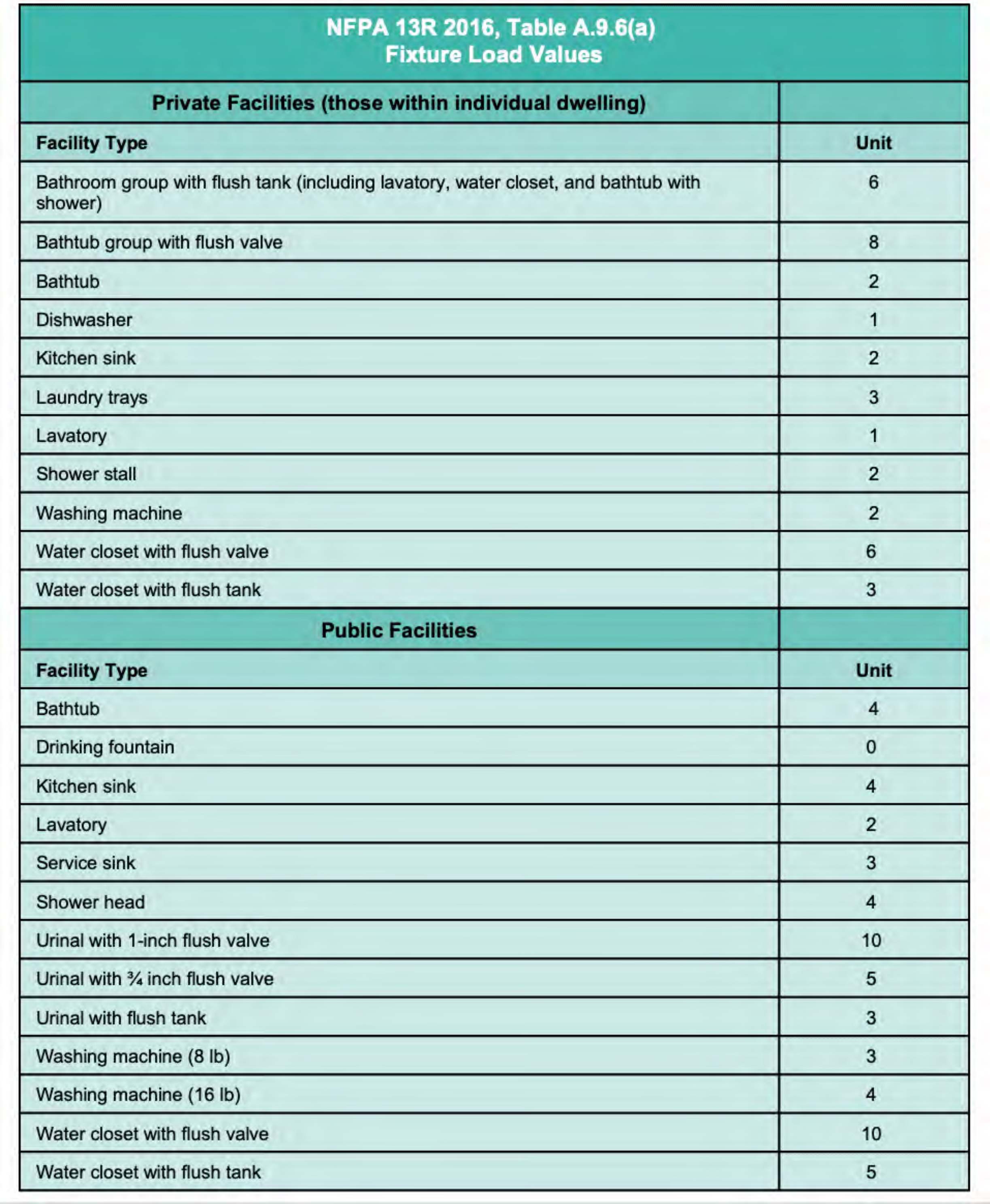
Fire pumps are to be installed per *NFPA* 20 requirements, and water tanks are to be installed per *NFPA* 22 requirements.

CONTINUE

NFPA 13R 2016, Section 9.6

Domestic demand is to be taken into consideration when determining the overall domestic design demand. Use the following tables to determine the demand.

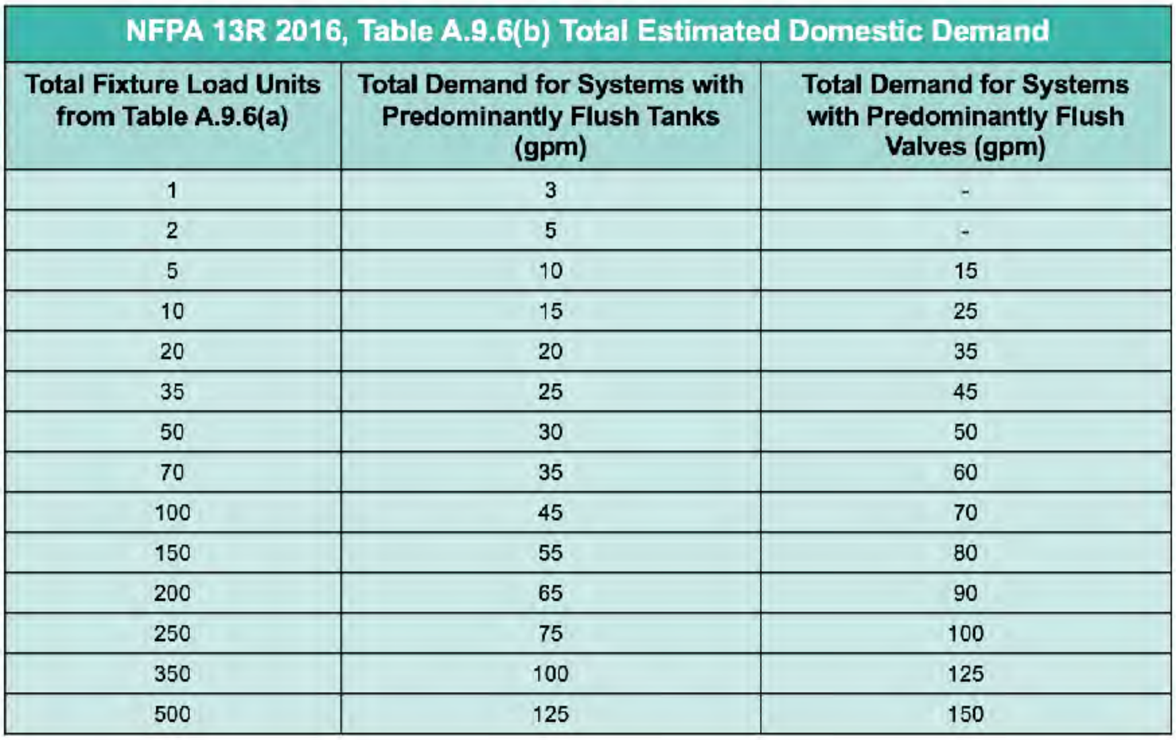
Table A.9.6(a) is used to determine the total number of water supply fixture units downstream of any point in the piping serving both sprinkler and domestic needs.



NFPA 13R 2016, Table A.9.6(a)
Fixture Load Values

Private Facilities (those within individual dwelling)	
Facility Type	**Unit**
Bathroom group with flush tank (including lavatory, water closet, and bathtub with shower)	6
Bathtub group with flush valve	8
Bathtub	2
Dishwasher	1
Kitchen sink	2
Laundry trays	3
Lavatory	1
Shower stall	2
Washing machine	2
Water closet with flush valve	6
Water closet with flush tank	3
Public Facilities	
Facility Type	**Unit**
Bathtub	4
Drinking fountain	0
Kitchen sink	4
Lavatory	2
Service sink	3
Shower head	4
Urinal with 1-inch flush valve	10
Urinal with ¾ inch flush valve	5
Urinal with flush tank	3
Washing machine (8 lb)	3
Washing machine (16 lb)	4
Water closet with flush valve	10
Water closet with flush tank	5

Table A.9.6(b) is then used to determine the appropriate total flow allowance. This value is added to the sprinkler demand at the total pressure for the sprinkler system at that point.

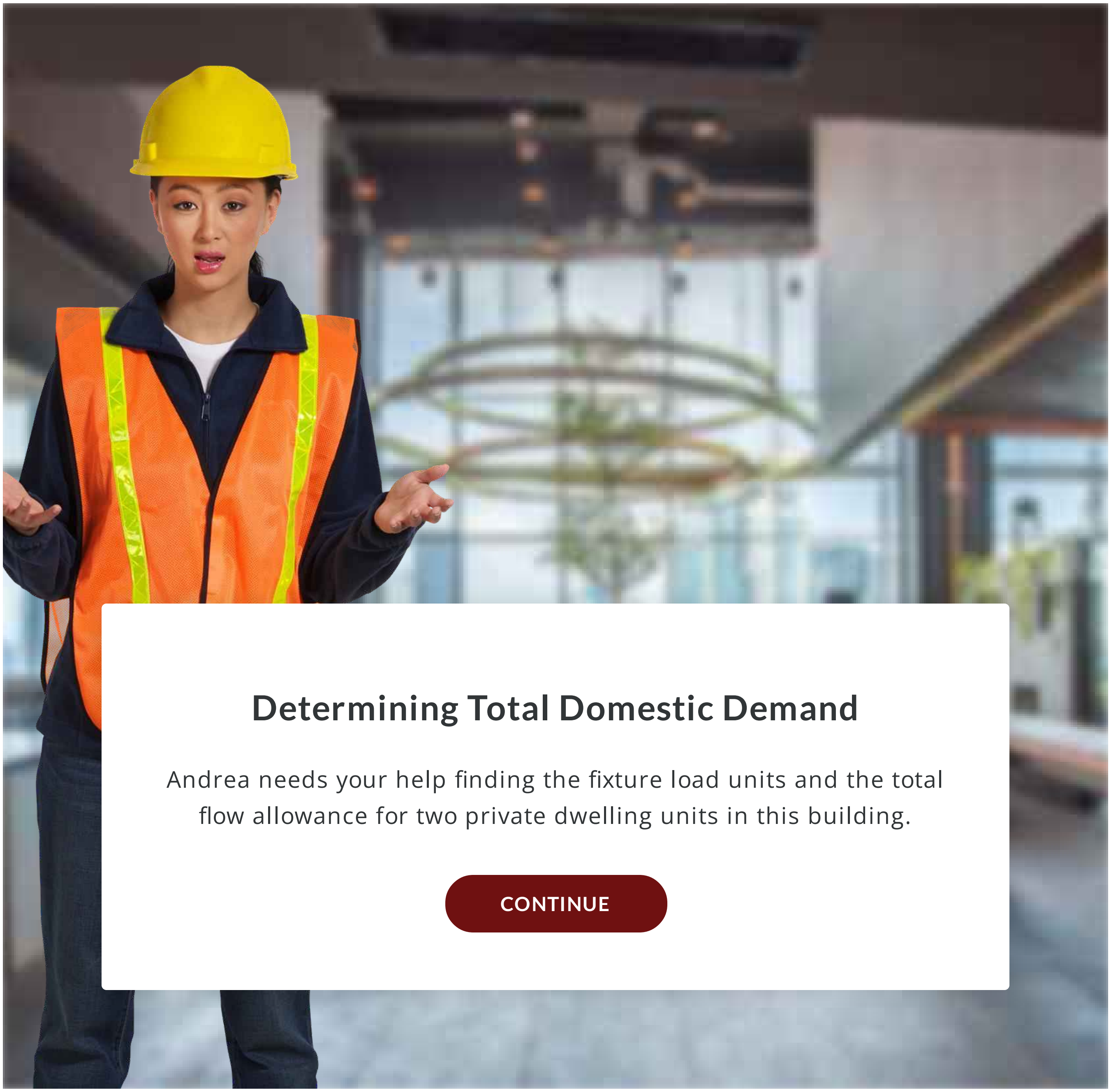


NFPA 13R 2016, Table A.9.6(b) Total Estimated Domestic Demand

Total Fixture Load Units from Table A.9.6(a)	Total Demand for Systems with Predominantly Flush Tanks (gpm)	Total Demand for Systems with Predominantly Flush Valves (gpm)
1	3	-
2	5	-
5	10	15
10	15	25
20	20	35
35	25	45
50	30	50
70	35	60
100	45	70
150	55	80
200	65	90
250	75	100
350	100	125
500	125	150

CONTINUE

It is important to review the information outlined in Tables A.9.6(a) and (b). The following scenario will allow you to apply information from the tables.



Determining Total Domestic Demand

Andrea needs your help finding the fixture load units and the total flow allowance for two private dwelling units in this building.

Scene 1 Slide 1

Continue → Next Slide

For a private dwelling unit with a flush tank that contains a dishwasher, a kitchen sink, and a washing machine, what are the units assigned to each of the fixtures?

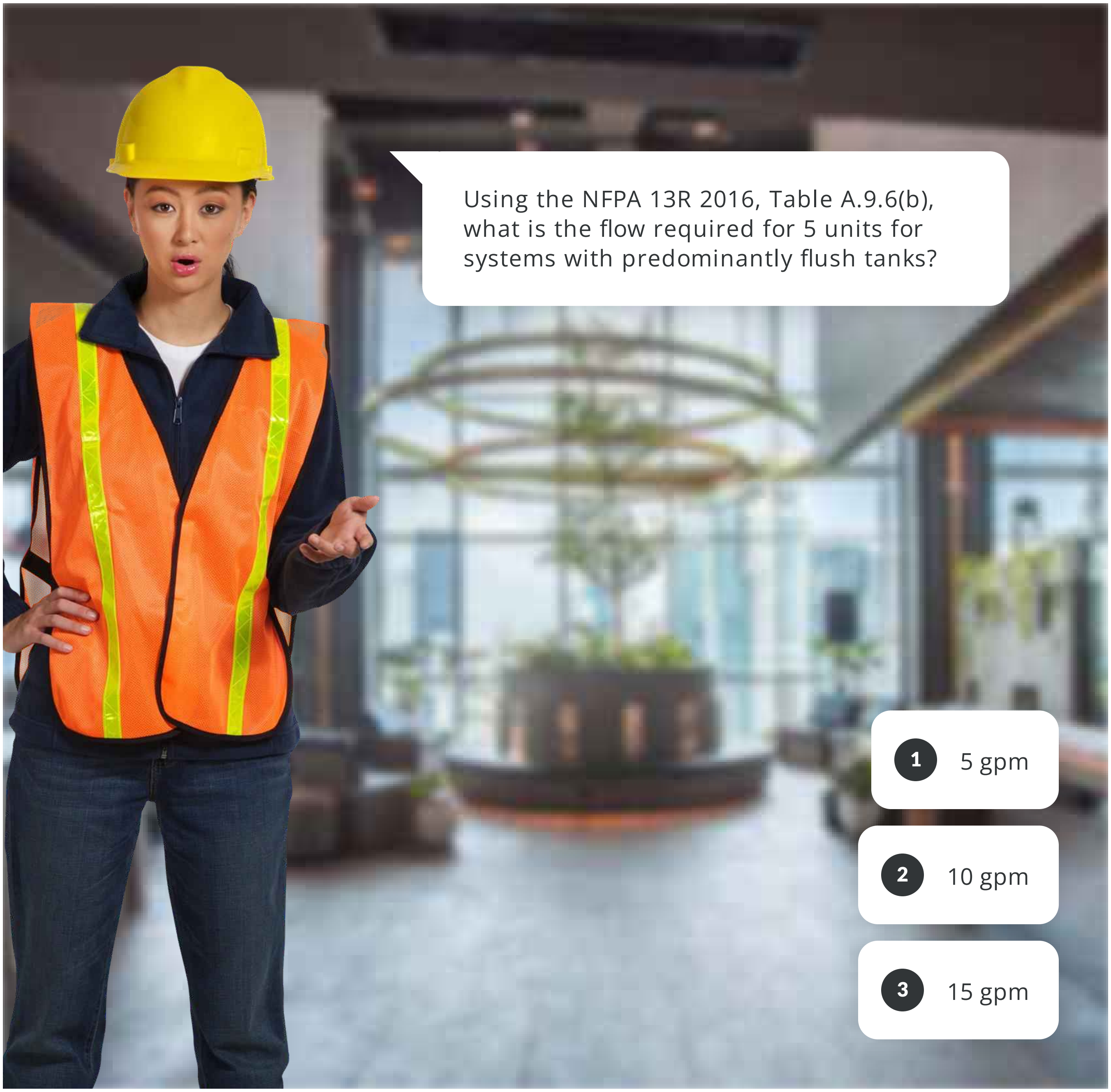
1
Dishwasher = 1 unit
Kitchen sink = 2 units
Washing machine = 2 units
Total fixture load units = 5 units

2
Dishwasher = 3 unit
Kitchen sink = 1 units
Washing machine = 1 units
Total fixture load units = 5 units

3
Dishwasher = 2 units
Kitchen sink = 1 unit
Washing machine = 3 units
Total fixture load units = 6 units

Scene 1 Slide 2

0 → Next Slide
1 → Next Slide
2 → Next Slide



Using the NFPA 13R 2016, Table A.9.6(b), what is the flow required for 5 units for systems with predominantly flush tanks?

1 5 gpm

2 10 gpm

3 15 gpm

Scene 1 Slide 3

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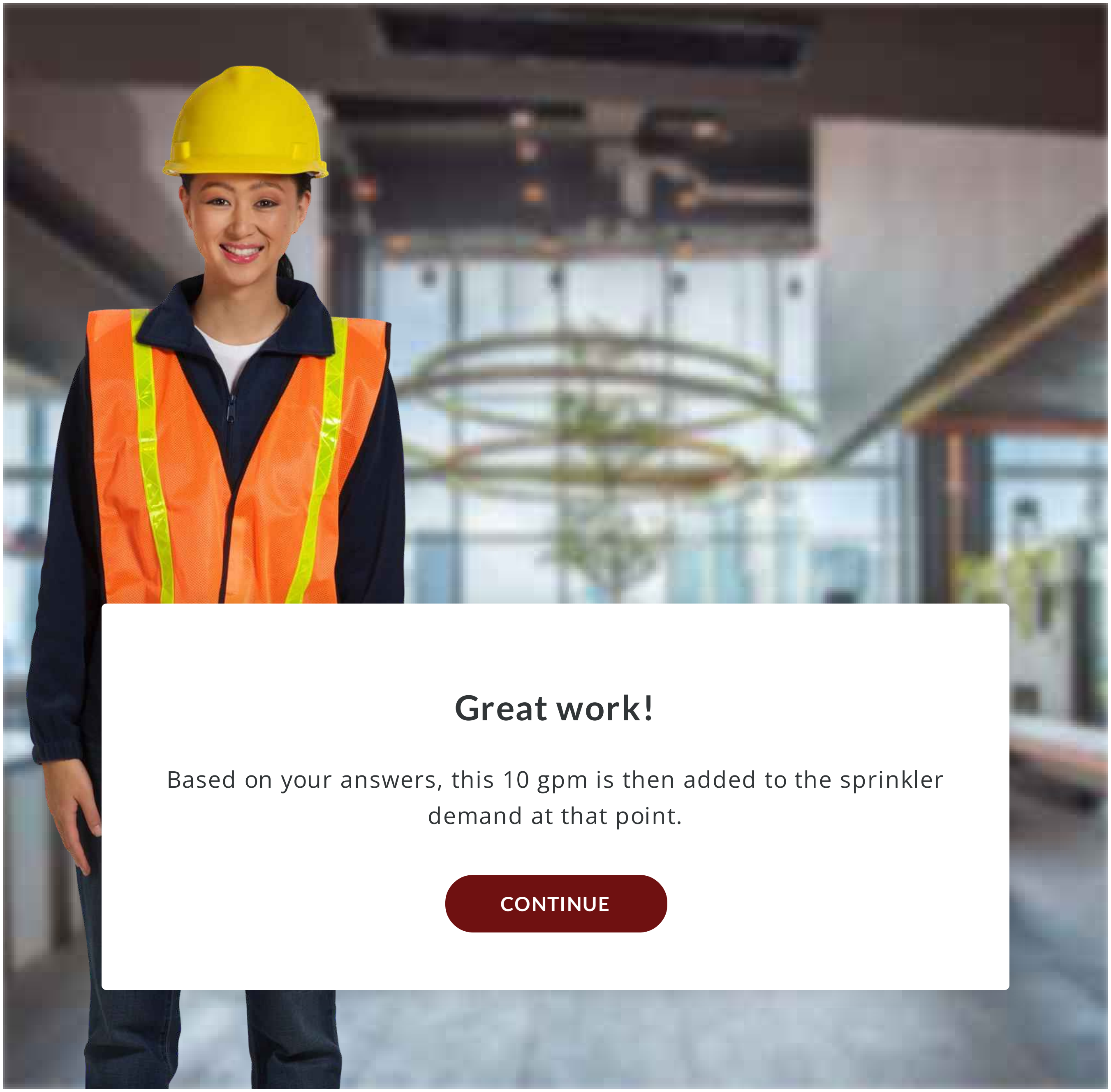
1 → Next Slide

2 → Next Slide



Great work!

Based on your answers, this 10 gpm is then added to the sprinkler demand at that point.

Scene 1 Slide 4

Continue → Next Slide

For a private dwelling unit with two bathrooms, what are the units assigned to each bathroom group?

1. Bathroom = 4 units
   4 units x 2 bathrooms = 8 units
2. Bathroom group with flush tank = 6 units
   6 units x 2 bathrooms = 12 units
3. Bathtub group with flush valve = 8 units
   6 units x 2 bathrooms = 16 units

Scene 1 Slide 5

0 → Next Slide
1 → Next Slide
2 → Next Slide

Based on the total fixture load units, what is the total flow allowance for the dwelling design? Refer to NFPA 13R 2016, Table A.9.6(b).

1 Since the total fixture load units is between 10 and 20, the total flow allowance is between 15 and 20 gpm for this design.

2 Since the total fixture load units is between 10 and 20, the total flow allowance is between 25 and 35 gpm for this design.

3 Since the total fixture load units is greater than 10, the total flow allowance is between 15 and 25 gpm for this design.

Scene 1 Slide 6

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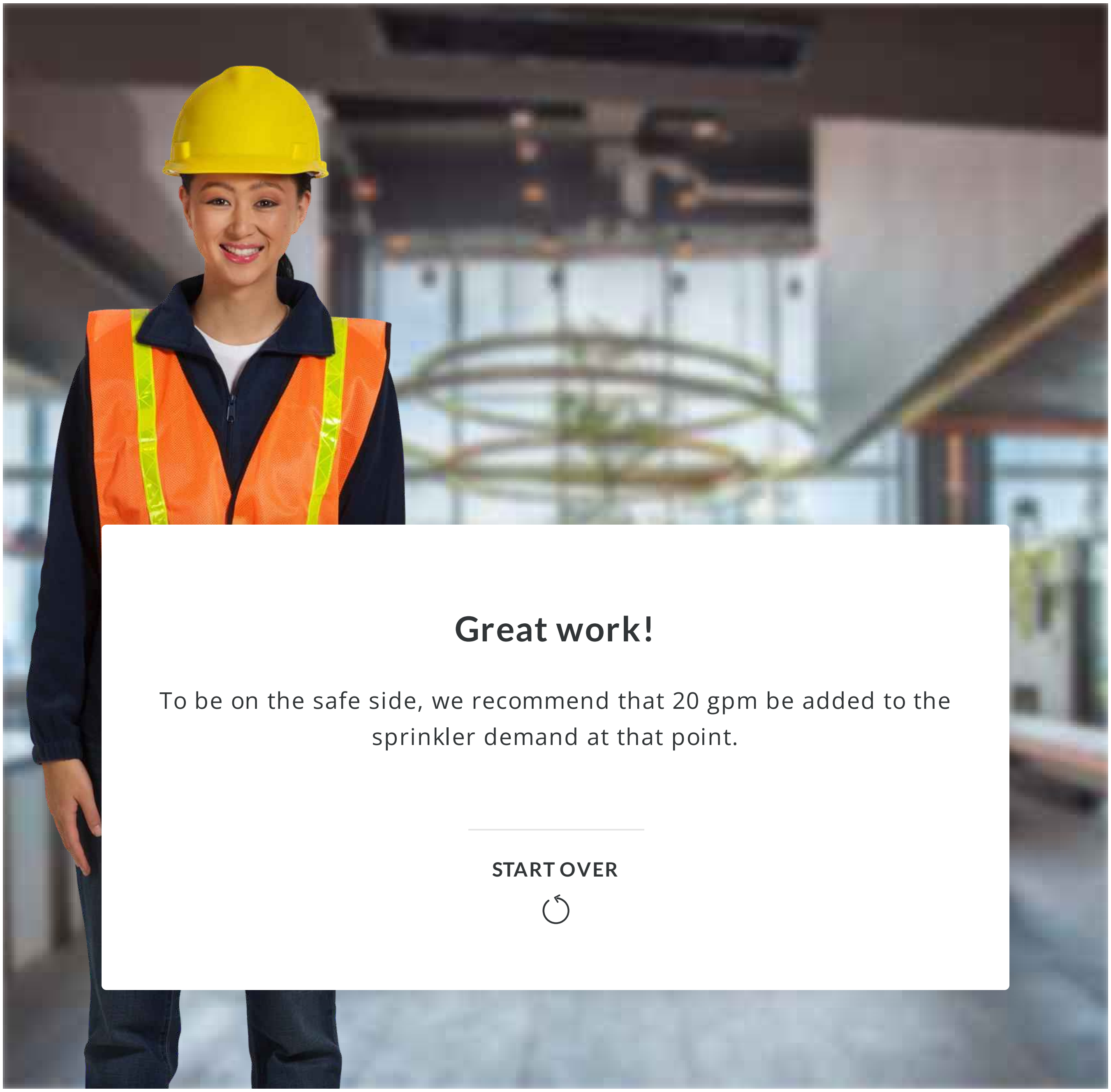
1 → Next Slide
2 → Next Slide



Great work!

To be on the safe side, we recommend that 20 gpm be added to the sprinkler demand at that point.

Scene 1 Slide 7

Continue → End of Scenario

Complete the scenario above before moving on.

System Acceptance

Chapter 10 contains the acceptance test requirements for *NFPA* 13R sprinkler systems. The purpose of these tests is to **make sure the system has been installed correctly, all piping has been joined properly, and the system components can withstand the pressures to which they might be exposed**. Many of the requirements are the same as those for systems in compliance with *NFPA* 13.

NFPA 13R 2016, Section 10.1

The Contractor’s Material Test Certificate is required to be completed and sent to the Authority Having Jurisdiction (AHJ) prior to having the system approved.

If the AHJ is required to be present during acceptance tests, then advance notification of the time and date are required to be provided prior to the testing.

The certificate is shown in Figure 10.1.2. Take the time to review what is contained in the entire certificate.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Each sprinkler system is required to have at least one automatic water supply, supplying the system demand for a minimum of ____ minutes.

Type your answer here

SUBMIT

The Contractor's Material Test Certificate is required to be completed and sent to the ____ prior to having the system approved.

Type your answer here

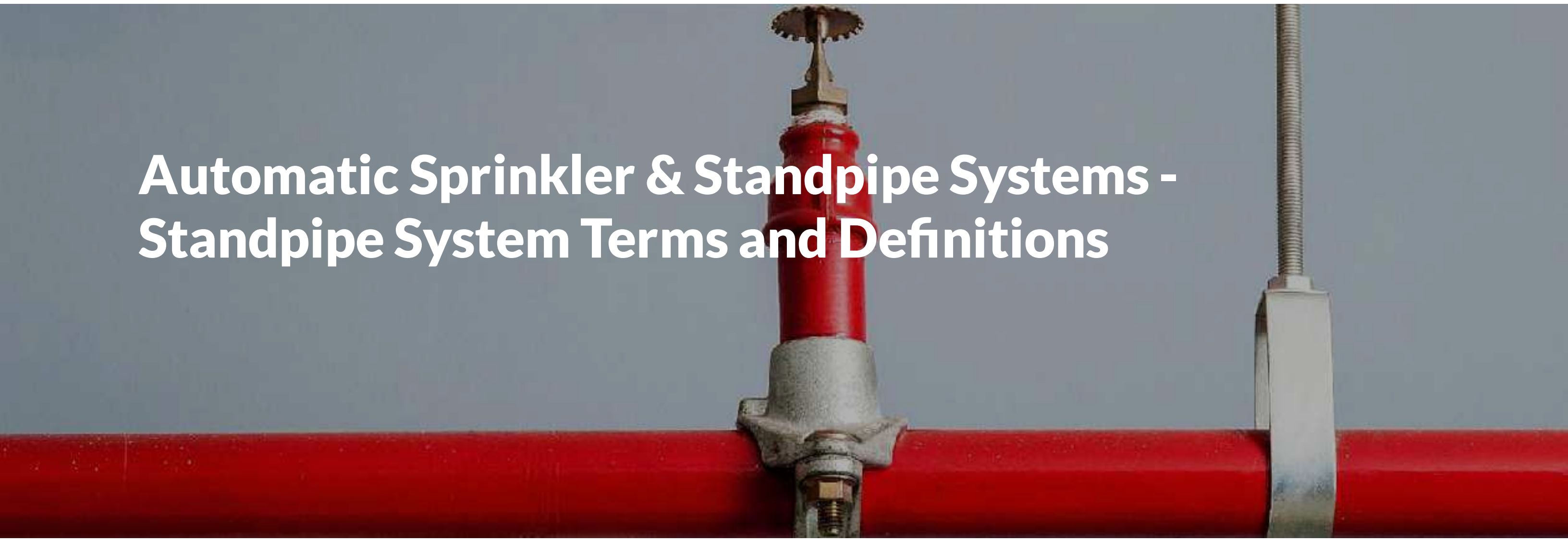
SUBMIT

Complete the knowledge checks above before moving on.

After completing this module, you should now have a better understanding of the requirements outlined in *NFPA* 13R.

Click on the “Next” arrow up on the right-hand corner of the screen to continue to the quiz.

Automatic Sprinkler & Standpipe Systems - Standpipe System Terms and Definitions



By the end of this module, you will be able to do the following:

- Explain the purpose of a standpipe system.
- Compare the different types of standpipe systems and how they operate.
- Identify different classifications of and valves for standpipe systems.

Key References:

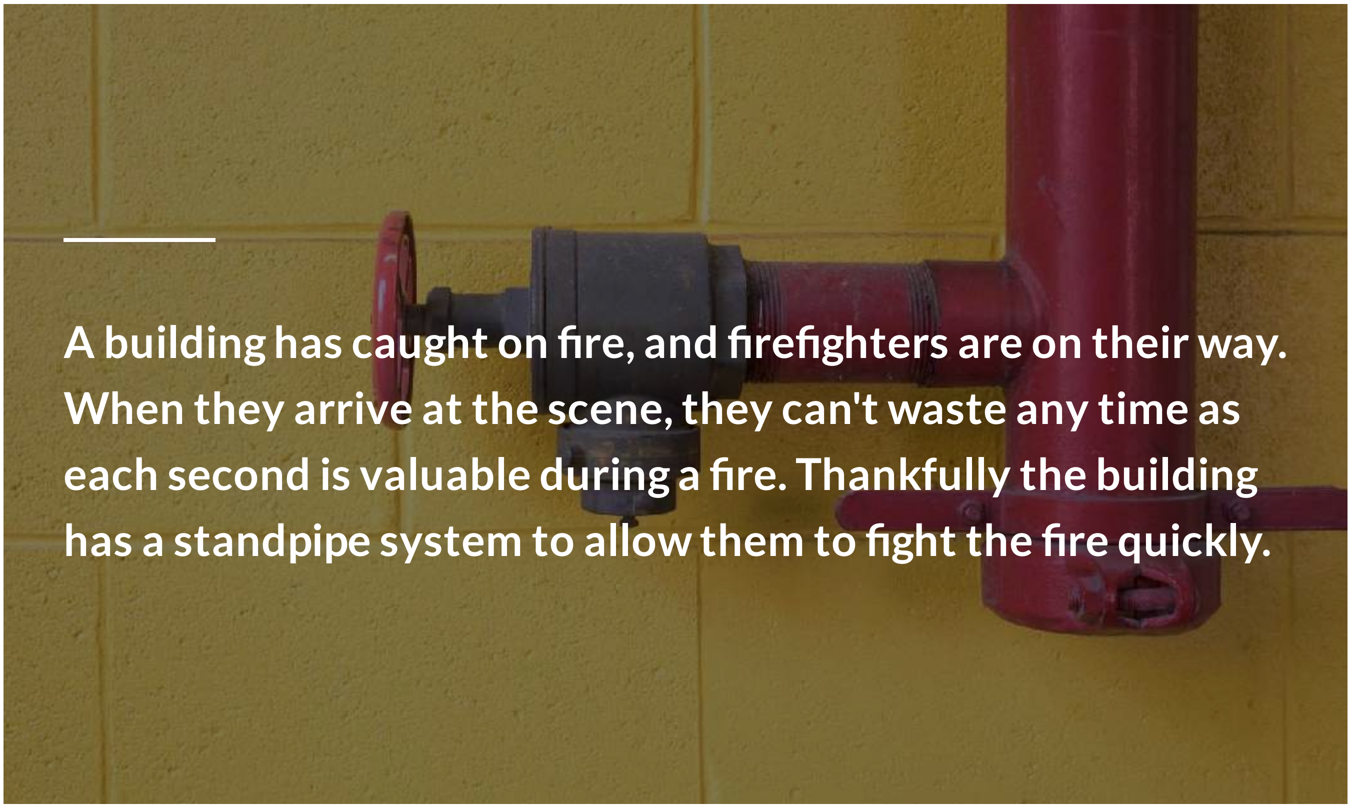
- *NFPA* 14 - *Standard for the Installation of Standpipe and Hose Systems*, 2016

When you are ready to begin, click on the button above to start the course.

Standpipe Terms and Definitions

Lesson 1 of 1

Standpipe Terms and Definitions



A building has caught on fire, and firefighters are on their way. When they arrive at the scene, they can't waste any time as each second is valuable during a fire. Thankfully the building has a standpipe system to allow them to fight the fire quickly.

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Explain the purpose of a standpipe system.

☐ Compare the different types of standpipe systems and how they operate.

☐ Identify different classifications of and valves for standpipe systems.

Key References

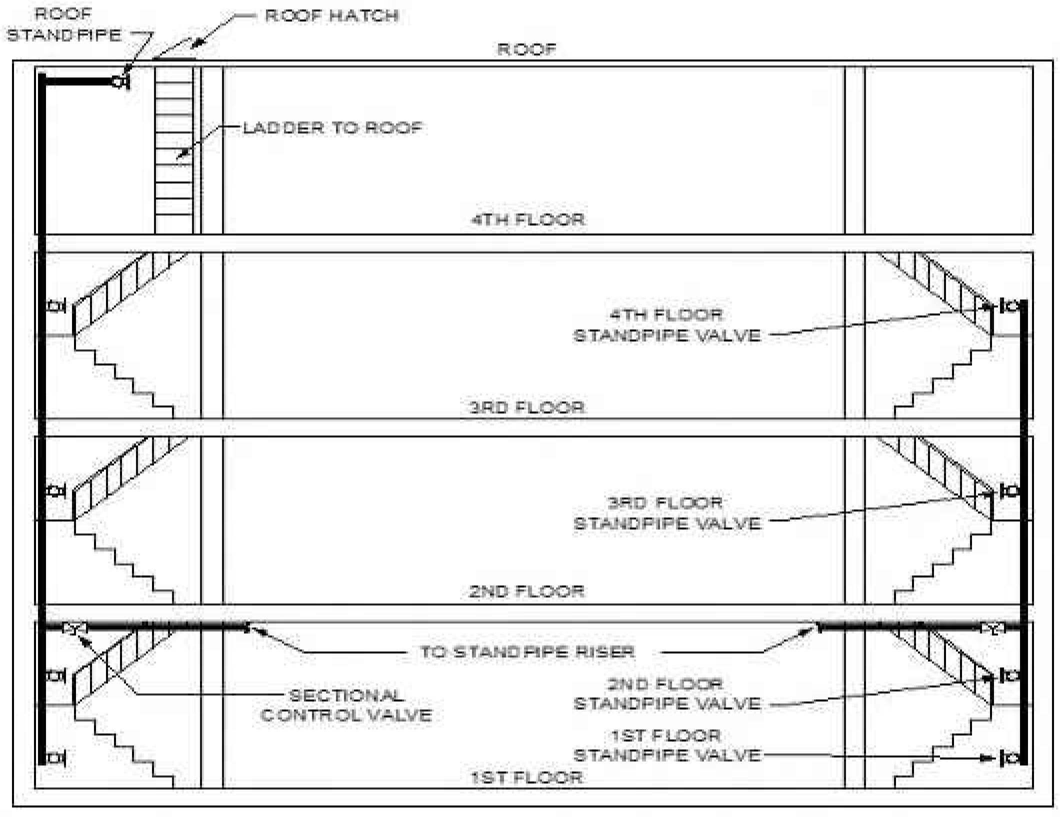
- *NFPA* 14 - *Standard for the Installation of Standpipe and Hose Systems*, 2016

LET'S BEGIN

Standpipe System

NFPA 14 2016, Section 3.3.17

What is a standpipe system? A standpipe system is a fire hydrant system inside a building. More specifically, this section defines a standpipe system as an arrangement of piping, valves, hose connections, and associated equipment installed in a building or structure, with the hose connections located in such a manner that water can be discharged in streams or spray patterns through attached hose and nozzles, for the purpose of extinguishing a fire, thereby protecting a building or structure and its contents in addition to protecting the occupants.



Click on the image to enlarge.

The **purpose** of a standpipe system is to allow firefighters to **connect a hose to a water source** and manually **fight a fire without having to run the hose all the way from the street** into the building, and up through the building to get to the fire.

CONTINUE

NFPA 14 2016, Section 3.3.16

The **standpipe** itself is the system piping that delivers the water supply for hose connections, and for sprinklers on combined systems, vertically from floor to floor.

A **horizontal standpipe** is the horizontal portion of the system piping that delivers the water supply for two or more hose connections, and sprinklers on combined systems, on a single level.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

What is the purpose of a standpipe system? (Check all that apply)

☐ Allows firefighters to run the hose all the way from the street into the building

☐ Allows firefighters to connect a hose to a water source

☐ Allows for a closer connection to the water source from the fire

☐ Automatically stops the fire

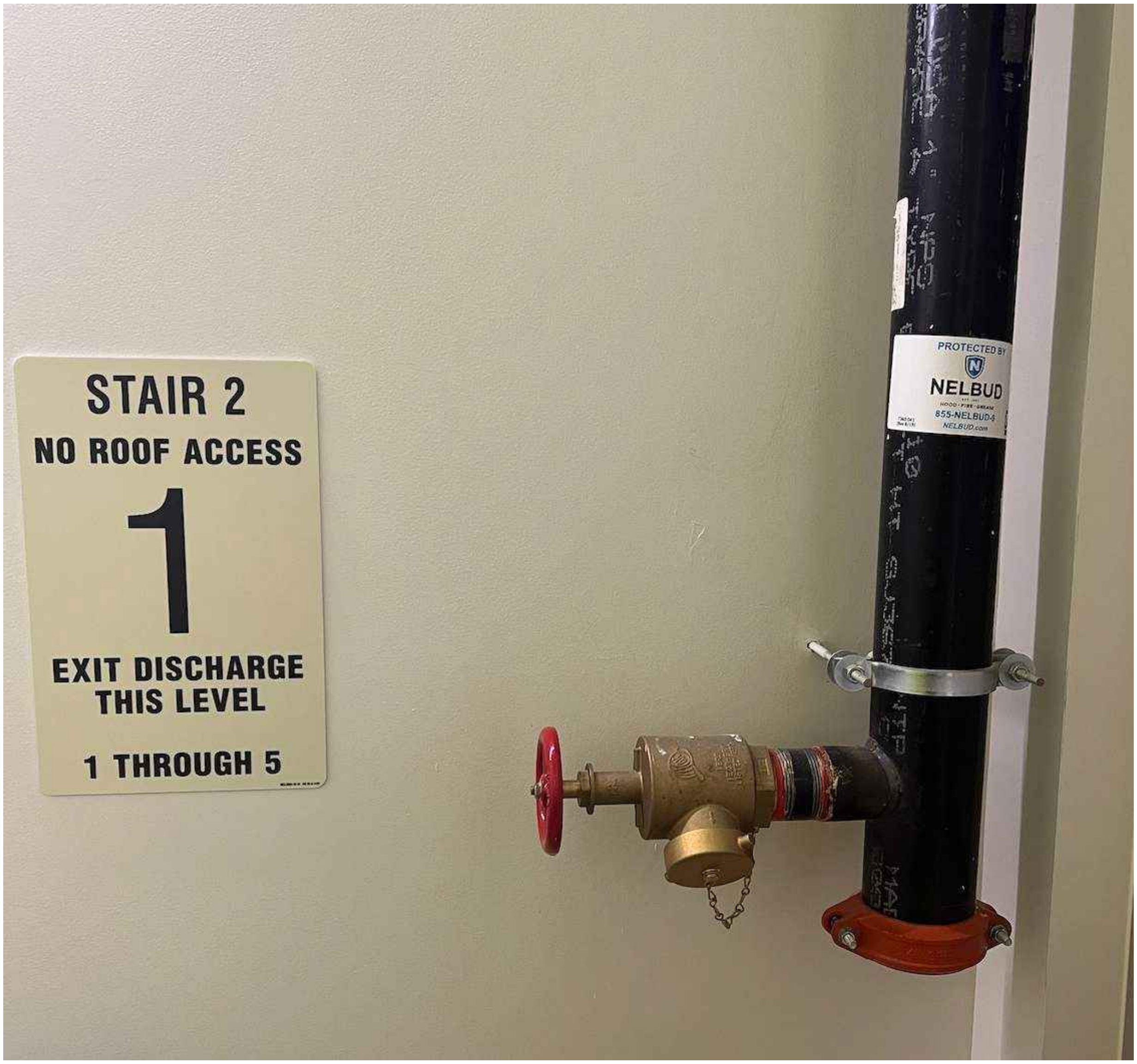
SUBMIT

Complete the knowledge check above before moving on.

Types of Standpipe Systems

NFPA 14 2016, Section 3.3.17

This section defines the following standpipe systems used in fire protection.



Automatic Wet

A standpipe system with **water under pressure available at the hose valve**. When the hose valve is opened, water **immediately** flows to the hose nozzle at the correct flow and pressure necessary to make the hose useful in fighting the fire.

Automatic wet standpipe systems are **very similar to wet pipe sprinkler systems** in how they operate.

CONTINUE

Automatic Dry

A standpipe system with **air under pressure in the pipes** is connected to a dry pipe valve that holds back the water. When a hose valve is opened, the **pressure drops**, allowing the dry pipe valve to open and deliver water to the hose connection.

Automatic dry standpipe systems are **very similar to dry pipe sprinkler systems** in how they operate.

CONTINUE

Semiautomatic Dry

A standpipe system with air under **minimal pressure in the pipe connected to a preaction or deluge valve** that holds the water back. When a hose valve is opened, the loss of air pressure will not send water to the hose valve. The firefighter **must push a button or activate a pull station** in order to get water to flow.

The electronic signal back to the preaction or deluge valve will trip that valve and start the flow of water.

A semiautomatic valve is **similar to a preaction sprinkler system** in how it operates.

CONTINUE

Manual Dry

A standpipe system with **no water** in the system piping. The system will not have any water in it until the **fire department arrives and pumps water into the fire department connection (FDC)**.

Manual dry systems are a **maintenance concern** because there is no way to monitor the integrity of the piping. Air pressure and water pressure are not kept in the system.

A manual dry standpipe system is basically an **empty piece of pipe**. There are **no similar sprinkler systems** to compare to it.

CONTINUE

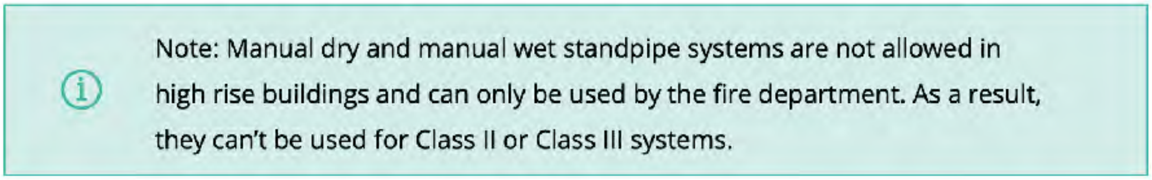
Working side of fire department pumper truck

Manual Wet

A standpipe system with a **water supply under pressure** but with **insufficient flow or pressure** to put multiple large hose streams in service until the fire department arrives with the **pumper truck**.

Once the fire department **pumps into the FDC** with their equipment, the pipe is sized to accommodate their needs and provides the demand flow and pressure.
Manual wet standpipe systems are **common in fully sprinklered buildings**. The water supply is sized to automatically meet the demand of the fire sprinkler system, which also uses the standpipe risers as sprinkler system risers.

However, the water supply does not need to meet the demand of the standpipe system automatically, saving the building owner from a pump in many cases.



ⓘ Note: Manual dry and manual wet standpipe systems are not allowed in high rise buildings and can only be used by the fire department. As a result, they can't be used for Class II or Class III systems.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Match the standpipe system to the correct definition.

Automatic wet	When the hose valve is opened, water immediately flows to the hose nozzle
Automatic dry	Has air under pressure in the pipes connected to a dry pipe valve that holds back water
Semiautomatic dry	The firefighter must push a button or activate a pull-station in order to get water flow
Manual dry	Are a maintenance concern because there is no way to monitor the integrity of the piping
Manual wet	Are common in fully sprinklered buildings.

SUBMIT

Complete the knowledge check above before moving on.

Standpipe Definitions

NFPA 14 2016, Chapter 3

As with other *NFPA* standards, the Definitions section is always a very important part of the standard to review. *NFPA* 14 defines the following key terms:

Branch line —

A piping system, generally in a horizontal plane, connecting not more than one hose connection with a standpipe. (*NFPA* 14 2016, Section 3.3.2)

Exit passageway —

Hallways, corridors, passages, or tunnels used as exit components and separated from other parts of the building in accordance with *NFPA* 101 - Life Safety Code. (*NFPA* 14 2016, Section 3.3.5.1)

Feed main —

The portion of a standpipe system that supplies water to one or more standpipes. (*NFPA* 14 2016, Section 3.3.9)

Fire department connection —

A connection through which the fire department can pump the secondary water supply to an automatic standpipe system at the required system demand. Supplemental water can also be provided into the sprinkler system or other system furnishing water for fire extinguishment to supplement existing water supplies. (*NFPA* 14 2016, Section 3.3.3)

Fire department connection for manual standpipe systems

A connection through which the fire department can pump the primary water supply to a manual standpipe system at the required system demand. (*NFPA* 14 2016, Section 3.3.3)

High-rise building

A building where the floor of an occupiable story is greater than 75 ft. above the lowest level of fire department vehicle access. (*NFPA* 14 2016, Section 3.3.7)

Horizontal exit

A way of passage from one building to an area of refuge in another building on approximately the same level, or a way of passage through or around a fire barrier to an area of refuge on approximately the same level in the same building that affords safety from fire and smoke originating from the area of incidence and areas communicating therewith. (*NFPA* 14 2016, Section 3.3.5.2)

Hose connection

A combination of equipment provided for connection of a hose to the standpipe system that includes a hose valve with a threaded outlet. (*NFPA* 14 2016, Section 3.3.3.2)

Hose station

A combination of a hose rack or reel, hose nozzle, hose, and hose connection. (*NFPA* 14 2016, Section 3.3.8)

Nozzle pressure

Pressure required at the inlet of a nozzle to produce the desired water discharge characteristics. (*NFPA* 14 2016, Section 3.3.11.1)

Pressure-regulating device

A device designed for the purpose of reducing, regulating, controlling, or restricting water pressure. (*NFPA* 14 2016, Section 3.3.13)

Pressure-restricting device

A valve or device designed for the purpose of reducing the downstream water pressure under flowing (residual) conditions only. (*NFPA* 14 2016, Section 3.3.13.2)

Rated capacity

The flow available from a device, at the designated residual pressure, either measured or calculated. (*NFPA* 14 2016, Section 3.3.14)

Residual pressure

For standpipe systems, pressure acting on a point in the system with a flow being delivered. (*NFPA* 14 2016, Section 3.3.11.2)

Standpipe system zone

A vertical subdivision of a standpipe system limited or determined by the pressure limitations of the system components. (*NFPA* 14 2016, Section 3.3.18)

Static pressure

For standpipe systems, pressure acting on a point in the system with no flow from the system. (*NFPA* 14 2016, Section 3.3.11.3)

System demand

The flow rate and residual pressure required from a water supply, measured at the point of connection of a water supply to a standpipe system, to deliver the total waterflow rate and the minimum residual pressures required for a standpipe system at the hydraulically most remote hose connection, and the minimum waterflow rate and residual pressure for sprinkler connections on combined systems. (*NFPA* 14 2016, Section 3.3.20)

LET'S REVIEW

Let's do a quick check about what has been covered so far.

A(n) ____ is designed for the purpose of reducing the downstream water pressure under flowing (residual) conditions only.

○ Exit passageway

○ Residual pressure

○ Pressure-regulating device

○ Pressure-restricting device

SUBMIT

Complete the knowledge check above before moving on.

Standpipe System Classes

NFPA 14 2016, Section 3.3.19

This section outlines the four classes of standpipe systems.

Class I

A system that provides **2 ½ in.** **hose connections** to supply water for use by fire departments.

Class II

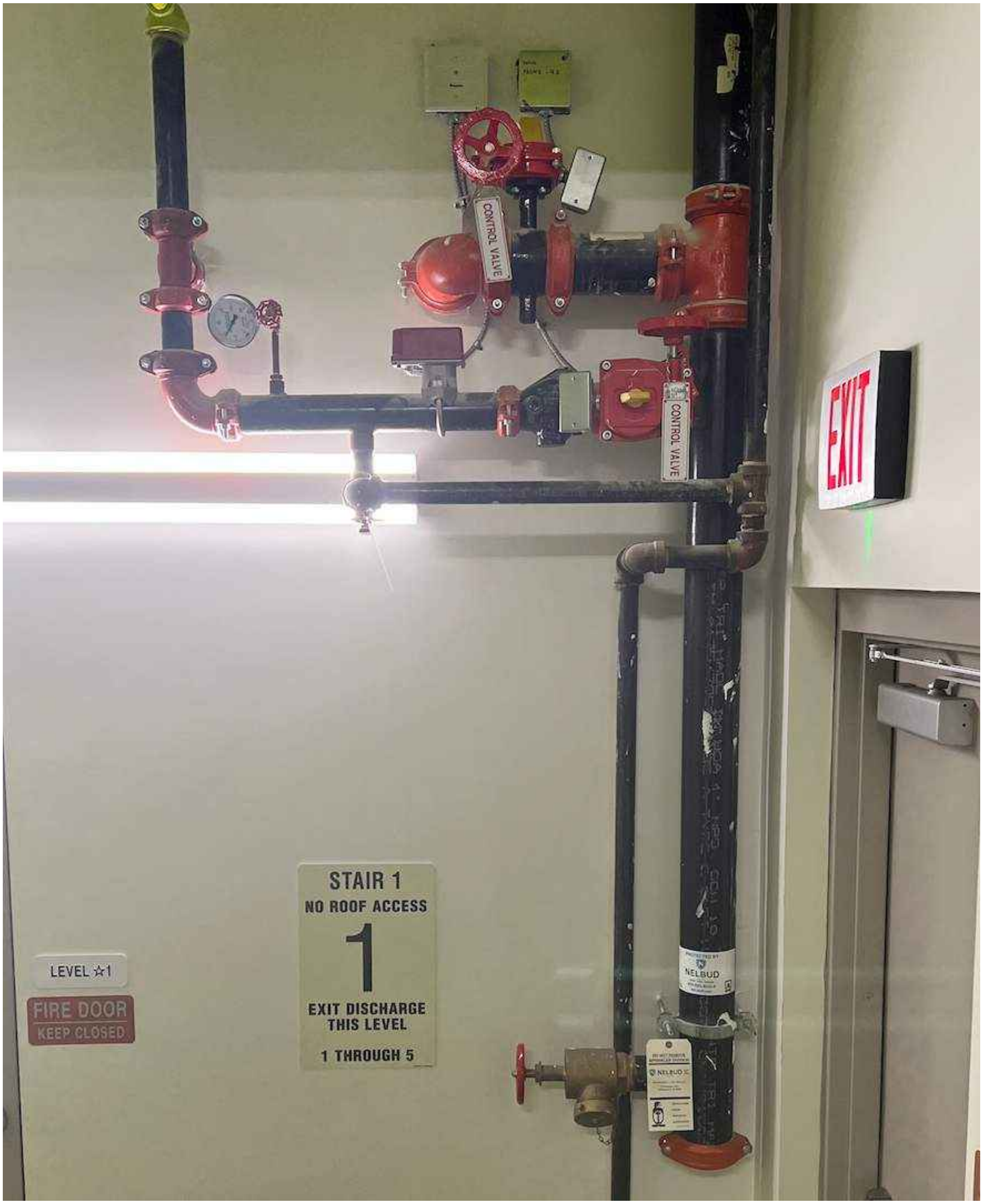
A system that provides **1 ½ in. hose stations** to supply water for use **primarily** by trained personnel or by the fire department during initial response.

Class III

A system that provides **1 ½ in. hose stations** to supply water for use by trained personnel and **2 ½ in. hose connections** to supply a larger volume of water for use by fire departments.

Combined System

A standpipe system having piping that supplies **both hose connections and automatic sprinklers**.



Refer to *NFPA* 14 2016, Figure A.6.3.5(a), Acceptable Piping Arrangement for Combined Sprinkler/Standpipe System

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Match the standpipe system classification to its corresponding definition.

SUBMIT

Complete the knowledge check above before moving on.

Standpipe Valves

NFPA 14 2016, Sections 3.3.12, 3.3.13, and 3.3.23

The following are types of valves used in standpipe systems.

PRESSURE CONTROL VALVE | PRESSURE-REDUCING VALVE | CONTROL VALVE | HOSE VALVE

A pilot-operated pressure-reducing valve designed for the purpose of reducing the downstream water pressure to a specific value under both flowing (residual) and nonflowing (static) conditions. (*NFPA* 14 2016, Section 3.3.12)

PRESSURE CONTROL VALVE | **PRESSURE-REDUCING VALVE** | CONTROL VALVE | HOSE VALVE

A valve designed for the purpose of reducing the downstream water pressure under both flowing (residual) and nonflowing (static) conditions. (*NFPA* 14 2016, Section 3.3.13.1)

PRESSURE CONTROL VALVE | PRESSURE-REDUCING VALVE | **CONTROL VALVE** | HOSE VALVE

A valve controlling flow to water-based fire protection systems. Control valves do **not** include hose valves, inspector's test valves, drain valves, trim valves for dry pipe, preaction and deluge valves, check valves, or relief valves. (*NFPA* 14 2016, Section 3.3.23.1)

PRESSURE CONTROL VALVE | PRESSURE-REDUCING VALVE | CONTROL VALVE | **HOSE VALVE**

The valve to an individual hose connection. (NFPA 14 2016, Section 3.3.23.2)

CONTINUE

After completing this module, you should now have a better understanding key terms for standpipe systems.

Click on the “Next” arrow up on the right-hand corner of the screen to continue to the quiz

Automatic Sprinkler & Standpipe Systems - Standpipe System Components

By the end of this module, you will be able to do the following:

- Explore the necessary components for standpipe systems.
- Compare the system requirements for automatic and semiautomatic dry systems and the three classes of standpipe systems.

Key References:

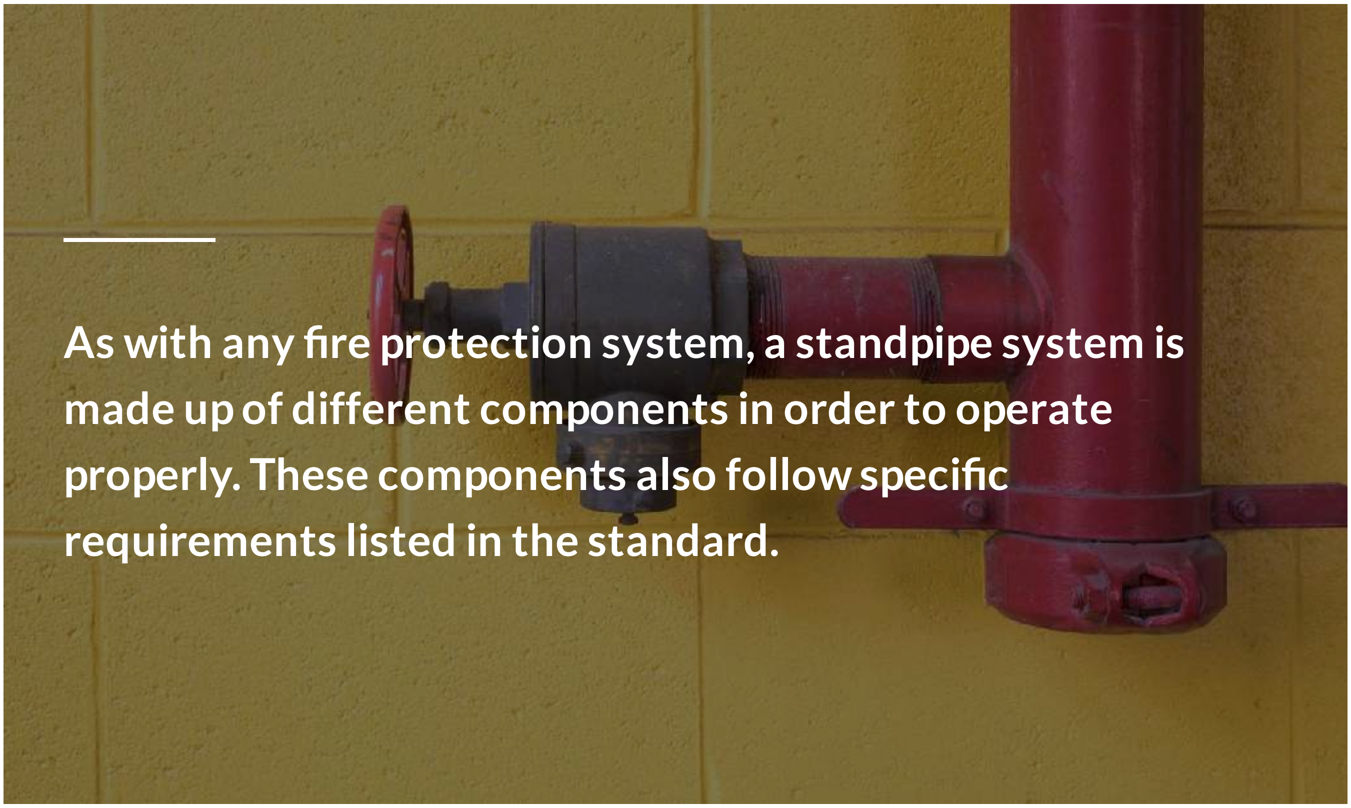
- *NFPA* 14 - *Standard for the Installation of Standpipe and Hose Systems*, 2016

When you are ready to begin, click on the button above to start the course.

Standpipe Components

Lesson 1 of 1

Standpipe Components



As with any fire protection system, a standpipe system is made up of different components in order to operate properly. These components also follow specific requirements listed in the standard.

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Explore the necessary components for standpipe systems.

☐ Compare the system requirements for automatic and semiautomatic dry systems and the three classes of standpipe systems.

Key References

- *NFPA* 14 - *Standard for the Installation of Standpipe and Hose Systems*, 2016

LET'S BEGIN

System Components

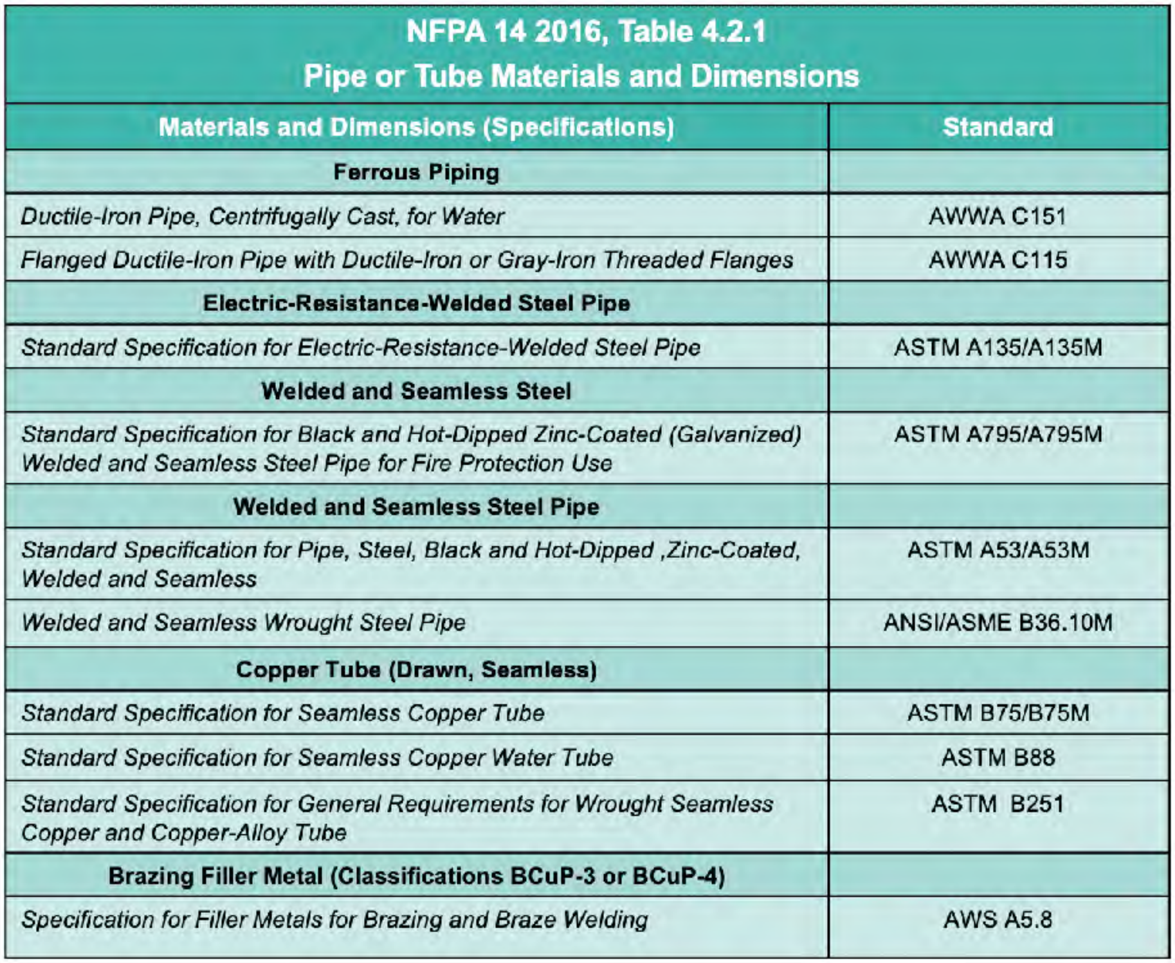
NFPA 14 2016, Chapter 4

Chapter 4 contains the specifications for the pipe, tubing, and fittings that must be used in standpipe systems.

The following tables show the specifications and are from *NFPA* 14.

CONTINUE

Table 4.2.1 lists the corresponding standards for different pipe and tube materials and dimensions.

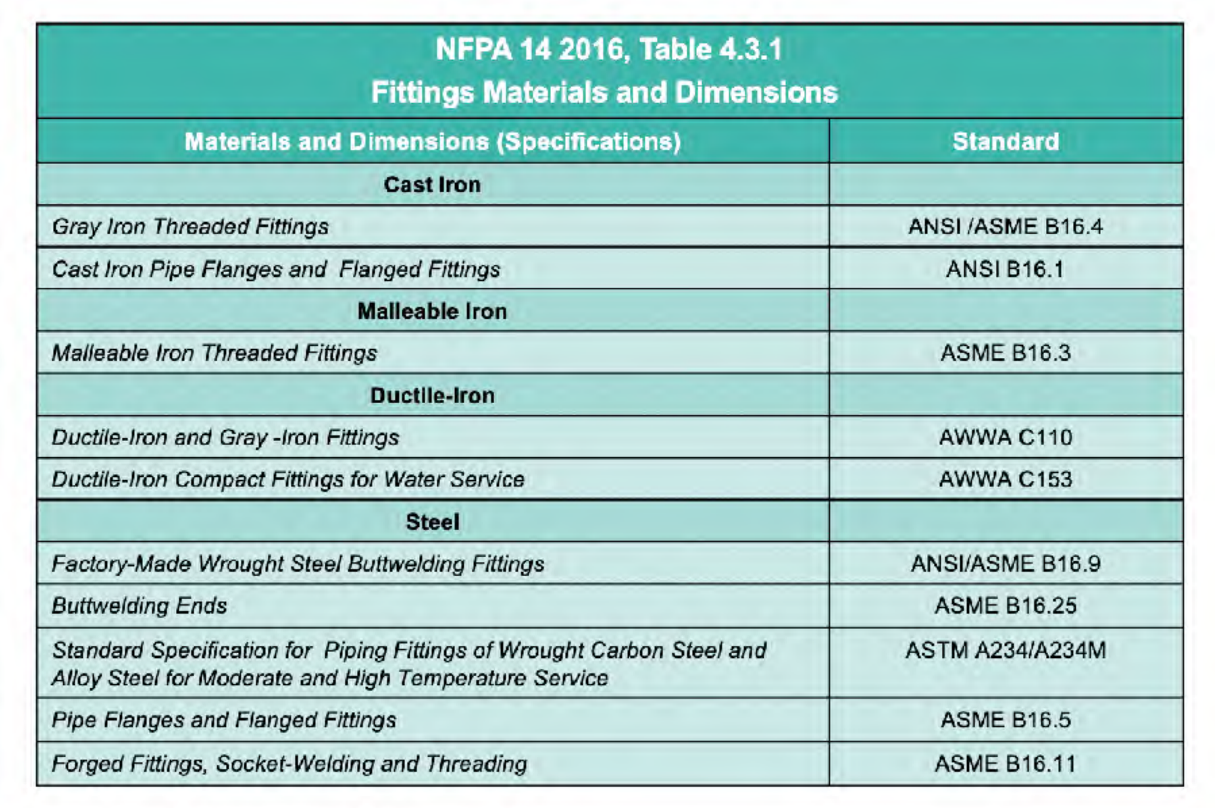


NFPA 14 2016, Table 4.2.1
Pipe or Tube Materials and Dimensions

Materials and Dimensions (Specifications)	Standard
Ferrous Piping	
Ductile-Iron Pipe, Centrifugally Cast, for Water	AWWA C151
Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges	AWWA C115
Electric-Resistance-Welded Steel Pipe	
Standard Specification for Electric-Resistance-Welded Steel Pipe	ASTM A135/A135M
Welded and Seamless Steel	
Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use	ASTM A795/A795M
Welded and Seamless Steel Pipe	
Standard Specification for Pipe, Steel, Black and Hot-Dipped ,Zinc-Coated, Welded and Seamless	ASTM A53/A53M
Welded and Seamless Wrought Steel Pipe	ANSI/ASME B36.10M
Copper Tube (Drawn, Seamless)	
Standard Specification for Seamless Copper Tube	ASTM B75/B75M
Standard Specification for Seamless Copper Water Tube	ASTM B88
Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube	ASTM B251
Brazing Filler Metal (Classifications BCuP-3 or BCuP-4)	
Specification for Filler Metals for Brazing and Braze Welding	AWS A5.8

CONTINUE

Table 4.3.1 lists the corresponding standards for different fittings materials and dimensions.



NFPA 14 2016, Table 4.3.1
Fittings Materials and Dimensions

Materials and Dimensions (Specifications)	Standard
Cast Iron	
Gray Iron Threaded Fittings	ANSI /ASME B16.4
Cast Iron Pipe Flanges and Flanged Fittings	ANSI B16.1
Malleable Iron	
Malleable Iron Threaded Fittings	ASME B16.3
Ductile-Iron	
Ductile-Iron and Gray -Iron Fittings	AWWA C110
Ductile-Iron Compact Fittings for Water Service	AWWA C153
Steel	
Factory-Made Wrought Steel Buttwelding Fittings	ANSI/ASME B16.9
Buttwelding Ends	ASME B16.25
Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service	ASTM A234/A234M
Pipe Flanges and Flanged Fittings	ASME B16.5
Forged Fittings, Socket-Welding and Threading	ASME B16.11

Click on the image to enlarge.

PIPING NETWORK

Piping Network

Chapter 4 gets into some significant detail regarding other requirements for the piping network.

In the case of standpipe systems, all material must be listed, unless it does not affect system performance, such as drain piping and valves.

CONTINUE

NFPA 14 2016, Section 4.2.7

Bending of Pipe and Tube

Schedule 40 steel pipe and Types K and L copper tube are **permitted to be bent**, as long as the bends are made with **none of the following**:

- Kinks
- Ripples
- Distortions
- Reductions in diameter
- Any noticeable deviations from a round shape

The **minimum radius** of a bend is six pipe diameters for pipe 2 in. and smaller, and five pipe diameters for pipe 2 ½ in. and larger.

CONTINUE

NFPA 14 2016, Section 4.4.2.2

Fabrication

The standard requires standpipe piping to be **shop-welded**. If welding in place is required per the design specifications, then the requirements in *NFPA* 51B are to be followed.

Welding is **not permitted** under adverse weather conditions, such as rain, snow, sleet, or high winds.

Torch cutting and welding are **not permitted** when modifying or repairing a standpipe system.

Welds between pipe and welding outlet fittings are permitted to be attached by full penetration, welds, partial penetration groove welds, or fillet welds. (*NFPA* 14 2016, Section 4.4.2.4)

LET'S REVIEW

Let's do a quick check about what has been covered so far.

When bending pipe, the minimum radius of a bend is ___ pipe diameters for pipe 2 in. and smaller, and __ pipe diameters for pipe 2 ½ in. and larger.

○ 4; 5

○ 5; 4

○ 5; 6

○ 6; 5

SUBMIT

🔒 Complete the knowledge check above before moving on.

NFPA 14 2016, Section 4.4.3

Groove Joining Methods

Pipe, fittings, valves, and devices to be joined with grooved couplings are required to contain **cut, roller, or cast grooves** that are compatible with the couplings.

CONTINUE

NFPA 14 2016, Section 4.4.4

Brazed Joints

Joints connecting copper tube are **required to be brazed**. Brazing fluxes, if used, **cannot be a highly corrosive type**.

CONTINUE

NFPA 14 2016, Section 4.4.5.2

Outlet Fittings

The following requirements apply to **rubber-gasketed outlet fittings** used in standpipe systems:

- Must be installed per the listing and manufacturer's installation instructions
- Must have all disks retrieved
- Must have smooth bores cut into the pipe, with all cutting residue removed
- Must not be modified

CONTINUE

NFPA 14 2016, Section 4.5

Valves

Control valves used in the systems must be listed indicating valves and must not close in less than **5 seconds**. This is to **prevent hammering and the related stresses** on the system.

CONTINUE

NFPA 14 2016, Sections 4.6 – 4.7

The chapter concludes with the requirements for hose stations, hose connections, and fire department connections (FDC). Key points include:

- All Class II and III (trained personnel) should have a **hose length of 100 ft. maximum**.
- 1- ½ in. hose should be equipped with a **listed storage rack** and those less than 1- ½ in. should have a **listed hose reel**.

ⓘ **Within the cabinet, the hose connections shall be located so that there are at least 2 inches between any part of the cabinet, other than the door and the handle of the valve when the valve is in any position ranging from fully open to fully closed. (*NFPA* 14 2016, Section 4.6.1.1)**

CONTINUE

NFPA 14 2016, Section 4.8

This section outlines the components for Fire Department Connections (FDC) for standpipe systems

First, FDCs are to be listed for a **working pressure equal to or greater than** the pressure requirements of the system demand.

In addition, FDCs shall have two 2½ in. internally threaded swivel fittings having NH connections as specified in *NFPA* 1963 unless the Authority Having Jurisdiction (AHJ) has other specifications.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Rubber-gasketed outlet fittings used in standpipe systems can be modified.

○ True

○ False

SUBMIT

Complete the knowledge check above before moving on.

System Requirements

NFPA 14 2016, Chapter 5

The System Requirements chapter provides requirements for **automatic** **and** **semiautomatic dry systems**, as well the requirements for the three classes of standpipe systems.

CONTINUE

NFPA 14 2016, Section 5.4

If you haven't already done so, be sure to review the definitions, so you understand the differences between the classes of standpipes.

Class I standpipe systems are the **large units for fire service** and other heavy fire stream trained personnel. These incorporate 2 ½ in. hose connections.

Class I standpipe systems in **high-rise buildings** are required to be automatic or semiautomatic.

Class I standpipe systems may be any of the following, in **non-high-rise buildings**:

- Automatic dry
- Automatic wet
- Semiautomatic dry
- Manual dry
- Manual wet

CONTINUE

Class II standpipe systems are smaller units that are designed primarily for building occupants using 1½ in. hose connections.

A Class III standpipe system is a combination of Classes I and II. It has both 2 ½ and 1 ½ in. hose stations for both applications.

Class II and Class III standpipe systems are required to be automatic wet systems, unless freezing is a concern and a fire brigade is trained to operate the system without fire department intervention. If this is the case, then an automatic dry or semiautomatic dry system is permitted.

Manual standpipe systems cannot be used in high-rise buildings. However, they can be used to satisfy the demand for a Class III system if the water supply provides 100 gpm at 65 psi to the most remote 1 ½ in. hose outlet. The fire department can provide the rest of the demand through the FDC.

Gauges

NFPA 14 2016, Section 5.5

An approved pressure gauge with a connection at least ¼ in. is required to be installed at the following locations:

- At each discharge pipe from the fire pump and the public waterworks
- At the pressure tank
- At each main drain connection
- At the air pump supplying the pressure tank
- At the top of each standpipe

Gauges are to be located where they will **not be subject to freezing**. If several standpipes are interconnected at the top, a single gauge can be substituted for a gauge at the top of each standpipe.

Pressure gauges are required to be installed above and below each of the following:

- Alarm check valve
- Dry pipe valve
- Deluge valve
- Backflow prevention device

- System riser check valve

LET'S REVIEW

Let's do a quick check about what has been covered so far.

In high-rise buildings, what type of Class I standpipe system(s) is/are required? (Check all that apply)

☐ Automatic

☐ Semiautomatic

☐ Manual

SUBMIT

Complete the knowledge check above before moving on.

After completing this module, you should now have a better understanding of the components of standpipe systems.

Click on the “Next” arrow up on the right-hand corner of the screen to continue to the quiz

Automatic Sprinkler & Standpipe Systems - Standpipe System Installation

By the end of this module, you will be able to do the following:

- Identify installation requirements for piping, valves, and fire department connections of standpipe systems.
- Compare and contrast design approaches for standpipe systems.
- Recognize the minimum residual pressures and minimum flow rates for given systems.

Key References:

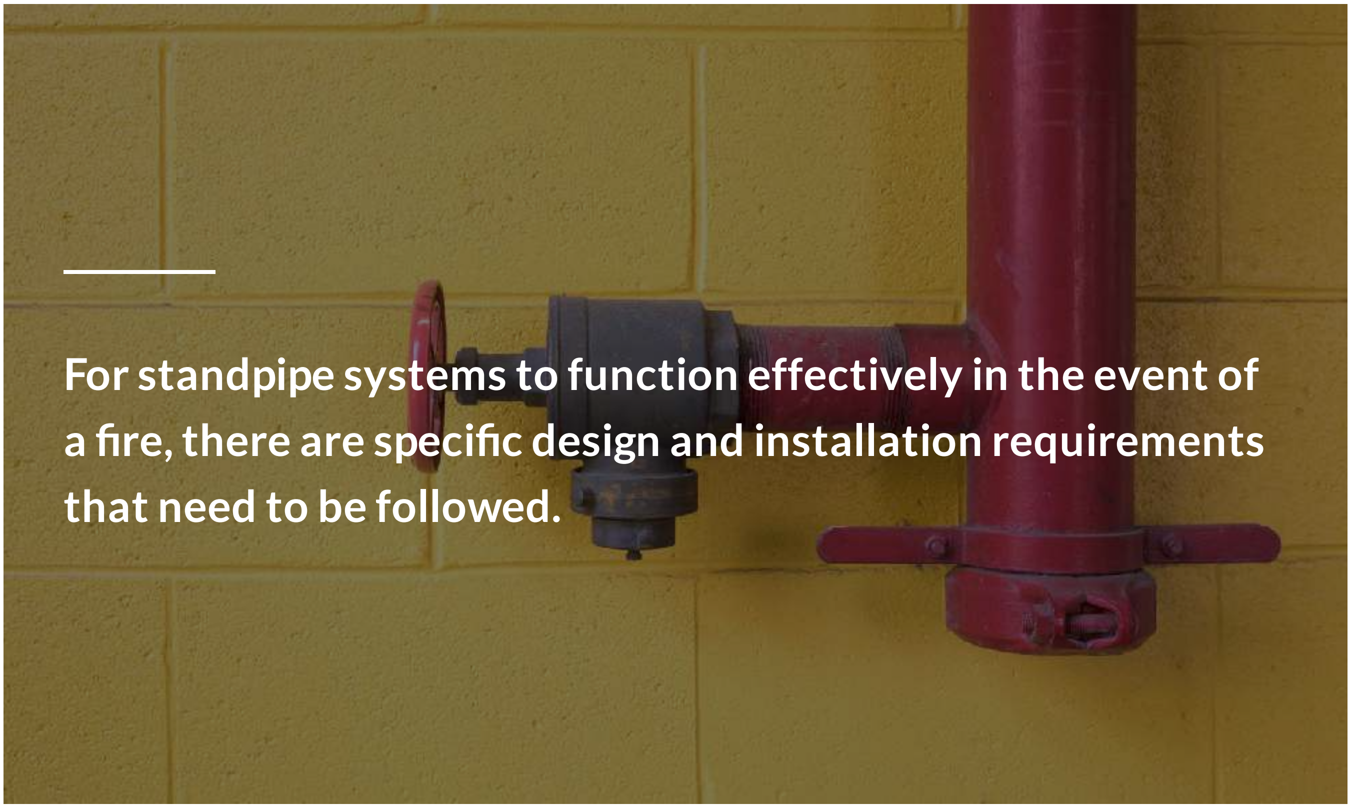
- *NFPA* 14 - *Standard for the Installation of Standpipe and Hose Systems*, 2016

When you are ready to begin, click on the button above to start the course.

Standpipe Installation and Design

Lesson 1 of 1

Standpipe Installation and Design



For standpipe systems to function effectively in the event of a fire, there are specific design and installation requirements that need to be followed.

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Identify installation requirements for piping, valves, and fire department connections of standpipe systems.

☐ Compare and contrast design approaches for standpipe systems.

☐ Recognize the minimum residual pressures and minimum flow rates for given systems.

Key References

- *NFPA* 14 - *Standard for the Installation of Standpipe and Hose Systems*, 2016

LET'S BEGIN

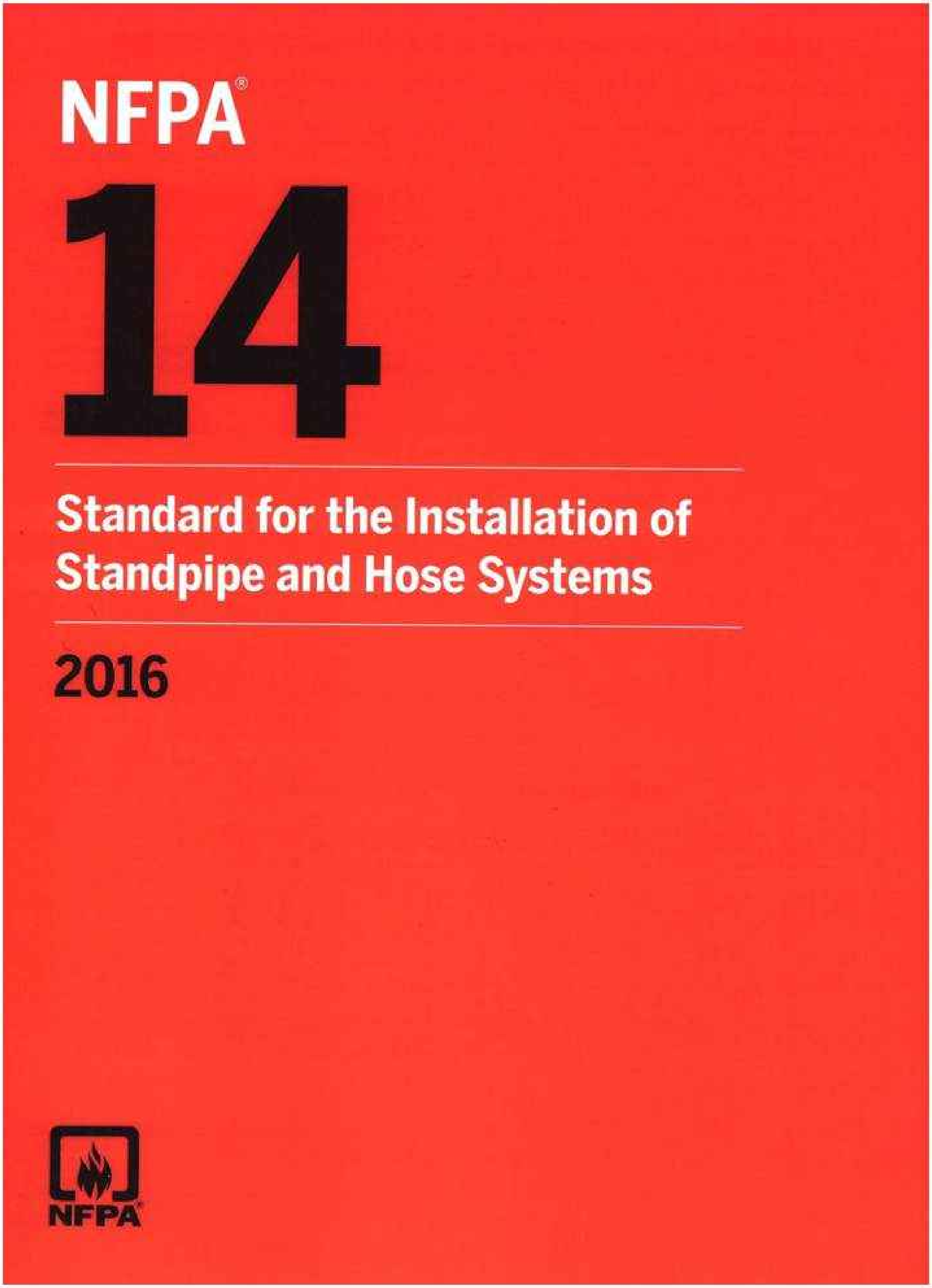
Installation Requirements

NFPA 14 2016, Chapter 6

Chapter 6 covers the various requirements for piping and valves.

Dry standpipes are required to be monitored with supervisory air pressure per *NFPA* 72.

Antifreeze solutions are not permitted to be used to prevent standpipes from freezing. However, listed **heat tracing is permitted** to be used as freeze protection for standpipes.



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14

Standard for the Installation of Standpipe and Hose Systems

2016

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Closely read Section 6.3 for valve requirements.

Note the exception for control valves and check valves on combined systems. It is required that a check valve be installed at the point of connection of the sprinkler system to the standpipe. The check valve is to be installed following the control valve and is to be the **same size as the connection**.

ⓘ **Refer to *NFPA* 14 2016, Figure A.6.3.5(a), Acceptable Piping Arrangement for Combined Sprinkler/Standpipe System.**

CONTINUE

NFPA 14 2016, Section 6.3.7

Valve Supervision

System water supply valves, isolation control valves, and other valves in feed mains are required to be **supervised in the open position** using one of the following methods:

- A central station, proprietary, or remote station signaling service
- A local signaling service that initiates an audible signal at a constantly attended location
- Locking of valves in the open position
- Sealing of valves and an approved weekly recorded inspection where valves are located within fenced enclosures under the control of the owner

CONTINUE

NFPA 14 2016, Section 6.4.3

Fire Department Connections

The **FDC** is required to be installed as follows:

- **Automatic wet** and **manual wet standpipe systems** – On the system side of the system control valve, check valve, or any pump, but on the supply side of any isolating valves required by 6.3.2.

- **Automatic dry standpipe systems** – On the system side of the control valve and check valve, and the supply side of the dry pipe valve.
- **Semiautomatic dry standpipe systems** – On the system side of the deluge valve.
- **Manual dry standpipe systems** – Directly connected to system piping with a check valve in the piping as required by Section 6.4.2.

FDCs are **not permitted** to be installed on the suction side of fire pumps.

Refer to *NFPA* 14 2016, Figure A.6.4 Typical Fire Department Connection for Wet Standpipes.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

The FDC is required to be installed on the system side of the deluge valve for which standpipe system?

○ Automatic wet standpipe systems

○ Manual wet standpipe systems

○ Automatic dry standpipe systems

○ Semiautomatic dry standpipe systems

○ Manual dry standpipe systems

SUBMIT

🔒 Complete the knowledge check above before moving on.

Design Requirements

NFPA 14 2016, Section 7.1

Many factors need to be considered when designing a standpipe system:

- Building height
- Area per floor occupancy classification

- Egress system design
- Required flow rate and residual pressure
- Distance of the hose connection from the source(s) of the water supply

CONTINUE

NFPA 14 2016, Section A.7.1

The Annex explains more:

- Building height determines the number of vertical zones.
- Floor or fire area and exit locations, as well as the occupancy classification, determine the number and locations of hose connections.
- Local building codes influence types of systems, classes of systems, and locations of hose connections.
- Pipe sizing depends on the number of hose connections flowing, the quantity of water flowing, the required residual pressure, and the vertical distance and horizontal distance of those hose connections from the water supplies.

ⓘ **Figures A.7.1(a) and (b) show typical elevation drawings.**

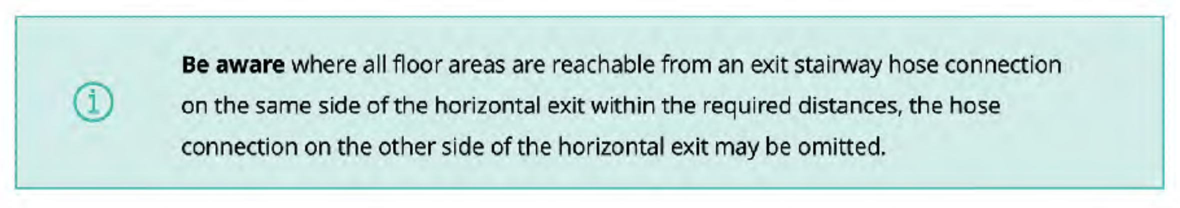
CONTINUE

NFPA 14 2016, Sections 7.2 and 7.3

Maximum system pressure cannot exceed 350 psi. However, **express mains** supplying higher standpipe zones are permitted to exceed 350 psi, if in accordance with their materials listings or with Authority Having Jurisdiction (AHJ) approval. In this case, no hose outlets on any part of the system can exceed 350 psi.

Hose connections must be positioned within 3 - 5 ft. from the floor.

Note the hose connection location requirements for Class I systems (2½ in. connection) and the 130 ft. maximum for a non-sprinklered floor and 200 ft. maximum travel distance requirements for a sprinklered floor.



Be aware where all floor areas are reachable from an exit stairway hose connection on the same side of the horizontal exit within the required distances, the hose connection on the other side of the horizontal exit may be omitted.

ⓘ **Figure A.7.3.2.2.1 illustrates the exception mentioned in the box above.**

CONTINUE

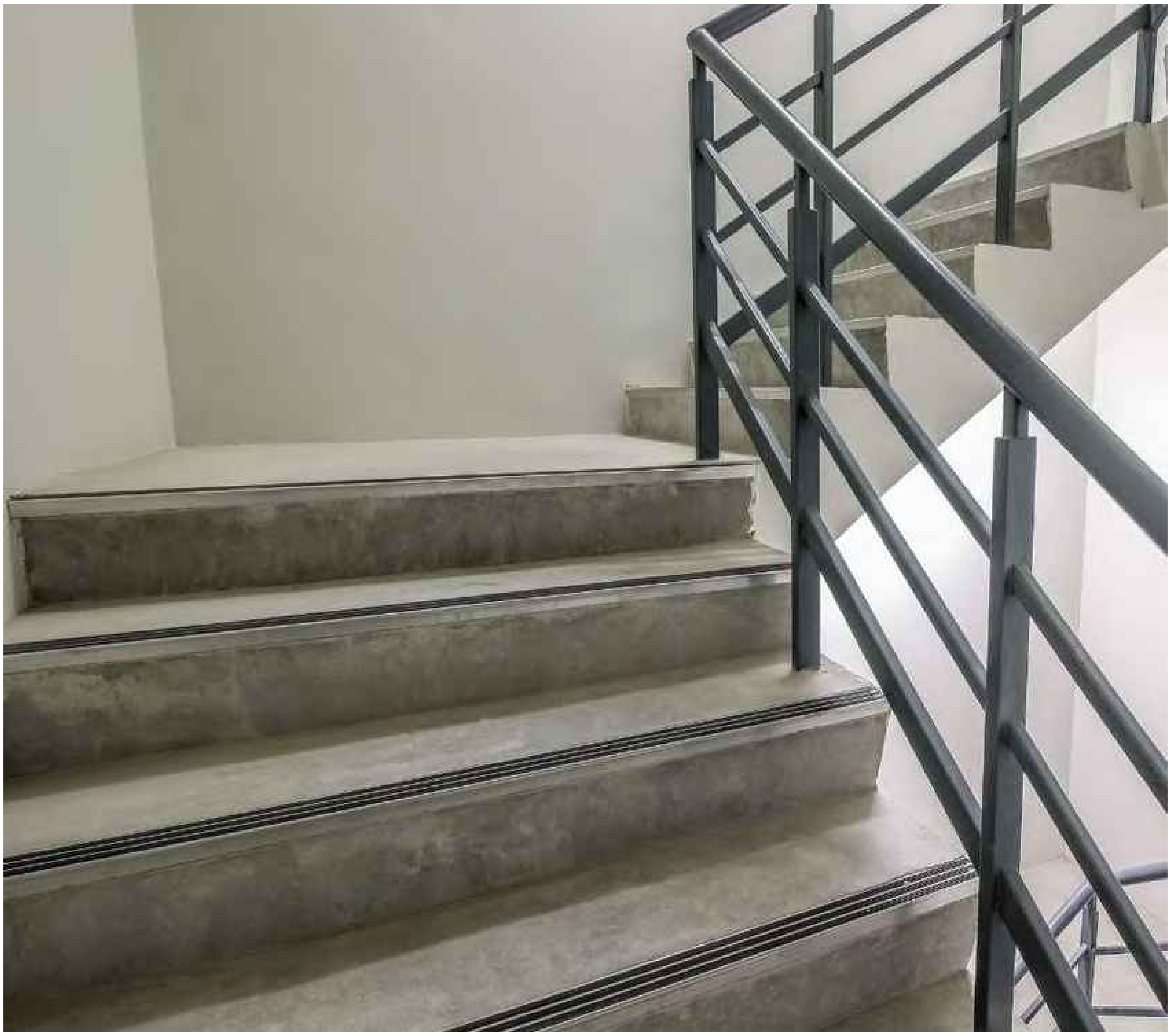
NFPA 14 2016, Section 7.3.2

Location of Hose Connections

Locations for Class I systems with 2½ in. connections include the following:

- At the main floor landing in exit stairways
- On each side of the wall adjacent to the exit openings of horizontal exits
- In each exit passageway at the entrance from the building areas into the passageway, with the exception of covered mall buildings
- For covered mall buildings, at the entrance to each exit passageway or exit corridor, and at the interior side of public entrances from the exterior to the mall
- At the highest landing of stairways with stairway access to a roof, and on roofs with a slope of less than 4 in 12 where stairways do not access the

roof



The Annex in Section A.7.3.2.7 also states that **access to the roof** can be by a stairwell that terminates at the roof level. Access could also be a permanent ladder, permanent ladder rungs, or a pull-down stair with a roof hatch.

ⓘ **Refer to *NFPA* 14 2016, Figure A.7.3.2.7 Roof Outlet Piping Arrangement.**

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Check all the factors that needs to be considered when designing a standpipe system.

☐ Area per floor of only Light Hazard occupancies

☐ Building height

☐ Distance of the nearest fire department

☐ Number of entrances/exits

☐ Egress system design

☐ Residual pressure

☐ Distance of the hose connection

SUBMIT

🔒 Complete the knowledge check above before moving on.

NFPA 14 2016, Section 7.3.3

Class II systems (1 ½ in. connection), utilizing 1 ½ in. and smaller hose have travel distance limitations of 120 ft. and 130 ft.

The 120 ft. maximum is for hose smaller than 1 ½ in. and the 130 maximum is for hose of 1 ½ in.

ⓘ **Separate standpipes are required to be provided in each required exit stairway. (*NFPA* 14 2016, Section 7.4)**

CONTINUE

NFPA 14 2016, Section 7.5

If two or more standpipes are installed in the same building or the same section of a building, then they are required to be **interconnected**.

The Annex explains that standpipe systems in separate buildings or structures, fed by the same water supply, are **not required** to be interconnected. As an example, the standpipe systems for a building (automatic wet standpipe system) and its adjacent parking garage (automatic dry standpipe system) are not required to be interconnected, even if fed by the same fire pump and water main, **since they protect different structures**.

CONTINUE

NFPA 14 2016, Section 7.6.1

This section explains that Class I and Class III standpipes must be at least 4 in. in size and combined systems must be at least 6 in.

There is an **exception** here for hydraulically designed systems in fully sprinklered buildings – these have a 4 in. minimum diameter.

CONTINUE

NFPA 14 2016, Section 7.8

Maximum Pressure at Hose Connections

Minimum **residual pressures** at the most hydraulically remote locations are specified at 100 psi for 2 ½ in. connections and 65 psi for 1 ½ in. connections.

Manual standpipes are to be sized to provide 100 psi at the topmost outlet, using a fire department pumper as the flow and pressure source.

CONTINUE

NFPA 14 2016, Section 7.10

Flow Rates

For Class I and Class III standpipes, the **minimum flow rate** at the most hydraulically remote location must be 500 gpm through the two most remote 2 ½ in. outlets.

☐ For additional standpipes, 250 gpm per additional standpipe must be added to this 500 gpm requirement, but the total cannot exceed 1250 gpm.

☐ Note that when the building is sprinklered throughout, the system demand is reduced to 1000 gpm.

☐ Where the protected floor area exceeds 80,000 ft^2, the 500 gpm requirement applies to the second most remote standpipe and 250 gpm for the third standpipe, if additional flow is required for an unsprinklered building.

ⓘ **Horizontal standpipes on Class I and III systems that supply three or more hose connections on any floor are required to provide a minimum of 250 gpm at the three hydraulically most remote hose connections on the standpipe. (*NFPA* 14 2016, Section 7.10.1.2.2)**

CONTINUE

Keep in mind that, for a fully sprinklered building, the sprinkler flow demand need not be added to the standpipe demand. When the system demand (including hose) for the sprinkler system exceeds the standpipe system demand, **the larger value is provided**.

Where partial automatic sprinkler protection is provided, the flow rates for Class I and Class III systems must, for Light Hazard occupancies, be increased by either the hydraulically calculated sprinkler demand or 150 gpm, **whichever is less**.

For Ordinary Hazard occupancies, the 150 gpm number is increased to 500 gpm.

Class II standpipe systems must be designed for a minimum flow of 100 gpm at the **hydraulically most remote connection**.

Chapter 7 concludes by specifying the requirements for drains and test risers.

- It also notes that one or more FDCs must be **provided for each zone** of a Class I and Class III system.
- High-rise systems must usually contain **at least two remotely located FDCs**.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

What is the maximum travel distance permitted for a 1 ½ in. hose in a Class II system?

○ 100 ft.

○ 130 ft.

○ 150 ft.

○ 180 ft.

SUBMIT

When three or more hose connections are supplied by horizontal standpipes on Class I and III systems, a minimum flow rate of 500 gpm is required at the three hydraulically most remote hose connections on the standpipe.

○ True

○ False

SUBMIT

Complete the knowledge checks above before moving on.

NFPA 14 2016, Chapters 8 - 10

Chapters 8, 9, and 10 cover the topics of plans and calculations, water supplies, and water supply testing, respectively.

Standpipe systems are to be sized hydraulically. The minimum duration for all three classes is **30 minutes**.

Acceptable water supplies for these systems are basically the same as for sprinkler systems:

☐ A public waterworks system where pressure and flow rate are adequate

☐ Automatic fire pumps connected to an approved water source per *NFPA* 20

☐ Manually controlled fire pumps in combination with pressure tanks

☐ Pressure tanks installed per *NFPA* 22

☐ Manually controlled fire pumps operated by remote control devices at each hose station, supervised per *NFPA* 72, at each hose station

☐ Gravity tanks installed per *NFPA* 22

SYSTEM ACCEPTANCE

NFPA 14 2016, Chapter 11

Chapter 11 notes that the installing contractor must complete and sign the included Contractor's Material and Test Certificate, shown in Figure 11.1.3(a).

For all new systems, the hydrostatic test requirement is 200 psi for two hours or 50 psi above the maximum pressure, **whichever is greater**. The hydrostatic test is to be taken at the low elevation point of the individual system or zone being tested.

BUILDINGS UNDER CONSTRUCTION

NFPA 14 2016, Chapter 12

Chapter 12 concludes the bulk of the standard. This chapter is short. It essentially provides **fire protection during construction**, as required by the AHJ, which is comparable to that which will be available in the completed building.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

For all new standpipe systems, the hydrostatic test requirement is ___ psi for two hours or ___ psi above the maximum pressure, whichever is greater.

○ 50; 100

○ 100; 50

○ 50; 200

○ 200; 50

SUBMIT

Complete the knowledge check above before moving on.

After completing this module, you should now have a better understanding of the design and installation of standpipe systems.

Click on the “Next” arrow up on the right-hand corner of the screen to continue to the quiz

Automatic Sprinkler & Standpipe Systems - ITM Requirements NFPA 25

By the end of this module, you will be able to do the following:

- Define key terms associated with the inspection, testing, and maintenance (ITM) of sprinkler systems.
- Recognize the responsibility associated with maintaining a fire protection system.
- Review the ITM requirements for fire protection systems and their components.
- Describe obstruction investigation procedures.
- Compare preplanned and emergency impairments.
- Review the procedures that must be implemented once impaired equipment is restored.

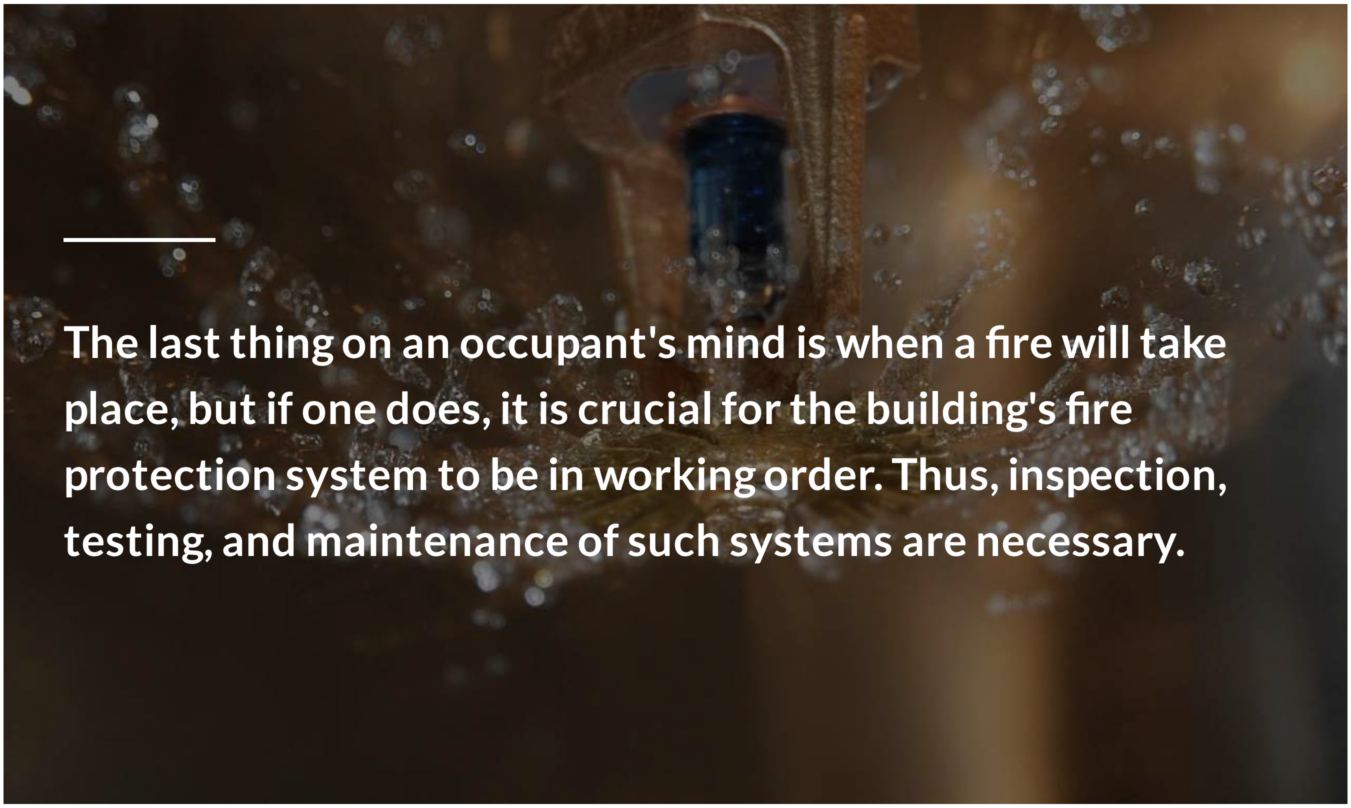
Key References:

- *NFPA 25 - Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2014

When you are ready to begin, click on the button above to start the course.

Lesson 1 of 2

ITM of Fire Protection Systems



The last thing on an occupant's mind is when a fire will take place, but if one does, it is crucial for the building's fire protection system to be in working order. Thus, inspection, testing, and maintenance of such systems are necessary.

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Define key terms associated with the inspection, testing, and maintenance (ITM) of sprinkler systems.

☐ Recognize the responsibility associated with maintaining a fire protection system.

☐ Review the ITM requirements for fire protection systems and their components.

Key References

- *NFPA* 25 - *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2014

LET'S BEGIN

Overview

The focus of this module is ***NFPA* 25** - Standard for Inspection, Testing and Maintenance of Water-Based Fire Protection Systems. If you are not familiar with ***NFPA* 25**, start by becoming very familiar with the Table of Contents.

When responding to a question, **look up the keywords** in either the Table of Contents or in the Index at the back of the standard. These will enable you to find the appropriate section of the standard in the **quickest possible time**.

Make sure you **read** and **understand** the definitions, which are always contained in Chapter 3 of any ***NFPA* standard**. The definitions are standardized across each standard.

Here are a few key terms:

Impairment —

A condition where a fire protection system or unit or portion thereof is out of order, and the condition can result in the fire protection system or unit not functioning in a fire event. (*NFPA* 25 2014, Section 3.3.21)

Inspection –

A visual examination of a system or portion thereof to verify that it appears to be in operating condition and is free of physical damage. (*NFPA* 25 2014, Section 3.3.23)

Qualified –

A competent and capable person or company that has met the requirements and training for a given field acceptable to the AHJ. (*NFPA* 25 2014, Section 3.3.34)

Testing –

A procedure used to determine the operational status of a component or system by conducting periodic physical checks, such as waterflow tests, fire pump tests, alarm tests, and trip tests of dry pipe, deluge, or preaction valves. (*NFPA* 25 2014, Section 3.3.47)

GENERAL REQUIREMENTS

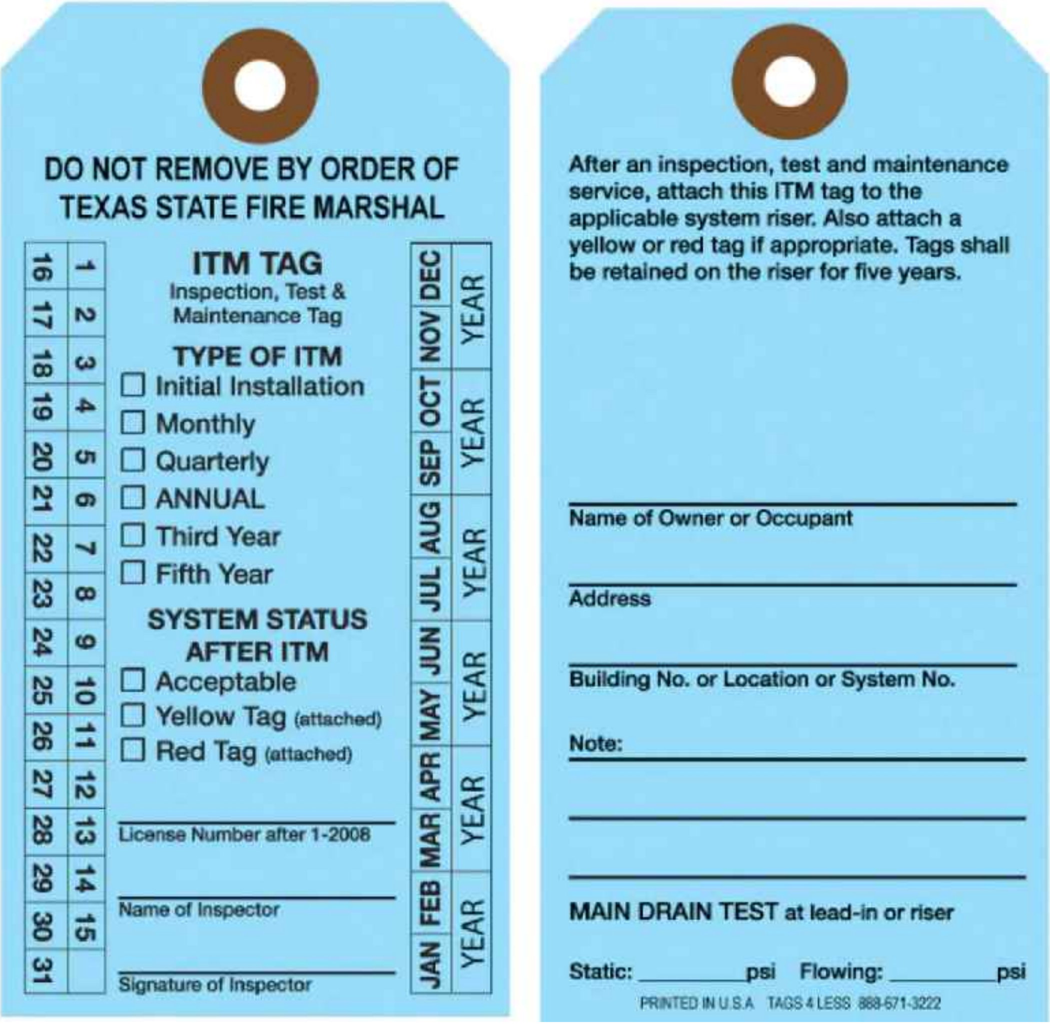
Responsibility

NFPA 25 2014, Section 4.1.1

The **property owner is responsible** for maintaining the fire protection system once it is installed.

This includes **correcting or repairing deficiencies or impairments** that are discovered during an **inspection, a test, or routine maintenance**.

Corrections and repairs are to be conducted by **qualified maintenance personnel**.



DO NOT REMOVE BY ORDER OF
TEXAS STATE FIRE MARSHAL

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

ITM TAG
Inspection, Test & Maintenance Tag

TYPE OF ITM
☐ Initial Installation
☐ Monthly
☐ Quarterly
☐ ANNUAL
☐ Third Year
☐ Fifth Year

SYSTEM STATUS AFTER ITM
☐ Acceptable
☐ Yellow Tag (attached)
☐ Red Tag (attached)

License Number after 1-2008

Name of Inspector

Signature of Inspector

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
YEAR YEAR YEAR YEAR YEAR YEAR

After an inspection, test and maintenance service, attach this ITM tag to the applicable system riser. Also attach a yellow or red tag if appropriate. Tags shall be retained on the riser for five years.

Name of Owner or Occupant

Address

Building No. or Location or System No.

Note:

MAIN DRAIN TEST at lead-in or riser

Static: ________psi Flowing: ________psi

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If the property owner is not the occupant, then the authority for inspecting, testing, maintaining, and managing impairments can be delegated to a **designated representative**.

GENERAL REQUIREMENTS

General Requirements

NFPA 25 2014, Section 4.1.4

If the system needs to be shut down, the property owner is **required to notify**:

- The Authority Having Jurisdiction (AHJ)
- The fire department
- The alarm-receiving facility

These same individuals are to be notified when the system is returned to service.

CONTINUE

NFPA 25 2014, Section 4.1.6

The property owner is **not permitted to make changes** in the occupancy, the use or process, or the stored materials in the building without first having an evaluation of the fire protection system. This is to determine the system can **properly protect** the newly proposed occupancy, use, or materials stored.

This evaluation is not part of the normal inspection, testing, and maintenance (ITM) tasks. If an evaluation takes place, it is required to include factors such as the following:

- **Occupancy changes**, such as converting office or production space into warehousing
- **Process or material changes**, such as metal stamping to molded plastics
- **Building revisions**, such as relocated walls, added mezzanines, and ceilings added below sprinklers
- **Removal of heating systems** in spaces with piping subject to freezing

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RECORDS

Records

NFPA 25 2014, Section 4.3

Records are required for **all** inspections, tests, and maintenance (ITM) of the system and its components. These records must be made available to the AHJ, if requested.

The records may be stored electronically, and are required to indicate the following:

☐ The procedure being performed (ITM)

☐ The organization performing the procedure

☐ The required frequency of the procedure

☐ The results and date of the procedure

☐ The name and contact information of the qualified contractor or owner, including the lead person for the procedure

These records are to be maintained by the property owner.

INSPECTION AND TESTING

Inspection and Testing

NFPA 25 2014, Sections 4.5 and 4.6

Inspection intervals are provided in each chapter, based on the system and components.

The systems and components are required to be tested to verify functionality, per the frequencies defined in *NFPA* 25.

The **test results need to be compared** to the original acceptance test results and with the most recent test results.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Who is responsible for maintaining the fire protection system once it is installed?

○ AHJ

○ Property owner

○ Building occupants

○ City governance

SUBMIT

If the system needs to be shut down, the property owner is required to notify whom? (List one of the three options)

Type your answer here

SUBMIT

🔒 Complete the knowledge checks above before moving on.

Sprinkler Systems

Chapter 5 provides requirements for the ITM of fire sprinkler systems, the most common type of fire protection systems installed in the built environment. Sprinkler systems are **exceptionally reliable**, but like any mechanical system, they require attention to remain operational.

Periodic ITM are necessary to ensure that the system and its components **will function as intended in the event of a fire emergency**.

CONTINUE

NFPA 25 2014, Section 5.2.1.1

This section outlines the **inspection requirements** for sprinkler systems. Sprinklers are required to be inspected from the **floor level on an annual basis**. Confirm the following during the sprinkler inspection:

☐ No signs of leakage

☐ Free of corrosion, foreign materials, paint, and physical damage

☐ Installed in the correct orientation

If any sprinkler has the following, it is required to be replaced:

- Leakage
- Corrosion
- Physical damage
- Loss of fluid in the glass bulb heat-responsive element
- Loading
- Painting not conducted by the sprinkler manufacturer

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CONTINUE

NFPA 25 2014, Section 5.3

This section outlines the **testing requirements** for sprinkler systems. When testing sprinklers, a representative sample shall consist of a minimum of not less than four sprinklers, or 1% of the number of sprinklers per individual sprinkler sample, **whichever is greater**.

Where one sprinkler within a representative sample fails to meet the test requirement, **all sprinklers represented by the sample shall be replaced**.

ⓘ **Review *NFPA* 25 2014, Table 5.1.1.2, Summary of Sprinkler System Inspection, Testing, and Maintenance, which provides the frequencies for evaluating sprinkler system components.**

Further inspection requirements outlined in this section include:

- If a sprinkler has been in service for **50 years**, it is required to be replaced or samples from one or more sample areas tested. The test procedures are required to be repeated at **10-year intervals**.
- All sprinklers manufactured **before 1920** are required to be replaced.
- Dry sprinklers that have been in service for **10 years** are required to be replaced (or samples taken to be tested and re-tested at 10-year intervals).
- Sprinklers installed in **harsh environments** are to be replaced on a **5-year basis** or have representative sprinkler samples tested.

CONTINUE

NFPA 25 2014, Section 5.3.2

Image courtesy of Viking.

Gauges

Gauges are required to be **replaced every 5 years**, or tested at this same interval and compared to a calibrated gauge.

If the gauge is not accurate to within **3% of the full scale**, it is required to be recalibrated or replaced.

CONTINUE

NFPA 25 2014, Section 5.3.3

This section outlines waterflow alarms. Waterflow devices including, but not limited to, mechanical water motor gongs shall be **tested quarterly**.

Vane-type and **pressure switch-type** waterflow devices shall be **tested semiannually**.

Testing the waterflow alarms on wet pipe systems must be accomplished by **opening the inspector's test connection**. Where freezing weather conditions or other circumstances prohibit the use of the inspector's test connection, the **bypass connection** is permitted to be used

Vane-Type Waterflow Switch

Inspector’s Test Outlet

Testing waterflow alarm devices on dry pipe, preaction, or deluge systems shall be accomplished by using the **bypass connection.**

CONTINUE

NFPA 25 2014, Section 5.4

This section outlines the **maintenance** of sprinkler systems. Here are some of the primary requirements discussed:

☐ If a sprinkler is removed for any reason, it shall not be reinstalled.

☐ Spare sprinklers are required to be maintained on-site (no less than six) so that any damaged or operated sprinklers can be promptly replaced.

☐ The sprinklers shall correspond to the types and temperature ratings of the sprinklers in the property.

Where dry sprinklers of different lengths are installed, **spare dry sprinklers are not required**, provided that a means of returning the system to service is furnished.

A **special sprinkler wrench** shall be provided and kept in the cabinet for the removal and installation of sprinklers. One sprinkler wrench is to be provided for each type of sprinkler installed.

Sprinklers subject to **overspray accumulations** are to be protected using plastic bags having a maximum thickness of 0.003 inches, or shall be protected with thin paper bags.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

When testing sprinklers, a representative sample shall consist of a minimum of not less than _____ sprinklers, or 1% of the number of sprinklers per individual sprinkler sample, whichever is greater.

○ three

○ four

○ five

○ six

SUBMIT

How often shall waterflow devices be tested?

○ Weekly

○ Quarterly

○ Semiannually

○ Annually

SUBMIT

Complete the knowledge checks above before moving on.

Standpipe Systems

Chapter 6 of *NFPA* 25 covers the ITM of standpipe systems. The operating condition of standpipe systems is important because standpipe systems are **critical equipment** in buildings where fire-fighting operations must be **conducted internally** due to the size or height of the building. A standpipe failure can have catastrophic consequences to both building occupants and first responders who rely on the system for their safety.

ⓘ **Review Table 6.1.1.2, which presents the frequencies of ITM of all classes of standpipe and hose systems.**

CONTINUE

NFPA 25 2014, Sections 6.1 – 6.3

A flow test is required to be **conducted every 5 years** on all Class I and Class III standpipe systems. This confirms the pressure and flow demands at the hydraulically most remote hose valve outlet of the system can be met while flowing the standpipe demand.

If a flow test of the hydraulically most remote outlets is not practical, the AHJ must be consulted for the appropriate location for test.

Section 6.3.1.5 states that a main drain test is required for **all standpipe systems** with automatic water supplies in accordance with the requirements of Chapter 13.

The test shall be performed at the low point drain for each standpipe, or the main drain test connection where the supply main enters the building (when provided).

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CONTINUE

NFPA 25 2014, Section 6.3.2

Hydrostatic tests shall be **conducted every 5 years**, at no less than 200 psi for 2 hours, or at 50 psi above the maximum pressure (where maximum pressure exceeds 150 psi) on manual standpipe systems and semiautomatic dry standpipe systems. This testing includes piping in the FDC.

Combined system

Manual wet standpipes that are part of a combined system shall not be required to be tested in accordance with these requirements.

Measure the hydrostatic test pressure at the low elevation point of the system or zone being tested.

Section 6.3.3 states that **waterflow alarms** shall be **tested on a quarterly basis**. Vane-type and pressure switch-type waterflow devices are to be **tested on a semi-annual basis**. Valve supervisory switches are to be **tested semi-annually**.

Where freezing conditions necessitate a delay in testing, tests shall be performed **as soon as weather allows**.

Pressure switch

Private Fire Service Mains

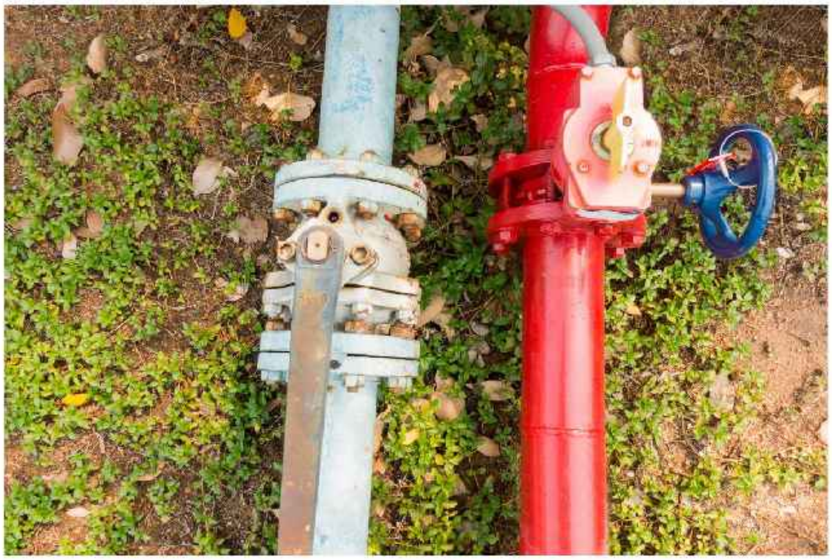
Chapter 7 of *NFPA* 25 addresses the ITM of **private underground mains** and their appurtenances. The term "**private**" indicates that the piping and equipment is located on private property and is neither owned by nor maintained by the local water district or purveyor.

NFPA 25 2014, Section 7.2.2

This section outlines the procedures that are to be carried out in accordance with the manufacturer's instructions, where applicable.

UNDERGROUND PIPING	DRY BARREL AND WALL HYDRANTS	WET BARREL HYDRANTS

Generally, underground piping cannot be inspected on a routine basis. However, flow testing can reveal the condition of underground piping and shall be conducted in accordance with Section 7.3.

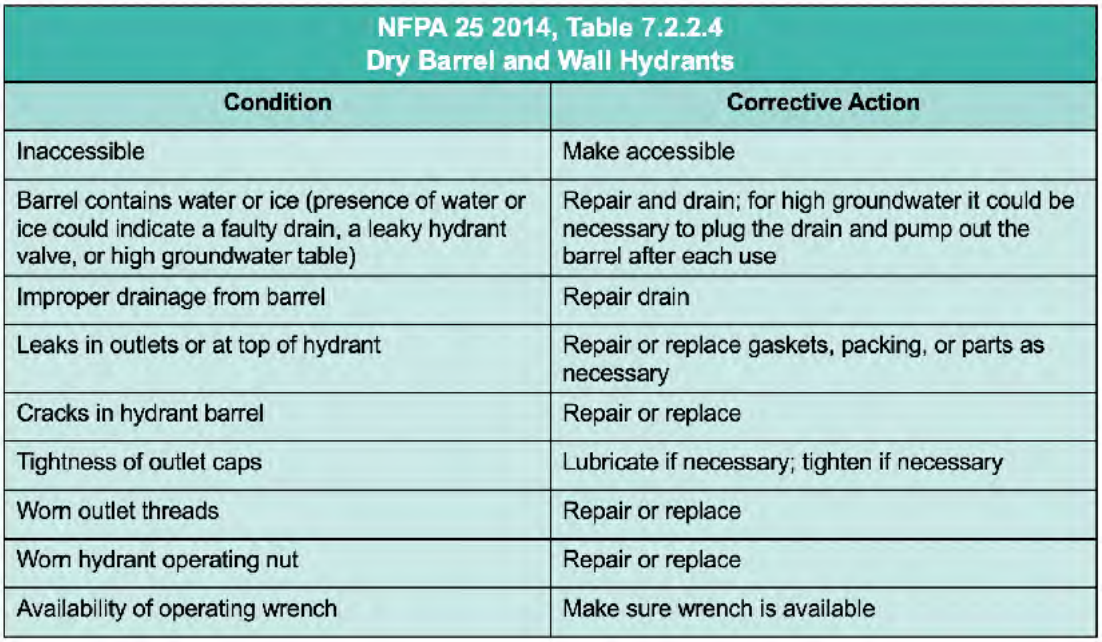


UNDERGROUND PIPING

DRY BARREL AND WALL HYDRANTS

WET BARREL HYDRANTS

Dry barrel and wall hydrants shall be inspected annually and after each operation, with necessary corrective action taken, as shown in Table 7.2.2.4.



NFPA 25 2014, Table 7.2.2.4
Dry Barrel and Wall Hydrants

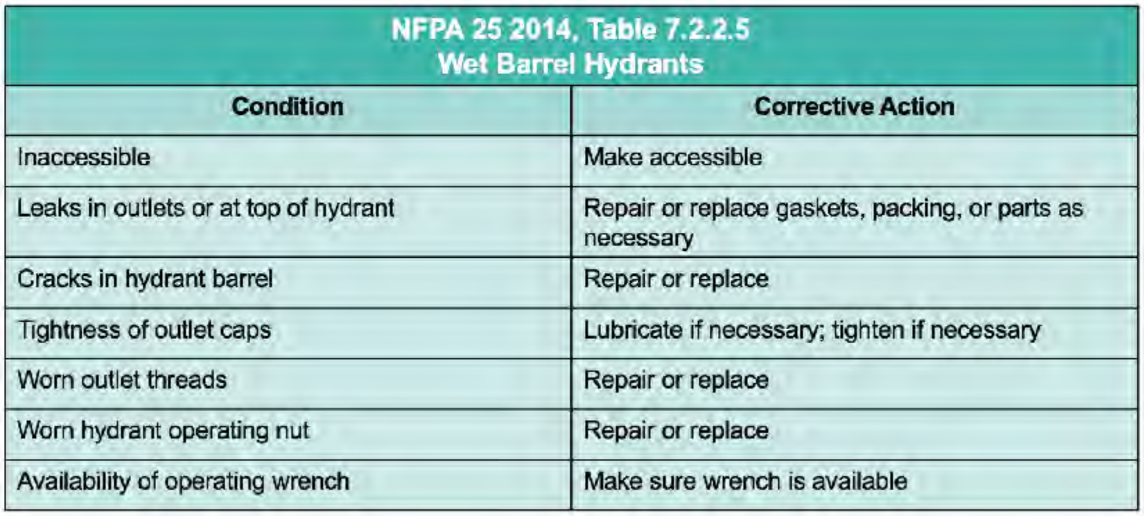
Condition	Corrective Action
Inaccessible	Make accessible
Barrel contains water or ice (presence of water or ice could indicate a faulty drain, a leaky hydrant valve, or high groundwater table)	Repair and drain; for high groundwater it could be necessary to plug the drain and pump out the barrel after each use
Improper drainage from barrel	Repair drain
Leaks in outlets or at top of hydrant	Repair or replace gaskets, packing, or parts as necessary
Cracks in hydrant barrel	Repair or replace
Tightness of outlet caps	Lubricate if necessary; tighten if necessary
Worn outlet threads	Repair or replace
Worn hydrant operating nut	Repair or replace
Availability of operating wrench	Make sure wrench is available

UNDERGROUND PIPING

DRY BARREL AND WALL HYDRANTS

WET BARREL HYDRANTS

Wet barrel hydrants shall be inspected annually and after each operation, with the necessary corrective action taken, as shown in Table 7.2.2.5.



NFPA 25 2014, Table 7.2.2.5 Wet Barrel Hydrants	
Condition	**Corrective Action**
Inaccessible	Make accessible
Leaks in outlets or at top of hydrant	Repair or replace gaskets, packing, or parts as necessary
Cracks in hydrant barrel	Repair or replace
Tightness of outlet caps	Lubricate if necessary; tighten if necessary
Worn outlet threads	Repair or replace
Worn hydrant operating nut	Repair or replace
Availability of operating wrench	Make sure wrench is available

CONTINUE

NFPA 25 2014, Section 7.3.2

This section outlines the requirements for hydrants as they are to be **tested annually** to ensure proper functioning.

- Each hydrant shall be opened fully and water flowed until all the foreign material has cleared, with the flow maintained for a **minimum of 1 minute**.
- After operation, **dry barrel and wall hydrants** shall be observed for proper drainage from the barrel.
- Full drainage shall take **no longer than 60 minutes**.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

How often is a flow test required to be conducted on all Class I and Class III standpipe systems?

○ Every month

○ Every year

○ Every two years

○ Every five years

SUBMIT

What is the corrective action for dry barrel and wall hydrants when there is improper drainage from the barrel?

○ Make the drain accessible

○ Repair the drain

○ Replace the gaskets

○ Lubricate the drain

SUBMIT

Complete the knowledge checks above before moving on.

Foam Systems

NFPA 25 2014, Chapter 11

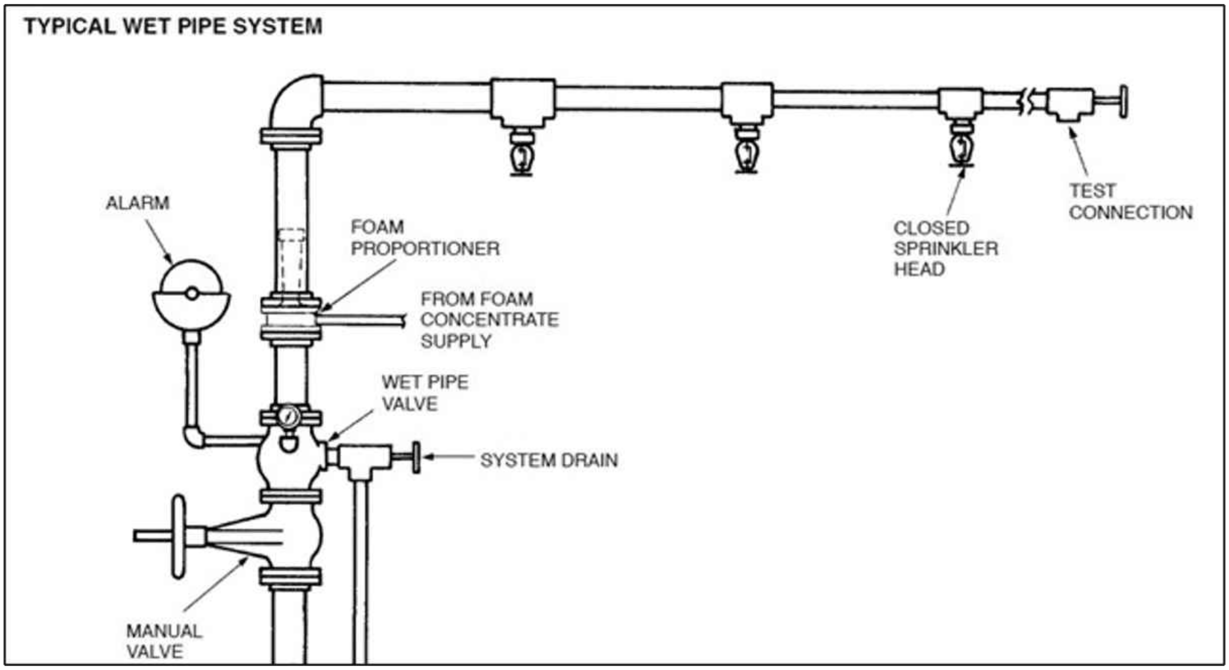
Chapter 11 of *NFPA* 25 covers the ITM of foam-water sprinkler and foam-water spray systems. Foam-water systems are used in Extra Hazard areas containing flammable or combustible liquids.

As is the case with water spray fixed systems, the proper ITM of foam-water systems requires specialized training and experience.

Inspections shall **verify** that all components including foam concentrate discharge devices and proportioning equipment are installed in accordance with their listing.

The **proportioning system** shall be permitted to be any of the following types:

- Standard pressure proportioner
- Bladder tank proportioner
- Line proportioner (Venturi pickup)
- Standard balanced pressure proportioner
- In-line balanced pressure proportioner
- Orifice plate, either direct or indirect
- Other approved proportioning method



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CONTINUE

NFPA 25 2014, Section 11.2.2

This section highlights **automatic detection equipment for foam systems**. This equipment is required to be inspected, tested, and maintained per *NFPA* 72 requirements.

Foam system with alarm

The inspector must ensure the following regarding the detectors:

- They are in place.
- They are securely fastened.
- They are protected from corrosion, weather, and mechanical damage.
- The communication wiring, control panels, or pneumatic tubing system is functional.

CONTINUE

NFPA 25 2014, Section 11.2.3

This section highlights **piping and fitting** for foam systems. System piping and fittings are required to be inspected for the following:

☐ Mechanical damage, such as broken piping or cracked fittings

☐ External conditions, such as missing or damaged paint or coatings, rust, and corrosion

☐ Misalignment or trapped sections

☐ Low-point drains

☐ Location and condition of rubber-gasketed fittings

CONTINUE

NFPA 25 2014, Section 11.2.4

This section highlights **hangers** and **supports** for foam systems. Hangers and supports shall be inspected for the following, and repaired as necessary:

- Condition (e.g., missing or damaged paint or coating, rust, and corrosion)
- Secure attachment to structural supports and piping
- Damaged or missing hangers

CONTINUE

NFPA 25 2014, Section 11.2.5

This section discusses **foam-water discharge devices** for foam systems. Foam-water discharge devices are required to be inspected visually and maintained to ensure that they:

- Are in place
- Continue to be aimed or pointed in the direction intended in the system design
- Are free from external loading and corrosion

LET'S REVIEW

Let's do a quick check about what has been covered so far.

When inspecting hangers in foam systems, which of the following need to be confirmed:

○ Secure attachment

○ No damaged or missing hangers

○ Acceptable condition

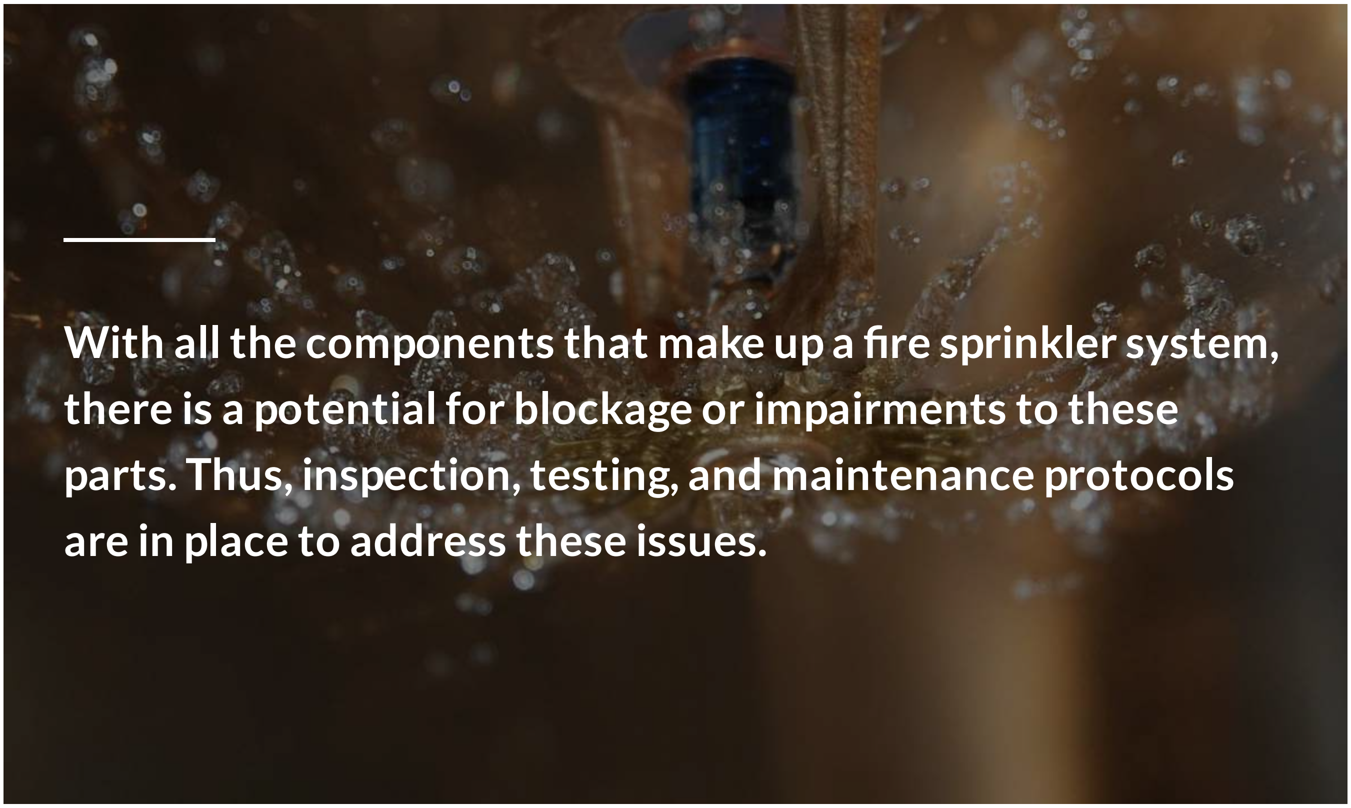
○ All of the above

SUBMIT

Complete the knowledge check above before moving on.

Lesson 2 of 2

ITM of Obstructions and Impairments



With all the components that make up a fire sprinkler system, there is a potential for blockage or impairments to these parts. Thus, inspection, testing, and maintenance protocols are in place to address these issues.

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Describe obstruction investigation procedures.

☐ Compare preplanned and emergency impairments.

☐ Review the procedures that must be implemented once impaired equipment is restored.

Key References

- *NFPA* 25 - *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2014

LET'S BEGIN

Obstruction Investigation

NFPA 25 2014, Chapter 14

The Obstruction Investigation chapter discusses the minimum requirements for conducting investigations of fire protection system piping for possible sources of materials that can cause pipe blockage.

An investigation of the internal condition of the pipe is required to be conducted **every 5 years**.

Tubercles or slime, if found, shall be tested for indications of microbiologically influenced corrosion (MIC).

CONTINUE

NFPA 25 2014, Section 14.3

Obstruction investigations are unique as they are **more extensive** and **do not have a specified frequency**. Obstruction investigations are **triggered by specific events or conditions** that can occur either within the system itself or within the water supply infrastructure for the system.

An obstruction investigation shall be conducted for system or yard main piping wherever any of the following conditions exist:

☐ Defective intake for fire pumps taking suction from open bodies of water

☐ The discharge of obstructive material during routine water tests

☐ Foreign materials in fire pumps, in dry pipe valves, or in check valves

☐ Foreign material in water during drain tests or plugging of inspector's test connection(s)

☐ Unknown materials are heard in system piping during draining, refilling, or otherwise flowing water through system

☐ Plugged sprinklers

☐ The presence of sufficient foreign organic or inorganic material is found in the pipe

☐ Failure to flush yard piping or surrounding public mains following new installations or repairs

☐ A record of broken public mains in the vicinity

☐ Abnormally frequent false tripping of a dry pipe valve(s)

☐ A system that is returned to service after an extended shutdown (greater than 1 year)

☐ There is reason to believe that the sprinkler system contains sodium silicate or highly corrosive fluxes in copper systems

☐ A system has been supplied with raw water via the fire department connection

☐ Pinhole leaks

☐ A 50% increase in the time it takes water to travel to the inspector’s test connection from the time the valve trips during a full flow trip test of a dry pipe sprinkler system when compared to the original system acceptance test.

CONTINUE

If the condition has not been corrected, or the condition is one that could result in obstruction of the piping despite any previous flushing procedures that have been performed, the system has to be **examined for internal obstructions every 5 years**.

Internal inspections shall be accomplished by **examining the interior of at least the following four points**:

- System valve
- Riser
- Cross main
- Branch line

Alternative nondestructive examination methods are permitted.

If an obstruction investigation indicates the presence of sufficient material to obstruct sprinklers, a **complete flushing program** is required to be conducted by qualified personnel.

CONTINUE

NFPA 25 2014, Section 14.4

This particular section discusses the prevention of **ice obstruction** in the pipe system.

Dry pipe or preaction sprinkler system piping protecting or passing through freezers or cold storage rooms are to be **inspected internally on an annual basis** for ice obstructions at the point where the piping enters the refrigerated area.

Alternative nondestructive examinations shall be permitted.

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LET'S REVIEW

Let's do a quick check about what has been covered so far.

Obstruction investigations are unique as they are less extensive and do not have a specified frequency.

○ True

○ False

SUBMIT

If an obstruction investigation indicates the presence of sufficient material to obstruct sprinklers, what is required to be conducted by qualified personnel?

Type your answer here

SUBMIT

🔒 Complete the knowledge checks above before moving on.

Impairments

NFPA 25 2014, Chapter 15

The Impairments chapter provides the **minimum requirements** for a sprinkler system impairment program. An impairment is a condition where a sprinkler system or a portion thereof will not function during a fire event.

Measures shall be taken during the impairment to **ensure that increased risks are minimized**, and the **duration of the impairment is limited**.

1. The building owner shall assign an **impairment coordinator** to comply with the requirements of this chapter.
2. In the absence of a specific designee, the owner shall be considered the impairment coordinator.
3. Where the lease, written use agreement, or management contract specifically grants the authority for inspection, testing, and maintenance of the fire protection system(s) to the tenant, management firm, or managing individual, the tenant, management firm, or managing individual shall assign a person as impairment coordinator.

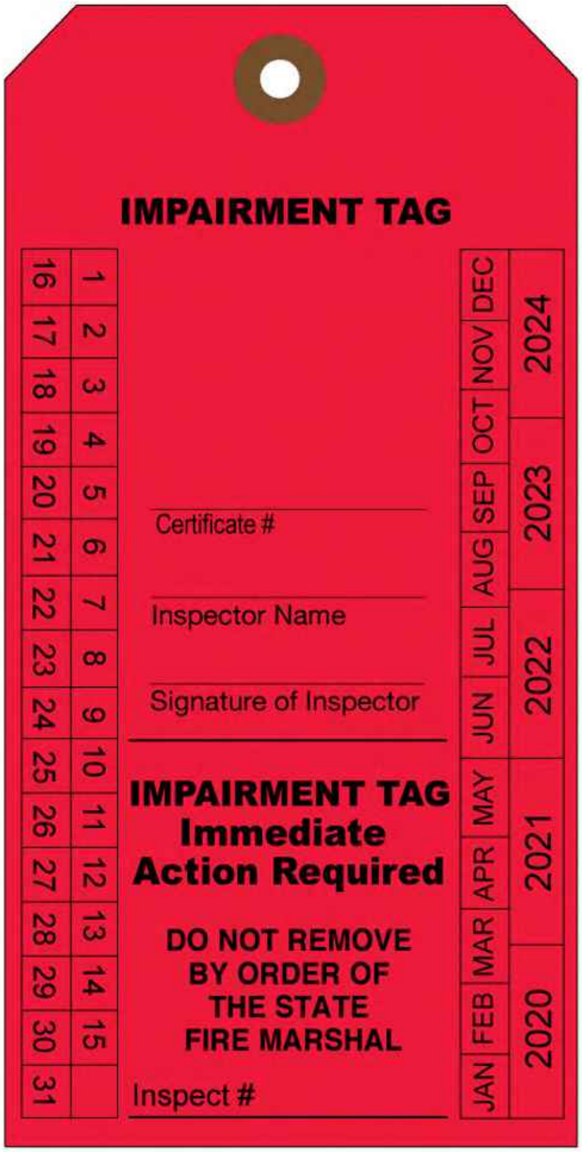
CONTINUE

NFPA 25 2014, Section 15.3.2

A **tag** is used to indicate that a system, or part thereof, has been removed from service.

The tag shall be **posted at each fire department connection and system control valve** indicating which system or part thereof has been removed from service.

The Authority Having Jurisdiction (AHJ) shall specify where the tag is to be placed.



IMPAIRMENT TAG

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

Certificate #

Inspector Name

Signature of Inspector

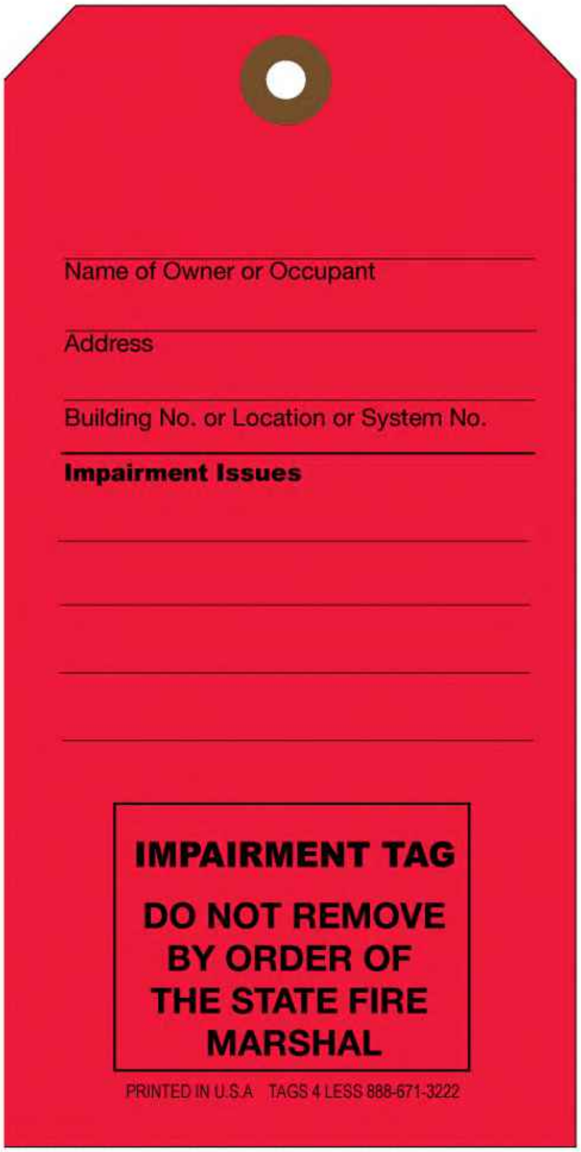
IMPAIRMENT TAG
Immediate
Action Required

DO NOT REMOVE
BY ORDER OF
THE STATE
FIRE MARSHAL

Inspect #

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

2020 2021 2022 2023 2024



Name of Owner or Occupant

Address

Building No. or Location or System No.

Impairment Issues

IMPAIRMENT TAG

DO NOT REMOVE
BY ORDER OF
THE STATE FIRE
MARSHAL

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CONTINUE

NFPA 25 2014, Section 15.4

The impaired equipment shall be considered to be the sprinkler system or part, thereof, that is **removed** from service.

The impaired equipment includes, but is not limited to, the following:

- Sprinkler systems

- Standpipe systems
- Fire hose systems
- Underground fire service mains
- Fire pumps
- Water storage tanks
- Water spray fixed systems
- Foam-water systems
- Water mist systems
- Fire service control valves

LET'S REVIEW

Let's do a quick check about what has been covered so far.

An impairment tag shall be posted ____ to indicate which system or part thereof has been removed from service. (Check all that apply)

☐ On the branch line

☐ In the system control panel

☐ At each fire department connection

☐ On the system control valve

SUBMIT

🔒 Complete the knowledge check above before moving on.

Preplanned Impairment Programs

NFPA 25 2014, Section 15.5

All preplanned impairments shall be authorized by the impairment coordinator.

Preplanned Impairment Programs

Before authorization is given, the impairment coordinator is responsible for verifying that the following procedures are implemented. Click the "Start" button below to begin.

1

Duration

The extent and expected **duration of the** **impairment** have been determined.

2

Increased risks

The areas of buildings involved have been inspected, and the **increased risks determined**.

3

Submitted recommendations

Recommendations to mitigate any increased risks have been submitted to management or the building owner/manager.

4

Impairment coordinator arrangements

Where a required fire protection system is out of service for more than 10 hours in a 24-hour period, the **impairment coordinator shall arrange for one of the following**:

1. Evacuation of the building or portion of the building affected by the system out of service
2. An approved fire watch
3. Establishment of a temporary water supply
4. Establishment and implementation of an approved program to eliminate potential ignition sources and limit the amount of fuel available to the fire

5

Notifying

The fire department has been **notified**.

The insurance carrier, the alarm company, building owner/manager, and other AHJs have been **notified**.

The supervisors in the areas to be affected have been **notified**.

6

Impairment tag

A **tag impairment system** has been implemented. (See Section 15.3).

7

Assembled tools and materials

All necessary **tools and materials have been assembled** on the impairment site.

Summary

Lastly, anyone who might be affected by fire protection system testing in the protected premises should be **notified that testing will take place**.

This notification should include, but might not be limited to:

- The property owner
- Property manager
- Switchboard operator
- Building engineer
- The building or floor fire wardens
- Building maintenance personnel
- The fire department communication center (if required)
- The alarm supervising station
- Building occupants

EMERGENCY IMPAIRMENTS

Emergency Impairments

NFPA 25 2014, Section 15.6

Emergency impairments include but are not limited to:

- System leakage
- Interruption of water supply
- Frozen or ruptured piping
- Equipment failure

When emergency impairments occur, emergency action shall be taken to **minimize potential injury and damage**.

The coordinator shall implement the steps outlined in the **Preplanned Impairment Programs'** section (Section 15.5).

ⓘ ***NFPA* 25 2014, Figure A.15.6.2 provides a sample impairment notice.**

RESTORING SYSTEMS TO SERVICE

Restoring Systems to Service

NFPA 25 2014, Section 15.7

When all impaired equipment is restored to normal working order, the impairment coordinator shall **verify the following procedures** have been implemented:

☐ Any necessary inspections and tests have been conducted to verify that affected systems are operational, consulting the appropriate chapter of this standard for guidance on the requirements.

☐ Supervisors have been advised that protection is restored.

☐ The fire department has been advised that protection is restored.

☐ The building owner/manager, insurance carrier, alarm company, and other AHJs have been advised that protection is restored.

☐ The impairment tag has been removed.

ⓘ **Refer to *NFPA* 25 2014, Figure A.15.3.1 Sample Impairment Tag**

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Check all that are considered emergency impairments.

☐ System leakage

☐ Interruption of water supply

☐ Frozen piping

☐ Ruptured piping

SUBMIT

Complete the knowledge check above before moving on.

After completing this module, you should now have a better understanding of the inspection, testing, and maintenance of fire protection systems.

Click on the “Next” arrow up on the right-hand corner of the screen to continue to the quiz.

Automatic Sprinkler & Standpipe Systems - ITM of Valves

By the end of this module, you will be able to do the following:

- Explain the purpose of and importance for inspection, testing, and maintenance (ITM) of system valves.
- Compare different types of sprinkler system valves and components discussed in *NFPA* 25 2014.
- Review the ITM requirements for fire protection valves and fire department connections.

Key References:

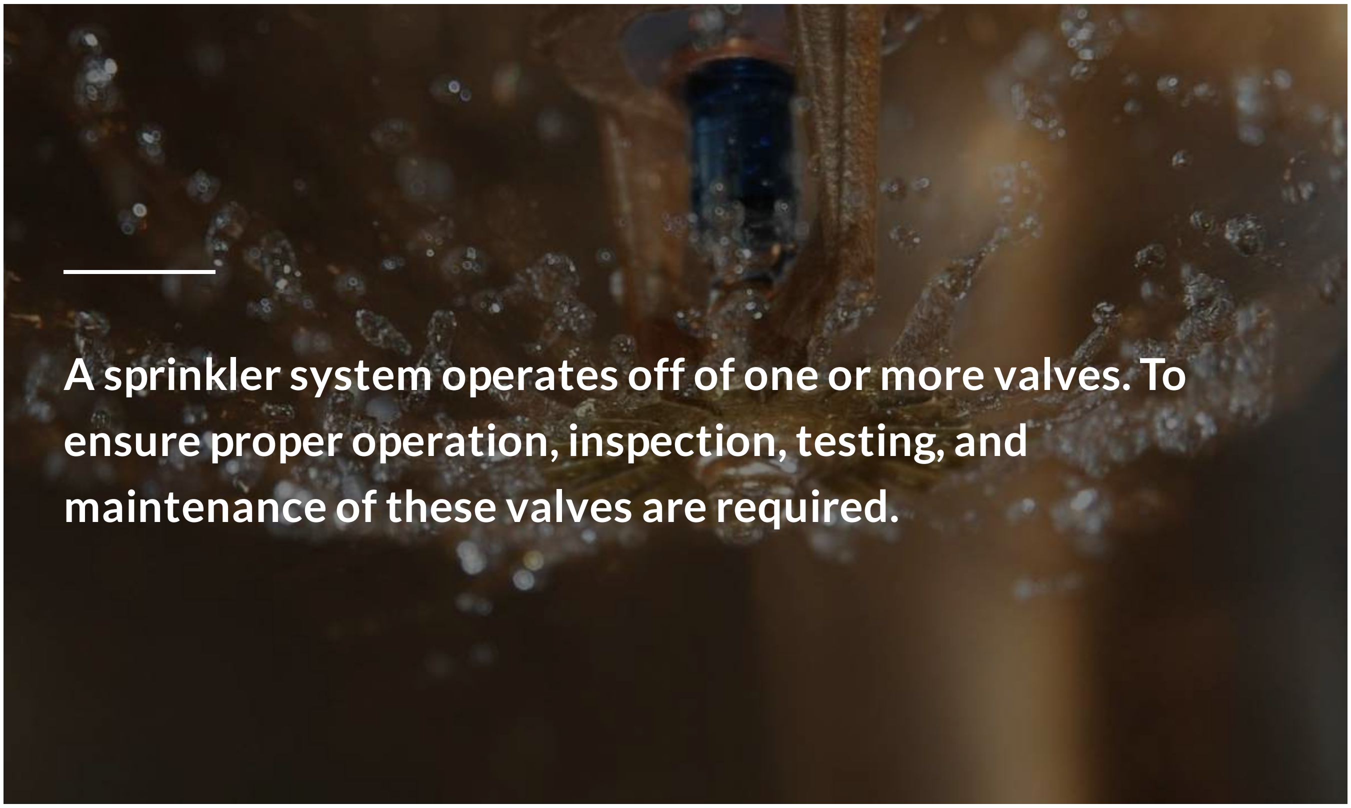
- *NFPA* 25 - *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2014

When you are ready to begin, click on the button above to start the course.

ITM of Valves

Lesson 1 of 1

ITM of Valves



A sprinkler system operates off of one or more valves. To ensure proper operation, inspection, testing, and maintenance of these valves are required.

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Explain the purpose of and importance for inspection, testing, and maintenance (ITM) of system valves.

☐ Compare different types of sprinkler system valves and components discussed in *NFPA* 25 2014.

☐ Review the ITM requirements for fire protection valves and fire department connections.

Key References

- *NFPA* 25 - *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2014

LET'S BEGIN

Valves

NFPA 25 2014, Chapter 13

Every type of sprinkler system has **one or more valves** that affect system operation. System and control valves form a critical part of any fire protection system; ever since the first fire protection systems were installed, both closed and partially closed valves have caused systems to not work as intended, resulting in **major fire loss**.

A fully maintained and tested fire sprinkler or fire pump system will **only work well as long as the valves controlling the system are fully open**. Thus, a comprehensive inspection, testing, and maintenance (ITM) program is not complete without diligence to constantly ensure system valves and associated components operate correctly and are in the correct position.

View the following videos and images for a better understanding of the different types of valves.

Alarm Valves

Sound a fire alarm when a flow of water from the system equals or exceeds the flow of a single discharge device. A retarding chamber, which minimizes false alarms due to surges and fluctuating water supply pressure, can be supplied with the alarm valve. (*NFPA* 25 2014, Section A.13.1)

The following video discusses alarm valves. The video run time is 1:40.

Backflow Prevention Devices

Prevent water in a fire protection system from entering the public water supply due to be reverse flow of water, thermal expansion, hydraulic shock, back pressure, or back siphonage. (*NFPA* 25 2014, Section A.13.1)

Refer to NFPA 25 2014, Figure A.13.1(a).

The following video discusses backflow preventers. The video run time is 0:42.

Ball Valves

Valves that are manually operated through their full range of open to closed positions with a one-quarter turn. (*NFPA* 25 2014, Section A.13.1)

The following video discusses butterfly valves. The video run time is 0:33.

Butterfly Valves

Water supply control valves with gear operators to assist in opening and closing. Butterfly valves can be of the wafer or grooved-end type. (*NFPA* 25 2014, Section A.13.1)

Refer to *NFPA* 25 2014, Figure A.13.1(b), Butterfly Post Indicator Valve.

The following video discusses butterfly valves. The video run time is 0:50.

Check Valves

Allow waterflow in one direction only. (*NFPA* 25 2014, Section A.13.1)

Refer to NFPA 25 2014, Figure A.13.1(c).

The following video discussed check valves. The video run time is 0:44.

Deluge Valves

Hold water at the valve until actuated by the operation of a detection system or manual release. (*NFPA* 25 2014, Section A.13.1)

Refer to *NFPA* 25 2014, Figure A.13.1(d), Deluge Valve.

The following video discusses deluge valves. The video run time is 1:26.

Drip Valves

Automatically drain condensation or small amounts of water that have leaked into system piping or valves. Drip valves close when exposed to system pressure. (*NFPA* 25 2014, Section A.13.1)

The following video discusses butterfly valves. The video run time is 1:01.

Dry Pipe Valves

Control the flow of water to areas that could be exposed to freezing conditions. Water is held at the valve by air pressure in the system piping. When the air pressure is reduced, the valve operates and floods the system. (*NFPA* 25 2014, Section A.13.1)

Refer to *NFPA* 25 2014, Figure A.13.1(e) Dry Pipe Valve.

The following video discusses dry pipe valves. The video run time is 0:42.

Indicating Valves

Provide a dependable, visible indication of the open position, seen at a distance. (*NFPA* 25 2014, Section A.13.1)

Indicator Posts

Includes wall and underground types and are intended for use in operating inside screwed pattern gate valves and for indicating the position of the gates in the valves. (*NFPA* 25 2014, Section A.13.1)

Refer to *NFPA* 25 2014, Figure A.13.1(g) Vertical Indicator Post.

NRS Gate Valves, OS&Y Gate Valves

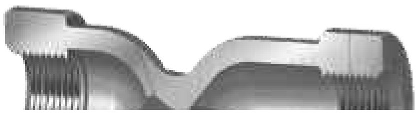
Non-rising stem (NRS) gate valves are used underground with indicator posts attached or as roadway box valves (curb-box installation). Outside screw and yoke (OS&Y) gate valves are used indoors and in pits outdoors. The valve stem moves out when the valve is open and moves in when it is closed. The stem indicates the positions of the valve. (*NFPA* 25 2014, Section A.13.1)

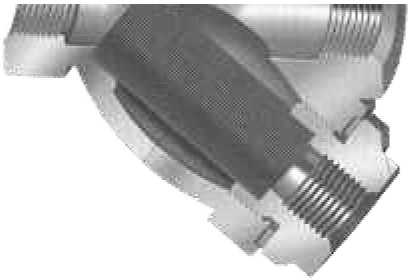
Refer to *NFPA* 25 2014, Figure A.13.1(h), OS&Y Gate Valve and Figure A.13.1(i), Non-indicating Type Gate Valve.

The following video discusses OS&Y Gate Valves. The video run time is 0:58.

Strainers

Used for protection against clogging of water discharge openings. (*NFPA* 25 2014, Section A.13.1)





Waterflow Detector Check Valves

Detector-type check valves allow flow in one direction only and have provisions for the connection of a bypass meter around the check valve. (*NFPA* 25 2014, Section A.13.1)

Refer to *NFPA* 25 2014, Figure A.13.1(c), Detector Check Valve.

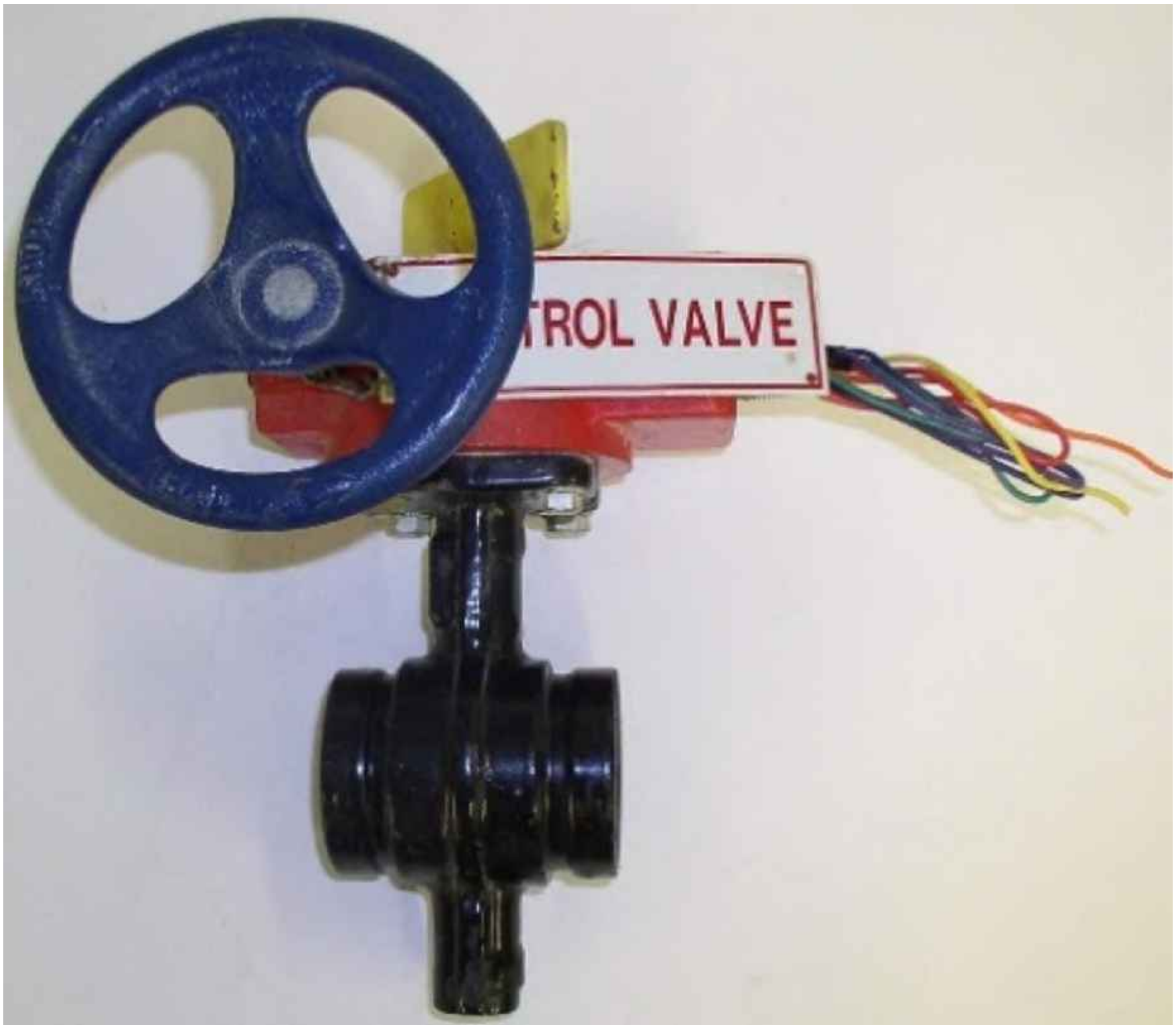
CONTROL VALVES IN SPRINKLER SYSTEMS

Control Valves in Sprinkler Systems

NFPA 25 2014, Section 13.3

Every control valve is required to be **identified** and have a **sign** that designates the system (or portion of the system) that it controls.

When a normally open valve is closed, the procedures in Chapter 15 (Impairments) are to be followed.



When the valve is returned to service, a **valve status test** (either main or sectional drain, as appropriate) shall be conducted to determine if the valve is open.

Each normally open valve shall be secured by means of a **seal or a lock, or shall be electrically supervised**. Normally closed valves shall be secured by means of a **seal or be electrically supervised** in accordance with the applicable *NFPA* standard.

Sealing or electrical supervision shall **not** be required for hose valves.

Control Valves in Sprinkler Systems – Inspection

NFPA 25 2014, Section 13.3.2.1

All valves shall be **inspected weekly**.

Valves secured with locks, or supervised per applicable *NFPA* standards, are permitted to be **inspected monthly**.

After any alterations or repairs, an inspection is required to be conducted by the owner to ensure that the system is in service, and all valves are in the normal position and properly sealed, locked, or electrically supervised.

The valve inspection shall **verify** that the valves are in the following condition:

☐ In the normal open or closed position

☐ Properly sealed, locked, or supervised

☐ Accessible

☐ PIVs are provided with appropriate wrenches

☐ Free from external leaks

☐ Provided with appropriate identification

LET'S REVIEW

Let's do a quick check about what has been covered so far.

What component is circled in the image below?

Type your answer here

SUBMIT

Complete the knowledge check above before moving on.

Control Valves in Sprinkler Systems – Testing

NFPA 25 2014, Section 13.3.3

The following section outlines the testing protocols of control valves in sprinkler systems.

Each control valve shall be **operated annually through its full range** and returned to its normal position.

A **post indicator valve** must have a **"spring test"** to verify the valve is fully open. The valve must be opened until spring tension or torsion is felt to indicate the rod has not become detached from the valve.

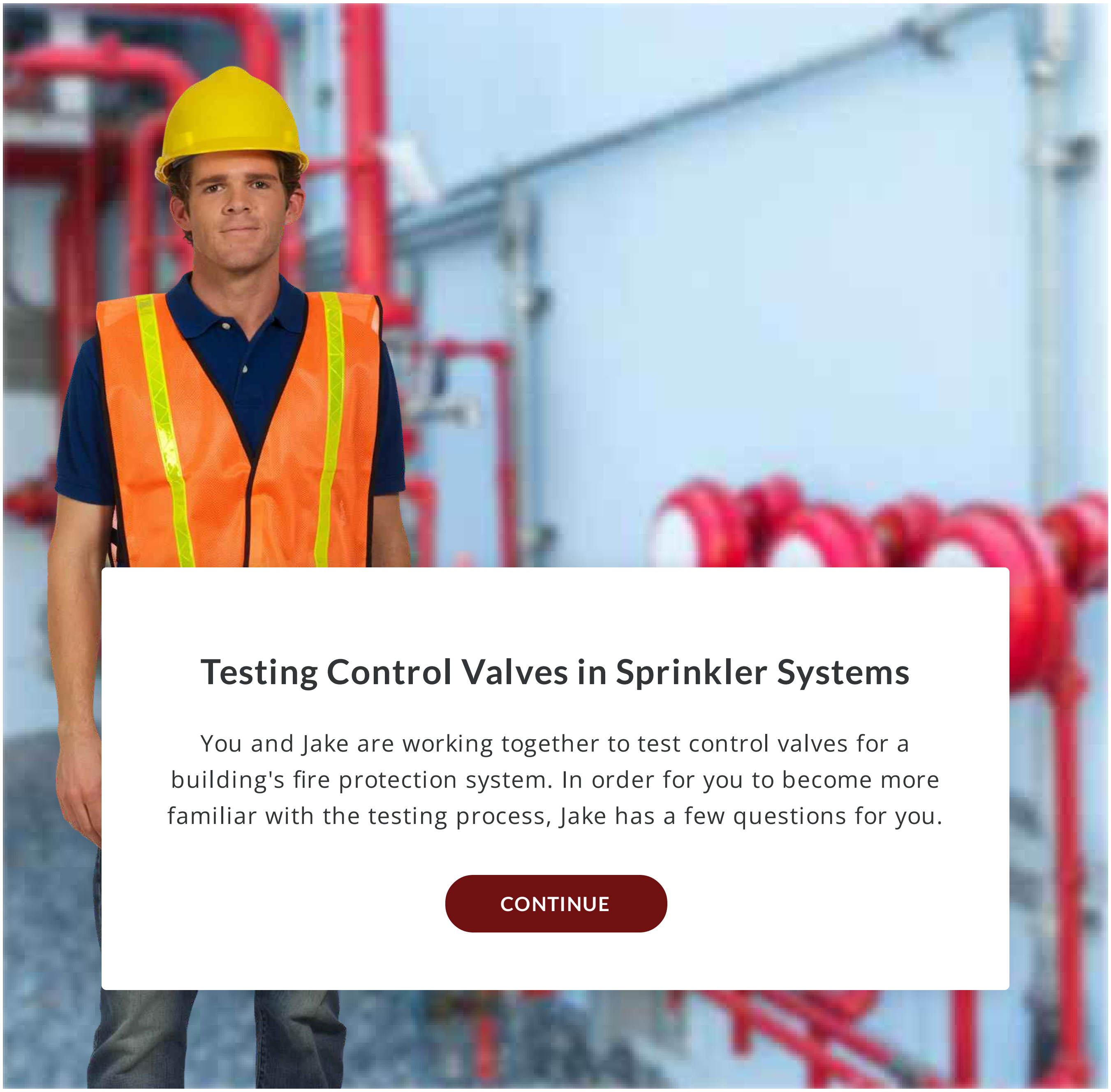
When the valve feels fully open, push in the open direction.

The handle should move approximately ¼ turn and spring back when released. If the valve is jammed, the handle will not spring back. If the valve gate is loose from the handle, the handle will continue to easily turn in the open direction. This “spring test" is to be **conducted every time the valve is closed.**

Post indicator and OS&Y valves shall be backed a ¼ turn from the fully open position to prevent jamming.

A main drain test shall be **conducted any time the control valve is closed and reopened** at the system riser.

The following scenario is based on Section 13.3.3 of *NFPA* 25 2014. Utilize your standard to answer the questions on testing control valves.

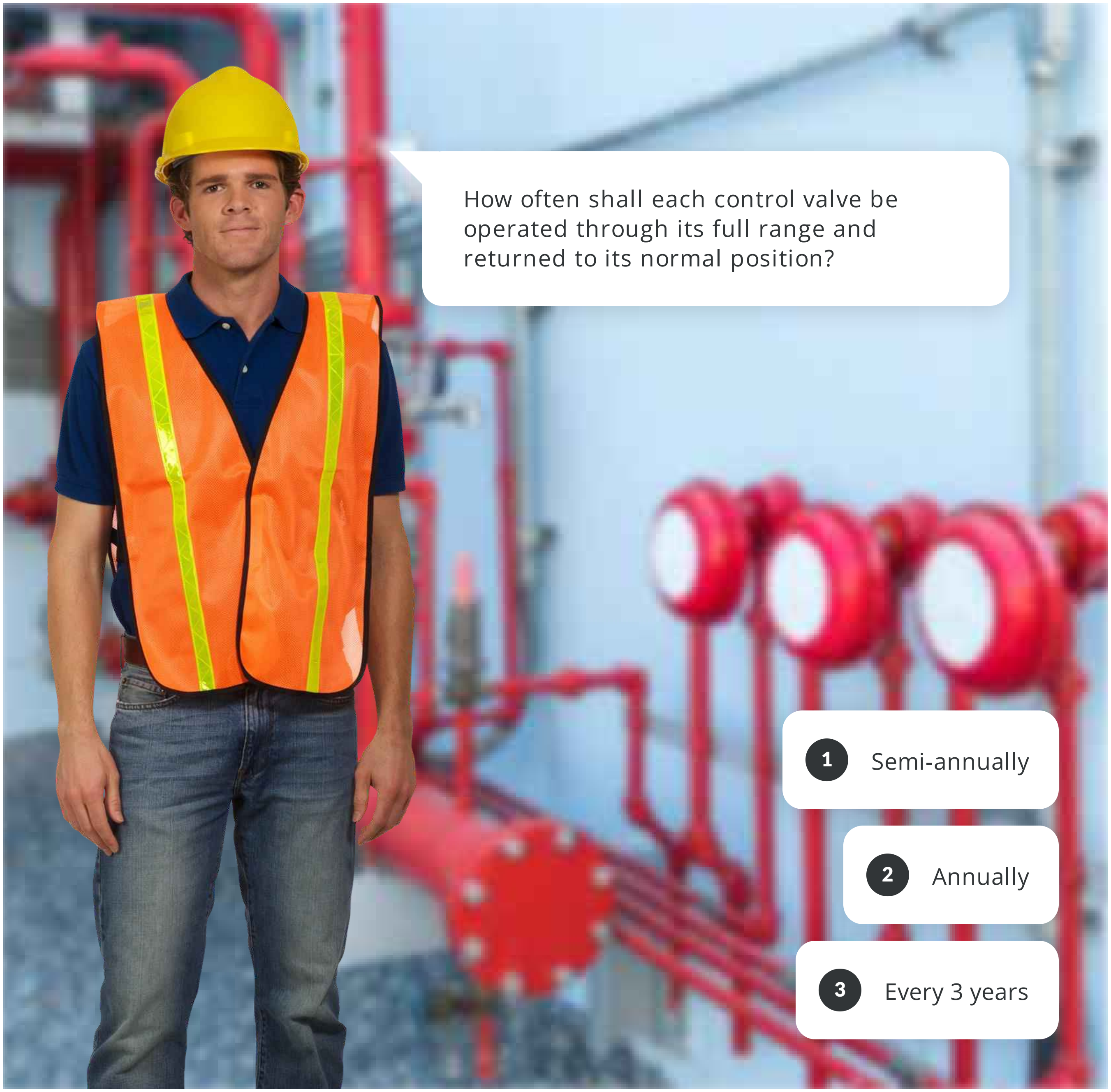


Testing Control Valves in Sprinkler Systems

You and Jake are working together to test control valves for a building's fire protection system. In order for you to become more familiar with the testing process, Jake has a few questions for you.

Scene 1 Slide 1

Continue → Next Slide



How often shall each control valve be operated through its full range and returned to its normal position?

1 Semi-annually

2 Annually

3 Every 3 years

Scene 1 Slide 2

0 → Next Slide

1 → Next Slide

2 → Next Slide

PIVs are required to be opened until spring or torsion is felt in the rod, indicating that the rod has done what?

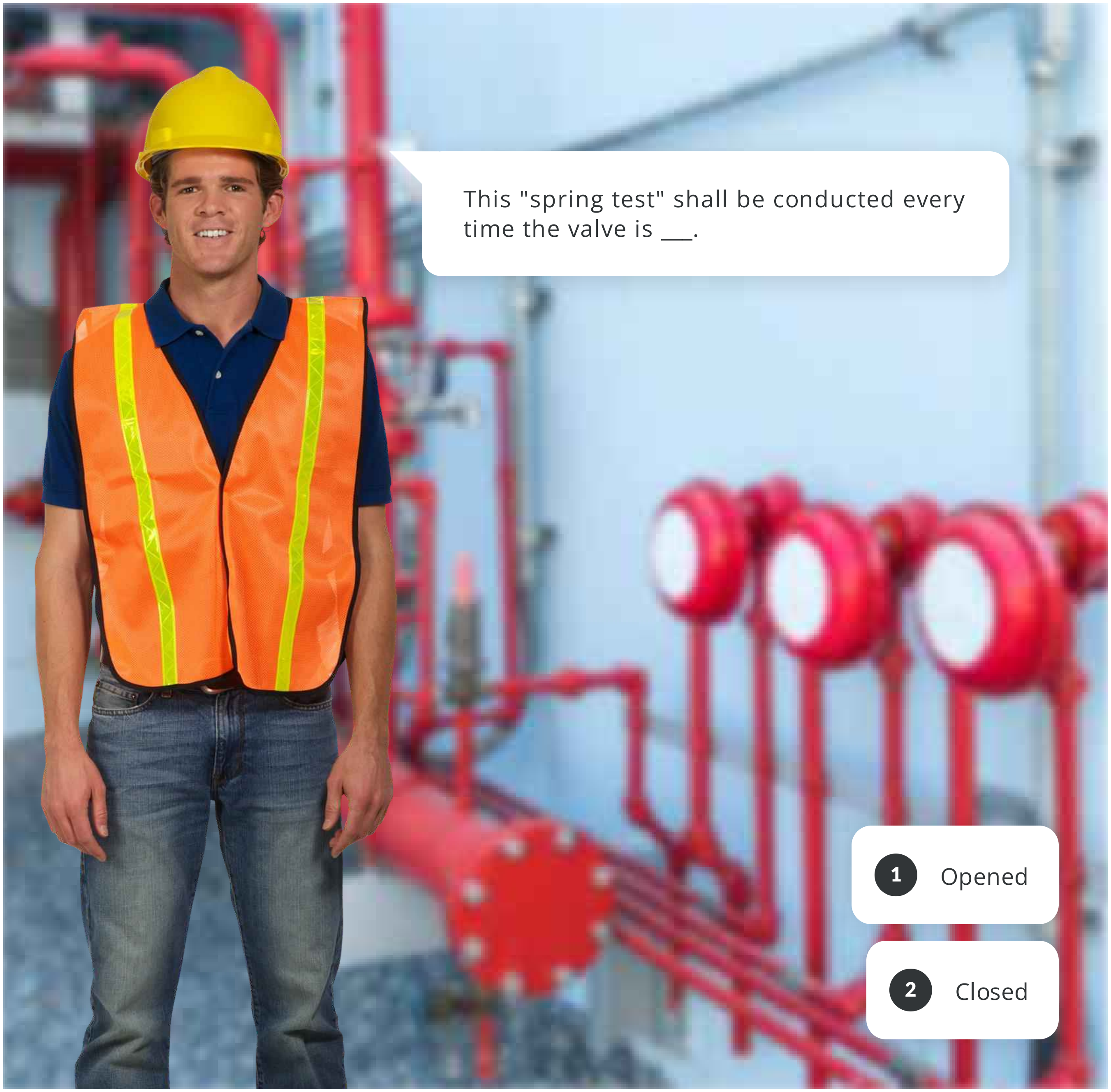
1 The rod has not become detached from the valve.

2 The rod has become detached from the valve.

Scene 1 Slide 3

0 → Next Slide

1 → Next Slide



This "spring test" shall be conducted every time the valve is ___.

1 Opened

2 Closed

Scene 1 Slide 4

0 → Next Slide

1 → Next Slide

Post indicator and OS&Y valves shall be backed how much of a turn from the fully open position to prevent jamming?

1 One-quarter

2 Half

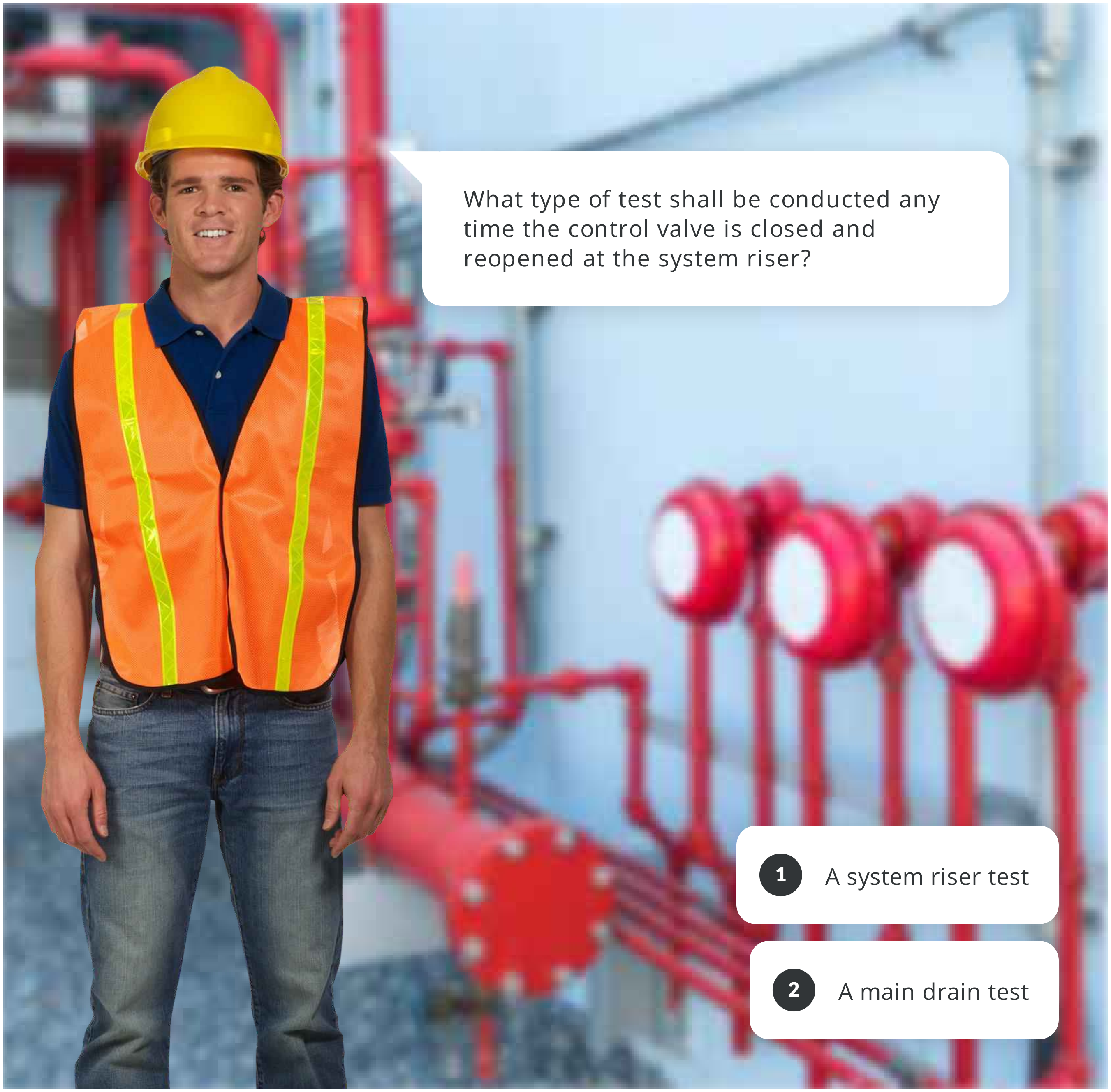
3 Full

Scene 1 Slide 5

0 → Next Slide

1 → Next Slide

2 → Next Slide



What type of test shall be conducted any time the control valve is closed and reopened at the system riser?

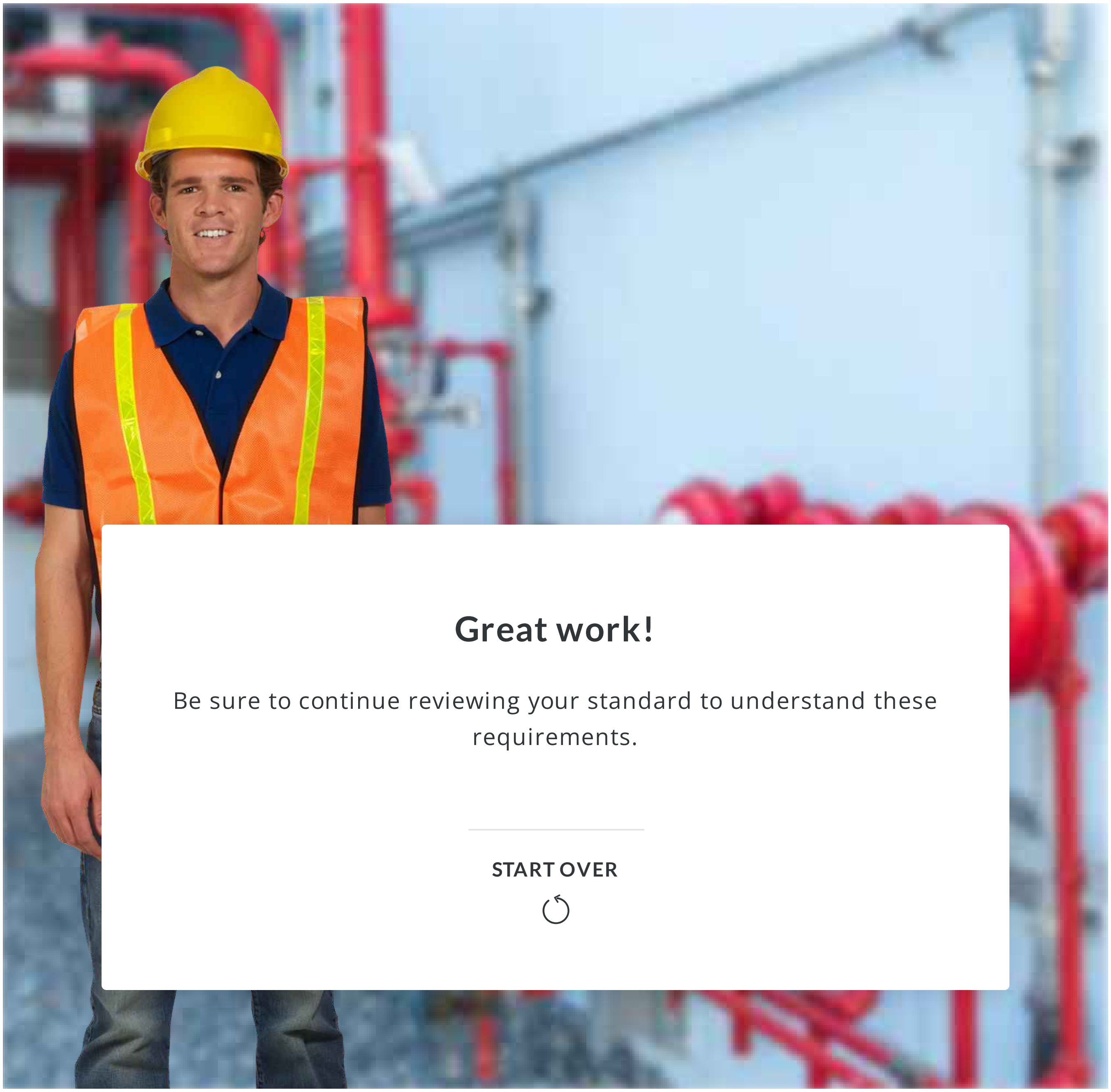
1 A system riser test

2 A main drain test

Scene 1 Slide 6

0 → Next Slide

1 → Next Slide



Great work!

Be sure to continue reviewing your standard to understand these requirements.

START OVER

↻

Scene 1 Slide 7

Continue → End of Scenario

Complete the scenario above before moving on.

Supervisory Switches

NFPA 25 2014, Section 13.3.3.5

Valve supervisory switches shall be **tested semiannually**.

A distinctive signal shall indicate movement from the valve's normal position during either the first two revolutions of a hand wheel or when the stem of the valve has moved 1/5 of the distance from its normal position.

The signal shall be restored only to the normal valve position.

MAINTENANCE

Maintenance

NFPA 25 2014, Section 13.3.4

The operating stems of OS&Y valves shall be **lubricated annually**.

The valve then shall be **completely closed and reopened** to test its operation and distribute the lubricant.

OS&Y valve

ALARM VALVES

Alarm Valves

NFPA 25 2014, Section 13.4.1

Alarm valves and system riser check valves are to be **externally inspected monthly** to verify the following:

- The gauges indicate normal supply water pressure is maintained.
- The valve is free of physical damage.
- The valves are in the appropriate open or closed position.
- The retarding chamber or alarm drains are not leaking.

Alarm valves and their associated strainers, filters, and restriction orifices shall be **inspected internally every 5 years** unless tests indicate a greater frequency is necessary.

CHECK VALVES

Check Valves

NFPA 25 2014, Section 13.4.2

Inspection

Check valves shall be inspected **internally every 5 years** to verify that all components operate correctly, move freely, and are in good condition.

Maintenance

Internal components shall be **cleaned, repaired, or replaced as necessary**, in accordance with the manufacturer's instructions.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

A(n) ___ allows waterflow in one direction only.

○ Alarm valve

○ Ball valve

○ Check valve

○ Drip valve

SUBMIT

Match the system to its appropriate testing frequency.

SUBMIT

Complete the knowledge checks above before moving on.

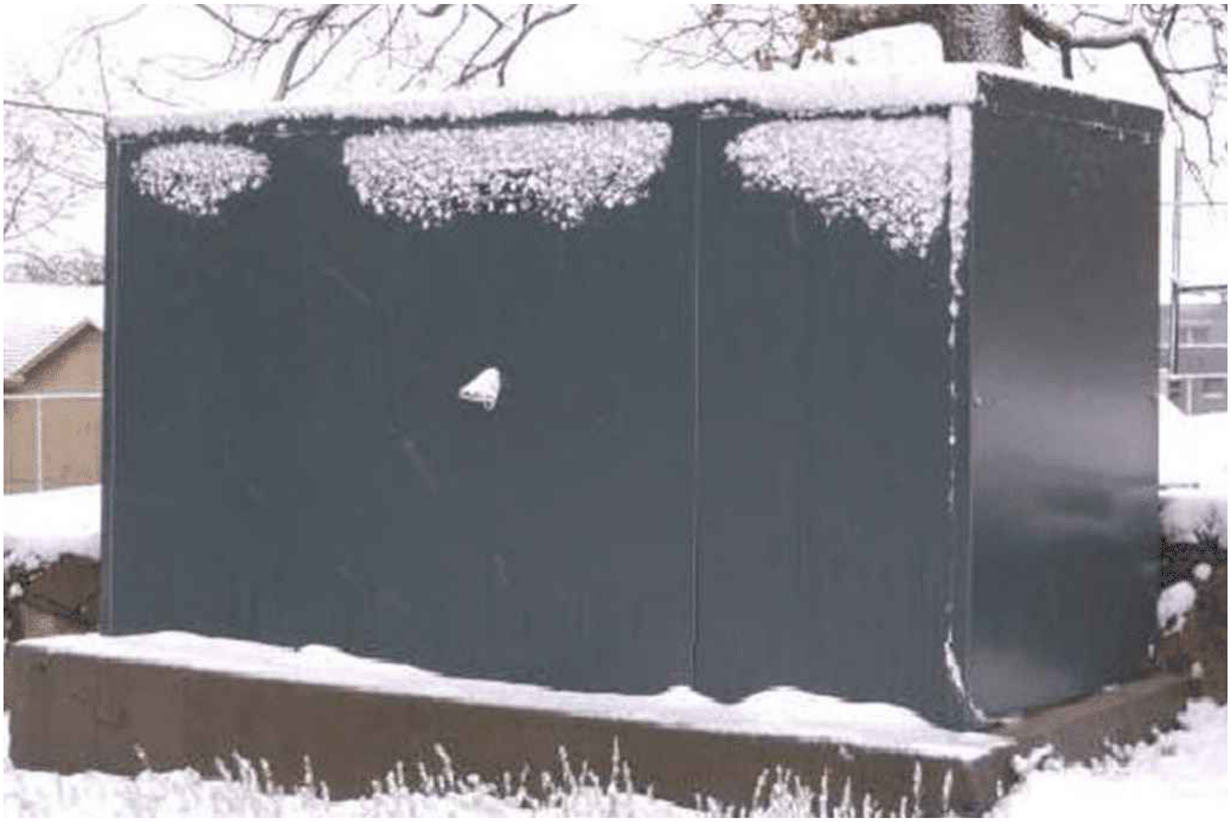
Preaction and Deluge Valves

NFPA 25 2014, Section 13.4.3.1 - Inspection

Valve enclosure heating equipment for **preaction and deluge valves**, subject to freezing, shall be **inspected daily during cold weather** for its ability to maintain a minimum temperature of at least 40° F.

Valve enclosures equipped with lower temperature alarms shall be **inspected weekly**.

Low-temperature alarms, if installed in valve enclosures, shall be **inspected annually at the beginning of the heating season**.



Gauges shall be **inspected weekly**.

The gauges on the supply side of the preaction or deluge valves shall indicate that the **normal supply water pressure** is maintained.

The gauge monitoring the detection system pressure, if provided, shall be **inspected monthly** to verify it indicates normal pressure is maintained.

CONTINUE

The preaction or deluge valve shall be **externally inspected monthly** to verify:

☐ The valve is free from physical damage.

☐ All trim valves are in the appropriate open or closed position.

☐ The valve seat is not leaking.

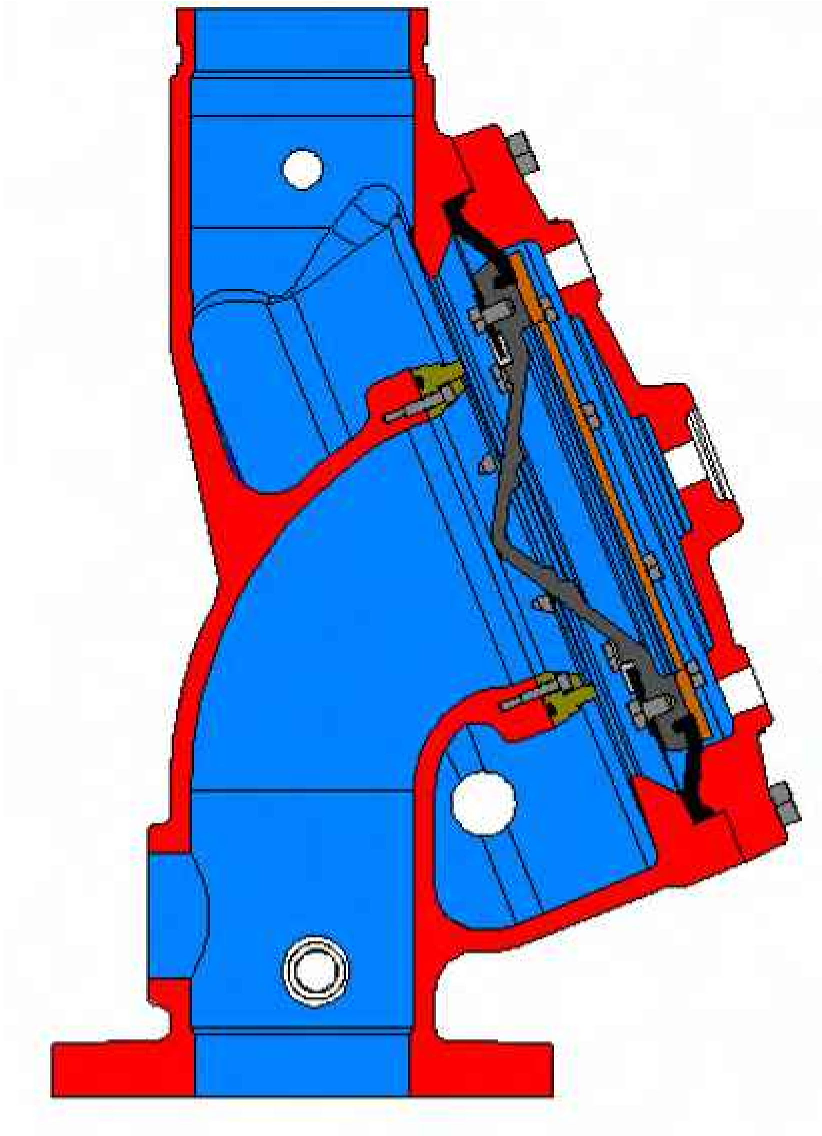
☐ Electrical components are in service.

The **interior** of the preaction or deluge valve and the condition of detection devices shall be **inspected annually when the trip test is conducted**.

Strainers, filters, restricted orifices, and diaphragm chambers shall be **inspected internally every 5 years**, unless tests indicate a greater frequency is necessary.

CONTINUE

NFPA 25 2014, Section 13.4.3.2 - Testing



Priming water in a preaction system. Image courtesy of Viking.

The priming water level in supervised preaction systems is required to be **tested quarterly** for compliance with the manufacturer’s instructions. Each deluge valve is to be **trip tested annually at full flow in warm weather**.

If the trip test cannot be conducted without shutting down protected equipment (such as energized electrical equipment), a full flow test is permitted to be conducted at the **next scheduled shutdown**.

ⓘ **Preaction or deluge valves that protect freezers are required to be trip tested in such a way that no moisture is introduced into the freezer piping. (*NFPA* 25 2014, Section 13.4.3.2.5)**

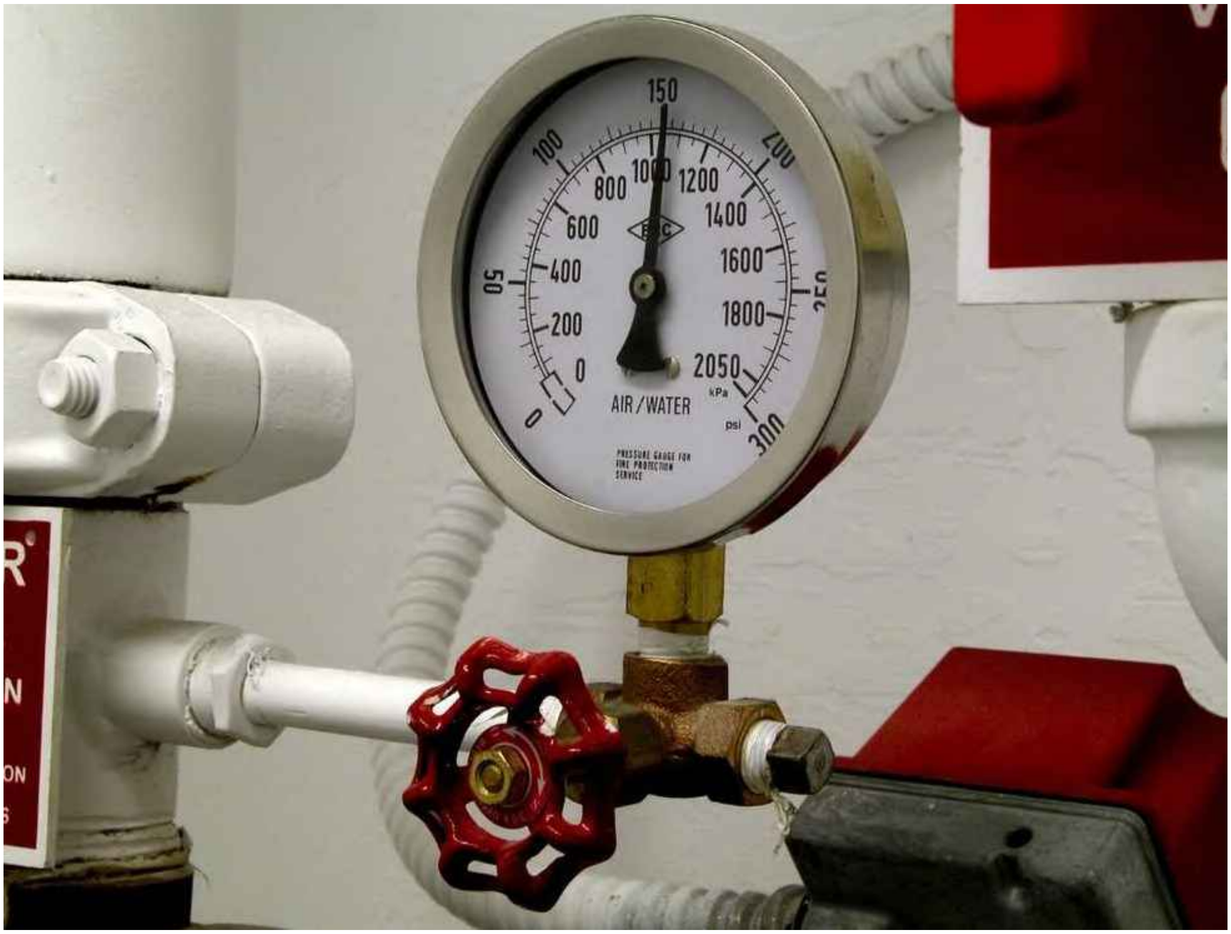
CONTINUE

The **water discharge patterns** from all open sprinklers or spray nozzles shall be observed to ensure:

- Patterns are not impeded by plugged nozzles.
- Nozzles are correctly positioned.
- Obstructions do not prevent discharge patterns from wetting surfaces to be protected.

Where the nature of the protected property is such that water cannot be discharged, the nozzles or open sprinklers shall be **inspected for proper orientation** and the system **tested with air** to ensure that the nozzles are not obstructed.

Where **obstructions** occur, the piping and sprinklers or nozzles shall be cleaned and the system retested.



Pressure readings shall be recorded at the **hydraulically most remote** nozzle or sprinkler.

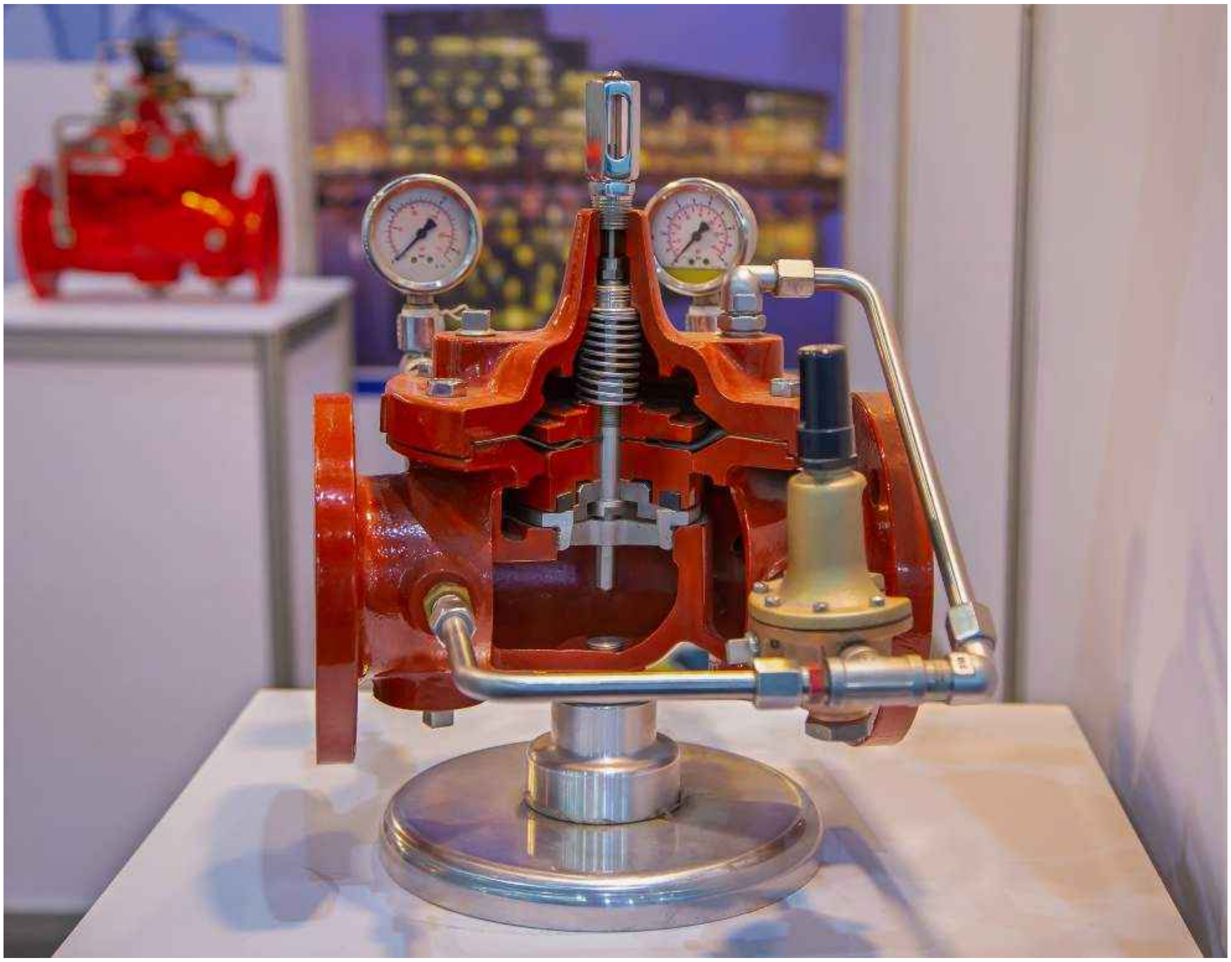
A second pressure reading shall be recorded at the **deluge valve**.

These readings shall be **compared** to the hydraulic design pressures to ensure the original system design requirements are met by the water supply.

CONTINUE

NFPA 25 2014, Section 13.4.3.3 - Maintenance

Leaks causing **drops in supervisory pressure**, sufficient to sound warning alarms and electrical malfunctions causing alarms to sound, shall be located and repaired.



Deluge valve

During the annual trip test, the interior of the preaction or deluge valve shall be cleaned **thoroughly**, and the parts replaced or repaired **as necessary**.

Interior cleaning and parts replacement or repair shall be permitted **every 5 years** for valves that can be reset without removal of a faceplate.

Auxiliary drains in preaction or deluge systems shall be **operated after each system operation** and **before the onset of freezing weather** conditions.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

When is a trip test for a deluge valve supposed to take place? (Check all that apply)

☐ Quarterly

☐ Annually

☐ In warm weather

☐ During cold weather

☐ At the next scheduled shutdown, if necessary for the protected equipment

☐ Any time, any place

SUBMIT

Section 13.4.3.2.7 requires pressure readings for deluge systems to be recorded at the hydraulically most remote nozzle or sprinkler. A second pressure reading is required to be taken _____.

○ On the supply side of the valve

○ At the hydraulically most remote nozzle or sprinkler

○ At the deluge valve

SUBMIT

Complete the knowledge checks above before moving on.

Dry Pipe Valves and Quick Opening Devices

NFPA 25 2014, Section 13.4.4 - Inspection

Valve enclosure heating equipment for these valves shall be **inspected daily during cold weather** to ensure a minimum temperature of at least 40° F.

Valve enclosures equipped with low-temperature alarms shall be **inspected weekly**.

Low-temperature alarms, if installed in valve enclosures, shall be **inspected annually at the beginning of the heating season** to confirm they are free from damage.

The gauge on the **supply side** of the dry pipe valve shall indicate that the **normal supply water pressure** is being maintained.

The gauge on the **system side** of the dry pipe valve shall indicate that the **proper ratio of air or nitrogen pressure** to water supply pressure is being maintained.

The gauge on the quick-opening device, if provided, shall indicate the same pressure as the gauge on the system side of the dry pipe valve. (*NFPA* 25 2014, Section 13.4.4.1.2.3)

CONTINUE

The **interior** of the dry pipe valve shall be **inspected annually** when the trip test is conducted.

The dry pipe valve is required to be **inspected monthly** to verify the following:

☐ The valve is free from physical damage.

☐ All trim valves are in the appropriate open or closed position.

☐ The intermediate chamber is not leaking.

Strainers, filters, and restricted orifices shall be **inspected internally every 5 years**, unless tests indicate a greater frequency is necessary.

CONTINUE

NFPA 25 2014, Section 13.4.4.2 - Testing

The priming water level shall be **tested quarterly**.

Each dry pipe valve shall be **trip tested annually during warm weather**.

Each dry pipe valve protecting freezers shall be trip tested in a manner that **does not introduce moisture** into the piping in the freezers.

Grease or other sealing materials shall **not be applied** to the seating surfaces of dry pipe valves.

ⓘ Quick-opening devices, if provided, are required to be tested quarterly. (*NFPA* 25 2014, Section 13.4.4.2.4)

Testing

Click on the "Start" button below to view the following testing protocols for dry pipe valves/quick opening devices as outlined in *NFPA* 25 2014, Section 13.4.4.2.

1

Attach tag or card

A **tag or card** is to be attached to the valve, showing:

- The **date** on which the dry pipe valve was last tripped.
- The **name** of the person and organization conducting the test.

2

Record keeping

Separate records of initial air and water pressure, tripping air pressure, and dry pipe valve operating conditions shall be maintained on the premises for **comparison with previous test results**.

Records of tripping time shall be maintained for full flow trip tests.

3

If the following alarms/devices are provided:

Low air pressure alarms, if provided, shall be tested **quarterly**.

Low-temperature alarms, if installed in valve enclosures, shall be tested **annually at the beginning of the heating season**.

Automatic air pressure maintenance devices, if provided, shall be tested **annually during the dry pipe valve trip test** in accordance with the manufacturer's instructions.

CONTINUE

Dry pipe systems shall be **tested once every 3 years** for air leakage, using one of the following:

- A gas (air or nitrogen) pressure test at 40 psi is required for 2 hours.
  - The system is permitted to lose up to 3 psi during this test period.
  - Gas leaks are required to be addressed if the system loses more than 3 psi during the test.
- With the system at normal system pressure, shut off the air source for 4 hours. If the low air pressure alarm goes off within this period, the air leaks need to be addressed.

HOSE VALVES

Hose Valves

NFPA 25 2014, Section 13.5.6.1 - Inspection

Hose valves shall be **inspected quarterly** and all deficiencies shall be corrected.

The following are to be **verified during the inspection**:

- Hose caps are in place and not damaged.

- Hose threads are not damaged.
- Valve handles are present and not damaged.
- Gaskets are not damaged or show signs of deterioration.
- No leaks are present.
- Valves are not obstructed or incapable of being normally operated.

CONTINUE

NFPA 25 2014, Section 13.5.6.2 - Testing

Class I and Class III standpipe system hose valves are to be **tested annually** by fully opening and closing the valves.

Hose valves on hose stations attached to sprinkler systems and Class II standpipe systems are required to be **tested every 3 years** by opening and closing the valves.

Hose valves that are **difficult to operate or that leak** shall be repaired or replaced.

NFPA 25 2014, Section 13.5.6.3 - Maintenance

Hose valves that do not operate smoothly or open fully shall be **lubricated, repaired, or replaced**.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

When are low temperature alarms required to be inspected to confirm they are free from damage?

○ Semiannually at the beginning of the heating season

○ Semiannually at the beginning of the summer

○ Annually at the beginning of the heating season

○ Annually at the beginning of the summer

SUBMIT

When a dry pipe valve trip test is completed, what information is required to be recorded on the tag attached to the valve? (Check all that apply)

☐ Date of the last warm day

☐ Date on which the dry pipe valve was last tripped

☐ Location of the dry pipe valve

☐ Name of the person and organization conducting the test

☐ Initial air and water pressure

SUBMIT

Complete the knowledge checks above before moving on.

Backflow

NFPA 25 2014, Section 13.6 - Inspection

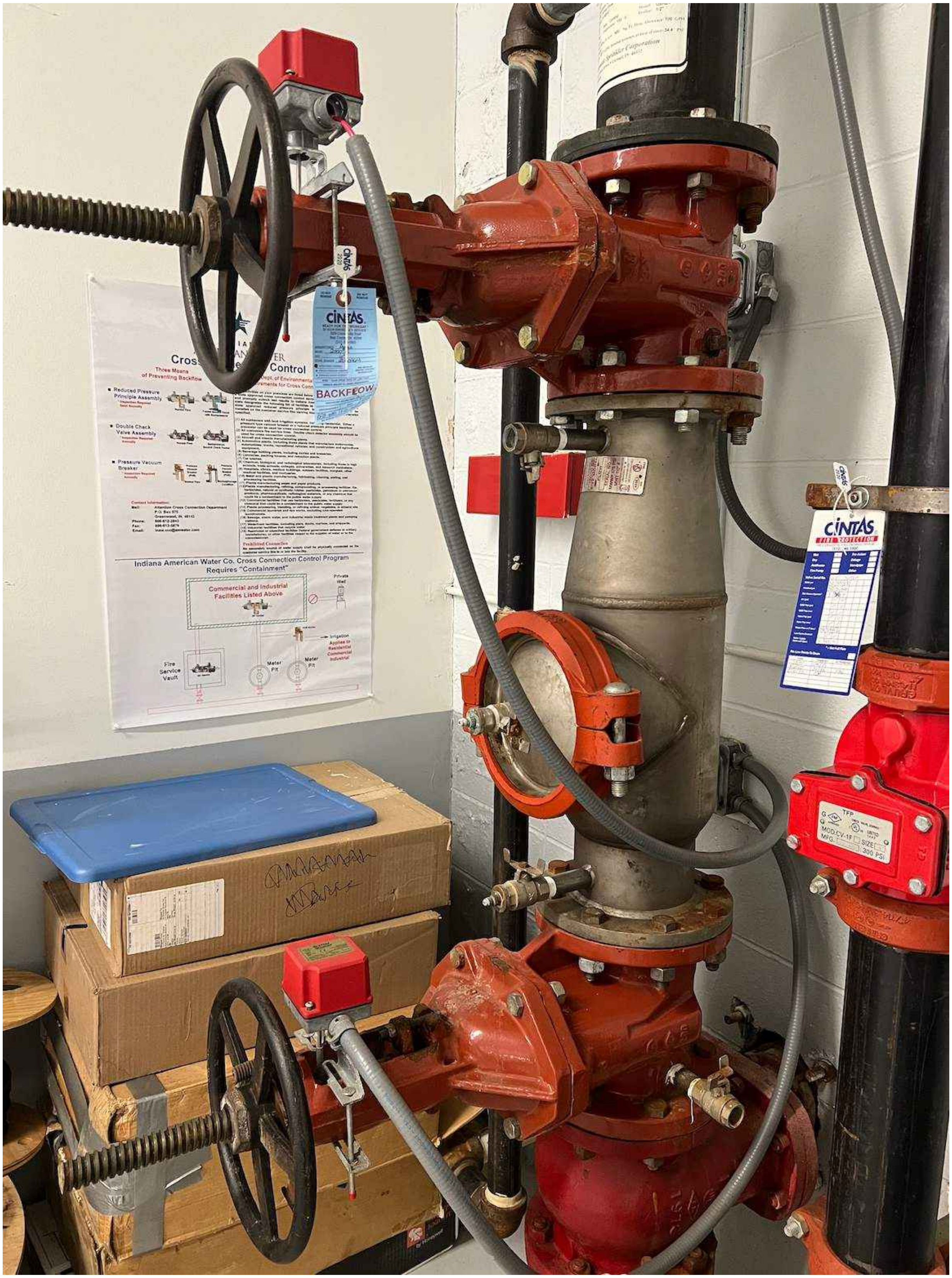
The isolation valves on **double-check assemblies (DCA)** and **double-check detector assemblies (DCDA)** are required to be **inspected weekly** to ensure that the OS&Y isolation valves are in the normal open position.

Valves secured with locks or electrically supervised in accordance with applicable *NFPA* standards shall be **inspected monthly**.

Double Check Detector Assemblies. Images courtesy of Viking

Reduced pressure assemblies (RPA) and **reduced pressure detector assemblies (RPDA)** shall be **inspected weekly** to confirm that the differential-sensing valve relief port is not continuously discharging.

After any testing or repair, an **inspection by the owner** shall be made to ensure that the system is in service, and all isolation valves are in the normal open position and properly locked or electrically supervised.



Backflow preventer on wet system riser

CONTINUE

NFPA 25 2014, Section 13.6.2 - Testing

All backflow prevention devices installed in fire protection piping shall be **tested annually** by conducting a forward flow test at the **minimum rate** of the system demand.

Where **water rationing** is enforced during shortages lasting more than 1 year, an **internal inspection** of the backflow preventer is permitted in lieu of conducting the annual forward flow test. This internal inspection needs to ensure the check valves will fully open.

The forward flow test shall not be required where annual fire pump testing causes the system demand to flow through the backflow preventer device.

Where connections do not permit a full flow test, tests shall be conducted at the **maximum flow rate** possible.

NFPA 25 2014, Section 13.6.3 - Maintenance

Maintenance of all backflow prevention assemblies shall be conducted by a trained individual following the manufacturer's instructions in accordance with the procedures and policies of the AHJ.

FIRE DEPARTMENT CONNECTIONS

Fire Department Connections

NFPA 25 2014, Section 13.7

Fire department connections (FDCs) shall be **inspected quarterly**, verifying the following:

☐ FDCs are visible and accessible.

☐ Couplings or swivels are not damaged and rotate smoothly.

☐ Plugs or caps are in place and undamaged.

☐ Gaskets are in place and in good condition.

☐ Identification signs are in place.

☐ The check valve is not leaking.

☐ The automatic drain valve is in place and operating properly.

☐ The FDC clapper(s) is in place and operating smoothly.

☐ Interior of the connection is inspected for obstructions.

Components shall be **repaired** or **replaced** as necessary in accordance with the manufacturer's instructions. Any obstructions that are present shall be **removed**.

CONTINUE

NFPA 25 2014, Section 13.7.4

FDC hydrostatic tests are required to be **conducted at least once every 5 years**, at 150 psi for 2 hours, testing the piping from the FDC to the fire department check valve.

Note there is a difference between this requirement and the hydrostatic test described in Section 6.3.2.1 for manual and semiautomatic dry standpipe systems.

- When the hydrostatic test is conducted in conjunction with both a standpipe system and FDC, the 200 psi hydrostatic test requirement in Section 6.3.2.1 applies to both the standpipe and the piping in the FDC.
- When only the FDC is tested, the 150 psi applies, per Section 13.7.4.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

A forward flow test on the backflow preventer is required to be conducted annually, even if water rationing is enforced during water shortages lasting for more than one year.

○ True

○ False

SUBMIT

How often shall FDC components be repaired or replaced?

○ As necessary

○ Quarterly

○ Annually

○ Every 5 years

SUBMIT

Complete the knowledge checks above before moving on.

By now, you should have a better understanding of fire sprinkler systems: why they're important, how they work, and how they're regulated.

If there is any section you'd like to go back and review, please feel free!

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.

Ohio Automatic Sprinkler & Standpipe Systems - Ohio Building Code & Ohio Fire Code

When you are ready to get started, click on the "**Begin**" button.

This module will provide information on SOME of the Ohio Building Code and Ohio Fire Code requirements for automatic sprinkler and standpipe systems.

It is not meant as a Building and Fire Code course, but to familiarize you with a few of the requirements.

Many of the requirements are the same or very similar to requirements from *NFPA* 13, The Standard for the Installation of Sprinkler Systems, 2016 edition.

In other instances, the Ohio Building and Ohio Fire Code will refer you back to *NFPA* 13D 2016, *NFPA* 13R 2016, *NFPA* 14 2016, and *NFPA* 25 2014 for the necessary requirements, inspection, testing, and maintenance of sprinkler and standpipe systems.

You can reference the Ohio Building Code at: https://codes.iccsafe.org/content/OHBCU2017/cover

You can reference the Ohio Fire Code at: http://codes.ohio.gov/oac/1301:7-7-09.

Key References for this module:

- Ohio Building Code - Fire Protection Systems
    - https://codes.iccsafe.org/content/OHBCU2017/chapter-9-fire-protection-systems
- Ohio Fire Code - Fire Protection Systems
    - https://codes.iccsafe.org/content/OHFCJAN2019E/ohio-administrative-code-1301-7-7-09-fire-protection-systems

Section 901 Fire Protection Systems

Section 903 – Automatic Sprinkler Systems

Section 905 – Standpipe Systems

Lesson 1 of 3

Section 901 Fire Protection Systems

Goals for this lesson:

- Gain a working knowledge of the Ohio Building Code and Ohio Fire Code general requirements for fire protection.
- Identify NFPA standards associated with different types of fire protection systems.
- Recognize acceptance testing and related documentation requirements.
- Follow the correct procedures for all system impairments.

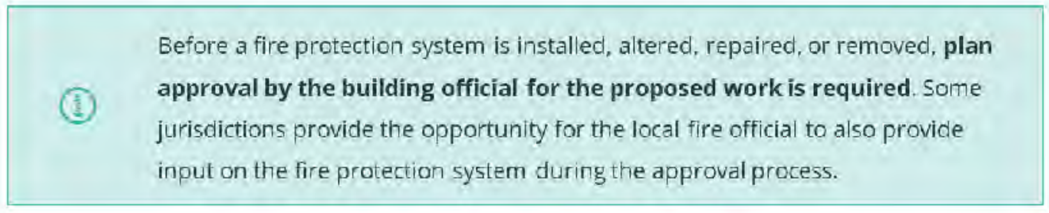
LET'S GET STARTED

Section 901

Fire Protection Systems

The Ohio Building Code and the Ohio Fire Code provide numerous requirements pertaining to fire protection systems. While the **majority of the requirements are found in Chapter 9** of the Ohio Building Code and Section 7-7-09 of the Ohio Fire Code, **Chapter 4 of the Ohio Building Code also contains special requirements to use for fire protection-related systems**, including high-rise buildings, malls, and atriums. We encourage you to be familiar with the requirements in both of these Codes.

Chapter 9 of the Ohio Building Code and **Section 901 of the Ohio Fire Code** apply to the **design**, **installation**, and **operation** of fire protection systems. These systems are to be **installed, repaired, operated, and maintained** per the Ohio Building Code and the Ohio Fire Code requirements.



Before a fire protection system is installed, altered, repaired, or removed, **plan approval by the building official for the proposed work is required**. Some jurisdictions provide the opportunity for the local fire official to also provide input on the fire protection system during the approval process.

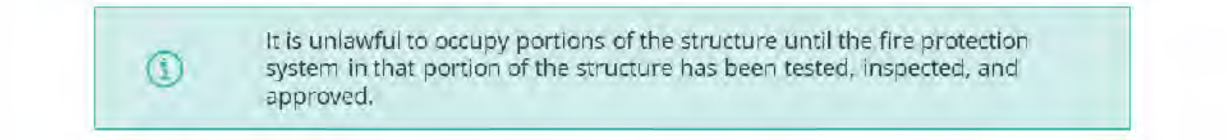
ACCEPTANCE TESTING

Acceptance Testing

Advanced coordination for all acceptance testing is to be provided to the building official, in the event the building official or the fire official requires a certified building inspector or certified fire protection system inspector to be present to witness these tests.

Note: The Ohio Fire Code requires at least 48 hours advanced notification of the test schedule to be provided to the fire official.

- Acceptance tests are to **follow Ohio Building Code and Fire Code requirements**, as well as the **applicable NFPA standards** for the portion of the fire protection system undergoing acceptance testing.
- All tests are to be **conducted at the owner's expense**, in the presence of either those who installed the equipment or their company's representative.
- The test **results are to be documented** and completed certificates are submitted to the building official and the fire official.
- Copies of the test **records are to be maintained on-site** and readily available to the inspector during the final inspection.



It is unlawful to occupy portions of the structure until the fire protection system in that portion of the structure has been tested, inspected, and approved.

Neither modification to nor removal of the fire protection system is permitted without advanced consent of the building official with input from the fire official.

CONTINUE

The Ohio Fire Code requires fire protection systems to be inspected, tested, and maintained per the requirements of their associated NFPA standard, as shown in **Table 901.6.1**.

Ohio Fire Code Table 901.6.1
Fire Protection Systems Maintenance Standards

System	Standard (As Listed in Rule 1301:7-7-80 of the Administrative Code)
Portable fire extinguishers	NFPA 10
Carbon dioxide fire-extinguishing systems	NFPA 12
Halon 1301 fire-extinguishing systems	NFPA 12A

Ohio Fire Code Table 901.6.1 Fire Protection Systems Maintenance Standards	
Dry-chemical extinguishing systems	NFPA 17
Wet-chemical extinguishing systems	NFPA 17A
Water-based fire protection systems	NFPA 25
Fire alarm systems	NFPA 72
Smoke and heat vents	NFPA 204
Water-mist systems	NFPA 750
Clean-agent extinguishing systems	NFPA 2001

ACCEPTANCE TESTING RECORDS

Acceptance Testing Records

Maintain records of all system inspections, tests, and maintenance tasks. Initial records shall be maintained for the life of the installation and include the following:

☑ Installation contractor ________

☑ Component manufacturers ________

☑ Location & number of components installed per floor ________

☑ Manufacturer's operation & maintenance instruction manuals

- Name of the installation contractor
- Component manufacturers
- Location and number of components installed per floor
- Manufacturer’s operation and maintenance instruction manuals

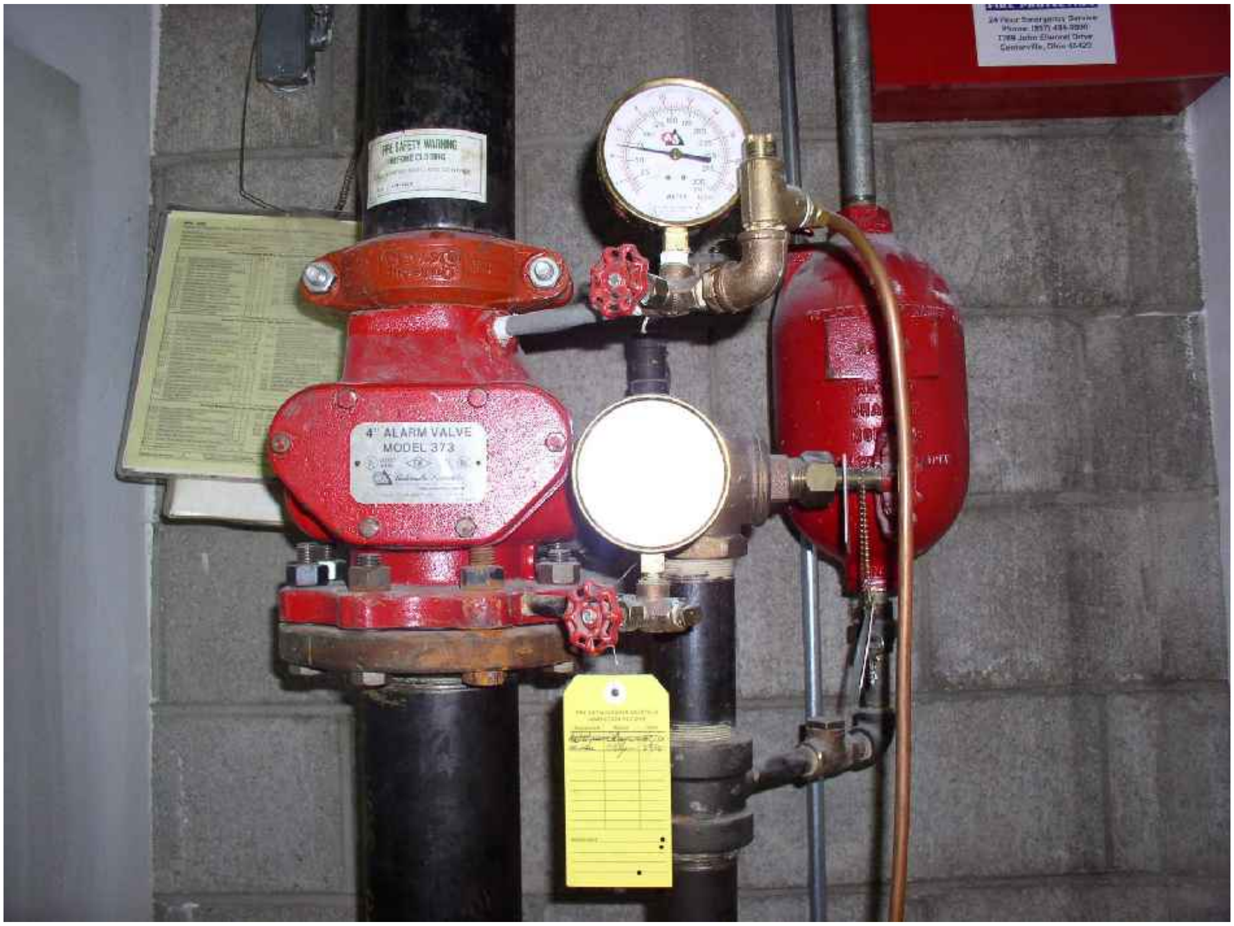
Acceptance testing records are required to be retained for the life of the system.

CONTINUE

The Ohio Fire Code additionally requires inspection tags to be attached to each fire protection system near the main control valve, main panel, or other appropriate visible locations as determined by the fire official. The annual inspection tag contains the following:

- The individual performing the work and the state fire marshal installer certification number(s) (if applicable)

- Date of test
- Results of inspection and test
- Deficiencies or impairments noted (yes or no)
- For sprinkler or standpipe systems, this tag requirement includes an impairment tag per NFPA 25



When a fire protection system is out of service, the fire department and fire official are to be notified immediately, and the building evacuated or an approved fire watch provided, per the discretion of the fire official, until the fire protection system is returned to service.

An impairment coordinator is to be assigned to the building and a tag is posted at each fire department connection, system control valve, fire alarm control unit, fire alarm annunciator, and fire command center indicating that the system (or portion thereof) has been removed from service. The fire official shall determine tag placement.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

It is acceptable to occupy the structure prior to approval by the fire code official as long as the acceptance test is complete.

○ True

○ False

SUBMIT

Initial records shall be maintained for the life of the installation and include the following:

☐ Component manufacturers

☐ Manufacturer’s operation and maintenance instruction manuals

☐ Name of the installation contractor

☐ Name and identification number of the AHJ

☐ Location and number of components installed per floor

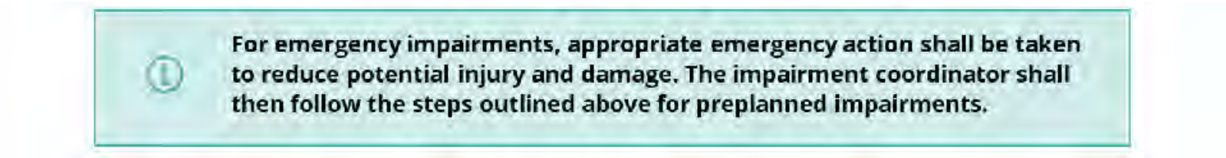
SUBMIT

PREPLANNED IMPAIRMENTS

Preplanned Impairments

Preplanned impairments require prior authorization by the impairment coordinator. Prior to approval, the following procedures shall be implemented and verified:

- **Determine the extent** and expected duration of the impairment
- **Inspect the areas** of the building involved to assess the increased risks
- **Submit recommendations** to management or the building owner
- **Notify** the fire department, the insurance carrier, the alarm company, the building owner, and other appropriate AHJs
- **Notify any supervisors** in the affected areas
- **Implement** a tag impairment system
- **Confirm** all needed tools and materials are on-site



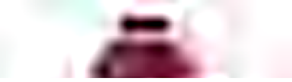
For emergency impairments, appropriate emergency action shall be taken to reduce potential injury and damage. The impairment coordinator shall then follow the steps outlined above for preplanned impairments.

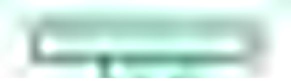
CONTINUE

Once the impaired equipment is ready to be restored to normal operations, the impairment coordinator needs to confirm the following procedures have been implemented:

- **Verify** by inspection and test that the affected systems are operational
- **Notify** supervisors that the system has been restored
- **Notify** the fire department, building owner, insurance carrier, alarm company and other appropriate parties that the system has been restored
- **Remove** the impairment tag

Note that it is unlawful to remove, tamper with, or disturb any of the following, except when extinguishing a fire, during training, or when recharging/repairing a system:





Fire hydrant

Fire detection and alarm system

Fire suppression system

Other fire appliances

When supervisory services are terminated, the fire official is required to be notified within 24 hours.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Once the impaired equipment is ready to be restored to normal operations, the impairment coordinator needs to confirm the following have been notified:

☐ Supervisors

☐ Fire Department

☐ Building owner

☐ Insurance carrier

SUBMIT

Preplanned impairments require prior authorization by the impairment coordinator.

○ True

○ False

SUBMIT

CONTINUE TO NEXT LESSON: SECTION 903 AUTOMATIC SPRINKLER SYSTEMS

Lesson 2 of 3

Section 903 – Automatic Sprinkler Systems

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Gain a working knowledge of Ohio Building Code and Ohio Fire Code requirements for automatic sprinkler systems.

☐ Compare the installation requirements of sprinkler systems for different locations.

☐ Follow the supervision and monitoring requirements for sprinkler systems.

INTRODUCTION

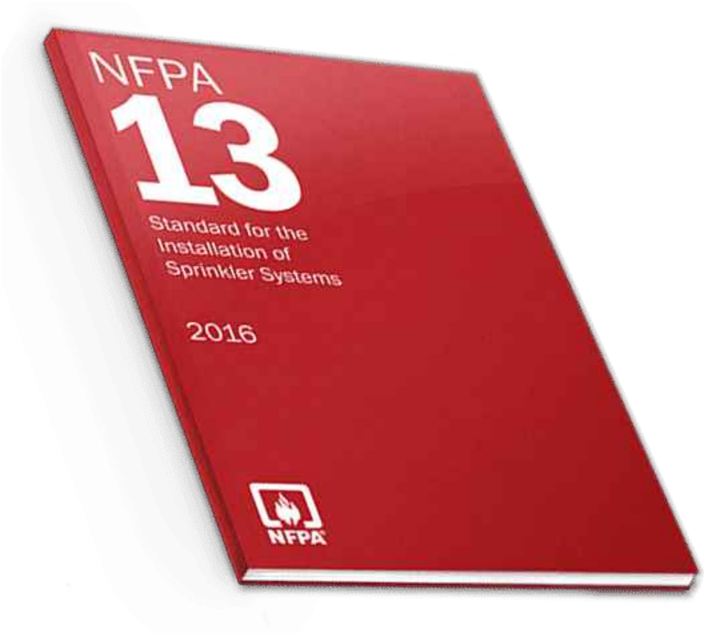
Introduction

This module will provide information on **some** of the Ohio Building Code and Ohio Fire Code requirements for **automatic sprinkler and standpipe systems**.

It is **not** meant as a Building and Fire Code course, but to **familiarize** you with a few of the requirements.

Many of the requirements are the **same or very similar** to requirements from *NFPA* 13, The Standard for the Installation of Sprinkler Systems, 2016 edition.

In other instances, the Ohio Codes will refer you back to *NFPA* 13D 2016, *NFPA* 13R 2016, *NFPA* 14 2016, and *NFPA* 25 2014 for the necessary requirements, inspection, testing, and maintenance of sprinkler and standpipe systems.



Fire Protection Systems portion

You can reference the Ohio Building Code and use this button to take you to the fire protection systems portion of the Building Code.

CLICK HERE

Fire Protection Systems portion

You can reference the Ohio Fire Code and use this button to take you to the fire protection systems portion of the Fire Code

CLICK HERE

CONTINUE

The Ohio Building Code lists all the sections that deal with sprinkler systems in **Chapter 35**, Referenced Standards. Similarly, the **Ohio Fire Code** lists these sections in **Section 1301:7-7-80**.

Referenced Standards Table

You can take a look at the table by clicking on this button.

The information we are looking for is on the *NFPA* table under the "Standard Reference Number" column and titled "13-16."

CLICK HERE

Per the *NFPA* table, the sections of the building code covering automatic sprinkler systems are:

- Section 903.3
- Section 904.12
- Section 905.3.4
- Section 907.6.4
- Section 914.3.2
- Section 1019.3
- Section 1103.4.8
- Section 3201.1
- Section 3204.2

We will not cover every section listed above but will provide information so that you **get a feel for what both the Ohio Building Code and the Ohio Fire Code entail**.

OHIO BUILDING CODE AND OHIO FIRE CODE SECTION 903

Ohio Building Code and Ohio Fire Code, Section 903

Section 903, Automatic Sprinkler Systems, outlines the requirements with which automatic sprinkler systems must comply.

Throughout this module, we'll dive into information on the installation requirements, location and placement requirements, water supply, and supervision and monitoring of sprinkler systems as discussed in this section of the Code.

ⓘ **Subsections of Section 903.2 outline additional requirements and exceptions for automatic sprinkler systems in terms of location and occupancy.**

SECTION 903.3: INSTALLATION REQUIREMENTS

Installation Requirements, Section 903.3

Section 903.3 discusses the requirements for the design and **installation** of automatic sprinkler systems.

Exempt Locations, Section 903.3.1.1.1

Sprinkler systems are **required to be installed per *NFPA* 13 2016** requirements but are **not required** in rooms or areas protected with automatic fire detection systems that respond to visible or invisible particles of combustion.

Sprinklers are **not permitted to be omitted** from a room because it is damp, consists of fire-resistance-rated construction, or contains electrical equipment.

CONTINUE

Bathrooms, Section 903.3.1.1.2

Sprinkler systems are **not required in bathrooms of Group R** occupancies (with the **exception of Group R-4**). These bathrooms must be no larger than 55 ft^2, located within individual dwelling units or sleeping units, with walls and ceilings made of non-combustible or limited-combustible materials with a 15-minute thermal barrier rating.

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CONTINUE

NFPA 13R Systems, Section 903.3.1.2

Automatic sprinkler systems in **Groups I-1, I-4, and R occupancies are permitted to be installed per *NFPA* 13R 2016 requirements**, which pertains to residential occupancies up to and including four stories in height in buildings not exceeding 60 ft. in height above grade plane.

Sprinkler protection is **required** for exterior balconies, decks, and ground floor patios of dwelling units and sleeping units in buildings of Type V construction, if there is a roof or deck above.

If sidewall sprinklers are used to protect these areas, they are to be located with their deflectors within **1-6 in. below the structural members**, with a **maximum distance of 14 in. below** the deck of exterior balconies and decks that are constructed of open wood joist construction.

Sprinkler protection is **required** in open-ended corridors and associated exterior stairways and ramps.

CONTINUE

NFPA 13D Systems, Section 903.3.1.3

Automatic sprinkler systems installed in buildings of **Groups I-1, R-3, R-4 Condition 1, and townhouses are permitted to be installed per *NFPA* 13D 2016** requirements.

LET'S REVIEW

Based on the Ohio Building Code, Ohio Fire Code, and *NFPA* 13 2016, decide if each room/area requires a sprinkler system or not.

Not Required

Area with fire detection systems that respond to visible or invisible particles

Bathrooms of Group R occupancies

Required

Room that consists of fire-resistance-rated construction

Area that contains electrical equipment

If sidewall sprinklers are used to protect the ground floor patio of a dwelling unit, they can be located with their deflectors 4 in. below the structural members.

○ True

○ False

SUBMIT

Complete the knowledge checks above before moving on.

Quick-Response and Residential Sprinklers, Section 903.3.2

In areas where sprinkler systems are required, quick-response or residential sprinklers are to be **installed in each of the following areas**:

- All spaces within a smoke compartment containing **care recipient sleeping units** in Group I-2 occupancies
- All spaces within a smoke compartment containing **treatment rooms in ambulatory care facilities**
- **Dwelling units** and **sleeping units** in Group I-1 and R occupancies
- **Light hazard occupancies** as defined in *NFPA* 13 2016

CONTINUE

Obstructions, Section 903.3.3

Obstructions can potentially delay sprinkler activation or impede the water spray from the sprinklers. **Location and placement** of sprinklers are important considerations to **avoid this problem**.

Additional sprinkler protection is **required** in or under covered kiosks, displays, booths, concession stands, or equipment that **exceeds 4 ft. in width**.

The **minimum clearance permitted** between automatic sprinklers and the top of storage is **3 ft**.

CONTINUE

Water Supplies, Section 903.3.5

The water supply used for a sprinkler system is required to be **protected from backflow contamination**. If the sprinkler system is connected to a public waterworks system, any **water supply tests** used for system design purposes are permitted to be adjusted to **account for seasonal and daily pressure fluctuations**.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

For dwelling units and sleeping units in Group I-1 and R occupancies, which of the following are permitted to be installed per the Ohio Building Code and Ohio Fire Code? (Select all that apply)

☐ Upright sprinklers

☐ Quick-response sprinklers

☐ Dry sprinklers

☐ Extended coverage sprinklers

☐ Residential sprinklers

SUBMIT

Complete the knowledge check above before moving on.

Sprinkler System Supervision and Alarms, Section 903.4

Valves controlling the water supply for the following are **required to be electronically supervised** by a **listed fire alarm control unit**:

- Automatic sprinkler systems
- Pumps
- Tanks
- Water levels and temperatures
- Critical air pressures
- Waterflow switches

Note the exceptions include:

☐ Limited area systems

☐ *NFPA* 13R 2016 systems that have a common supply main for both domestic water and the automatic sprinkler system, but no separate shutoff valve for the sprinkler system

☐ Valves that are sealed or locked in the open position:

  - Jockey pump control valves
  - Control valves for commercial kitchen hoods, paint spray booths, or dip tanks
  - Valves controlling the fuel supply to fire pump engines
  - Trim valves to pressure switches in dry, preaction, and deluge sprinkler systems

CONTINUE

Monitoring, Section 903.4.1

Alarm, supervisory, and trouble signals are required to be **distinct from each other** and also automatically transmit to an approved supervising station or sound an audible alarm at a constantly attended location (if approved).

Approved audible devices are required to be connected to each sprinkler system and located on the exterior of the building in an approved location. These waterflow alarm devices are required to actuate when the waterflow equals the flow of a single sprinkler with the smallest orifice size in the system.

If a fire alarm system is installed, sprinkler system activation is **required** to also actuate the fire alarm system.

Floor control valves are required at the point of connection to the **riser** on each floor in high-rise buildings.

TESTING AND MAINTENANCE

Testing and Maintenance, Section 903.5

Sprinkler systems are to be **tested and maintained** per the Ohio Fire Code and *NFPA* 25 2014 requirements.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

If a valve is controlling the water supply for a tank, it is required to be electronically supervised by a ___.

○ check valve

○ backflow preventer

○ fire alarm control unit

○ waterflow alarm device

SUBMIT

Waterflow alarm devices are required to actuate when the waterflow ____ the flow of a single sprinkler with the smallest orifice size in the system.

○ is less than

○ equals

○ is greater than

SUBMIT

Complete the knowledge checks above before moving on.

Lesson 3 of 3

Section 905 – Standpipe Systems

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Gain a working knowledge of Ohio Building Code and Ohio Fire Code requirements for standpipe systems.

☐ Incorporate installation requirements based on building height and type.

☐ Differentiate between the three Classes of standpipe connections.

LET'S BEGIN

The **Ohio Building Code** lists all the sections that deal with **standpipe systems** in **Chapter 35**, Referenced Standards. Similarly, the **Ohio Fire Code** lists these sections in **Section 1301:7-7-80,** Referenced Standards.

Referenced Standards Table

You can take a look at the table by clicking on this button.
The information we are looking for is on the *NFPA* table under the "Standard Reference Number" column and titled "14-16."

Per the *NFPA* table, the sections of the building code covering standpipe systems are:

- Section 905.2
- Section 905.3.4
- Section 905.4.2
- Section 905.6.2
- Section 905.8

We will not cover every section listed above but will provide information so that you **get a feel for what both the Ohio Building Code and the Ohio Fire Code entail**.

OHIO BUILDING CODE AND OHIO FIRE CODE, SECTION 905

Ohio Building Code and Ohio Fire Code, Section 905

Section 905, Automatic Sprinkler Systems, outlines the requirements with which standpipe systems must comply.

Standpipe systems are **required in all new buildings and structures**, in accordance with *NFPA* 14 2016 requirements.

Combined sprinkler/standpipe systems are **permitted**.

Standpipe systems are **not required in Group R - 3** occupancies.

SECTION 905.3: REQUIRED INSTALLATIONS

Required Installations, Section 905.3

Height, Section 905.3.1

Class III standpipe systems are required in buildings where the floor level of the highest story is greater than 30 ft. above the lowest level of the fire department vehicle access, or where the floor level of the lowest story is located more than 30 ft. below the highest level of fire department vehicle access.

There are **exceptions that allow Class I standpipes systems**:

☐ Buildings with automatic sprinkler systems installed

☐ Open parking garages that have the highest floor located no more than 150 ft. above the lowest level of fire department access (Class I manual standpipes are permitted)

☐ Open parking garages in areas subject to freezing (Class I manual dry standpipes are permitted), if the hose connections are located per Class II requirements

☐ Basements equipped with automatic sprinkler systems

CONTINUE

Group A, Section 905.3.2

Non-sprinklered Group A buildings with an occupant load greater than 1,000 are **required** to have **Class I automatic wet standpipe systems**. There are two **exceptions**:

☐ Open-air-seating spaces without enclosed spaces

☐ Class I automatic dry and semiautomatic dry standpipes or manual wet standpipes are permitted in non-high-rise buildings

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Section 905.3.1 requires Class III standpipe systems in buildings with specific heights for the floor levels related to fire department vehicle access. Some exceptions for these buildings are permitted, including basements equipped with an automatic sprinkler system which allow a Class __ standpipe system.

○ I

○ II

○ III

SUBMIT

Complete the knowledge check above before moving on.

Covered and Open Mall Buildings, Section 905.3.3

Covered mall and open mall buildings are **required to have standpipe systems**, as defined in Section 905.3.1.

Mall buildings that are not required to have standpipe systems are required to have **Class I hose connections connected to the sprinkler system**, sized to deliver 250 gallons/minute at the most hydraulically remote connection, while still meeting the sprinkler system demand.

Pressure loss **cannot exceed 50 psi residual pressure** with a flow of 250 gallons/minute from the fire department connection to the hydraulically most remote hose connection.

Hose connections are required at the following locations:

- Within the mall entrance to each exit passageway or corridor
- At each floor-level landing within interior exit stairways opening directly on the mall
- At exterior public entrances to the mall of a covered mall building
- At public entrances at the perimeter line of an open mall building
- At other locations as needed, so the distance to reach all portions of the tenant space does not exceed 200 ft. from a hose connection

CONTINUE

Stages, Section 905.3.4

Stages larger than 1000 ft^2 are required to have a **Class III wet standpipe system** with 1 ½ in. and 2 ½ in. hose connections **on each side of the stage**.

If the building or area has an automatic sprinkler system, a 1 ½ in. hose connection is **required for Class II or III standpipes**.

The hose at these connections needs to be long enough to protect the stage area. Hose connections are to be **mounted in a cabinet or on a rack** and have an **adjustable fog nozzle**.

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CONTINUE

Underground Buildings, Section 905.3.5

Underground buildings are required to have **Class I automatic wet or manual wet standpipe systems** throughout the building.

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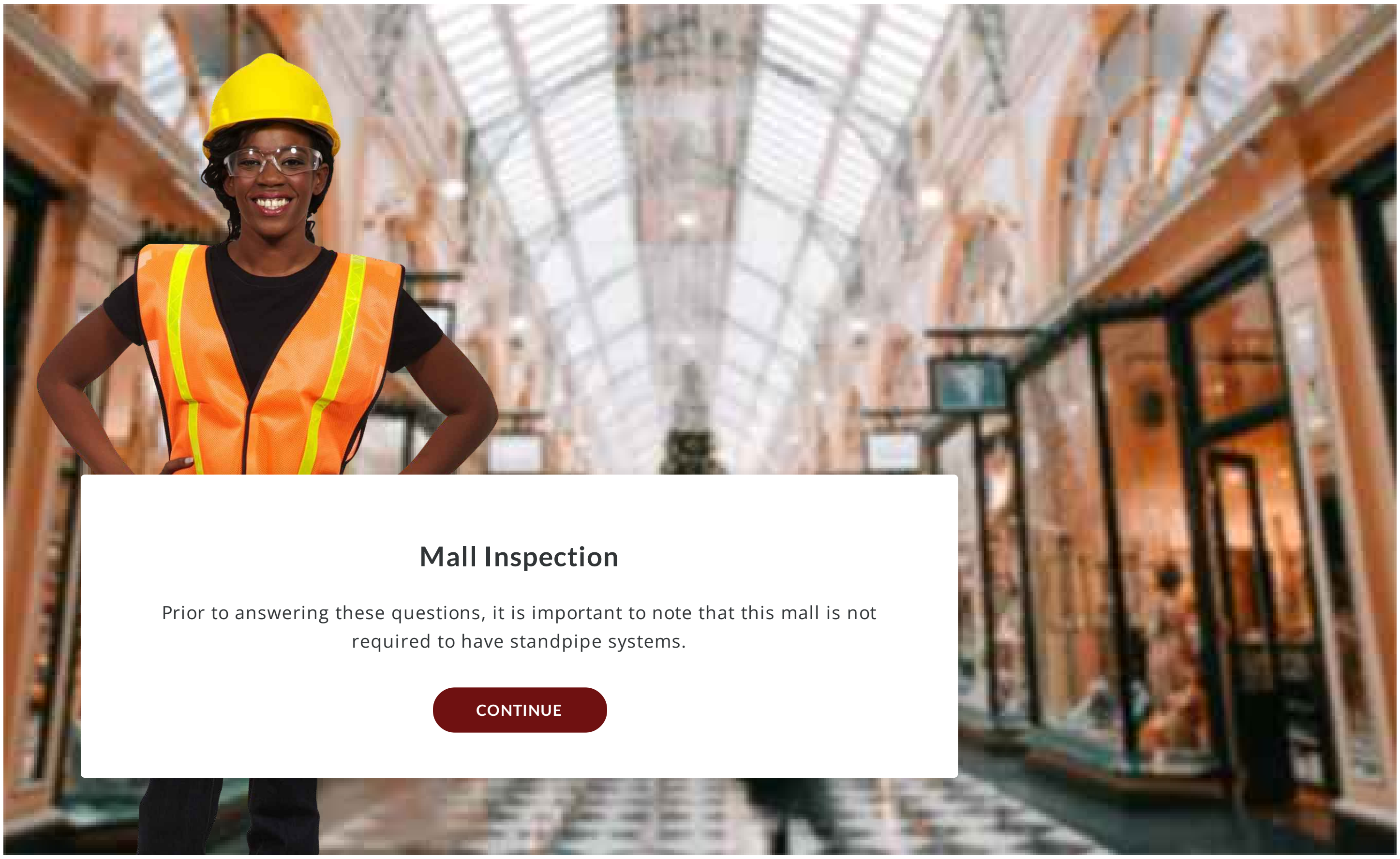
CONTINUE

You and Kayla are inspecting the standpipe systems in a mall in Ohio. To get a better understanding of the Ohio Building Code and Ohio Fire Code, let's work through the following scenario.

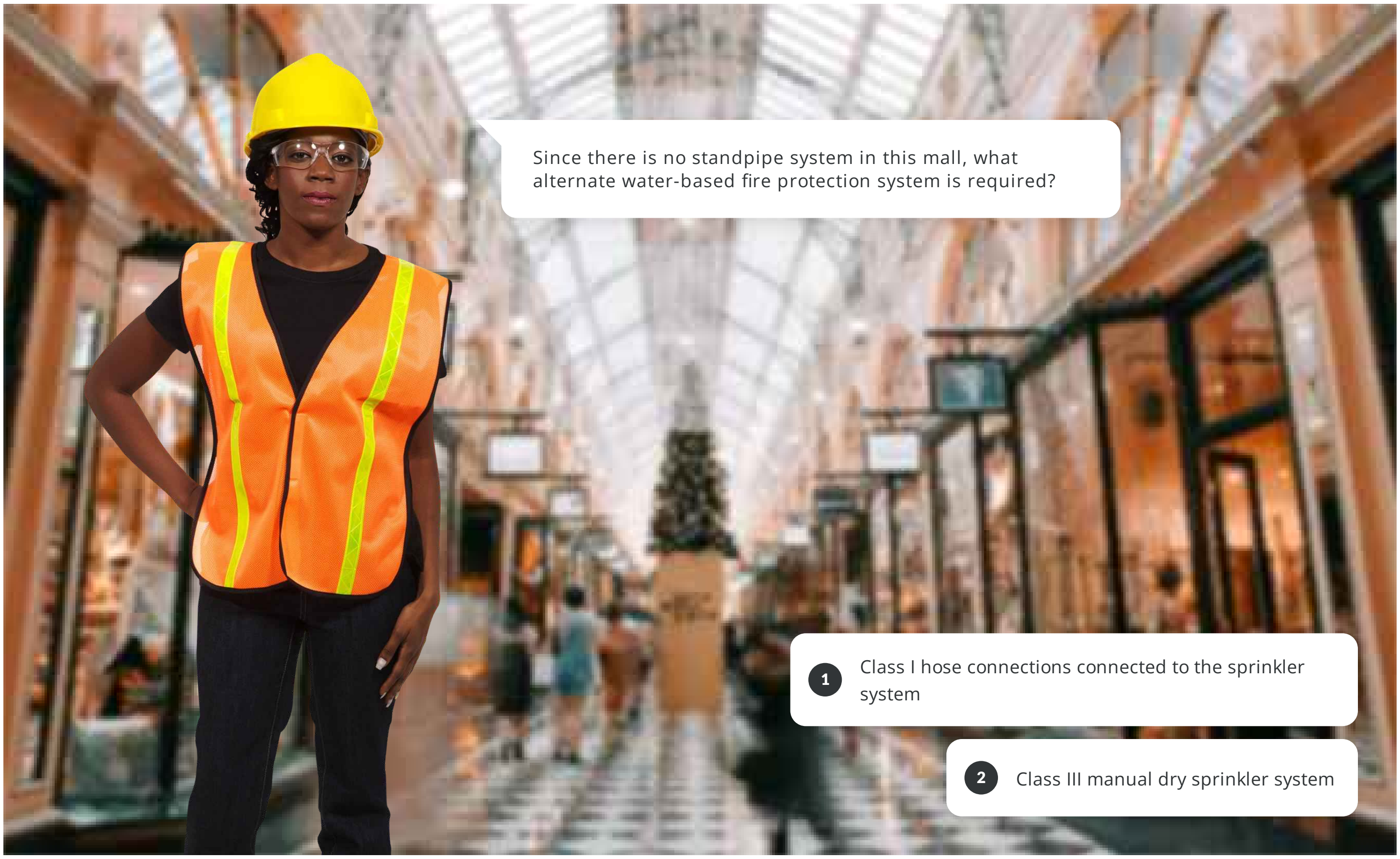


Mall Inspection

Prior to answering these questions, it is important to note that this mall is not required to have standpipe systems.

Scene 1 Slide 1

Continue → Next Slide



Since there is no standpipe system in this mall, what alternate water-based fire protection system is required?

① Class I hose connections connected to the sprinkler system

② Class III manual dry sprinkler system

Scene 1 Slide 2

0 → Next Slide

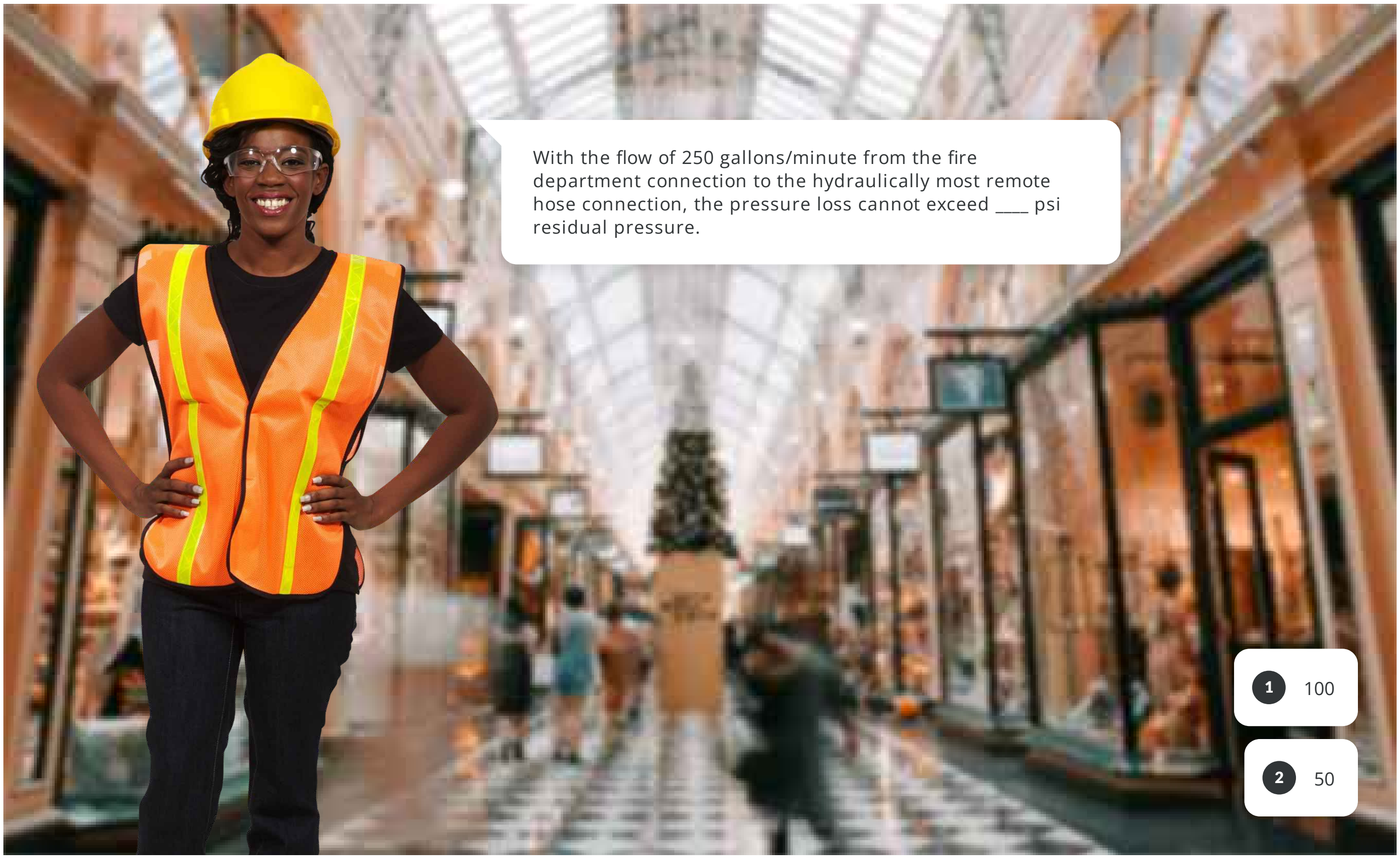
1 → Next Slide

For the Class I hose connections in this mall, it must be sized to deliver ____ gallons/minute at the most hydraulically remote connection.

Scene 1 Slide 3

0 → Scene 1 Slide 1

1 → Next Slide



With the flow of 250 gallons/minute from the fire department connection to the hydraulically most remote hose connection, the pressure loss cannot exceed ____ psi residual pressure.

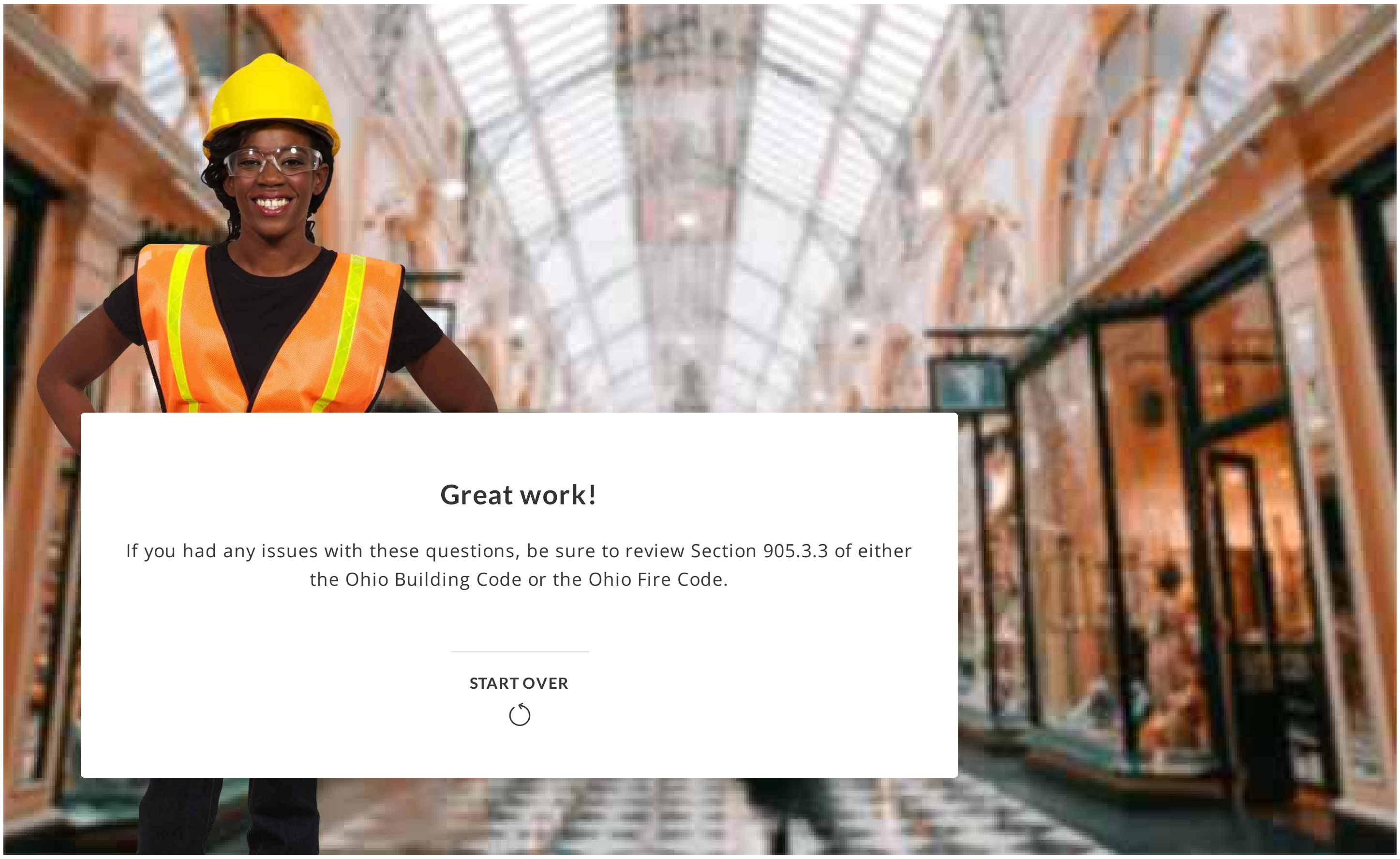
1 100

2 50

Scene 1 Slide 4

0 → Scene 1 Slide 1

1 → Next Slide



Great work!

If you had any issues with these questions, be sure to review Section 905.3.3 of either the Ohio Building Code or the Ohio Fire Code.

START OVER

Scene 1 Slide 5

Continue → End of Scenario

SECTIONS 905.4 – 905.6: LOCATION OF STANDPIPE HOSE CONNECTIONS

Location of Standpipe Hose Connections

Location of Class I Standpipe Hose Connections, Section 905.4

Class I hose connections are required in the following locations:

☐ For every required interior exit stairway – A hose connection is required for each story above or below grade plane.

☐ One on each side of the wall adjacent to the exit opening of a horizontal exit

☐ In every exit passageway, at the entrance from the exit passageway to other areas of a building

- In mall buildings

- For covered mall buildings, adjacent to each exterior public entrance to the mall and adjacent to each entrance from an exit passageway or exit corridor to the mall.
- For open mall buildings, adjacent to each public entrance to the mall at the perimeter line and adjacent to each entrance from an exit passageway or exit corridor to the mall.

☐ For roofs with a slope less than 33.3%, a hose connection is required to serve the roof or at the highest landing of an interior exit stairway with access to the roof.

☐ If the most remote portion of a non-sprinklered floor or story is more than 150 ft. from a hose connection or the most remote portion of a sprinklered floor or story is more than 200 ft. from a hose connection, additional hose connections may be required by the fire code official.

Buildings with **more than one standpipe system** are required to **interconnect the systems** following *NFPA* 14 2016 requirements.

CONTINUE

Location of Class II Standpipe Hose Connections, Section 905.5

Class II standpipe connections are required to be located so that all portions of the building are within 30 ft. of a **nozzle** attached to 100 ft. of hose.

Group A - 1 and A - 2 occupancies with occupant loads exceeding 1000 people are required to have hose connections as follows:

- On each side of any stage

- On each side of the rear of the auditorium
- On each side of the balcony
- On each tier of dressing rooms

1-inch hose is permitted for **Light Hazard occupancies** if approved by the building official with input from the fire official.

CONTINUE

Location of Class III Standpipe Hose Connections, Section 905.6

Class III standpipe systems are required to have hose connections located following Class I standpipe requirements and have Class II hose connections.

Similar to Class I standpipe systems, buildings with **more than one Class III standpipe system are required to interconnect the systems** per *NFPA* 14 2016 requirements.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Group A-1 and A-2 occupancies with occupant loads exceeding 1000 people are required to have hose connections in the following locations: (Select all that apply)

☐ On each side of any stage

☐ On each side of the wall adjacent to the exit opening

☐ On each side of the rear of the auditorium

☐ Adjacent to each entrance from an exit passageway or exit corridor

☐ On each side of the balcony

SUBMIT

Buildings with more than one Class III standpipe system are required to ____ the systems following *NFPA* 14 2016 requirements.

Type your answer here

SUBMIT

Complete the knowledge checks above before moving on.

Cabinets, Section 905.7

Cabinets containing fire-fighting equipment are **required to be unobstructed and in clear sight**. These cabinets are to be identified with a **permanently attached sign** that shows the contained equipment. The lettering on the sign is required to be a least 2 in. high, with colors contrasting from the background.

Note the exceptions for small and glass doors.

The cabinets are to remain **unlocked**. Exceptions include:

- Visual identification glass panels that can be easily broken to allow access
- Approved locking arrangements
- Group I-3 occupancies

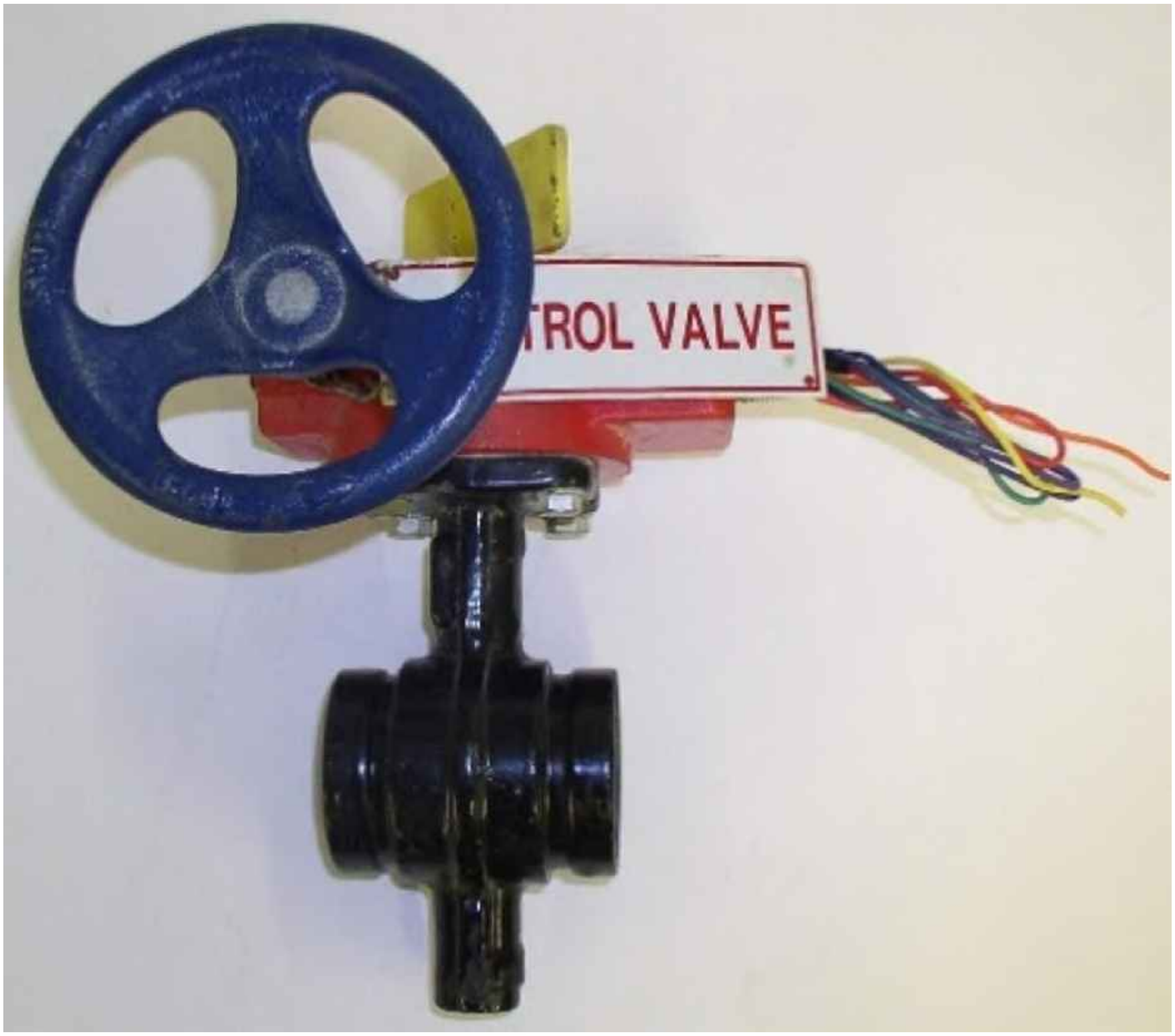
SECTION 905.8: DRY STANDPIPES

Dry Standpipes, Section 905.8

Dry standpipes are not permitted, except in areas where **freezing** is a concern.

SECTION 905.9: VALVE SUPERVISION

Valve Supervision, Section 905.9



Control valves for water supplies are required to be supervised in the open position. A change from normal is required to generate a **supervisory signal at the supervising station**. If a fire alarm system is provided, the signal is also required to be transmitted to the control unit.

Exceptions include valves to underground key or hub valves in roadway boxes and valves locked in the normal position in buildings without a fire alarm system.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Even if a cabinet containing fire-fighting equipment has breakable glass panels, should the cabinet remain locked or unlocked?

○ Locked

○ Unlocked

SUBMIT

Complete the knowledge check above before moving on.

After completing this module, you should now have a better understanding of the Ohio Building Code and the Ohio Fire Code for automatic sprinklers and standpipes.

Please press the button to proceed.

SS 102 Glossary

This is the glossary for the Automatic Sprinkler and Standpipe Systems 102 course. Click on a letter below to see each term and its definition.

A

B

C

D

E

F

G

H

I

K

L

M

N

O

P

Q

R

S

T

U

W

QUESTION BANKS

Lesson 1 of 21

A

Alarm Check Valve

Alarm valves are installed in water-based fire protection systems to sound a fire alarm when a flow of water from the system equals or exceeds the flow of a single discharge device. A retarding chamber, which minimizes false alarms due to surges and fluctuating water supply pressure, can be supplied with the alarm valve. (*NFPA* 25 2014, Section A.13.1)

Antifreeze Sprinkler System

A wet pipe system using automatic sprinklers that contains a liquid solution to prevent freezing of the system, intended to discharge the solution upon sprinkler operation, followed immediately by water from a water supply. (*NFPA* 13 2016, Section 3.4.1)

Approved

Acceptable to the authority having jurisdiction. (*NFPA* 13 2016, Section 3.2.1)

Authority Having Jurisdiction (AHJ)

An organization, office, or individual responsible for enforcing requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure. (*NFPA* 13 2016, Section 3.2.2)

Automatic Dry Standpipe System

A standpipe system permanently attached to a water supply capable of supplying the system demand at all times, containing air or nitrogen under pressure, the release of which (as from opening a hose valve) opens a dry pipe valve to allow water to flow into the piping system and out of the opened hose valve. (*NFPA* 14 2016, Section 3.3.17.1)

Automatic Sprinkler

A fire suppression or control device that operates automatically when its heat-activated element is heated to its thermal rating or above, allowing water to discharge over a specified area. (*NFPA* 13

2016, Section 3.3.1)

Automatic Wet Standpipe System

A standpipe system containing water at all times that is attached to a water supply capable of supplying the system demand at all times and that requires no action other than opening a hose valve to provide water at hose connections. (*NFPA* 14 2016, Section 3.3.17.2)

B

Backflow Preventer

Backflow prevention devices are used to prevent water in a fire protection system from entering the public water supply due to a reverse flow of water, thermal expansion, hydraulic shock, back pressure, or back siphonage. (*NFPA* 25 2014, Section A.13.1)

Bathroom

Within a dwelling unit, any room or compartment containing a lavatory dedicated to personal hygiene, or a water closet, or bathing capability such as a shower or tub, or any combination of facilities thereof. (*NFPA* 13R 2016, Section 3.3.1)

Branch Lines

The pipes supplying sprinklers, either directly or through sprigs, drops, return bends, or arm-overs. (*NFPA* 13 2016, Section 3.5.4)

Butterfly Valve

Water supply control valves with gear operators to assist in opening and closing. Butterfly valves can be of the wafer or grooved-end type. (*NFPA* 25 2014, Section A.13.1)

Lesson 3 of 21

C

Check Valve

A valve that allows flow in one direction only. (*NFPA* 13 2016, Section 3.8.1.15.1)

Class I Systems

A system that provides 2 1/2 in. (65 mm) hose connections to supply water for use by fire departments. (*NFPA* 14 2016, Section 3.3.19.1)

Class II Systems

A system that provides 1 1/2 in. (40 mm) hose stations to supply water for use primarily by trained personnel or by the fire department during initial response. (*NFPA* 14 2016, Section 3.3.19.2)

Class III Systems

A system that provides 1 1/2 in. (40 mm) hose stations to supply water for use by trained personnel and 2 1/2 in. (65 mm) hose connections to supply a larger volume of water for use by fire departments. (*NFPA* 14 2016, Section 3.3.19.3)

Combined System

A standpipe system that supplies both hose connections and automatic sprinklers. (*NFPA* 14 2016, Section 3.3.17.3)

Compartment

A space completely enclosed by walls and a ceiling. Each wall in the compartment is permitted to have openings to an adjoining space if the openings have a minimum lintel depth of 8 in. from the ceiling, and the total width of the openings in each wall does not exceed 8 ft. in width. A single opening of 36 inches or less in width without a lintel is permitted when there are no other openings to adjoining spaces. (*NFPA* 13R 2016, Section 3.3.2)

Control Mode Specific Application (CMSA) Sprinkler

A type of spray sprinkler that is capable of producing characteristic large water droplets and that is listed for its capability to provide fire control of specific high-challenge fire hazards. (*NFPA* 13 2016, Section 3.6.4.2)

Control Valve

A valve controlling flow to water-based fire protection systems and devices. (*NFPA* 13 2016, Section 3.3.7)

Corrosion-Resistant Sprinkler

A sprinkler fabricated with corrosion-resistant material, or with special coatings or platings, to be used in an atmosphere that would normally corrode sprinklers. (*NFPA* 13 2016, Section 3.6.3.1)

Cross Main

The pipes supplying the branch lines, either directly or through riser nipples. (*NFPA* 13 2016, Section 3.5.5)

Lesson 4 of 21

D

Deluge Sprinkler System

A sprinkler system employing open sprinklers or nozzles that are attached to a piping system that is connected to a water supply through a valve that is opened by the operation of a detection system installed in the same areas as the sprinklers or the nozzles. When this valve opens, water flows into the piping system and discharges from all sprinklers or nozzles attached thereto. (*NFPA* 13 2016, Section 3.4.4)

Deluge Valve

Deluge valves hold water at the valve until actuated by the operation of a detection system or manual release. (*NFPA* 25 2014, Section A.13.1)

Detector

A device suitable for connection to a circuit that has a sensor that responds to a physical stimulus such as gas, heat, or smoke. (*NFPA* 72 2016, Section 3.3.66)

Dry Pipe Sprinkler System

A sprinkler system employing automatic sprinklers that are attached to a piping system containing air or nitrogen under pressure, the release of which (as from the opening of a sprinkler) permits the water pressure to open a valve known as a dry pipe valve, and the water then flows into the piping system and out the opened sprinklers. (*NFPA* 13 2016, Section 3.4.5)

Dry Pipe Valve

Dry pipe valves control the flow of water to areas that could be exposed to freezing conditions. Water is held at the valve by air pressure in the system piping. When the air pressure is reduced, the valve operates and floods the system. (*NFPA* 25 2014, Section A.13.1)

Dwelling

Any detached building, or any part of a townhouse structure that is separated from the remainder of the townhouse structure with fire resistance rated assemblies in accordance with local building code, that contains no more than two dwelling units intended to be used, rented, leased, let, or hired out to be occupied or that are occupied for habitation purposes. (*NFPA* 13D 2016, Section 3.3.3)

Dwelling Unit

One or more rooms arranged for the use of one or more individuals living together, as in a single housekeeping unit normally having cooking, living, sanitary, and sleeping facilities. (*NFPA* 13R 2016, Section 3.3.4)

Lesson 5 of 21

E

Early Suppression Fast-Response (ESFR) Sprinkler

A type of fast-response sprinkler that has a thermal element with an RTI of 50 (meters-seconds)$^{1/2}$ or less and is listed for its capability to provide fire suppression of specific high-challenge fire hazards. (*NFPA* 13 2016, Section 3.6.4.3)

Emergency Impairment

A condition where a water-based fire protection system or portion thereof is out of order due to an unplanned occurrence, or the impairment is found while performing inspection, testing, or maintenance activities. (*NFPA* 25 2014, Section 3.3.21.1)

Extended Coverage Sprinkler

A type of spray sprinkler with maximum coverage areas as specified in Sections 8.8 and 8.9 of *NFPA* 13 2016. (*NFPA* 13 2016, Section 3.6.4.4)

Extra Hazard (Group 1) Occupancy

Extra hazard (Group 1) occupancies shall be defined as occupancies or portions of other occupancies where the quantity and combustibility of contents are very high and dust, lint, or other materials are present, introducing the probability of rapidly developing fires with high rates of heat release but with little or no combustible or flammable liquids. (*NFPA* 13 2016, Section 5.4.1)

Extra Hazard (Group 2) Occupancy

Extra hazard (Group 2) occupancies shall be defined as occupancies or portions of other occupancies with moderate to substantial amounts of flammable or combustible liquids or occupancies where shielding of combustibles is extensive. (*NFPA* 13 2016, Section 5.4.2)

F

Feed Mains

The pipes supplying cross mains, either directly or through risers. (*NFPA* 13 2016, Section 3.5.7)

Fire Department Connection

A connection through which the fire department can pump supplemental water into the sprinkler system, standpipe, or other water-based fire protection systems, furnishing water for fire extinguishment to supplement existing water supplies. (*NFPA* 13 2016, Section 3.8.1.4)

Fire Pump

A pump that is a provider of liquid flow and pressure dedicated to fire protection. (*NFPA* 13 2016, Section 3.8.1.5)

Flashover

A transition phase in a compartment fire that occurs when heat from a fire is absorbed into a building and its contents, heating up the combustible gases and contents to their auto-ignition temperature, which then triggers sudden combustion.

Lesson 7 of 21

G

Gridded Sprinkler System

A sprinkler system in which parallel cross mains are connected by multiple branch lines, causing an operating sprinkler to receive water from both ends of its branch line while other branch lines help transfer water between cross mains. (*NFPA* 13 2016, Section 3.4.6)

Lesson 8 of 21

H

Hanger

A device or assembly used to support the gravity load of the system piping. (*NFPA* 13 2016, Section 3.11.4)

High-Piled Storage

Solid-piled, palletized, rack storage, bin box, and shelf storage in excess of 12 ft (3.7 m) in height. (*NFPA* 13 2016, Section 3.9.1.16)

Horizontal Standpipe

The horizontal portion of the system piping that delivers the water supply for two or more hose connections, and for sprinklers on combined systems, on a single level. (*NFPA* 14 2016, Section 3.3.16.1)

Hose Connection

A combination of equipment provided for connection of a hose to the standpipe system that includes a hose valve with a threaded outlet. (*NFPA* 14 2016, Section 3.3.3.2)

Hose Valve

The valve to an individual hose connection. (*NFPA* 14 2016, Section 3.3.23.2)

Hydraulically Designed System

A calculated sprinkler system in which pipe sizes are selected on a pressure loss basis to provide a prescribed water density, in gallons per minute per square foot, or a prescribed minimum discharge

> pressure or flow per sprinkler, distributed with a reasonable degree of uniformity over a specified area. (*NFPA* 13 2016, Section 3.3.15)

I

Impairment

A condition where a fire protection system or unit or portion thereof is out of order, and the condition can result in the fire protection system or unit not functioning in a fire event. (*NFPA* 25 2014, Section 3.3.21)

Indicating Valve

A valve that has components that provide the valve operating position, open or closed. (*NFPA* 13 2016, Section 3.8.1.15.2)

Inspection

A visual examination of a system or portion thereof to verify that it appears to be in operating condition and is free of physical damage. (*NFPA* 25 2014, Section 3.3.23)

Inspector's Test Connection

A test connection used to simulate the flow from the smallest orifice (most demanding waterflow) in the sprinkler system.

K

K-Factor

A coefficient (specific number) for a sprinkler that relates to the amount of water that flows through the orifice (opening). Each sprinkler has its own unique k-factor, which impacts the relationship between pressure and flow.

L

Light Hazard Occupancy

Light hazard occupancies shall be defined as occupancies or portions of other occupancies where the quantity and/or combustibility of contents is low and fires with relatively low rates of heat release are expected. (*NFPA* 13 2016, Section 5.2)

Listed

Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose. (*NFPA* 13 2016, Section 3.2.3)

Looped Sprinkler System

A sprinkler system in which multiple cross mains are tied together so as to provide more than one path for water to flow to an operating sprinkler and branch lines are not tied together. (*NFPA* 13 2016, Section 3.4.7)

M

Manual Dry Standpipe System

A standpipe system with no permanently attached water supply that relies exclusively on the fire department connection to supply the system demand. (*NFPA* 14 2016, Section 3.3.17.4)

Manual Wet Standpipe System

A standpipe system containing water at all times that relies exclusively on the fire department connection to supply the system demand. (*NFPA* 14 2016, Section 3.3.17.5)

Manufactured Home

A structure, transportable in one or more sections, which, in the traveling mode, is 8 body-ft (2.4 m) or more in width or 40 body-ft (12.2 m) or more in length or, when erected on site, is 320 ft^2 (29.7 m^2) or more and which is built on a permanent chassis and designed to be used as a dwelling, with or without a permanent foundation, when connected to the required utilities, and includes plumbing, heating, air-conditioning, and electrical systems contained therein; except that such terms include any structure that meets all the requirements of this paragraph except the size requirements and with respect to which the manufacturer voluntarily files a certification required by the regulatory agency. Calculations used to determine the number of square feet in a structure are based on the structure's exterior dimensions, measured at the largest horizontal projections when erected on site. These dimensions include all expandable rooms, cabinets, and other projections containing interior space, but do not include bay windows. (*NFPA* 13D 2016, Section 3.3.5)

Multipurpose Piping Sprinkler System

A piping system intended to serve both domestic needs in excess of a single fixture and fire protection needs from one common piping system throughout the dwelling unit(s). (*NFPA* 13D 2016, Section 3.3.11.3)

Lesson 13 of 21

N

Nozzle

A device for use in applications requiring special water discharge patterns, directional spray, or other unusual discharge characteristics. (*NFPA* 13 2016, Section 3.6.4.5)

Lesson 14 of 21

O

Occupancy Classification

The formal designation of the primary purpose of the building, structure, or portion thereof. Structures shall be classified into one or more of the occupancy groups specified based on the nature of the hazards and risks to building occupants generally associated with the intended purpose of the building structure. (*International Building Code* 2018, Section 302.1)

Ordinary Hazard (Group 1) Occupancy

Ordinary hazard (Group 1) occupancies shall be defined as occupancies or portions of other occupancies where combustibility is low, quantity of combustibles is moderate, stockpiles of combustibles do not exceed 8 ft (2.4 m), and fires with moderate rates of heat release are expected. (*NFPA* 13 2016, Section 5.3.1)

Ordinary Hazard (Group 2) Occupancy

Ordinary hazard (Group 2) occupancies shall be defined as occupancies or portions of other occupancies where the quantity and combustibility of contents are moderate to high, stockpiles of contents with moderate rates of heat release do not exceed 12 ft (3.7 m), and stockpiles of contents with high rates of heat release do not exceed 8 ft (2.4 m). (*NFPA* 13 2016, Section 5.3.2)

OS&Y Gate Valve

Outside screw and yoke (OS&Y) gate valves are used indoors and in pits outdoors. The valve stem moves out when the valve is open and moves in when it is closed. The stem indicates the position of the valve. (*NFPA* 25 2014, Section A.13.1)

Lesson 15 of 21

P

Pendent Sprinkler

A sprinkler designed to be installed in such a way that the water stream is directed downward against the deflector. (*NFPA* 13 2016, Section 3.6.2.3)

Pipe Schedule System

A sprinkler system in which the pipe sizing is selected from a schedule that is determined by the occupancy classification and in which a given number of sprinklers are allowed to be supplied for specific sizes of pipe. (*NFPA* 13 2016, Section 3.4.9)

Preaction Sprinkler System

A sprinkler system employing automatic sprinklers that are attached to a piping system that contains air that might or might not be under pressure, with a supplemental detection system installed in the same areas as the sprinklers. (*NFPA* 13 2016, Section 3.4.10)

Preplanned Impairment

A condition where a water-based fire protection system or a portion thereof is out of service due to work planned in advance, such as revisions to the water supply or sprinkler system piping. (*NFPA* 25 2014, Section 3.3.21.2)

Pump

A mechanical device that transfers or raises, or transfers and raises, the pressure of a fluid (water). (*NFPA* 13D 2016, Section 3.3.8)

Q

Qualified

A competent and capable person or company that has met the requirements and training for a given field acceptable to the AHJ. (*NFPA* 25 2014, Section 3.3.34)

Quick Response Sprinklers

A type of spray sprinkler that has a thermal element with an RTI of 50 (meter-seconds)$^{1/2}$ or less and is listed as a quick-response sprinkler for its intended use. (*NFPA* 13 2016, Section 3.6.4.8)

R

Residential Sprinkler

A type of fast-response sprinkler having a thermal element with an RTI of 50 (meters-seconds)$^{1/2}$ or less that has been specifically investigated for its ability to enhance survivability in the room of fire origin, and that is listed for use in the protection of dwelling units. (*NFPA* 13 2016, Section 3.6.4.9)

Residual Pressure

The pressure that exists in the distribution system, measured at the residual hydrant at the time the flow readings are taken at the flow hydrants. (*NFPA* 13 2016, Section 3.8.1.9.1)

Risers

The vertical supply pipes in a sprinkler system. (*NFPA* 13 2016, Section 3.5.10)

S

Semiautomatic Dry Standpipe System

A standpipe system permanently attached to a water supply that is capable of supplying the system demand at all times arranged through the use of a device such as a deluge valve and that requires activation of a remote control device to provide water at hose connections. (*NFPA* 14 2016, Section 3.3.17.6)

Shadow Area

The dry floor area within the protection area of a sprinkler created by the portion of sprinkler discharge that is blocked by a wall or partition. (*NFPA* 13D 2016, Section 3.3.9)

Shall

Indicates a mandatory requirement. (*NFPA* 13 2016, Section 3.2.4)

Should

Indicates a recommendation or that which is advised but not required. (*NFPA* 13 2016, Section 3.2.5)

Sprinkler System

A system that consists of an integrated network of piping designed in accordance with fire protection engineering standards that includes a water supply source, a water control valve, a waterflow alarm, and a drain. The portion of the sprinkler system above ground is a network of specifically sized or hydraulically designed piping installed in a building, structure, or area, generally overhead, and to which sprinklers are attached in a systematic pattern. The system is commonly activated by heat from a fire and discharges water over the fire area. (*NFPA* 13 2016, Section 3.3.23)

Standard

An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides. (*NFPA* 13 2016, Section 3.2.6)

Standpipe

The system piping that delivers the water supply for hose connections, and for sprinklers on combined systems, vertically from floor to floor. (*NFPA* 14 2016, Section 3.3.16)

Standpipe System

An arrangement of piping, valves, hose connections, and associated equipment installed in a building or structure, with the hose connections located in such a manner that water can be discharged in streams or spray patterns through attached hose and nozzles, for the purpose of extinguishing a fire, thereby protecting a building or structure and its contents in addition to protecting the occupants. (*NFPA* 14 2016, Section 3.3.17)

Static Pressure

The pressure that exists at a given point under normal distribution system conditions measured at the residual hydrant with no hydrants flowing. (*NFPA* 13 2016, Section 3.8.1.9.2)

Strainer

A device capable of removing from the water all solids of sufficient size that are obstructing water spray nozzles. (*NFPA* 25 2014, Section 3.3.44)

System Demand

The flow rate and residual pressure required from a water supply, measured at the point of connection of a water supply to a standpipe system, to deliver the total waterflow rate and the minimum residual pressures required for a standpipe system at the hydraulically most remote hose connection, and the minimum waterflow rate and residual pressure for sprinkler connections on combined systems. (*NFPA* 14 2016, Section 3.3.20)

System Pressure

The pressure within the system (e.g., above the control valve). (*NFPA* 13D 2016, Section 3.3.7.2)

System Working Pressure

The maximum anticipated static (non-flowing) or flowing pressure applied to sprinkler system components exclusive of surge pressures and exclusive of pressure from the fire department connection. (*NFPA* 13 2016, Section 3.3.24)

T

Tree Sprinkler Systems

The most basic system of sprinkler pipe layouts where the cross mains and the branch lines are not tied together, providing only one path for the water to flow to an operating sprinkler. (*Automatic Sprinkler Systems Handbook* of *NFPA* 13 2016)

Testing

A procedure used to determine the operational status of a component or system by conducting periodic physical checks, such as waterflow tests, fire pump tests, alarm tests, and trip tests of dry pipe, deluge, or preaction valves. (*NFPA* 25 2014, Section 3.3.47)

Lesson 20 of 21

U

Upright Sprinkler

A sprinkler designed to be installed in such a way that the water spray is directed upwards against the deflector. (*NFPA* 13 2016, Section 3.6.2.6)

W

Waterflow Alarm Device

An attachment to the sprinkler system that detects a predetermined waterflow and is connected to a fire alarm system to initiate an alarm condition or is used to mechanically or electrically initiate a fire pump or local audible or visual alarm. (*NFPA* 13 2016, Section 3.5.14)

Waterflow Detector

An electric signaling indicator or alarm check valve actuated by water flow in one direction only. (*NFPA* 13D 2016, Section 3.3.15)

Wet Pipe Sprinkler System

> A sprinkler system employing automatic sprinklers attached to a piping system containing water and connected to a water supply so that water discharges immediately from sprinklers opened by heat from a fire. (*NFPA* 13 2016, Section 3.4.11)

File Attachments for Item:

EC-4 Ohio Diesel Fire Pump Technician (Fire Tech Productions)

All Certifications (5 hours)

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

APPLICATION FOR CONTINUING EDUCATION APPROVAL
COURSE CONDITIONS AND GUIDELINES

The Ohio Board of Building Standards is committed to the ongoing education and professional development of board-certified personnel through the delivery of high-quality, accurate and engaging professional continuing education content. To this end, the Board reviews and approves Continuing Education Courses for building department personnel.

Board approval is granted for course instruction on current codes and standards, including the OBC, OMC, OPC, and RCO, and any other content areas directly related to the responsibilities of the certification for which credit is being requested.

Promotion: Any person or organization promoting an approved course is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, categories 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 may not falsely state BBS approval before approval is granted. Course providers may state that BBS approval is pending.

Application Submission: All Applications and associated materials shall be submitted by email in .pdf format. Instructions for completing the application are attached.

Certificate of Completion: Course providers shall 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.

Any person or organization administering an approved course shall return a completed BBS Course Attendance form by email.

Participants: Participants must attend the complete course as presented by the instructor to receive credit hours approved by the Board. The organization or instructor of online courses shall plan and execute methods to verify the individual's attendance and completion of the course. No partial credit will be given to any participant who failed to complete the entire course as approved.

Board approval: All courses are approved for the calendar year in which application is made. Courses may be renewed so long as the referenced code is in effect, and the CEUs, certification and content remain unchanged. When the referenced code is updated, courses must be updated, and new approvals obtained.

Facility/training area: BBS Course may be delivered in person or online, or both, at the sponsor's option.
Course facilities shall include the following:

In Person Classes:	Online Classes:
Sufficient seating capacity	Web-accessible
ADA accessible facilities	ADA accessible delivery
Appropriate Audio/Visual devices for delivery	Tech support available
Writing surfaces for participants	Live and recorded courses permitted

In-person facilities shall comfortably and safely seat at least the number of attendees present in the room and shall be climate controlled, non-smoking, and sound controlled so that outside noise will not interfere with the training.

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Julie Miller

Organization: Fire Tech Productions

Address: 7976 Clyo Rd., Centerville, OH 45459

E-mail: julie@firetech.com Telephone: 937.434.3473

Website: firetech.com

Conference Sponsor (if applicable)________ Conference Email:________

Check here if Course Renewal:________ Prior course number ________ (*i.e. BBS2018-429*)

Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: Ohio Diesel Fire Pump Technician - NFPA 20 2016 - FPOH 103 2016

Course instructor: Tom Doty

Course description: Understand requirements for fire pump diesel engine drivers per NFPA 20 2016 and NFPA 25 2014.
This course provides the knowledge to:
Identify diesel engine instrumentation, starting methods, fuel supply arrangement, and system operation
Conduct system acceptance tests
Perform periodic inspections, tests, and maintenance
Recognize Ohio Building Code and Ohio Fire Code requirements for fire pumps

Instructional hours per session: 5.0 Number of Sessions:________

Course Date(s) and Location:________

Special Content:

Code Administration:______
Existing Buildings: ______
Electrical Instruction: ______
Plumbing Instruction:______

Conference Course: ________
Conference Name: ________
Conference location:________

Course to be offered online? X **On Demand** X **Webinar**______

Course Website: firetech.com

Detail online course participation confirmation method (*i.e. test, quizlets, participant activity confirmation*):

100% completion/review of all lessons/knowledge checks and 70% passing on all quizzes/exams

Course applicable for the following certifications

Residential Certifications Only: ______ Commercial Certifications: X

Administrative Course, All Certifications: ______

Application materials included:

______ Course Outline or Course Learning Objectives
______ Presentation Materials/Slides (not required for roundtable courses)
______ Assessment Materials (for online courses)
______ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

Ohio | Department of Commerce
Mike DeWine, Governor
Jon Husted, Lt. Governor
Sheryl Maxfield, Director

Instructions for new Continuing Education Approval form

Provider Information

1. Please include all contact information.
2. If course is not part of a conference, leave conference sponsor and email blank.

Course Renewal

1. Indicate if the course is being submitted for renewal. Include prior approval letter and write in prior course number.
2. Certification approval for courses has now changed: all existing courses being renewed will be approved within the new classification system.
    a. Courses previously approved for only residential certifications will be approved for all residential certifications.
    b. Courses previously approved for at least on commercial certification will now be approved for all commercial certifications and all residential certifications.
    c. Courses on required instruction topics, Ohio Ethics, Code Administration and Existing Buildings, will be noted as Administrative Courses and be approved for all certifications.
3. Courses being renewed should skip the New Course information section and are not required to submit outline, agenda, slides or other instructional materials for review. Skip to Special Content, and mark any item that applies to the course.

New Course Information

1. Enter course title, name of instructor, and a brief description of the course content. Learning objectives may be substituted for course description, if desired.
2. Number of instructional hours per session is the length of instructional time.
3. Number of sessions: can be 1 or the number of sessions planned.
4. Course date(s) and location: not necessary at this time, enter if known.

Special Content

1. Indicate if the course will meet instructional time in Code Administration or Existing Buildings.
2. Indicate if the course is a plumbing or electrical course, for ESIAC review and trainee course tracking.
3. If the course is associated with a conference, indicate the conference name and location, as this will allow BBS to coordinate approvals with the conference provider.
4. If the course will be offered online, specify whether it will be on demand or offered as a virtual webinar, or both. Include website where the course will be provided.

Course applicable for the following certifications

This section represents a major change from previous BBS course approval forms.

1. If the course is only for residential certifications, check 'Residential Certifications Only'. The course, if approved, will be approved for all residential certifications.
2. If the course is appropriate for any commercial certifications, check Commercial Certifications. The course, if approved, will be approved for all commercial certification **AND** all residential certifications.
3. If the course is intended to meet required instruction in Code Administration (Chapter 1) or Existing Buildings (commercial or residential) check 'Administrative Course, All Certifications'.

Application Materials Included

This is a checklist for the course submitter's use, to be sure all materials necessary for review are included with the application. All materials should be submitted in .pdf format, along with the application, via email to Michael.Lane@com.ohio.gov or BBS@com.ohio.gov

Ohio Course Submission

Included in this document: Course Outline, Instructor resume(s)

Course: Ohio Diesel Fire Pump Technician - NFPA 20 2016 - FPOH 103 2016

Course Outline:

- **01.**

Course Navigation Video (Optional)

  - Course Navigation Video (Optional)

- **02.**

Ohio Diesel Fire Pump Technician - NFPA 20 2016

  - Introduction
  - Fire Pump General Requirements
  - Diesel Engines
  - Acceptance Testing, Performance, & Maintenance
  - Periodic Inspection and Testing

- **03.**

Practice Exam

  - Practice Exam

Instructor Resume:

THOMAS DOTY

21 Meadowcrest Dr.

Franklin, OH 45005

937-434-3473

tom@firetech.com

Seasoned fire protection professional following strong adherence to the codes and top-notch attention to customer service.

Certifications include: Sprinkler/Standpipe • Fire Alarm and Detection Systems • Fire Pumps • Fire Service Mains • Portable Fire Extinguishers • Pre-Engineered Extinguishers – OTW • State of Kentucky Certified

PROFESSIONAL EXPERIENCE

- CertaSite, 2801 Thunderhawk Court, Dayton, Ohio 45414
  Installation Manager - 2021- Present

- Fire Tech Productions, Inc., 7986B Clyo Rd., Centerville, Ohio 45459
  President - 2015 - 2022

  Instructor/Developer - 2015 - Present

- Craynon Fire Protection Inc., 2801 Thunderhawk Court, Dayton, Ohio 45414
  Partner/Vice-President – 2011 – 2021

  Operations Manager -- 12/11/2005 – 2021

- Guardian Fire Protection, 480 Randy Lane, Monroe, Ohio 45050
  Owner – 11/30/2003 – 12/11/2005

- Sprinkler Inspection Services, Inc., 8 Perkins Drive, Alexandria, KY 41001
  Superintendent / Operations Manager – 10/07/1995 – 11/30/2003

- Bestol Plumbing Company, P.O. Box 4192, Branson, MO
  Foreman – 2/1995 – 10/1995

- Grinnell Fire Protection Systems, Inc., San Diego, CA
  Service Foreman – 8/1993 – 2/1995

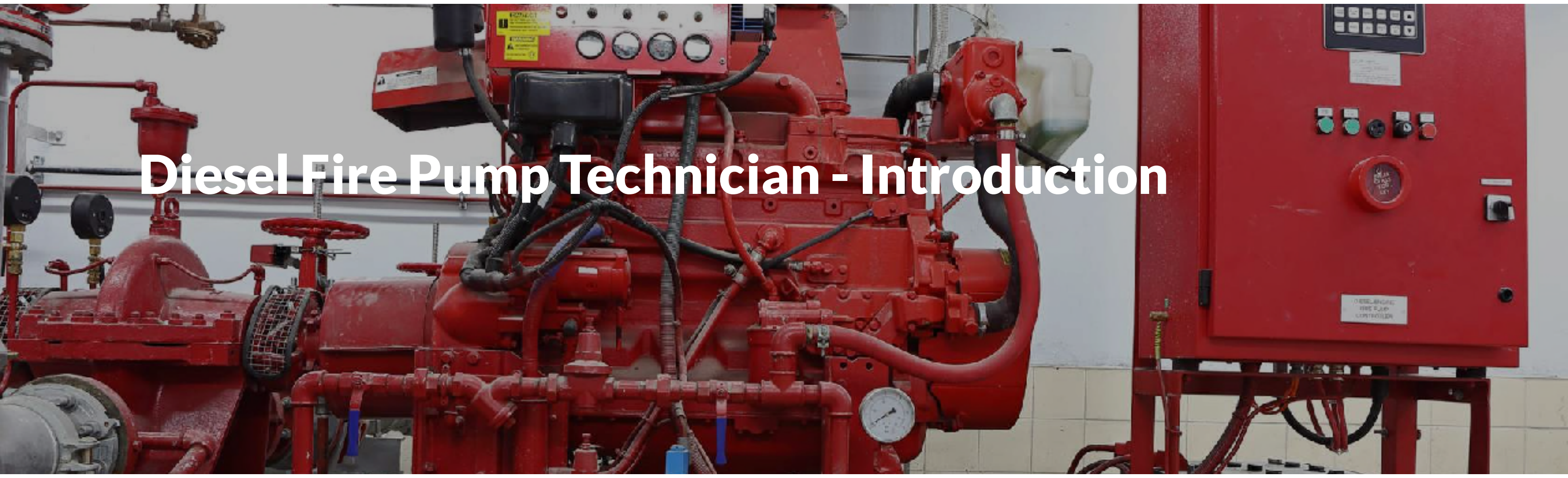
- Advanced Fire Protection Company, 1657 Monte Vista Drive, Vista, CA 92084
  Owner – 10/1990 – 8/1993

- Ryan Automatic Sprinkler Company, San Marcos, CA
  Superintendent – 4/1988 – 10/1990

- Vanguard Fire Protection, Carlsbad, CA

Foreman – 3/1985 – 4/1988

- Sentinel Fire Protection, San Diego, CA -- 8/1983 – 3/1985
- Local Union 669 – 5/1981 – 8/1983
- Local #821, Central Florida – 4/1980 – 5/1981
- American Automatic Fire Protection – 1/1979 – 4/1980
- Illinois Central Gulf Railroad – 4/1978 – 12/1978
- Orlando Automatic Sprinkler Company – 10/1976 – 3/1978



Diesel Fire Pump Technician - Introduction

Welcome to the Ohio Diesel Fire Pumps course!

When you are ready to get started, click on the "**Begin**" button.

This introduction provides a brief overview of what will be covered in the course.

You can come back to this module and reference this information anytime in your menu.

Topics that are covered in this introduction are as follows:

- Key References
- Training Modules
- Preparing for the Exam
- *NFPA* 20 2016 Definitions
- *NFPA* 25 2014 Definitions

Overview

Glossary

Lesson 1 of 2

Overview

Welcome

Please review this introduction before getting started on the course.

The focus of this course comes from:

- *NFPA* 20 2016, Chapters 3, 11, and 14
- *NFPA* 25 2014, Chapter 8
- *The Ohio Building Code* 2017
- *The Ohio Fire Code* 2017

We will look at key references and study tips. In addition, we will highlight key vocabulary terms in the glossary.

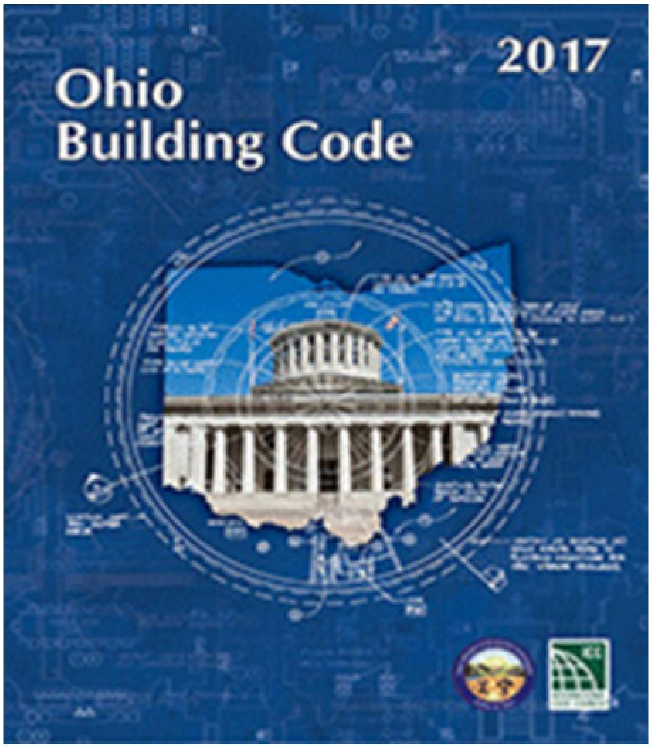
KEY REFERENCES

Key References

As you work through this course, it is important to refer to your standards and codes as the following references will be discussed.

OHIO BUILDING CODE	OHIO FIRE CODE	NFPA 20	NFPA 25

The Ohio Building Code establishes uniform minimum requirements for building construction, repair, alteration, and maintenance. These rules govern the intended use and occupancy of the buildings with respect to performance, extent of use, and standardization. *The Ohio Building Code* can be accessed through this link:
https://codes.iccsafe.org/content/OHBCU2017



OHIO BUILDING CODE

OHIO FIRE CODE

NFPA 20

NFPA 25

The **Ohio Fire Code, 2017**, establishes state fire marshal rules for the administration and enforcement of authorities. These rules govern the occupancy and maintenance of all structures and premises for precautions against fire and the spread of fire and general requirements of fire safety.

The Ohio Fire Code can be accessed through this link: https://codes.iccsafe.org/content/OHFCJAN2019E/ohio-administrative-code-1301-7-7-09-fire-protection-systems

2017

Ohio Fire Code

State of Ohio

Department of Commerce

Division of State Fire Marshal

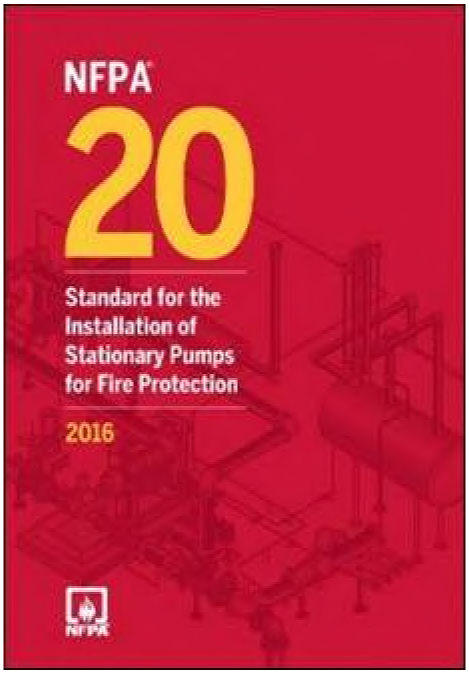
OHIO BUILDING CODE

OHIO FIRE CODE

NFPA 20

NFPA 25

NFPA* 20 2016 – *Standard for the Installation of Stationary Pumps for Fire Protection: The purpose of the standard is to specify how to install a fire pump properly when one is needed and which components, equipment, and power supplies are acceptable for use in a fire pump installation. In other words, *NFPA* 20 indicates how to properly arrange and install a fire pump and its supporting equipment.



NFPA* 25 2014 – *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems: This standard covers the administrative requirements for the periodic inspection, testing, and maintenance (ITM) of water-based fire protection systems. The purpose of the standard is to verify the operational status of a system and to provide a reasonable degree of certainty that the system will perform when needed.

ⓘ Each *NFPA* standard contains several Annexes with valuable examples and information. It is recommended you study this material as well.

OHIO CODES

Ohio Codes

The Ohio Fire Protection Exams are prepared from the Ohio Building Code Chapter 9, 2017 edition, the Ohio Administrative Code Section 1301:7-7-09 (Ohio Fire Code) 2017 edition, as well as the pertinent NFPA standards previously discussed. This course will focus on those referenced sections found in the Ohio Building Code and the Ohio Fire Code.

The Ohio Fire Code states that fire pumps shall be installed, inspected, tested, and maintained per *NFPA* 20 2016 and *NFPA* 25 2014. The code also defines specific rules for Ohio as well as reinforces some of the *NFPA* 20 2016 requirements.

- One of these requirements is to be certified and licensed by the state of Ohio.

- The only exception is for a provisional person in an approved formal apprenticeship program. They are permitted to work under the constant supervision of a certified person. The certified person is only allowed to supervise one provisional person.

ADDITIONAL RESOURCES

Additional Resources

Below is additional information and resources for the Ohio exam.

Ohio Department of Commerce – Division of State Fire Marshal:

Ohio Department of Commerce

To access the Ohio Department of Commerce – Division of State Fire Marshal, click on this "Click Here" button.

CLICK HERE

Ohio Department of Commerce phone: **(614) 752-7126**

The following downloadable PDF is for the Fire Protection Exam Application through the Ohio Department of Commerce:

PDF **FireProtectionExamApplication.pdf**
548.9 KB

PSI Candidate Information Bulletin

A very important source of information is the PSI Candidate Information Bulletin from PSI Services LLC. Take time to read it below in its **ENTIRETY**.

PDF **OhioCertificationExaminationBulletin.pdf**
230.9 KB

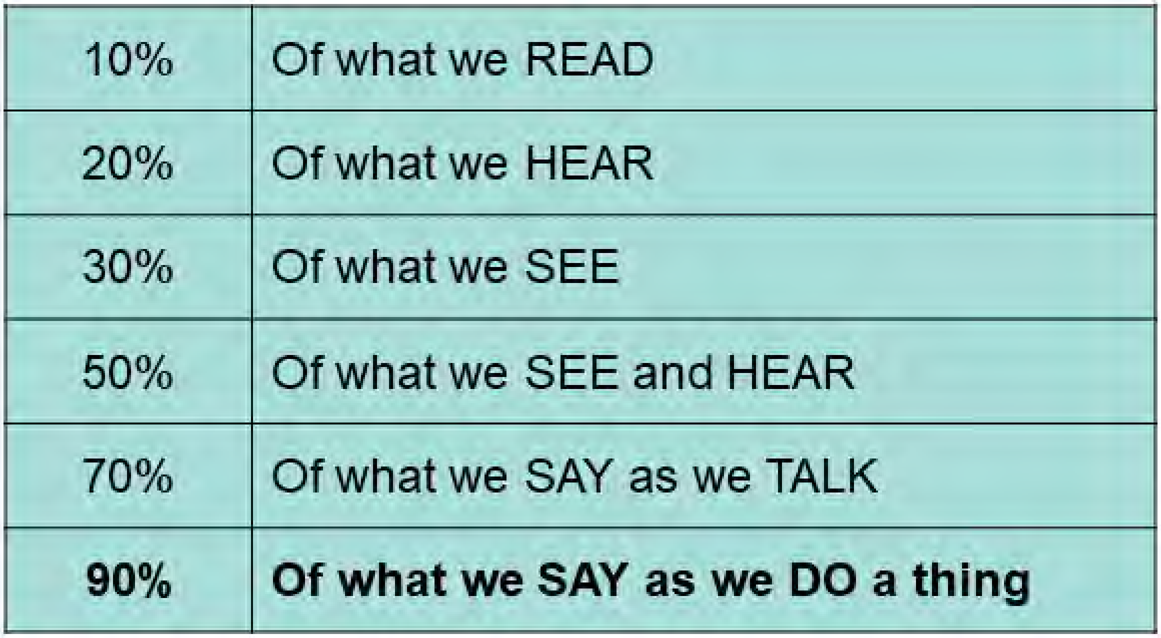
PSI Online Exams

To check for the most updated information on PSI Services, visit their website by clicking on this "Click Here" button.

CLICK HERE

HOW WE LEARN

Thinking about How We Learn



10%	Of what we READ
20%	Of what we HEAR
30%	Of what we SEE
50%	Of what we SEE and HEAR
70%	Of what we SAY as we TALK
90%	**Of what we SAY as we DO a thing**

Source: ***Skill With People*** by Les Giblin

Different people learn in different ways.

It is important to discover what works **best for you** and use your strengths to ensure you retain the material.

TRAINING MODULES

Training Modules

As you are studying, be prepared to **refer to your copy of the referenced NFPA standards constantly** throughout these modules. Be comfortable with the technical material.

Each training module is carefully planned and designed to **highlight areas of the standards that you need to know in order to increase your chances of success on the exam.** The goal of these training modules is to help you become knowledgeable of important areas of the standards and to gain a working understanding of how to apply these requirements on the job.

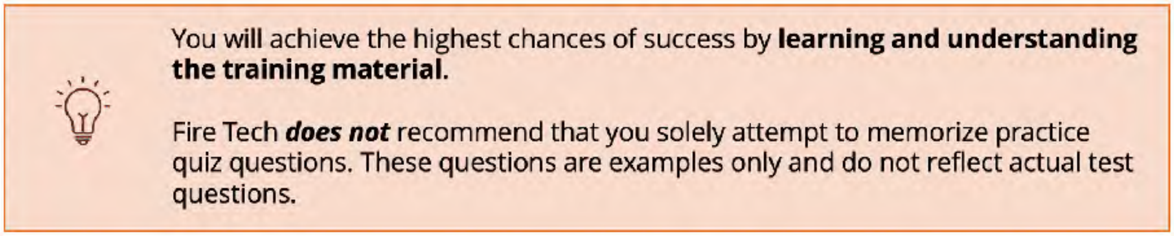
Take notes as you are studying, and **highlight** areas of the standards that are important to know.

The more familiar you are with the requirements, tables, and figures, the better your chances of success on the exam.

QUIZZES

The Quizzes

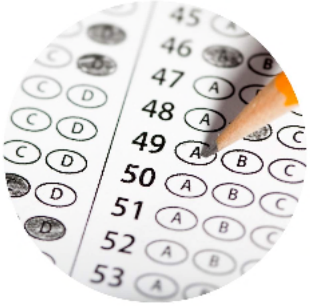
Fire Tech provides a practice quiz associated with each training module, which should be taken following completion of the module. As you take each practice quiz, use your copy of the referenced NFPA standards to **look up every answer to each quiz question**. This will assist you in **becoming more familiar with the requirements and where they are located** in each of the codes and standards.



You will achieve the highest chances of success by **learning and understanding the training material.**

Fire Tech ***does not*** recommend that you solely attempt to memorize practice quiz questions. These questions are examples only and do not reflect actual test questions.

Additionally, **read each question carefully**. Sift through what is pertinent to the question and what is irrelevant information that may be included as a distractor.



KNOWLEDGE CHECKS

Knowledge Checks

To help you apply course material and prepare for the quizzes, **knowledge checks** are sprinkled throughout each course.

Completing these knowledge checks is **required** to proceed further in the lesson. If you're stuck on a question, refer to previous lesson material and use your NFPA standard to find the answer.

True or false: Knowledge checks will help you apply course material and prepare for course quizzes.

○ True

○ False

SUBMIT

🔒 Complete the knowledge check above before moving on.

Practice Exam

Once you have read all of the lessons in this course and passed all of the quizzes, you will be ready to take the **Practice Exam**.

The Practice Exam consists of questions from the quizzes and is presented in a randomized manner.

LEARNING STRATEGIES

Learning Strategies

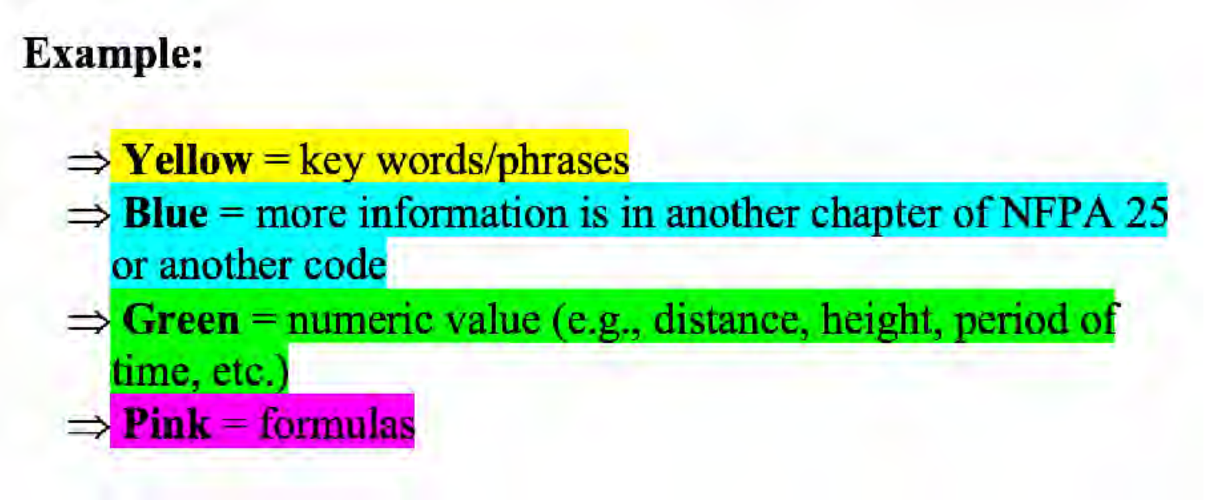
Click each of the strategies below and begin to incorporate them as you prepare for the Practice Exam.

Learning Strategies

Use these strategies to help you utilize the course materials.

Strategy 1

Create a color-coded highlighting system



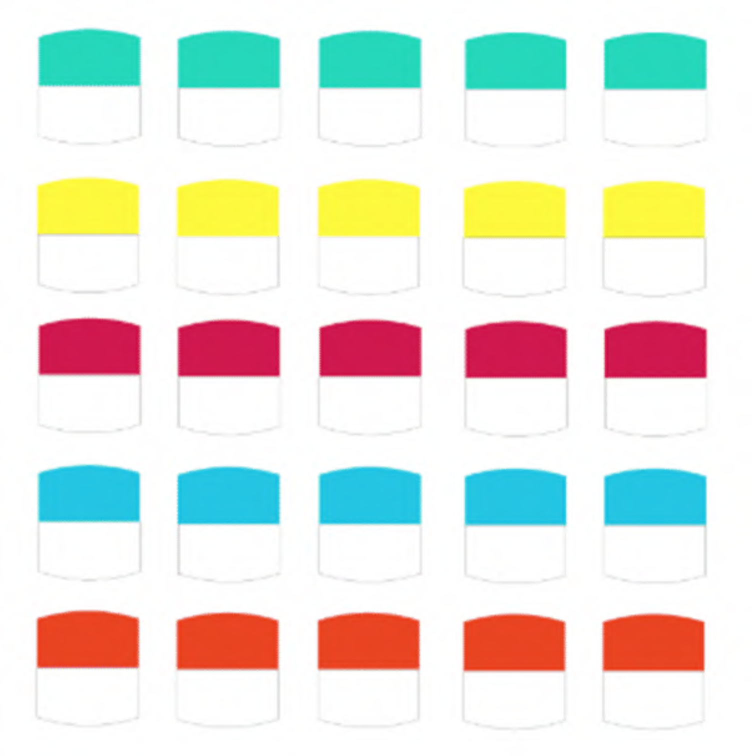
Example:

- ⇒ **Yellow** = key words/phrases
- ⇒ **Blue** = more information is in another chapter of NFPA 25 or another code
- ⇒ **Green** = numeric value (e.g., distance, height, period of time, etc.)
- ⇒ **Pink** = formulas

Fire Tech recommends highlighting important areas of the code. Some customers use up to four colors and different methods of highlighting. A simple strategy is to highlight based on type of information. Use one color for major sections or topics and another color for details and exceptions.

Strategy 2

Use tabs on your standards



Helps you look things up much faster! This can be especially helpful if you are looking up a reference for a customer.

Add tabs yourself or:

- purchase pre-tabbed standards from Fire Tech Productions
- purchase labeled tabs to add to your standard from Fire Tech Productions

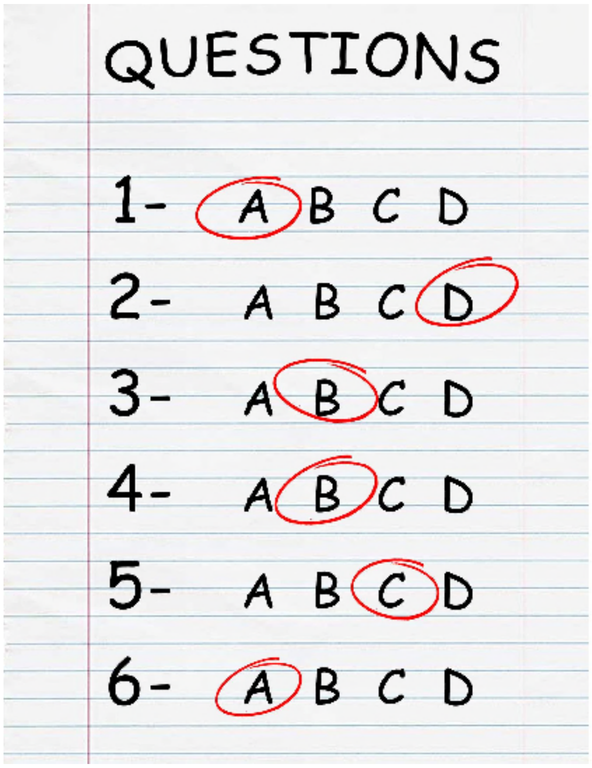
Strategy 3

Find a learning partner or a mentor

Have someone hold you accountable or quiz you, even if they’re not taking the course themselves. Driving to and from a job site with a co-worker is a great opportunity to do this.

Strategy 4

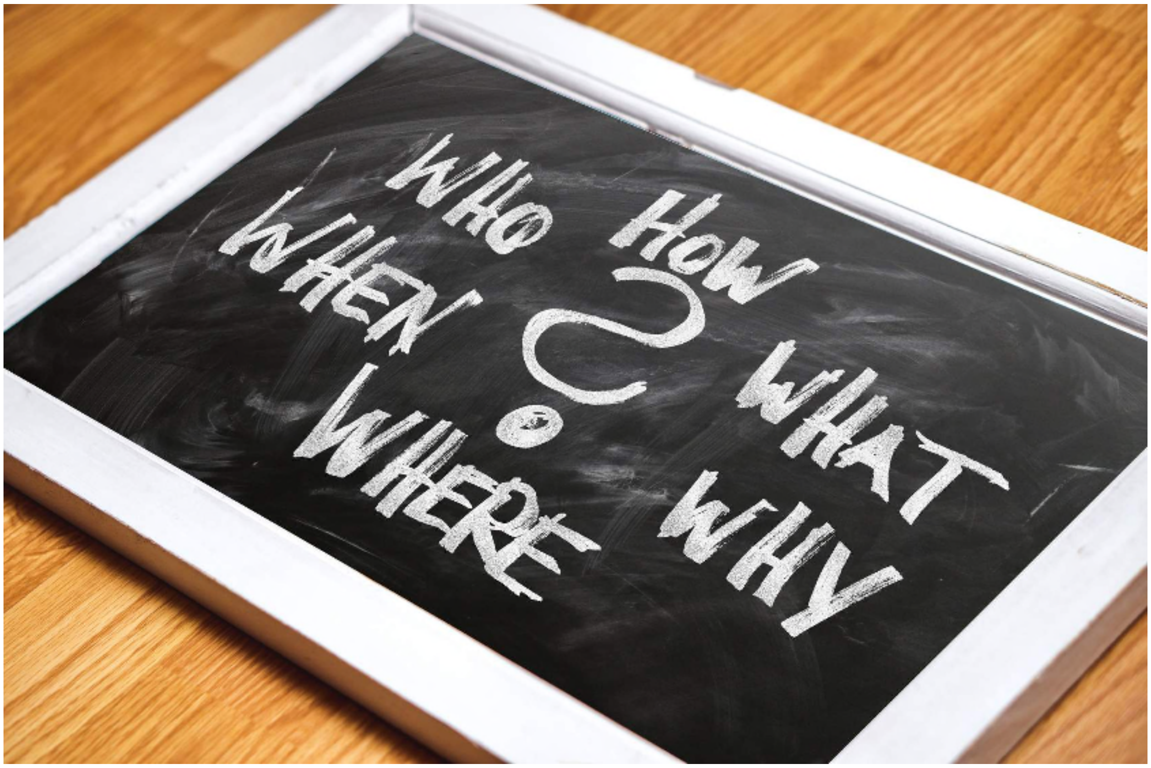
Practice



Take the practice quizzes and tests in the Fire Tech online course. Many studies show that recalling information helps to “make it stick”.

Strategy 5

Write your own questions



As you go through the material, turn the information into possible questions that you can go back and answer later. This will help you check how well you are retaining the information in the course.

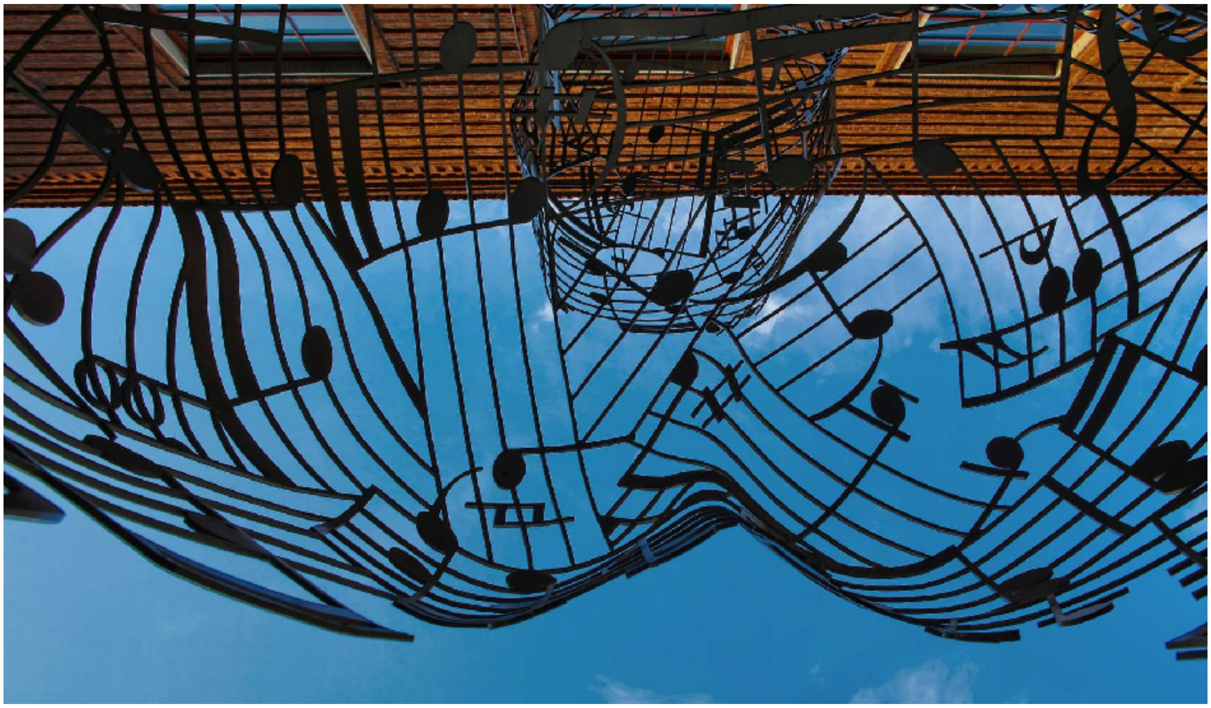
Strategy 6

Make time for your course

Work on your course for at least **20 minutes** every day. Spreading out the course material over time is a much more effective way to learn.

Strategy 7

Make up songs



Our brains remember music really well. Put those formulas, definitions, or requirements to music.

Strategy 8

Teach someone else

It will solidify ideas in your brain and improve your understanding.

GLOSSARY

Lesson 2 of 2

Glossary

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Define key terms associated with fire pumps.

Key References

- *NFPA* 20 - *Standard for the Installation of Stationary Pumps for Fire Protection*, 2016
- *NFPA* 25 - *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2014

LET'S BEGIN

Key Terms

NFPA 20 2016, Chapter 3 and *NFPA* 25 2014, Chapter 3

Below are key glossary terms that will be highlighted throughout this course. Click on each **+** symbol to see the definition for each word below.

Approved

Acceptable to the authority having jurisdiction. (*NFPA* 20 2016, Section 3.2.1)

Authority Having Jurisdiction (AHJ)

An organization, office, or individual responsible for enforcing requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure. (*NFPA* 20 2016, Section 3.2.2)

Centrifugal Pump

A pump in which the pressure is developed principally by the action of centrifugal force. (*NFPA* 20 2016, Section 3.3.44.3)

Circulation Relief Valve

A valve used to cool a pump by discharging a small quantity of water. This valve is separate from and independent of the main relief valve. (*NFPA* 20 2016, Section 3.3.67.5.1)

Control Valve —

A valve controlling flow to water-based fire protection systems. (*NFPA* 25 2014, Section 3.5.1)

Diesel Engine —

An internal combustion engine in which the fuel is ignited entirely by the heat resulting from the compression of the air supplied for combustion. (*NFPA* 20 2016, Section 3.3.15.1)

The oil-diesel engine operates on fuel oil injected near the top dead center of the compression stroke. The combustion is effected within the working cylinder and not in external chambers.

Electric Motor —

A motor that is classified according to mechanical protection and methods of cooling. (*NFPA* 20 2016, Section 3.3.35.4)

End Suction Pump —

A single suction pump having its suction nozzle on the opposite side of the casing from the stuffing box and having the face of the suction nozzle perpendicular to the longitudinal axis of the shaft. (*NFPA* 20 2016, Section 3.3.44.4)

Fire Pump —

A pump that is a provider of liquid flow and pressure dedicated to fire protection. (*NFPA* 20 2016, Section 3.3.44.5)

Fire Pump Controller

A group of devices that serve to govern, in some predetermined manner, the starting and stopping of the fire pump driver and to monitor and signal the status and condition of the fire pump unit. (*NFPA* 20 2016, Section 3.3.19)

Head

A quantity used to express a form (or combination of forms) of the energy content of water per unit weight of the water referred to any arbitrary datum. (*NFPA* 20 2016, Section 3.3.25)

Horizontal Pump

A pump with the shaft normally in a horizontal position. (*NFPA* 20 2016, Section 3.3.44.8)

Horizontal Split-Case Pump

A centrifugal pump characterized by a housing that is split parallel to the shaft. (*NFPA* 20 2016, Section 3.3.44.9)

In-Line Pump

A centrifugal pump whose drive unit is supported by the pump having its suction and discharge flanges on approximately the same centerline. (*NFPA* 20 2016, Section 3.3.44.10)

Jockey (Pressure Maintenance or Make-Up) Pump

A pump designed to maintain the pressure on the fire protection system(s) between preset limits when the system is not flowing water. (*NFPA* 20 2016, Section 3.3.44.15)

Listed

Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose. (*NFPA* 20 2016, Section 3.2.3)

Main Drain

The primary drain connection located on the system riser. (*NFPA* 25 2014, Section 3.3.10.1)

Maximum Pump Brake Horsepower

The maximum brake horsepower required to drive the pump at rated speed. The pump manufacturer determines this by shop test under expected suction and discharge conditions. Actual field conditions can vary from shop conditions. (*NFPA* 20 2016, Section 3.3.34)

No Flow (Churn, Shutoff) –

The condition of zero flow when the fire pump is running but the only water passing through the pump is a small flow that is discharged through the pump circulation relief valve or supplies the cooling for a diesel engine driver. (*NFPA* 20 2016, Section 3.3.38)

Pressure Control Valve –

A pilot-operated pressure-reducing valve designed for the purpose of reducing the downstream water pressure to a specific value under both flowing (residual) and non-flowing (static) conditions. (*NFPA* 20 2016, Section 3.3.67.3)

Pressure Maintenance (Jockey or Make-Up) Pump –

A pump designed to maintain the pressure on the fire protection system(s) between preset limits when the system is not flowing water. (*NFPA* 20 2016, Section 3.3.44.15)

[Pressure] Relief Valve –

A device that allows the diversion of liquid to limit excess pressure in a system. (*NFPA* 25 2014, Section 3.5.6)

Qualified –

A competent and capable person or company that has met the requirements and training for a given field acceptable to the AHJ. (*NFPA* 25 2014, Section 3.3.34)

Rated Flow –

The capacity of the pump at rated speed and rated pressure as marked on the manufacturer's nameplate. (*NFPA* 20 2016, Section 3.3.47)

Rated Speed –

The speed for which the fire pump is listed and that appears on the fire pump nameplate. (*NFPA* 20 2016, Section 3.3.57.3)

Relief Valve –

A device that allows the diversion of liquid to limit excess pressure in a system. (*NFPA* 20 2016, Section 3.3.67.5)

Shall –

Indicates a mandatory requirement. (*NFPA* 20 2016, Section 3.2.4)

Should

Indicates a recommendation or that which is advised but not required. (*NFPA* 20 2016, Section 3.2.5)

Sprinkler System

A system that consists of an integrated network of piping designed in accordance with fire protection engineering standards that includes a water supply source, a water control valve, a waterflow alarm, and a drain. The portion of the sprinkler system above ground is a network of specifically sized or hydraulically designed piping installed in a building, structure, or area, generally overhead, and to which sprinklers are attached in a systematic pattern. The system is commonly activated by heat from a fire and discharges water over the fire area. (*NFPA* 25 2014, Section 3.6.4)

Standard

An NFPA Standard, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase “standards development process” or “standards development activities,” the term “standards” includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides. (*NFPA* 20 2016, Section 3.2.6)

Supervisory Signal

A signal that results from the detection of a supervisory condition. (*NFPA* 72 2016, Section 3.3.253.9)

Testing

A procedure used to determine the operational status of a component or system by conducting periodic physical checks, such as waterflow tests, fire pump tests, alarm tests, and trip tests of dry pipe, deluge, or preaction valves. (*NFPA* 25 2014, Section 3.3.47)

Total Head, Horizontal Pumps

The measure of the work increase, per pound of liquid, imparted to the liquid by the pump, and therefore the algebraic difference between the total discharge head and the total suction head. Total head, as determined on test where suction lift exists, is the sum of the total discharge head and total suction lift. Where positive suction head exists, the total head is the total discharge head minus the total suction head. (*NFPA* 20 2016, Section 3.3.25.3.1)

Refer to *NFPA* 20 2016, Figure A.3.3.25.3.1

Total Head, Vertical Turbine Pumps

The distance from the pumping liquid level to the center of the discharge gauge plus the total discharge head. (*NFPA* 20 2016, Section 3.3.25.3.2)

Refer to *NFPA* 20 2016, Figure A.3.3.25.3.2

Velocity Head

The kinetic energy of a unit weight of fluid moving with velocity (v) determined at the point of the gauge connection. (*NFPA* 20 2016, Section 3.3.25.6)

Vertical Lineshaft Turbine Pump

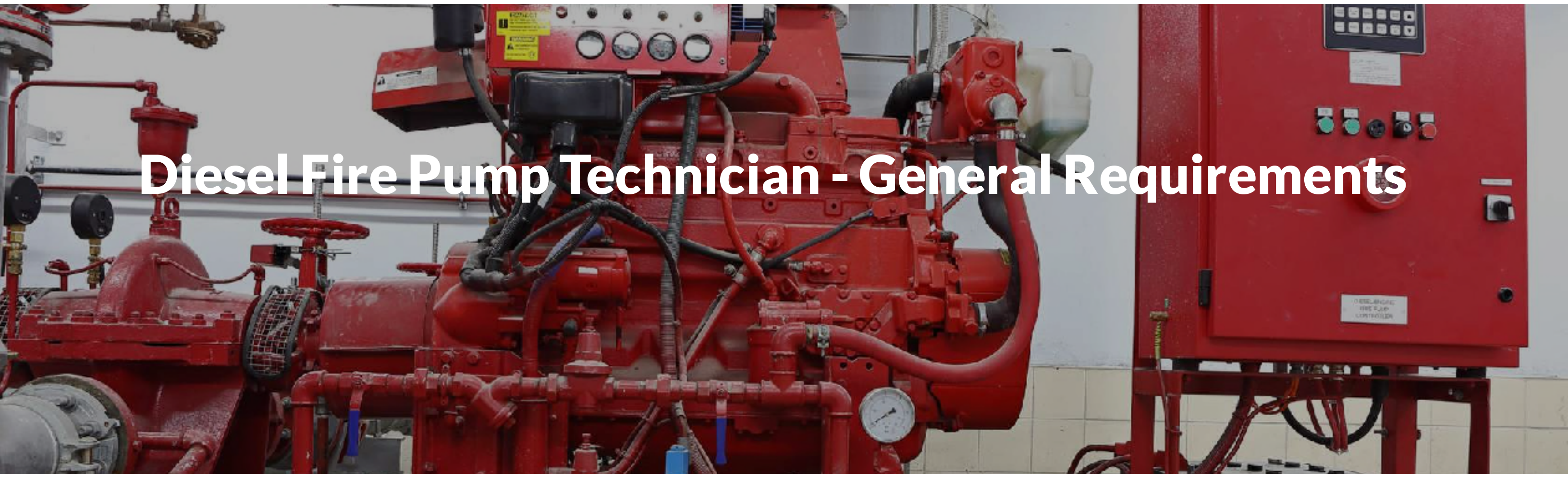
A vertical shaft centrifugal pump with rotating impeller or impellers and with discharge from the pumping element coaxial with the shaft. The pumping element is suspended by the conductor system, which encloses a system of vertical shafting used to transmit power to the impellers, the prime mover being external to the flow stream. (*NFPA* 20 2016, Section 3.3.44.18)

Water Supply

A source of water that provides the flows [gal/min] and pressures [psi (bar)] required by the water-based fire protection system. (*NFPA* 25 2014, Section 3.3.51)

CONTINUE

Please press the button to proceed.



Diesel Fire Pump Technician - General Requirements

When you are ready to begin, click on the "**Begin**" button to start.

By the end of this module, you will be able to do the following:

- Describe the purpose of a fire pump as a part of a fire protection system.
- Calculate the energy that a fire pump can add to a sprinkler system.
- Recognize different types of fire pumps and their components.

Key References for this module:

- *NFPA 20 – Standard for the Installation of Stationary Pumps for Fire Protection, 2016*

General Fire Pump Information

Lesson 1 of 1

General Fire Pump Information

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

- Describe the purpose of a fire pump as a part of a fire protection system.
- Calculate the energy that a fire pump can add to a sprinkler system.

- Recognize different types of fire pumps and their components.

Key References

- *NFPA 20 – Standard for the Installation of Stationary Pumps for Fire Protection, 2016*
- *NFPA Fire Protection Handbook*, 2008

LET'S BEGIN

General Information

NFPA 20 2016 Requirements

The requirements for fire pumps are found in *NFPA* 20 2016 which provides the minimum fire pump design, installation, and acceptance testing requirements. *NFPA* 20 2016 covers the selection and installation of pumps supplying liquid for private fire protection. The purpose of the standard is to provide a reasonable degree of protection for life and property from fire through installation requirements for stationary fire pumps.

The **scope** of the standard includes areas such as:

- Liquid supplies
- Suction, discharge, and auxiliary equipment
- Power supplies and power supply arrangements
- Electric drive and control

- Diesel engine drive and control
- Steam turbine drive and control
- Acceptance tests and operation

The standard **does not** discuss:

- **System liquid supply capacity and pressure requirements**
- **Periodic inspection, testing, and maintenance of fire pump systems**
- **Installation wiring of fire pump units**

PUMP VERSUS FLUID

Pump versus Fluid

Before diving into the requirements found in *NFPA* 20 2016, here is a quick review of some key terms and concepts:

Pump

A pump is simply a device that adds energy to a fluid. The key here is that **energy from the pump is being added to the energy which already exists in the liquid**.

Fluid

A fluid can either be **compressible or incompressible**. In this specific instance, we're talking about an **incompressible fluid, namely; water**.

In general, the fire pump will either enhance the pressure of an existing water supply or provide water supply pressure to power the fire protection system.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Is water considered a compressible or incompressible fluid?

○ Compressible

○ Incompressible

SUBMIT

Complete the knowledge check above before moving on.

Pumps Add Energy

Since the pressure and flow continually decrease as water moves through a sprinkler system, it is the fire pump's job to add energy to the water supply. This process, in turn, allows the sprinkler system to meet its intended pressure and flow criteria.

For example:

If a pump has the capability of **achieving a pressure of 150 psi**, this means that the **static pressure which can be achieved by the pump is 150 psi**.

If an **independent water supply** is available at a **pressure of 30 psi**, it will eventually be able to achieve a **downstream static pressure maximum of 180 psi**.

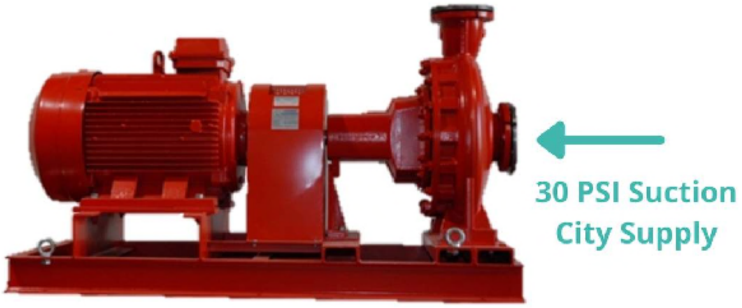
The **150 psi added by the pump to the 30 psi** which already existed in the water supply would give the **resulting pressure of 180 psi**.

Visual Explanation

Click on the "Start" button to see how a fire pump adds energy to a sprinkler system.

1

Existing Water Supply



A city water supply has a pressure of 30 psi for the given sprinkler system.

2

Adding a Pump

The pump added to the system has the capability of achieving a pressure of 100 psi.

3

Energy Output

With the addition of this pump and the energy it provides to the system, the water pressure output/discharge will increase to 130 psi.

PUMP HEAD

Pump Head

Head is measured either in psi or in "feet of head" (usually abbreviated to "feet"). **Pump Head** is the total resistance a pump must overcome, consisting of the following components:

STATIC HEAD
FRICTION HEAD
VELOCITY HEAD

Static head represents the **net change in height**, in feet, that the pump must overcome.

STATIC HEAD
FRICTION HEAD
VELOCITY HEAD

Also called **pressure drop**. When fluid flows through any system component, friction results, causing a **loss in pressure that the pump must overcome**. Components causing friction include piping, couplings, valves, and fittings. Friction head is usually expressed as **"feet of head."**
A foot of friction head is equal to lifting the fluid one foot of static height.

STATIC HEAD
FRICTION HEAD
VELOCITY HEAD

Velocity head is the **vertical distance a body would have to fall** to acquire the velocity. This is **calculated using the average velocity**, which can be obtained by dividing the flow in cubic feet per second by the actual area of pipe cross-section in square feet.

Note:

The net pump shutoff (churn or 0 gpm) pressure plus the maximum static suction pressure, adjusted for head or elevation, can't exceed the pressure for which the system components are rated. This is typically **175 psi**.

You can convert Pressure to Head by using the following formula:

Head in feet = Pressure in psi ÷ 0.433 specific gravity

You can convert Head to psi by multiplying Head by 0.433.

CENTRIFUGAL PUMP CAPACITIES

Centrifugal Pump Capacities

NFPA 20 2016, Section 4.9

A centrifugal pump for fire protection shall be selected to operate at **less than or equal to 150% of the rated capacity**.

The Annex provides further guidance:

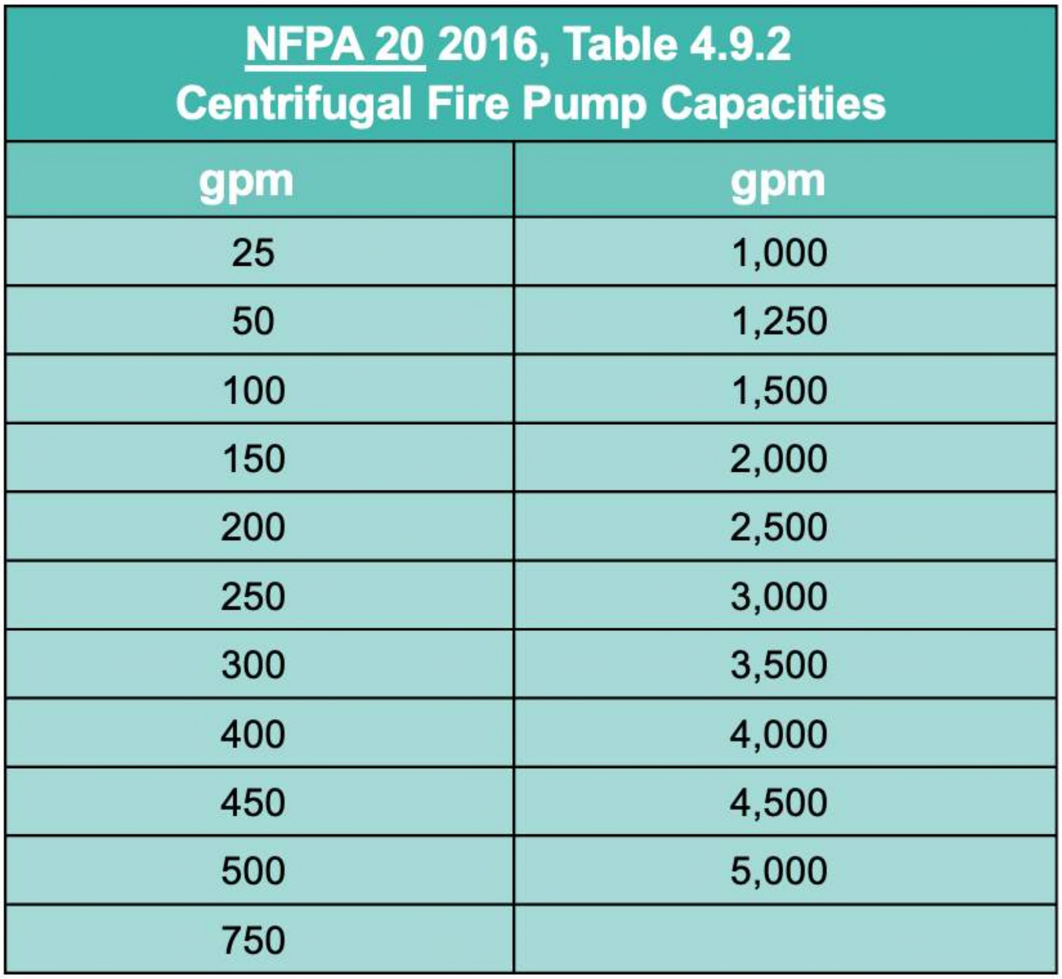
- The performance of the pump when applied at capacities **over 140% of rated capacity** can be **adversely affected by the suction conditions**.
- Application of the pump at capacities **less than 90%** of the rated capacity is **not recommended**.

The selection and use of the fire pump should **not be confused with pump operating conditions**. Under proper suction conditions, the pump can operate at any point on its characteristic curve from

shutoff to 150% of its rated capacity.

Centrifugal fire pumps are required to have one of the rated capacities contained in the following table and be rated at **net pressures of 40 psi or above**. Centrifugal fire pumps with **ratings above 5000 GPM** are subject to **individual review by the** AHJ **or a listing laboratory**.

Table 4.9.2 shows the requirements for centrifugal fire pump capacities.



NFPA 20 2016, Table 4.9.2
Centrifugal Fire Pump Capacities

gpm	gpm
25	1,000
50	1,250
100	1,500
150	2,000
200	2,500
250	3,000
300	3,500
400	4,000
450	4,500
500	5,000
750	

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Match the term on the left with its description on the right.

SUBMIT

Centrifugal fire pumps are required to have one of the rated capacities contained in the following *NFPA* 20 2016, Table 4.9.2, and be rated at net pressures of _____ or above.

○ 40 psi

○ 60 psi

○ 80 psi

○ 100 psi

SUBMIT

Complete the knowledge checks above before moving on.

Circulation Relief Valves

NFPA 20 2016, Section 4.12

You would not want to buy a pump rated at the exact system pressure requirement. Over time, pressure capacity in the pump may decrease, so you should buy a higher pressure pump.

When a centrifugal pump is operating at churn, energy is **continuously imparted to the water in the impeller**, causing the **water to heat**. For electric driver fire pumps and radiator-cooled engine–driven fire pumps, a listed circulation relief valve is needed to provide cooling water when the pump is operating at churn. Failure or the omission of this valve can result in overheating and subsequent damage to the fire pump.

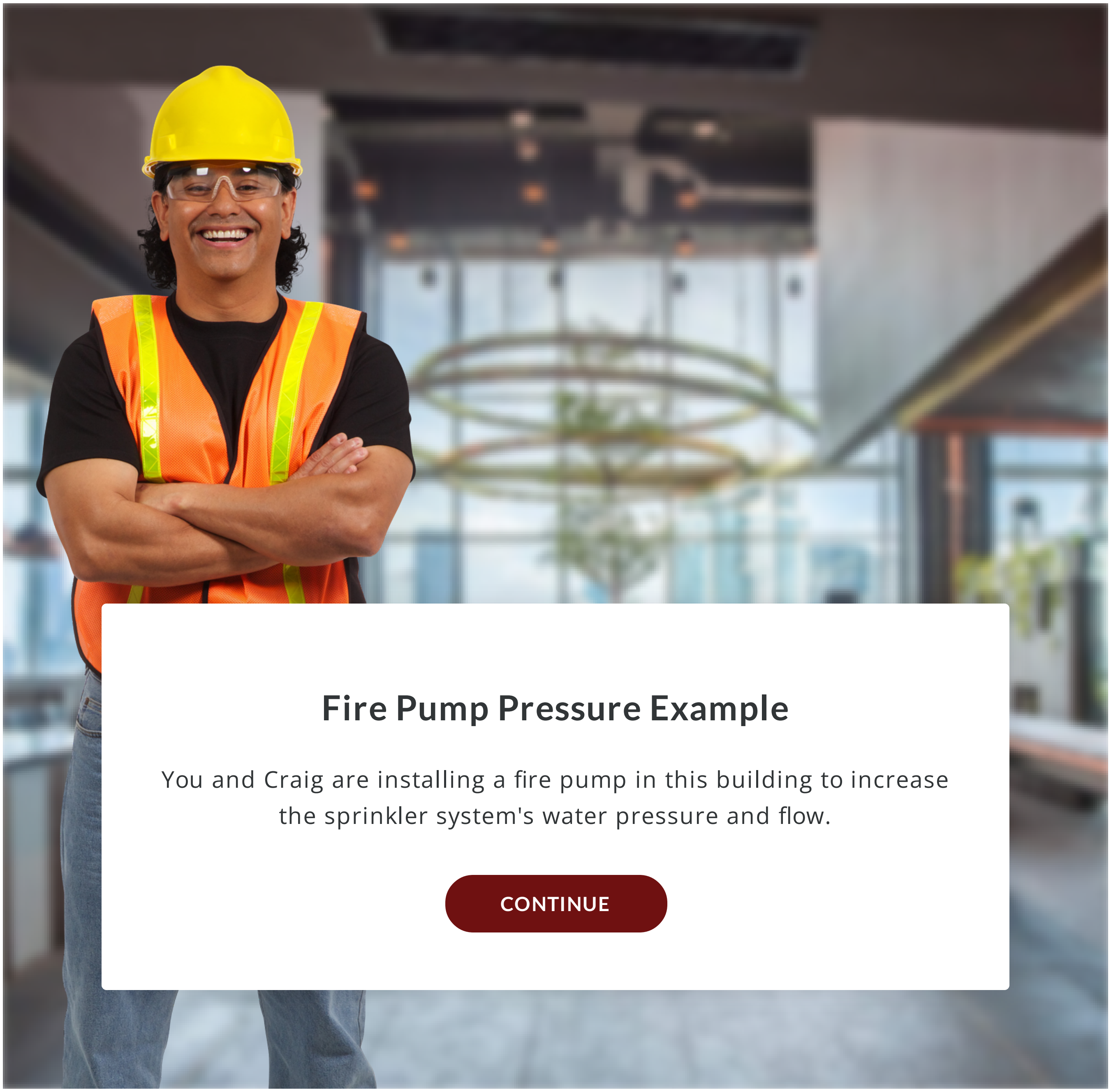
The automatic circulation relief valve is required to be set at a **minimum of 5 psi lower than the operation set pressure** if an electric variable speed pressure limiting controller is installed.

Each pump is **required** to have an automatic circulation relief valve listed for the fire pump service installed and set below the shutoff pressure at the minimum expected suction pressure. The valve needs to be **installed on the discharge side of the pump** before the discharge check valve to provide sufficient flow to prevent the pump from overheating when operating with no discharge.

Casing/Circulation relief valve. Image courtesy of SPP Pumps

CONTINUE

The following scenario will provide an example of how fire pumps add energy and pressure to a sprinkler system.



Fire Pump Pressure Example

You and Craig are installing a fire pump in this building to increase the sprinkler system's water pressure and flow.

Scene 1 Slide 1

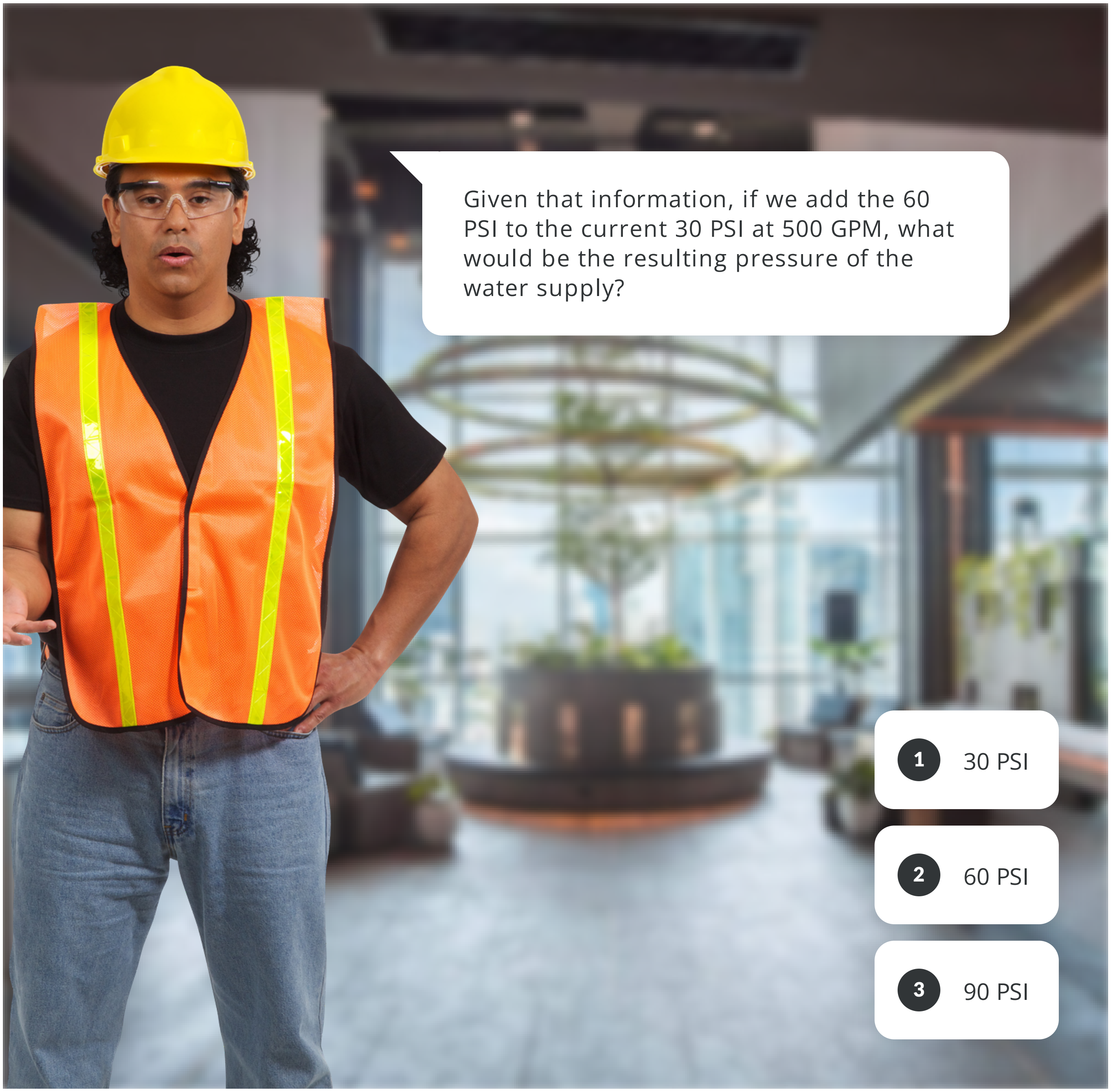
Continue → Next Slide

Hey! It looks like we'll be installing a pump that is rated at 500 GPM at 60 PSI.

Scene 1 Slide 2

And it looks like the building's current water supply can only provide 30 PSI at 500 GPM.

Scene 1 Slide 3



Given that information, if we add the 60 PSI to the current 30 PSI at 500 GPM, what would be the resulting pressure of the water supply?

1 30 PSI

2 60 PSI

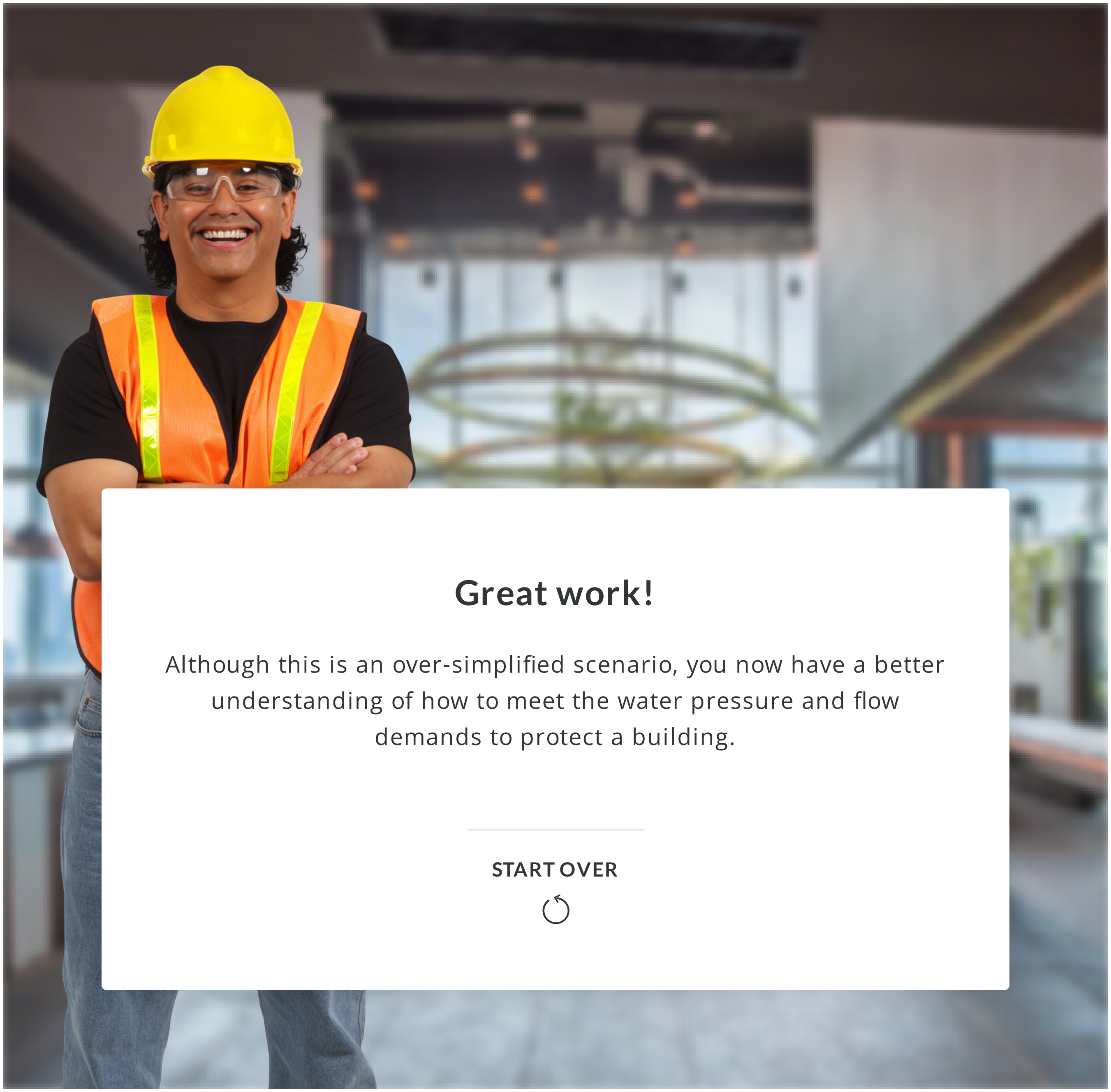
3 90 PSI

Scene 1 Slide 4

0 → Next Slide

1 → Next Slide

2 → Next Slide



Great work!

Although this is an over-simplified scenario, you now have a better understanding of how to meet the water pressure and flow demands to protect a building.

Scene 1 Slide 5

Continue → End of Scenario

Complete the scenario above before moving on.

Fire Pump Drivers

NFPA 20 2016, Section 4.7

A fire pump must have a **driver** - the engine or motor needed to turn the impeller.

There are 3 types of drivers that may be used with fire pumps: electric motors, diesel engines, and steam turbines.

The size of the motor relative to the pump is an important consideration in order to ensure that the motor has the necessary power to operate the pump at its rated speed while delivering the rated flow and pressure.

An **advantage** of choosing an **electric driver** includes ease of maintenance. The **disadvantage** of these drivers is the reliance upon electric power.

The **diesel engine is highly reliable** and is commonly chosen for fire protection uses.

Each pump is required to have its own dedicated driver, and a **pump can only be equipped with one driver**.

ELECTRIC MOTORS

Electric Motors

The objective of an electric motor is the **continuity of power** to drive the fire pump motor in the event of a fire. They are typically used where there is a **reliable source of power**.

There are various factors that determine the **size of an electric fire pump**:

- Desired flow and head
- Site voltage
- Need for a transfer switch, which is used when the source of power may not be reliable and/or as a precaution
- Full versus reduced voltage starting method based on electrical design

Watch the following video to get a better understanding of electric-driven fire pumps.

Run time 4:11

DIESEL ENGINES

Diesel Engines

Diesel engine–driven fire pumps are often used where there is **insufficient or unreliable electrical power** for an electric motor–driven fire pump. They are used in conjunction with, or in addition to, electric motor–driven fire pumps as the best combination for reliable pumping systems.

When combined with on-site water storage — such as a ground storage tank, an underground reservoir, a tower, a pond, or a well — a diesel-driven fire pump is completely **self-contained**.

Diesel engine fire pumps are especially nice because of their **reliability** and their **inexpensive control panel**.

Properly designed and installed diesel-driven fire pump units **can also survive extended periods in the absence of AC power**. Some installations can remain in extended service when the fire pump controller, engine, and other battery loads are low enough for the weekly run function to replenish the batteries, depending on the availability of fuel.

Watch the following video to get a better understanding of diesel-driven fire pumps.

Run time 2:00

STEAM TURBINES

Steam Turbines

Steam-driven fire pump technology has evolved to its current state over many years. The application of steam as a driver for fire pumps is **not as common** as that of electric driver or diesel engine driver, because **steam is not as readily available as it once was**. Furthermore, steam generation is **not very energy efficient**, so other forms of heating have been developed for most modern buildings. In fact, the number of new installations of steam-driven fire pumps worldwide is decreasing steadily each year.

Steam has to be generated by a separate unit (boiler, steam generator, etc.) and steam must either be available at all times or there is a **delay while the steam is generated** and the generators need to be provided with emergency fuel and power.

The only places these pumps are seen are in older installations that are using steam for other process, such as **power plants, factories and other industrial settings**.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Each pump is required to have its own _____ driver, and a pump can only be equipped with one driver.

Type your answer here

SUBMIT

Let's do a quick check about what has been covered so far regarding acceptable drivers for pumps.

Electric Motor

Typically used where there is a reliable source of power

The need for a transfer switch determines pump size

Diesel Engine

Used where there is insufficient or unreliable electrical power

Completely self-contained when combined with on-site water storage

Utilizes an inexpensive control panel

Steam Turbine

Not as common of a driver as it used to be

May rely on emergency fuel and power

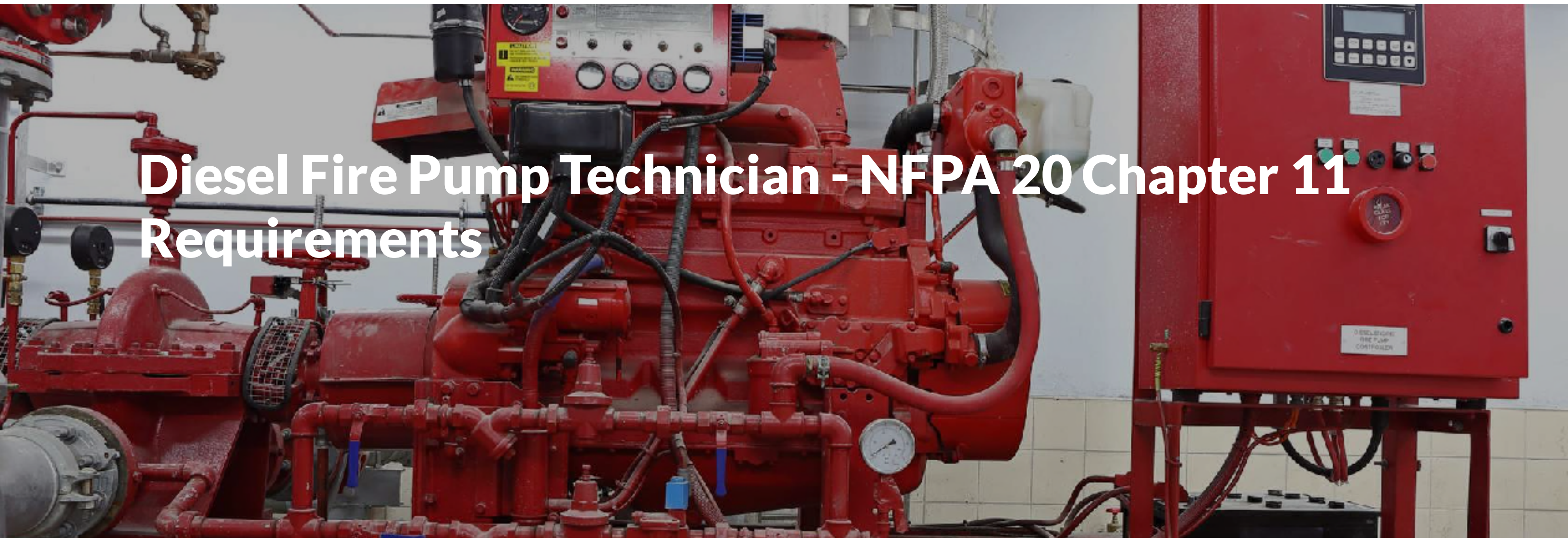
Typically found in power plants and factories

🔒 Complete the knowledge checks above before moving on.

After completing this module, you should now have a general understanding of fire pumps.

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.

Diesel Fire Pump Technician - NFPA 20 Chapter 11 Requirements



When you are ready to begin, click on the "**Begin**" button to start.

By the end of this module, you will be able to do the following:

- Recognize engine speed control requirements.
- Identify information displayed on the engine instrument panel.
- Determine acceptable starting methods for diesel engines.
- Explain the purpose and functionality of the engine cooling system.
- Recognize fuel supply tank limitations.
- Describe diesel engine operational requirements.

Key References for this module:

- *NFPA 20 – Standard for the Installation of Stationary Pumps for Fire Protection, 2016*

NFPA 20 2016 Chapter 11 Diesel Engine Drivers

Lesson 1 of 1

NFPA 20 2016 Chapter 11 Diesel Engine Drivers

Goals for this Lesson:

- Recognize engine speed control requirements.
- Identify information displayed on the engine instrument panel.
- Determine acceptable starting methods for diesel engines.
- Explain the purpose and functionality of the engine cooling system.
- Recognize fuel supply tank limitations.
- Describe diesel engine operational requirements.

DIESEL ENGINES

Diesel Engines

Requirements for diesel engines are found in *NFPA* 20 2016, Chapter 11.

The *NFPA* 20 *Stationary Fire Pumps Handbook* explains that diesel engine-driven fire pumps are chosen for situations where the electric power is insufficient or unreliable. Used either in conjunction with or in addition to electric motor-driven fire pumps, this combination provides a reliable pumping system. Some installations can go for extended periods of time without ac power, while others can remain in service indefinitely if the loads are low enough for the weekly run to recharge the batteries.

NFPA 20 2016, Section 11.1.3

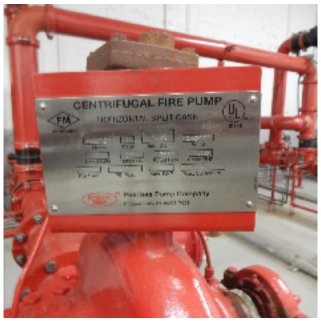
Compression ignition diesel engines are required. Spark-ignition internal combustion engines are not permitted.

ENGINES

Engines

NFPA 20 2016, Section 11.2

Diesel engines are required to be listed for fire pump service and have a **nameplate** indicating the listed horsepower rating available to drive the pump. The nameplate power is based on an **ambient operating temperature of 77°F at 300 ft. above sea level**. The engine is required to have a **4-hour minimum horsepower rating** at least **10% greater** than the power rating shown on the engine nameplate.



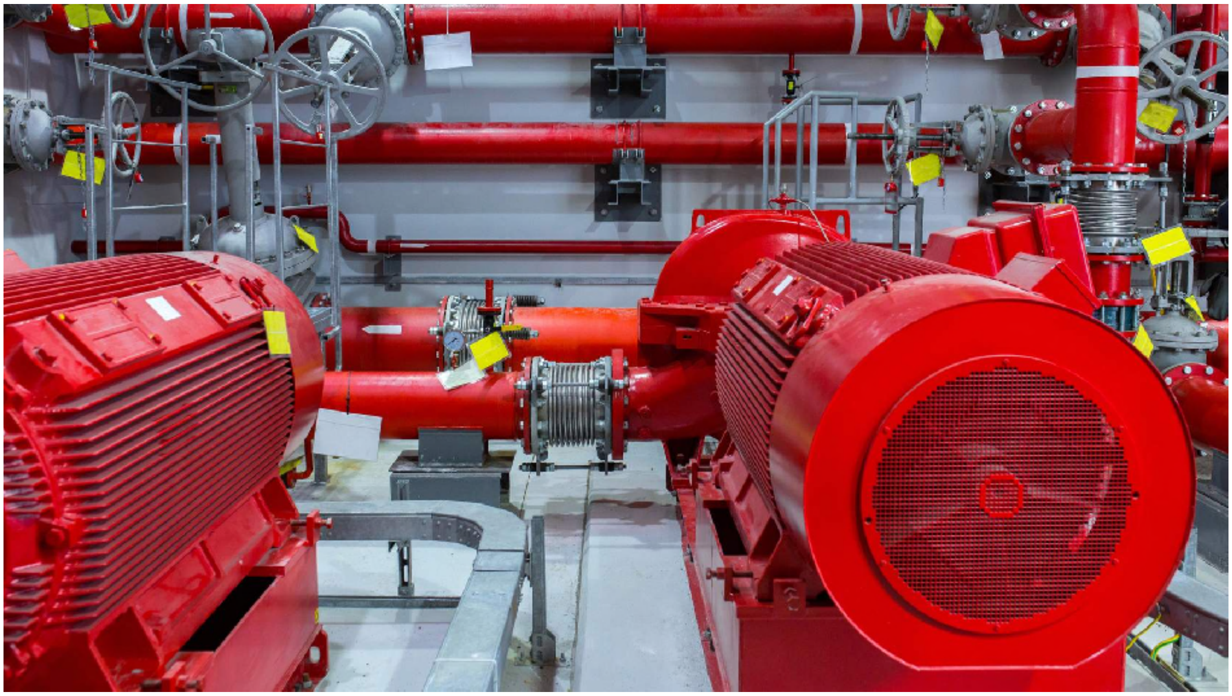
If right-angle gear drives are used between the vertical pump and its driver, the power loss through the right-angle gear needs to be taken into consideration as an additional load and added to the maximum pump load. As a result, **the pump's horsepower requirement needs to increase to compensate for the power loss in the gear drive**. This power loss of the gear drive is typically provided by the gear manufacturer.

ENGINE POWER CONNECTION TO PUMP

Engine Power Connection to Pump

NFPA 20 2016, Section 11.2.3

Installation data sheets and/or the Operations and Maintenance Manual must be followed when installing and setting up the engine and gear drive. As a reminder, always use caution when servicing the connecting shaft or the diesel driver by following **lock-out and tag-out procedures**.



Horizontal shaft engines are required to have the means to allow direct attachment of a flexible coupling adaptor, a flexible connecting shaft adapter, a stub shaft, or a torsional vibration damping type coupling to the engine flywheel.

ENGINE SPEED CONTROLS

Engine Speed Controls

NFPA 20 2016, Section 11.2.4

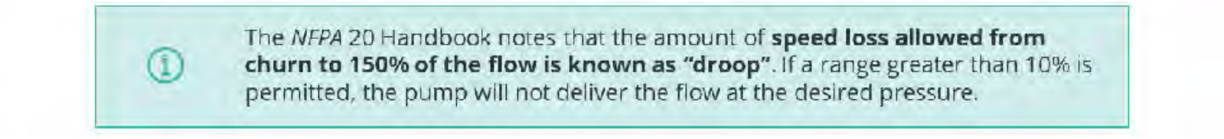
Diesel engine speed controls are required. The **governor** needs to be:

- capable of regulating engine speed within a range of 10% between the shutoff and maximum load condition of the pump
- field adjustable

and

- set to maintain rated pump speed at maximum pump load

Acceleration to rated output speed shall be **reached within 20 seconds**.



The *NFPA* 20 Handbook notes that the amount of **speed loss allowed from churn to 150% of the flow is known as "droop"**. If a range greater than 10% is permitted, the pump will not deliver the flow at the desired pressure.

ELECTRONIC FUEL MANAGEMENT CONTROL

Electronic Fuel Management Control

In the past, diesel engines were built with mechanical devices that controlled fuel injection into the combustion chamber. Recent reduced emissions regulations have encouraged manufacturers to use an **electronic control module (ECM)** to accomplish the fuel injection processes instead. Diesel engines that have an ECM are required to also have an alternate ECM permanently mounted and wired to allow the engine to produce its full rated power output if the primary ECM fails. ECMs are to be protected from transient voltage spikes and reverse dc current.

The ECM or its connected sensors are not permitted to intentionally reduce the engine's ability to produce the rated power output. Backup sensors are required in case the primary sensor fails. A common supervisory signal is required to display at the controller for at least the following events:

- Fuel injection trouble
- Low fuel pressure
- Primary sensor failure

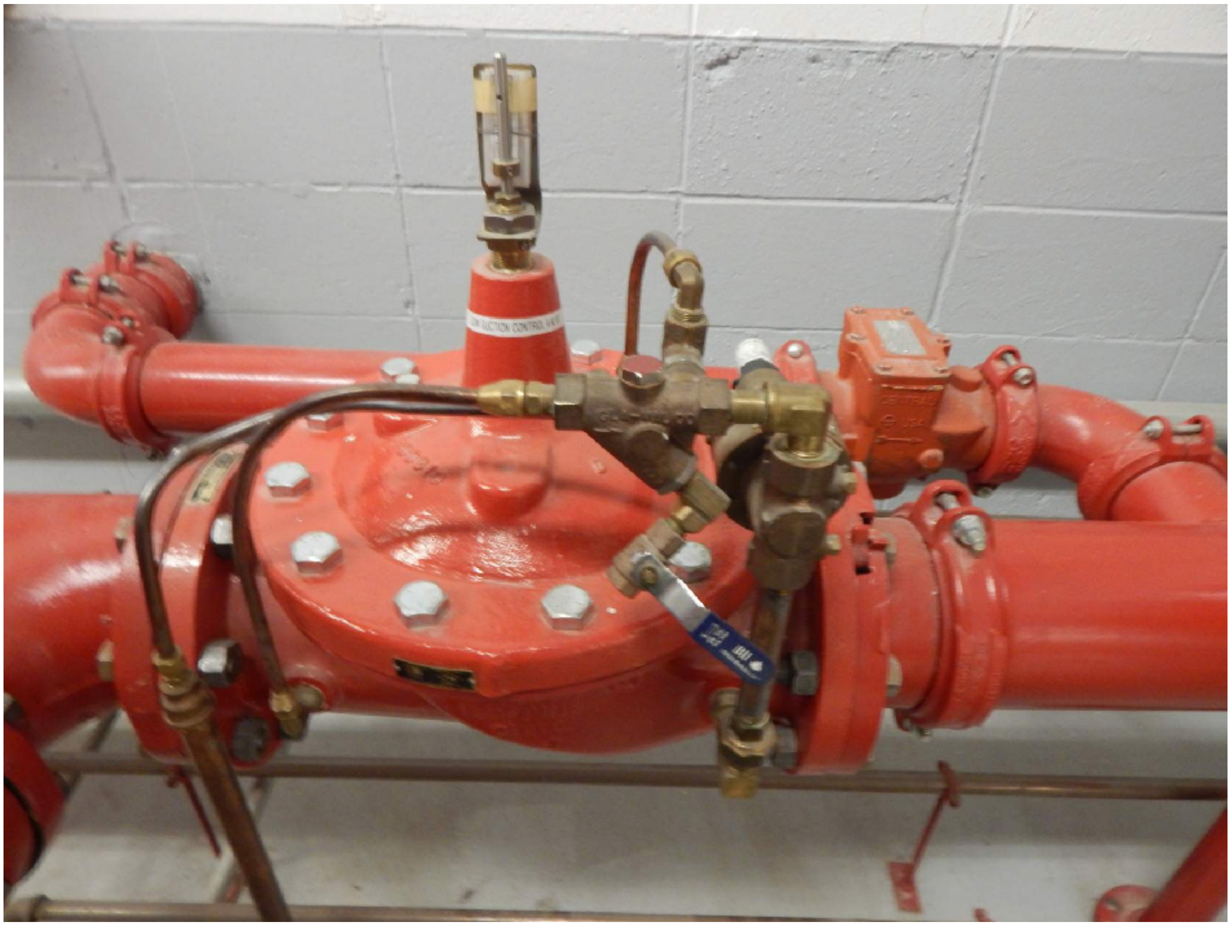
VARIABLE SPEED PRESSURE LIMITING CONTROL (VSPLC) OR VARIABLE SPEED SUCTION LIMITING CONTROL

Variable Speed Pressure Limiting Control (VSPLC) or Variable Speed Suction Limiting Control

These variable speed features can be used on diesel engines for fire pump drive to limit the pump output pressure or suction pressure by reducing the pump speed. These systems are **not** permitted to replace the engine governor.

PRESSURE SENSING LINE

Pressure Sensing Line



A pressure sensing line for the operation of the variable speed feature is to be provided to the engine with a ½ in. nominal size inside the diameter line. This line is dedicated to controlling the VSPLC function in the diesel engine driver onboard controls and differs from the sensing line that is used to control the starting and running time for the fire pump.

Pressure Limiting Control

For **pressure limiting control**, a sensing line is required running from a connection between the pump discharge flange and the discharge check valve to the engine. If sediment can enter the line, a drop-down trap and a cleanout are required.

Suction Limiting Control

For **suction limiting control**, a sensing line is required from a connection at the pump inlet flange to the engine.

ENGINE OVERSPEED SHUTDOWN CONTROL

Engine Overspeed Shutdown Control

Overspeed shutdown devices are required as a precaution in the event the governor fails, and the engine goes into overspeed. As the engine speed increases, the pump discharge pressure also increases which can damage piping and system components. *NFPA* 20 2016 requires a main relief valve to be installed to release any excess pressure that occurs due to overspeed and prevent any damage from occurring.

The overspeed shutdown device is to be set up to shut down the engine in a speed range of 10-20% above the rated engine speed and manually reset. An overspeed trouble signal is to be sent to the engine controller, and the controller cannot be reset until the overspeed shutdown device is manually reset to a normal operating position.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Diesel engine-driven fire pumps are chosen for situations where the electric power is _____ or _____.

○ insufficient; unreliable

○ sufficient; unreliable

○ insufficient; reliable

○ sufficient; reliable

SUBMIT

Diesel engine speed controls are required. Acceleration to rated output speed shall be reached within _____ seconds.

○ 10

○ 20

○ 30

○ 40

SUBMIT

Variable speed features used on diesel engines are permitted to replace the governor.

○ True

○ False

SUBMIT

Complete the knowledge checks above before moving on.

Signals to the Controller

The following signaling means are to be provided to the controller:

- Critically low oil pressure in the engine lubrication system
- High engine temperature
- Low engine temperature
- High cooling water temperature

The following shall be provided on the engine to test the operation of the signal to the controller resulting in visible and common audible alarms:

- Oil pressure signal
- High engine temperature signal
- Low engine temperature signal
- High cooling water temperature signal

These tests are typically conducted during the pump's commissioning. Instructions for conducting each of these tests are to be provided in the engine manual.

INSTRUMENTATION

Instrumentation

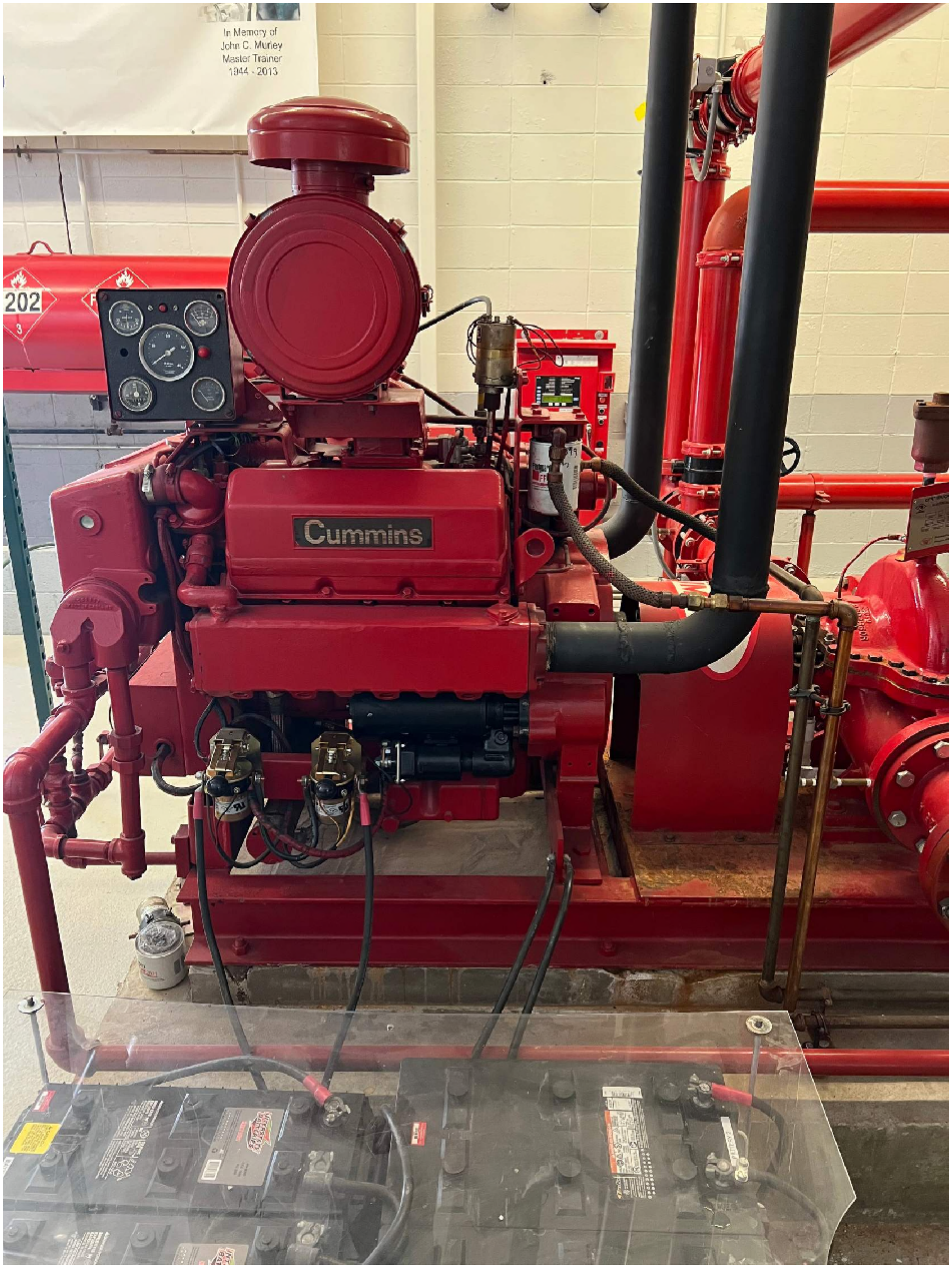
NFPA 20 2016, Section 11.2.5

A tachometer (or another device) is required to indicate the engine rpm, including zero. Total time of engine operation shall be recorded by the tachometer or alternate device. If the tachometer has a digital display, the display is permitted to be blank when the engine is not running. Oil pressure and temperature gauges are also required to show lubricating oil pressure and engine coolant temperature, respectively.

STARTING METHODS

Starting Methods

NFPA 20 2016, Section 11.2.7


In Memory of
John C. Murley
Master Trainer
1944 - 2013
202
3
Cummins

Engines are required to be equipped with reliable starting devices. For electric starting methods, the electric starting device is required to take current from a storage battery. Each engine is to have two storage battery units. The batteries are to be sized to have a capacity to carry the defined loads for **72 hours** of standby power followed by three **15-second attempt-to-start cycles** per battery unit without ac power being available to charge the battery.

The *NFPA* 20 Handbook provides an important reminder that the **batteries need to be as equal in power as possible**. If one battery fails a battery test or becomes weak, it is advisable to replace both batteries at the same time with those in the same class and amp-hour rating as recommended by the engine manufacturer.

Engines with only **one cranking motor** are required to have the **main battery contactor installed between each battery and the cranking motor to allow for battery isolation**. The main battery contactors are required to be listed for use with fire pump drivers, be rated for the cranking motor current, and be capable of manual mechanical operation.

Engines with **two cranking motors** are required to have **one cranking motor dedicated to each battery**. Each of these cranking motors needs to satisfy the requirements for a single cranking motor system and have an integral solenoid relay that can be operated by the pump set controller to activate cranking. Each cranking motor integral solenoid relay is required to be energized from a manual operator listed and rated for the cranking motor solenoid relay. **A mechanical switch is required on the engine panel to energize the starting motor if the controller circuit fails**.

Storage batteries are to be rack supported above the floor and secured, located where they will not be exposed to extreme temperatures, vibration, mechanical injuries, or flooding due to water. **The current-carrying parts are to be located at least 12 in. above the floor level**. They are **not** permitted to be placed in front of engine-mounted instruments and controls and must be easily accessible for servicing.

CONTINUE

If hydraulic starting is used, enclose or protect the accumulators and other accessories. Install the enclosure as close as possible to the engine. This helps to prevent a large pressure drop between the engine and the enclosure. **The diesel engine needs to be capable of carrying its full rated load within 20 seconds after cranking is initiated, with the following at 32°F**:

- Intake air
- Room ambient temperature
- All starting equipment

For air starting, all conductors for automatic controllers are required to be harnessed or flexibly enclosed, mounted on the engine, and connected in an engine junction box to terminals numbered to correspond with numbered terminals in the controller.

Signal for Engine Running and Crank Termination

Engines are required to have a speed-sensitive switch to signal running and crank termination. The power for the signal **cannot** be drawn from the engine compressor.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Oil pressure, engine temperature, and water cooling temperature signals are required to be tested to confirm the signals result in alarms. These tests are typically conducted during _____.

Type your answer here

SUBMIT

A tachometer is required to indicate engine rpm. If it has a digital display, the display may be blank when the engine isn't running.

○ True

○ False

SUBMIT

Match the starting method on the left with its expression on the right.

SUBMIT

Complete the knowledge checks above before moving on.

Engine Cooling System

NFPA 20 2016, Section 11.2.8

The engine cooling system has numerous functions, in addition to removing heat from the internal parts of the engine. The system must also:

- Remove entrapped air from the coolant

- Allow for coolant expansion
- Allow for a defined volume of coolant loss
- Maintain minimum flow under varying conditions

The engine cooling system is a part of the engine assembly and is required to be either a heat exchanger type or a radiator type. The heat exchanger type is a traditional type of cooling system that takes water from the pump's discharge piping and uses it to cool the engine. The radiator type does **not** require water from the pump. Instead, it needs a high volume of air to pass through the pump room, making pump room ventilation an important priority.

The heat exchanger cooling system is to include the following:

- A circulating pump driven by the engine
- A heat exchanger
- An engine jacket temperature regulating device

The radiator cooling system is to include the following:

- A circulating pump driven by the engine
- A radiator
- An engine jacket temperature regulating device
- An engine-driven fan for providing positive movement of air through the radiator

The engine is to be **maintained at 120^{o}F** so the engine can start quickly and **achieve full speed within 20 seconds**.

PUMP ROOM

Pump Room

NFPA 20 2016, Section 11.3

Drainage and ventilation are important factors in a fire pump room. The floor needs to be pitched to allow adequate drainage, so the water moves away from the pump, engine, controller fuel tank, and other important equipment. Ventilation is required for the following:

- To control the **maximum temperature to 120°F** at the combustion air cleaner inlet with the engine running at the rated load
- To supply air for engine combustion
- To remove any hazardous vapors
- To supply and exhaust air as needed for radiator cooling of the engine when required

The Annex recommends the air supply ventilator and air discharge be located on opposite walls to allow for better room ventilation. The air supply ventilator includes anything in the air supply path to the pump room. Conversely, the air discharge ventilator includes anything in the air discharge path from the engine to the outdoors.

Radiator discharge needs to be **ducted outdoors** to prevent recirculation. **The duct is required to be attached to the radiator with a flexible section**. A recirculation duct is permitted for cold weather conditions, under specific circumstances as defined in **Section 11.3.2.4.3.4**.

FUEL SUPPLY AND ARRANGEMENT

Fuel Supply and Arrangement

NFPA 20 2016, Section 11.4

Each engine is required to have its own fuel supply tank, fuel supply, and return line.

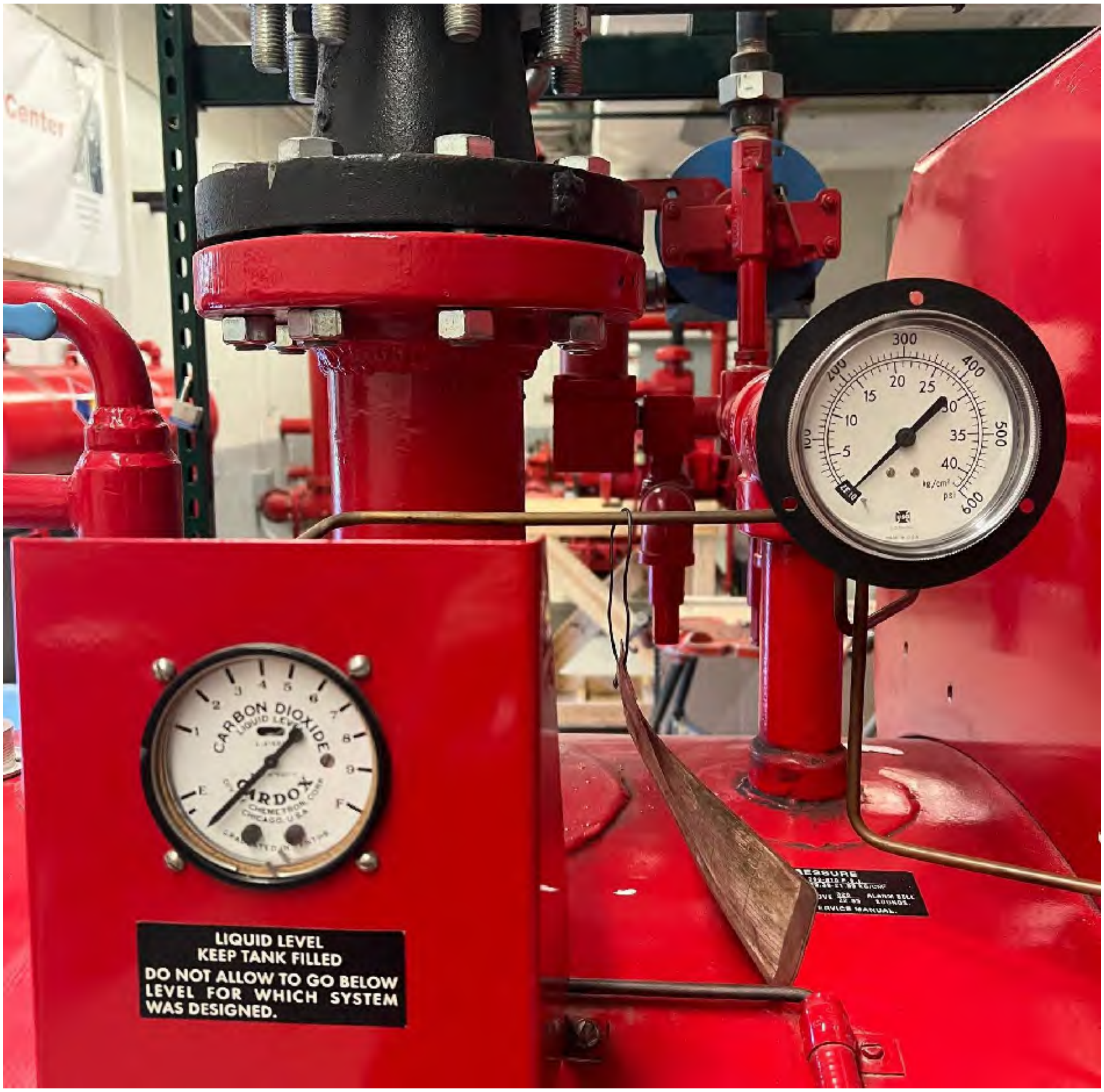
Fuel Supply Tanks

Fuel supply tanks are to have the capacity to hold at least 1 gallon per hp, plus 5% volume for expansion and 5% volume for the sump. The tanks can be either single wall or double-wall construction, meeting ANSI/UL 142 requirements. Single-wall fuel tanks require an enclosure of a wall, curb, or dike to hold the entire tank capacity.

Tank size is limited to 1320 gallons. Tanks that exceed this size shall meet *NFPA* 37 requirements rather than *NFPA* 20 2016.

Fuel tanks are required to have the following connections:

- Fill connection
- Drain connection
- Vent connection
- Engine supply connection
- Engine return connection
- Fuel level switch
- Active fuel maintenance return connection



Tank Level Indication

Fuel level indicators showing the amount of fuel in each storage tank are required. The indicators are to activate at the 2/3 tank level, with a **low fuel level** condition resulting in a supervisory signal being initiated.

CONTINUE

Fuel Piping

Galvanized steel or copper fuel piping is **not** permitted. If black steel pipe is used, steel or malleable iron fittings are required. Shutoff valves are **not** permitted in the fuel return line to the tank. A manual shut-off valve is required within the tank fuel supply line, that is locked in the open position. **No other valves are permitted in the fuel line from the fuel tank to the engine**.

Fuel Line Protection

Fuel lines that are exposed to traffic or damage are required to be protected by a guard, pipe protection, or approved double-walled pipe.

Fuel Type

The type and grade of diesel fuel is specified by the engine manufacturer. The pour point and cloud point need to be at least 10°F below the lowest expected fuel temperature. **Biodiesel and other alternative fuels are not recommended for fire protection diesel engines**, due to storage life concerns.

The fuel grade is required to be indicated on the engine nameplate and also on the fuel tank. The letters on the tank **shall be at least 6 in. in height** and contrast in color to the tank.

CONTINUE

Static Electricity

The tank, pump, and piping are required to be:

- Designed and operated to prevent electrostatic ignitions
- Bonded
- Grounded

Engine Exhaust

Each pump engine is required to have an independent exhaust system. A flexible connection is required between the engine exhaust outlet and exhaust pipe. The connection shall have a section of stainless steel, seamless or welded corrugated (**not interlocked**), **at least 12 in. in length**.

The exhaust pipe is required to be as short as possible. However, it is **not permitted** to be smaller in diameter than the engine exhaust outlet. **The exhaust pipe needs to be guarded to protect personnel from injury**. High-temperature insulation or guards are permitted.

Install exhaust pipes with a **minimum 9 in. clearance** to combustible materials. Guard any exhaust pipe that passes directly through combustible roofs, using ventilated metal thimbles at the point of passage. **The thimbles are required to extend at least 9 in. above and 9 in. below roof construction and are at least 6 in. larger in diameter than the exhaust pipe**.

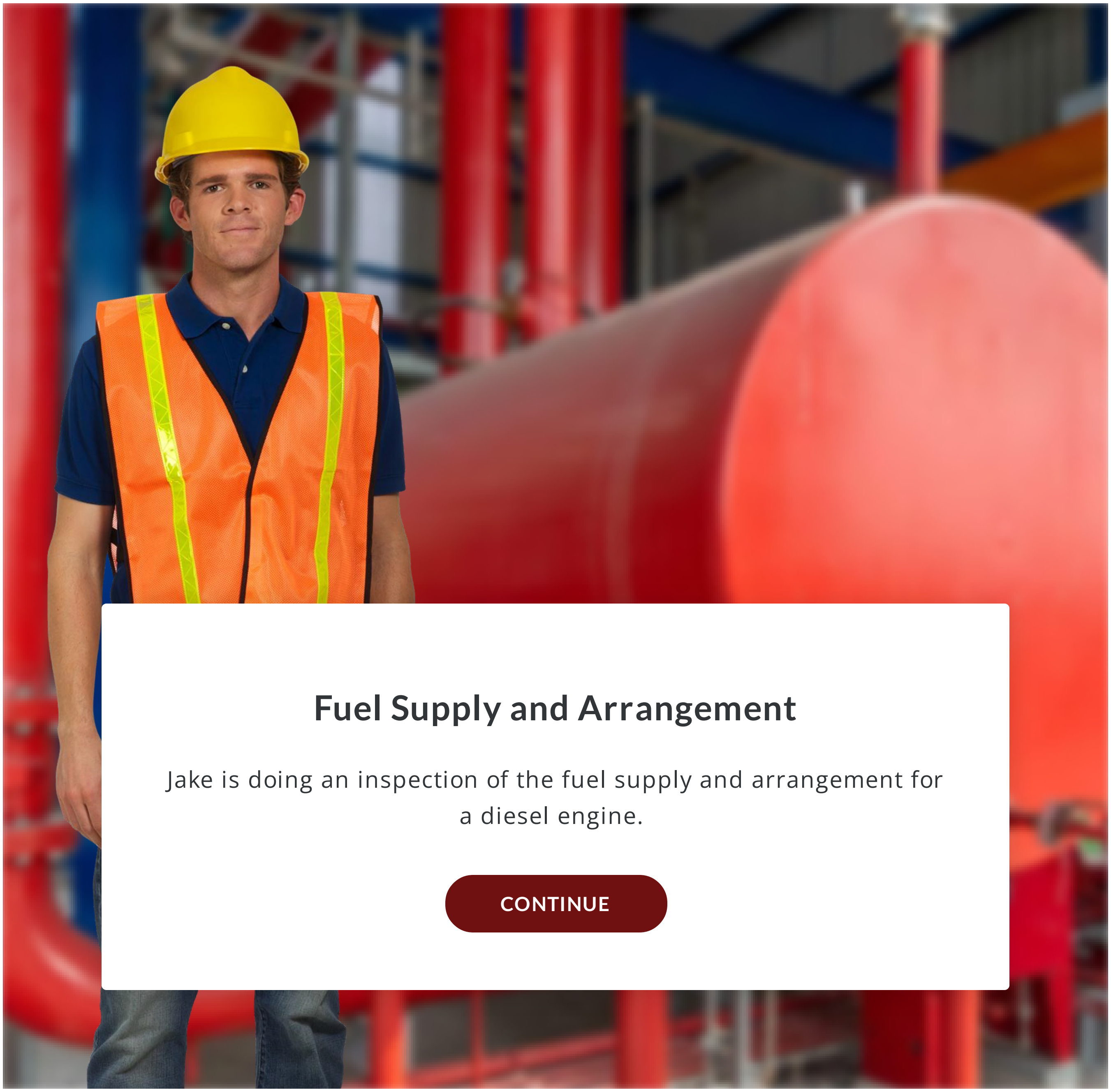
If the exhaust pipes pass directly through combustible walls or partitions, they are required to be guarded at the point of passage using one of the following:

- Metal ventilated thimbles **not less** than **12 in. larger** in diameter than the exhaust pipe
- Metal or burned clay thimbles built in brickwork or other approved materials providing **not less** than **8 in. of insulation** between the thimble and construction material

Exhaust from the engine is required to be discharged to a safe location outside the pump room, where people and buildings **will not** be endangered. Terminate exhaust systems outside the structure allowing hot gases, sparks, or combustion products to discharge to a safe location.

CONTINUE

The following scenario will provide an example of inspecting the fuel supply and arrangement for a diesel system.

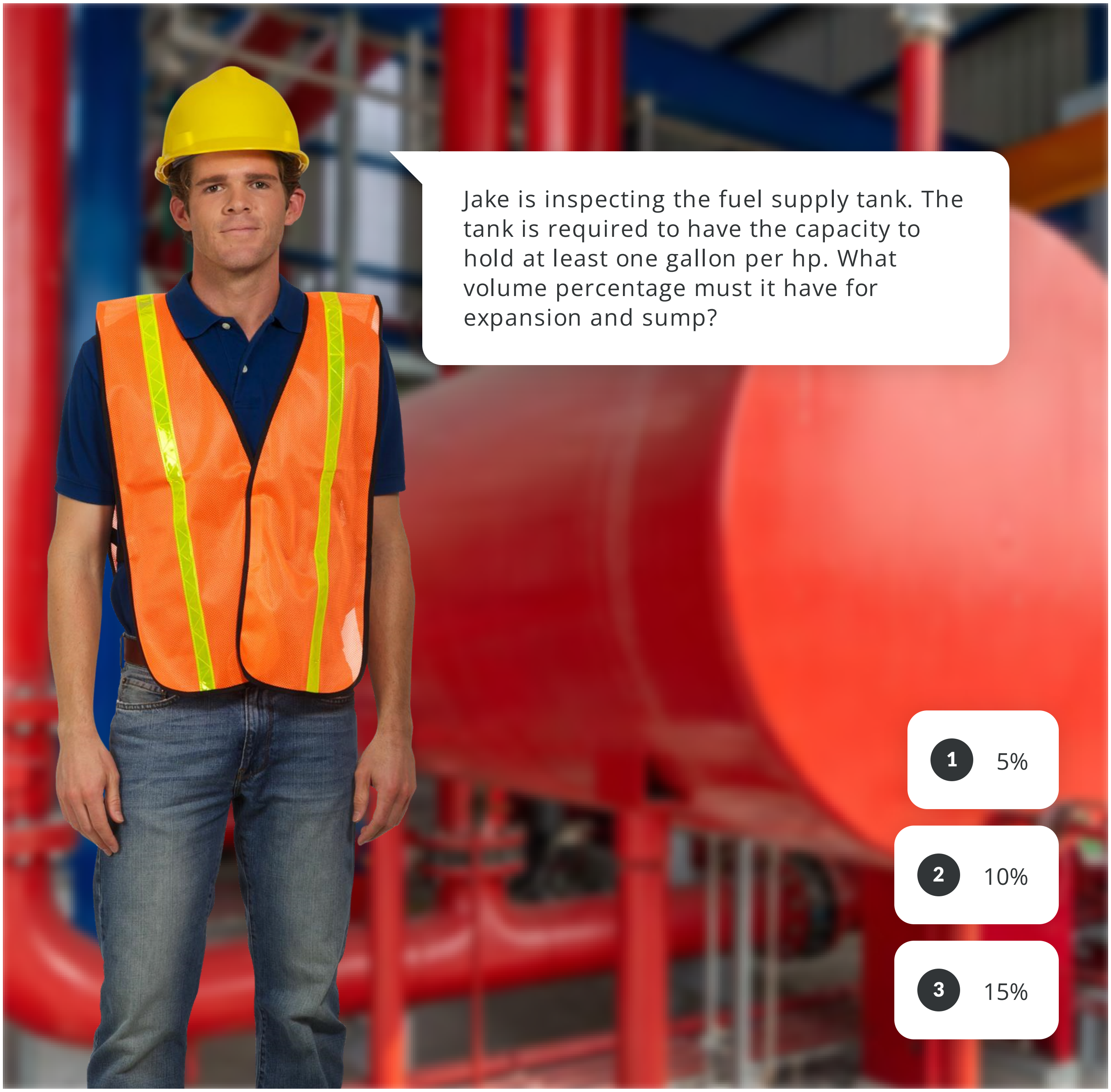


Fuel Supply and Arrangement

Jake is doing an inspection of the fuel supply and arrangement for a diesel engine.

Scene 1 Slide 1

Continue → Next Slide



Jake is inspecting the fuel supply tank. The tank is required to have the capacity to hold at least one gallon per hp. What volume percentage must it have for expansion and sump?

1 5%

2 10%

3 15%

Scene 1 Slide 2

0 → Next Slide
1 → Next Slide
2 → Next Slide

Next Jake takes a look at the tank level and it appears to be lower than required. A supervisory signal was initiated. At what fuel level do the indicators activate for a low fuel level condition?

1 1/3 tank level

2 1/2 tank level

3 2/3 tank level

Scene 1 Slide 3

0 → Next Slide

1 → Scene 1 Slide 1

2 → Next Slide

Jake inspects the flexible connection that is required between the engine exhaust outlet and exhaust pipe. The connection shall have a section of stainless steel at least _____ in length.

1 12 inches

2 18 inches

3 24 inches

Scene 1 Slide 4

0 → Next Slide

1 → Next Slide

2 → Next Slide

Be sure to review Section 11.4 for all of the requirements for fuel supply and arrangement.

START OVER

Scene 1 Slide 5

Continue → End of Scenario

Complete the scenario above before moving on.

Let's do a quick check about what has been covered so far.

Air supply ventilator and air discharge can be located on opposite walls of a fire pump room to permit better ventilation.

○ True

○ False

SUBMIT

Fuel supply tanks are limited to a _____ gal. capacity.

○ 1230

○ 1320

○ 1420

SUBMIT

Which of the following is permitted in fuel piping?

○ Galvanized steel

○ Copper

○ Black steel

SUBMIT

🔒 Complete the knowledge checks above before moving on.

Diesel Engine Driver System Operation

NFPA 20 2016, Section 11.6

Engines are required to be **started at least once a week** and run for a **minimum of 30 minutes**. This allows the engine to reach full operating temperature and for condensation to evaporate from the crankcase. The engines are required to be designed and installed so they remain clean, dry, and well lubricated.

Battery Maintenance

Storage batteries are required to be designed and installed so they always remain charged and can be frequently tested to determine the battery cell condition and amount of charge in the battery.

Only use distilled water in the battery cells and keep battery plates constantly submerged.

The battery and charger are required to be designed and installed to allow periodic inspections of both the battery and the charger. The inspection determines the following:

- The charger is operating properly
- The water level in the battery is correct
- The battery is holding the appropriate charge

Fuel Supply Maintenance

Fuel storage tanks are to be designed and installed to allow the tanks to:

- Be kept full and be properly maintained
- Maintain a fuel level in the tank above 2/3 capacity
- Allow removal of water and foreign material, ensuring the fuel quality

System Operation 3

Emergency Starting and Stopping

Instruction for emergency manual operation shall be posted on the fire pump engine, providing step-by-step instructions for the sequence to follow.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Each pump engine is required to have an independent exhaust system. Exhaust pipes are to be installed with a _____ in. clearance to combustible materials.

○ 6

○ 9

○ 12

○ 15

SUBMIT

Storage batteries are required to remain charged. Use _____ water in the battery cells and keep the battery plates constantly submerged.

Type your answer here

SUBMIT

Instruction for emergency manual operation shall be posted on the fire pump engine.

○ True

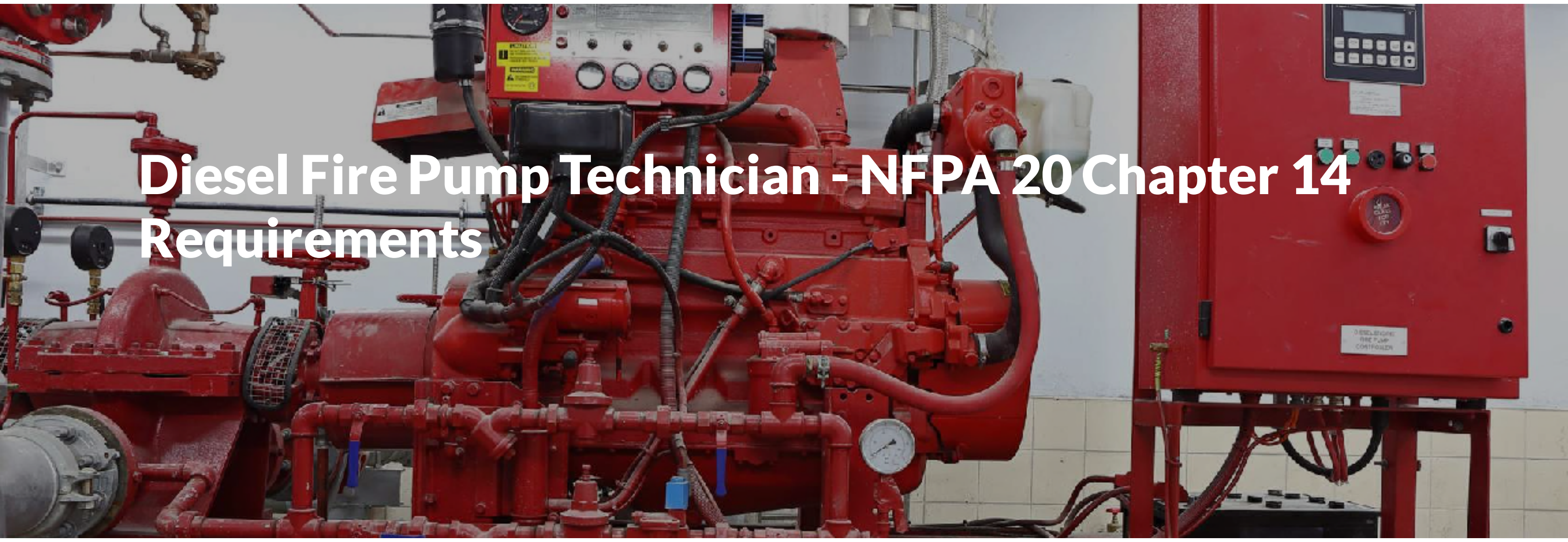
○ False

SUBMIT

Complete the knowledge checks above before moving on.

After completing this module, you should now have a better understanding of diesel engine drivers and documentation.

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.



Diesel Fire Pump Technician - NFPA 20 Chapter 14 Requirements

When you are ready to begin, click on the "**Begin**" button to start.

By the end of this module, you will be able to do the following:

- Describe the requirements for fire pump hydrostatic tests and field acceptance tests.
- Review the requirements listed in the Contractor's Material and Test Certificate for Fire Pump Systems.
- Compare the acceptance test requirements for different fire pump power supply sources.
- Follow proper procedures to obtain appropriate measurements during fire pump testing.

Key References for this module:

- *NFPA* 20 – *Standard for the Installation of Stationary Pumps for Fire Protection,* 2016
- *NFPA* 25 – *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2014

NFPA 20 2016 Chapter 14 Acceptance, Testing, Performance, and Maintenance

Lesson 1 of 1

NFPA 20 2016 Chapter 14 Acceptance, Testing, Performance, and Maintenance

Goals for this Lesson:

- Describe the requirements for fire pump hydrostatic tests and field acceptance tests.
- Review the requirements listed in the Contractor’s Material and Test Certificate for Fire Pump Systems.
- Compare the acceptance test requirements for different fire pump power supply sources.
- Follow proper procedures to obtain appropriate measurements during fire pump testing.

LET'S BEGIN

Introduction

This portion of the standard covers areas such as hydrostatic tests, flushing, field acceptance tests, and component replacement.

Acceptance tests evaluate the pump’s performance to confirm that the pump will operate as needed if a fire occurs. An acceptance test is intended to verify the following:

1. Adequacy of the pump to deliver water per the manufacturer's test characteristic curve.
2. Proper pump driver performance under all anticipated conditions.
3. Acceptable primary and alternative power supply equipment (if supplied) operations under all anticipated conditions. This includes either automatic or manual operation of the controller.
4. Correct operation and pressure settings of the variable speed pressure limiting control (VSPLC) system.

All defects and/or performance issues must be **corrected before final acceptance is permitted**.

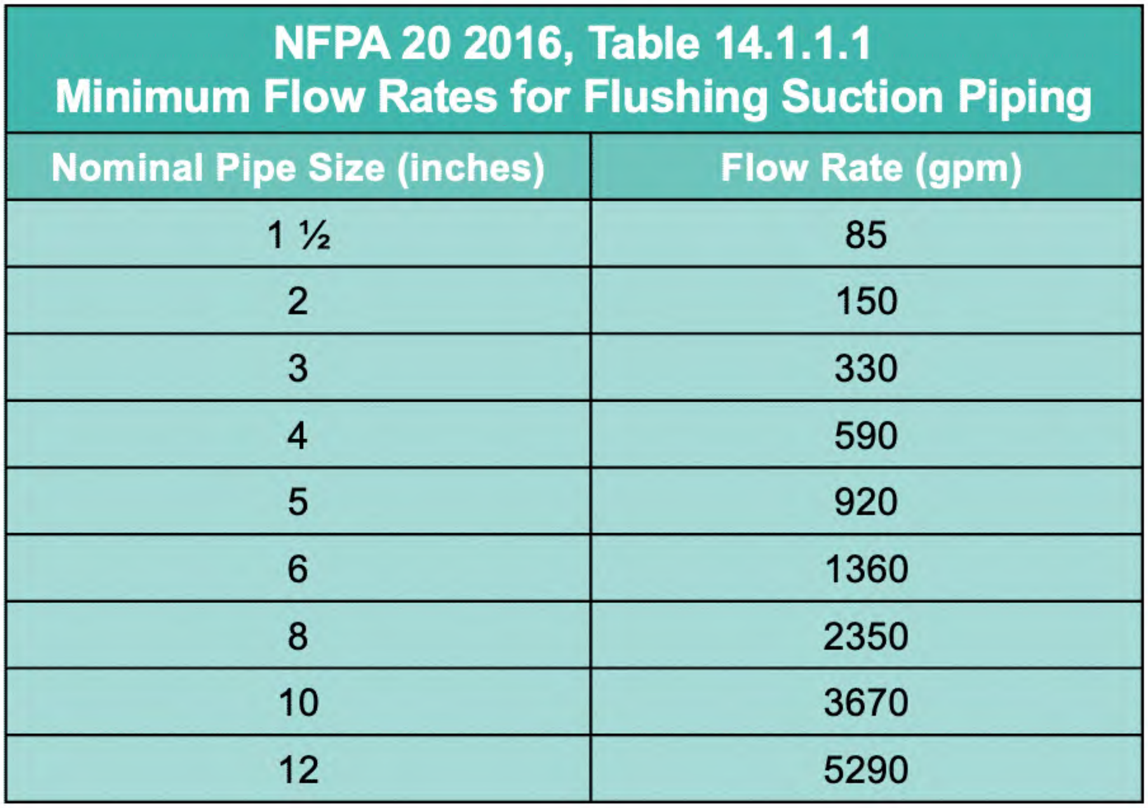
HYDRAULIC TESTS AND FLUSHING

Hydraulic Tests and Flushing

NFPA 20 2016, Chapter 14.1

The typical hydrostatic test requirement is **200 psi minimum pressure** maintained for a period of **two hours**, or you must boost your test pressure to **50 psi over the maximum** operating pressure, **whichever is greater**.

> Flushing must be conducted prior to hydrostatic testing, at a flow rate no less than found in Table 14.1.1.1 or at the hydraulically calculated water demand rate of the system, whichever is greater.



NFPA 20 2016, Table 14.1.1.1 Minimum Flow Rates for Flushing Suction Piping	
Nominal Pipe Size (inches)	Flow Rate (gpm)
1 ½	85
2	150
3	330
4	590
5	920
6	1360
8	2350
10	3670
12	5290

This produces a **velocity of approximately 15 ft./sec**. If the flow rate cannot be achieved with the existing water supply, a **supplemental source** could be necessary.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

If a flushing suction piping has a size of 4 in., the minimum flow rate for the piping is ___ GPM.

○ 85

○ 330

○ 590

○ 1360

SUBMIT

Complete the knowledge check above before moving on.

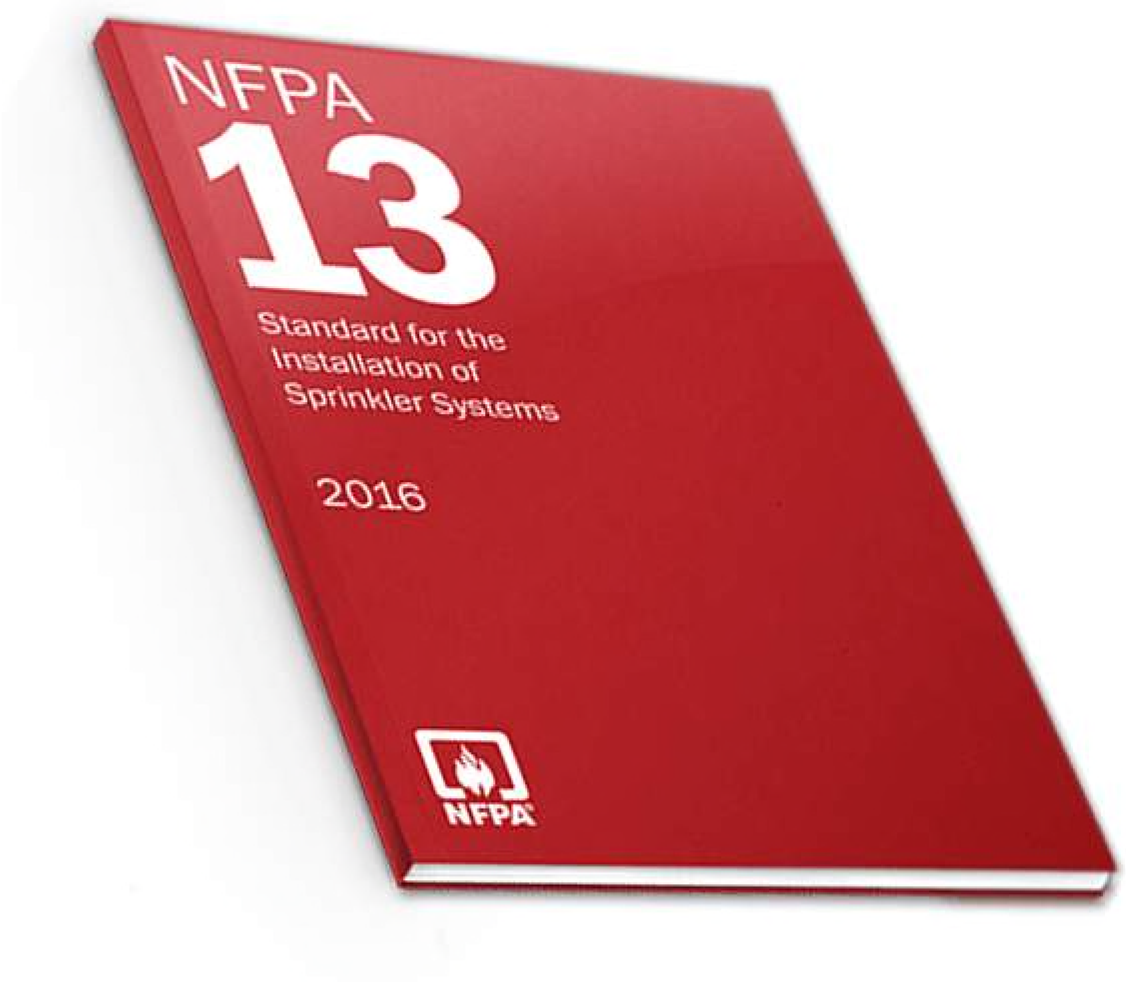
Hydrostatic Testing

Hydrostatic test pressure is measured at the **lowest elevation** of the system or portion of the system being tested. The hydrostatic test should **include all suction and discharge piping** between the suction pipe control valve and the discharge pipe control valve, as well as any bypass, meter, pressure maintenance (jockey) pump, cooling water piping, and hose header piping. The hose header valve should be **open** during this test.

Suction piping on the upstream side of the suction piping control valve on booster pumps, and discharge piping on the system side of the discharge piping control valve which feed into underground mains are **required to be hydrostatically tested**. See *NFPA* 24 for additional requirements.

Hydrostatic tests for **discharge piping on the system side** are to be conducted per *NFPA* 13 and *NFPA* 14 requirements.

Keep in mind that **underground** and **aboveground** piping should be **isolated** during the hydrostatic test, with leakage in underground piping approximated by measuring the amount of water needed to restore the initial pressure at the end of the test.



LET'S REVIEW

Let's do a quick check about what has been covered so far.

For a typical hydrostatic test, a minimum pressure of ____ PSI for two hours is required, or you must boost your test pressure to 50 PSI over the maximum operating pressure, whichever is greater.

Type your answer here

SUBMIT

During a hydrostatic test, the hose header valve should remain ____.

○ open

○ closed

SUBMIT

🔒 Complete the knowledge checks above before moving on.

Material and Test Certificate

NFPA 20 2016, Figure A.14.1.3

Annex **Figure A.14.1.3(a)** provides the Contractor's Material and Test Certificate for Fire Pump Systems.

Note the following found in the certificate:

Procedure

Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and the system left in service before the contractor's personnel finally leave the job.

Certificate

A certificate shall be filled out and signed by **both** representatives.

Copies shall be prepared for approving authorities, owners, and contractor. It is understood the owner's representative's signature in no way prejudices any claim against the contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.

ⓘ Refer to *NFPA* 20 2016, Figure A.14.1.3(a) Sample of Contractor's Material and Test Certificate for Fire Pump Systems

TEST DESCRIPTION REQUIREMENTS

Test Description Requirements

Flushing

Flow the required rate until water is clear as indicated by no collection of foreign material in burlap bags at outlets such as hydrants and blow-offs. Flush at flows not less than:

Gallons Per Minute (gpm)	Pipe diameter (inches)
390	4
610	5
880	6
1560	8
2440	10
3520	12

When the supply cannot produce stipulated flow rates, obtain the maximum available.

ⓘ **A sample of the Contractor's Material and Test Certificate for Private Fire Service Mains is found in Figure A.14.1.3(b). Review this certificate as well.**

TEST DESCRIPTION REQUIREMENTS

Test Description Requirements

Note the following Test Description Requirements found in this certificate:

Hydrostatic Tests

Hydrostatic tests shall be made at not less than 200 psi for 2 hours or 50 psi above static pressure in excess of 150 psi for 2 hours.

Leakage

- New pipe laid with rubber gasketed joints, shall, if the workmanship is satisfactory, have little or no leakage at the joints. The amount of leakage at the joints shall not exceed 2 qt./hr. per 100 joints irrespective of pipe diameter.
- The amount of allowable leakage specified above can be increased by 1 fl. oz. per in. valve diameter per hour for each metal seated valve isolating the test section.
- If dry barrel hydrants are tested with the main valve open so the hydrants are under pressure, an additional 5 oz. per minute leakage is permitted for each hydrant.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

According to the Contractor's Material and Test Certificate for Fire Pump Systems, inspection and tests are to be made by the _____ representative and witnessed by a(n) ______ representative.

○ owner's; contractor's

○ contractor's; owner's

SUBMIT

The amount of leakage at the gasketed joints of new pipe cannot exceed ___ qt./hr. per 100 joints irrespective of pipe diameter.

○ 1

○ 2

○ 3

○ 4

SUBMIT

🔒 Complete the knowledge checks above before moving on.

Field Acceptance Tests

NFPA 20 2016, Sections 14.2.1 – 14.2.4

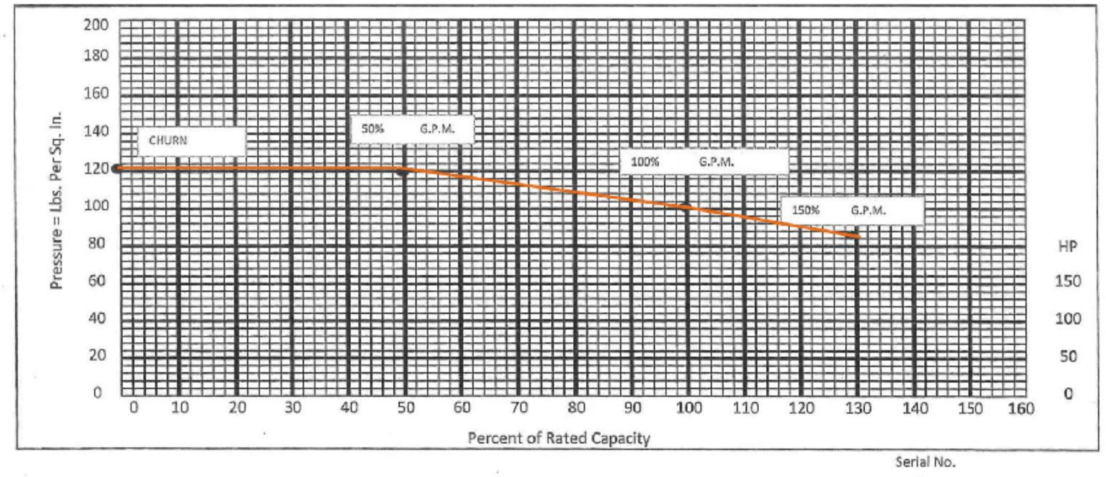
In this section, the standard requires that the pump manufacturer or a designated representative **be present for the acceptance test**. The AHJ must be **notified** of the time and place of the acceptance test.

All electric wiring to the fire pump motor(s) including control interwiring for multiple pumps, normal and alternate power supplies, and jockey pump are required to be completed and checked by the electrical contractor before the initial start-up and acceptance test.

In addition, a **copy of the manufacturer's pump test characteristic curve** must be available to compare with the acceptance test results. A **comparison of the test results with the certified pump curves** will provide an indication if the pump performance is acceptable.

The fire pump should **equal** the performance of the manufacturer's certified shop test curve at all flow conditions, within the accuracy limits of the test equipment.

The following is an example of a pump test characteristic curve that would be used for a field performance test.



All electric wiring to the fire pump motor(s), are required to be completed and checked by the electrical contractor prior to the

initial startup and acceptance test. This includes control interwiring for multiple pumps, normal power supply, alternate power supply where provided, and the jockey pump. (*NFPA* 20 2016, Section 14.2.3)

TEST EQUIPMENT

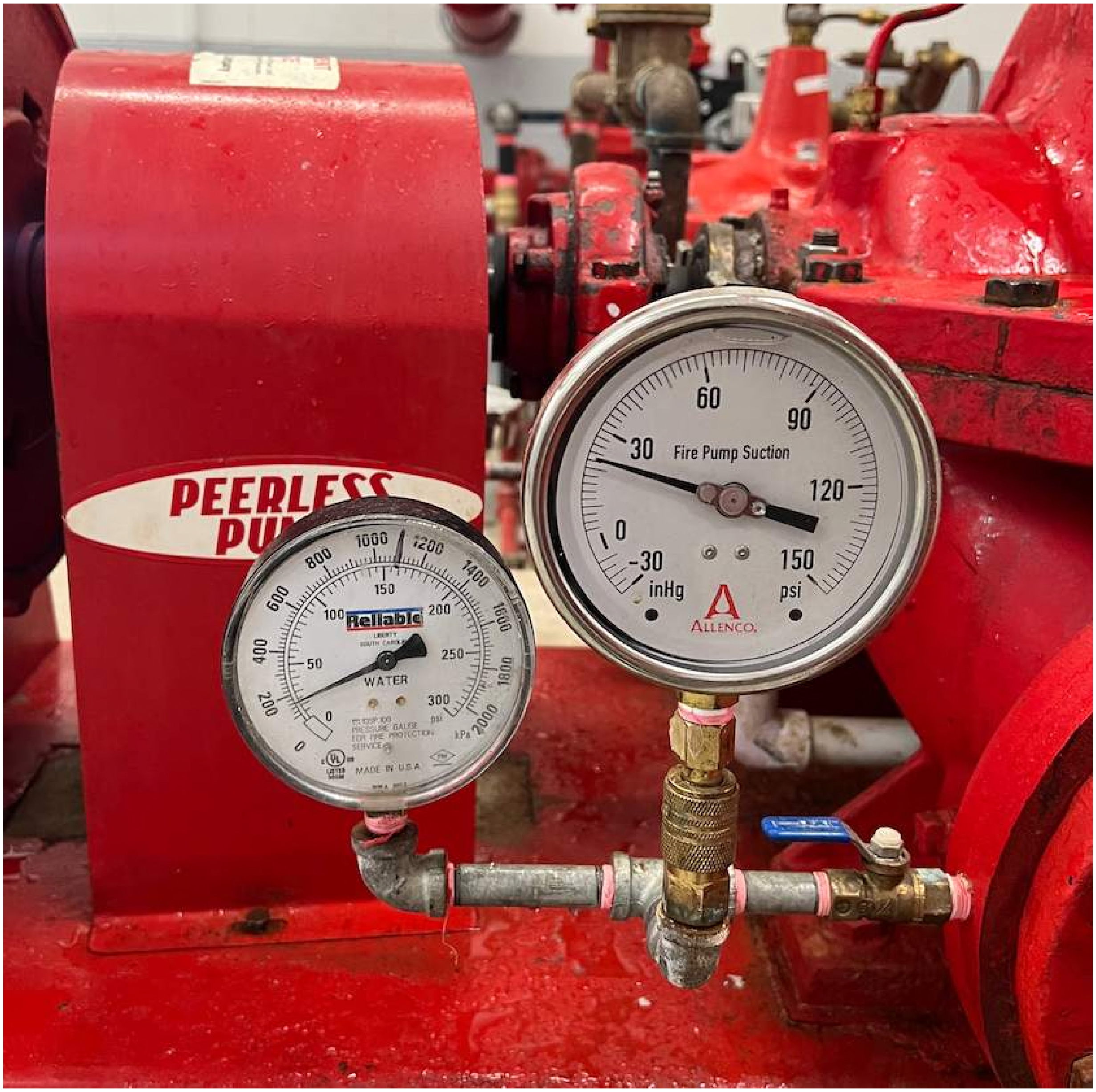
Test Equipment

NFPA 20 2016, Section 14.2.6

Progressing on in the standard, the next section discusses requirements for the availability of test equipment.

Calibrated test equipment is required to determine:

- Net pump pressures
- Rate of flow through the pump
- Volts and amperes for electric motor-driven pumps
- Speed



Calibrated test gauges are required, must be calibrated at a minimum on an **annual** basis bearing the latest date of calibration, and must be maintained at an **accuracy level of ± 1%**.

The minimum, rated, and peak loads of the fire pump are to be determined by controlling the amount of water discharged through the test devices.

CONTINUE

NFPA 20 2016, Section A.14.2.6

The Annex provides additional recommendations regarding test equipment.

The test equipment should be provided by either the **AHJ, the installing contractor, or the pump manufacturer**. The equipment should include at least the following:

Equipment for Use with Test Valve Header

50 ft. lengths of 2 ½ in. lined hose should be provided including Underwriters Laboratories' play pipe nozzles as needed to flow the required volume of water.
This may not be needed if a test meter is provided.

Instrumentation

- Clamp-on volt/ammeter
- Test gauges
- Tachometer

- Pitot tube with gauge (for use with hose and nozzle)

Instrumentation Calibration

All test instrumentation should be calibrated by an approved testing and calibration facility within the 12 months prior to the test.

Calibration documentation should be available for AHJ review.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

In a field acceptance test, the fire pump should be ____ the performance of the manufacturer’s certified shop test curve at all flow conditions, within the accuracy limits of the test equipment.

○ greater than

○ less than

○ equal to

SUBMIT

Who must be notified of the time and place of a pump's acceptance test?

Type your answer here

SUBMIT

How often are test gauges required to be calibrated, at minimum?

○ Weekly

○ Monthly

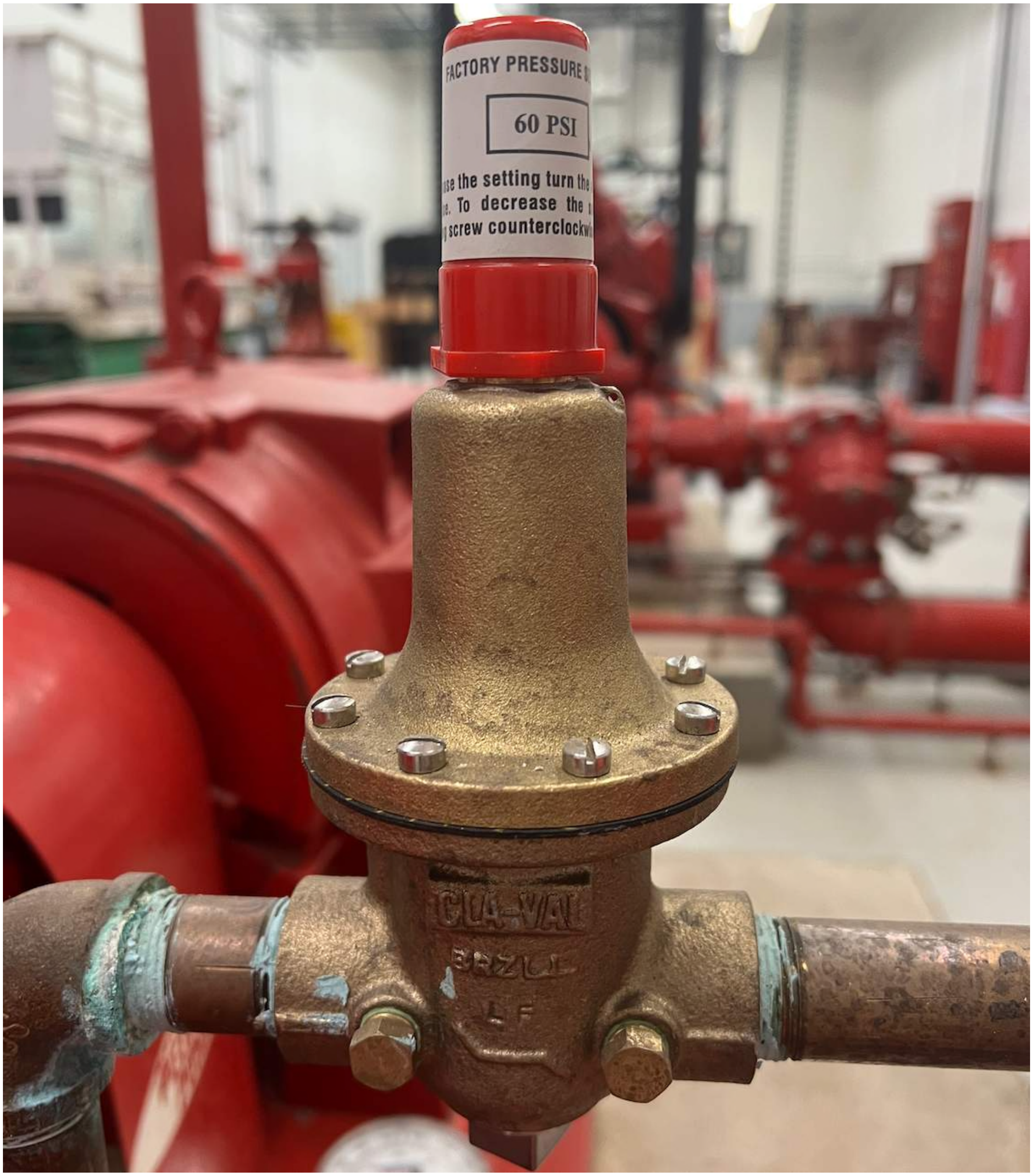
○ Annually

○ Whenever the accuracy level is over +5%

SUBMIT

Complete the knowledge checks above before moving on.

A **true churn condition (no flow)** is ideal during the test so that the results can be compared to the manufacturer's pump characteristics curve. However, it is **not** always possible to achieve under all circumstances.



Pumps with circulation relief valves allow a small amount of water to discharge, even when there is no flow into the fire protection system, in order to **keep the pump from overheating**.

- Therefore, the minimum flow in a test occurs where **no water is flowing** to the fire protection system, with a small amount of flow through the circulation relief valve.

During a test on a pump with a **pressure relief valve**, the valve should **not** **open**.

- Overspeed conditions **should** **not** occur during the test, and the **pressure relief valve** **should remain closed**.

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CONTINUE

When **pressure relief valves** are installed on systems to relieve pressure under normal operating conditions, and if a true churn condition is desired during acceptance testing, the **system discharge**

valve can be closed and the **pressure relief valve can be adjusted** again to **allow flow and relief of pressure**.

This is considered to be a "**one-time test**," allowing the **net pressure to serve as the reference point** with the relief valve open. The relief valve can then **remain open** during subsequent **annual tests** allowing a comparison back to the reference residual net pressure rather than the manufacturer's curve.

The **quantity of water discharging** from the fire pump assembly must be **determined and stabilized**, immediately followed by measuring the operating conditions of the fire pump and driver.

CONTINUE

NFPA 20 2016, Section A.14.2.6(4)

Fire pump settings during acceptance testing include:

1. The jockey pump stop point should **equal** the pump churn pressure **plus** the minimum static supply pressure.
2. The jockey pump start point should be **at least 10 psi less than** the jockey pump stop point.
3. The fire pump start point should be **5 psi less than** the jockey pump start point. Use **10 PSI increments** for each additional pump.
4. Where minimum run times are provided, the pump will **continue to operate** after attaining these pressures. The final pressures should **not exceed** the pressure rating of the system.
5. If the operating differential of pressure switches does not permit these settings, the settings should be **as close as equipment will permit**. The settings should be established by pressures observed on test gauges.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

How do circulation relief valves keep pumps from overheating?

○ They remain closed as to not allow excess heat into the system.

○ They control the speed at which the pump runs.

○ They allow a small amount of water to discharge.

○ They produce ice when running.

SUBMIT

For a fire pump acceptance test, the jockey pump start point should be at least ____ psi less than the jockey pump stop point.

Type your answer here

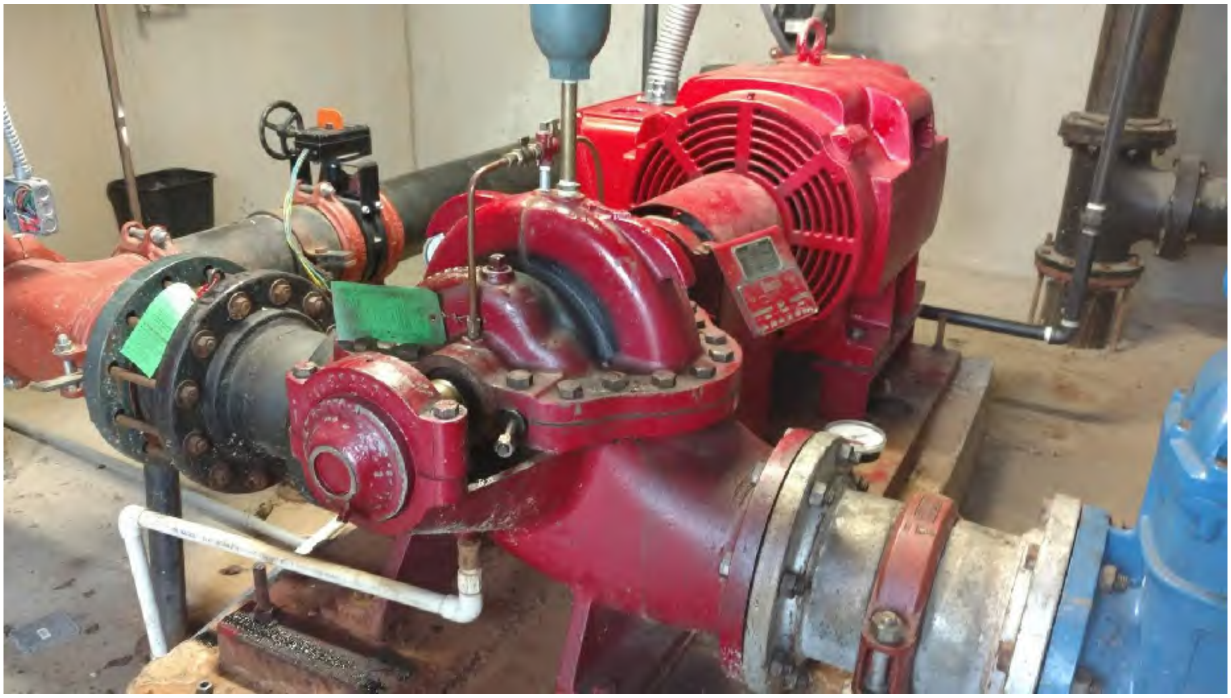
SUBMIT

🔒 Complete the knowledge checks above before moving on.

Measurement Procedures

NFPA 20 2016, Section 14.2.6.5

The **quantity of water discharging** from the fire pump assembly must be determined and stabilized, immediately followed by **measuring the operating conditions** of the fire pump and driver.



CONTINUE

NFPA 20 2016, Section A.14.2.6.5

Sample Procedure

Click the "Start" button below to view the detailed process as outlined in the Annex to obtain the measurements during the testing procedure.

Step 1

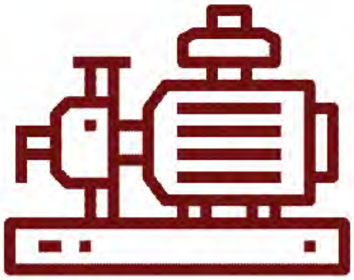
Check the Unit

Visually check the unit, verifying:

- The hose and nozzles are secured.
- The hose valves are closed.
- The valve on the discharge side of the meter is closed, if a test meter is used.

Step 2

Start Pump



Start the pump.

Step 3

Partially Open Valves

Partially open one or two hose valves, or slightly open the meter discharge valve.

Step 4

Check Unit Operation

Check the operation of the unit, adjust the packing glands, and watch for:

- Vibration
- Leaks
- Unusual noises
- General operation

Step 5

Measure Water Discharge

Measure the water discharge.

Specific steps to follow, as detailed in the Annex.

Step 6

Record Data

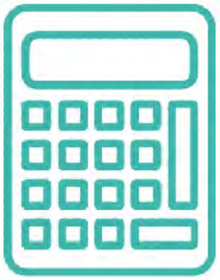
Record the data for each test point. **See Figure A.14.2.6.5(a).**

- Pump RPM
- Suction pressure
- Discharge pressure
- Number and size of hose nozzles:
  - Pitot pressure for each nozzle
  - Total GPM
  - For the test meter, record the GPM
- Amperes (for each phase for electric motor-driven pump)
- Volts (phase to phase for electric motor-driven pump)
- Engine back pressure (diesel engine drive pump)

- Oil pressure (diesel engine drive pump)
- Cooling loop pressure (diesel engine drive pump)
- Engine temperature (diesel engine drive pump)
- Steam pressure (steam drive pump)

Step 7

Calculate Test Results



Calculation of the test results include:

- **Discharge Flow and Pressure –** Confirm discharge pressure and flow will meet the fire protection system demand.
- **Rated Speed** – Determine the pump is operating at rated RPM.
- **Capacity –** For hose valve header, using a fire stream table, determine the GPM for each nozzle at each pitot reading.
    - As an example, 16 psi pitot pressure with a 1 ¾ in. nozzle indicates 356 GPM. Add the GPM for each hose line to determine the total volume. For a test meter, the total GPM is read directly.
- **Total Head for Horizontal Pump**– Total head is the sum of the following:
    - Pressure measured by the discharge gauge at pump discharge flange
    - Velocity head difference, pump discharge and pump suction

  - Gauge elevation corrections to pump centerline (plus or minus)
  - Pressure measured by a suction gauge at pump suction flange – negative value when pressure is above zero

- **Total Head for Vertical Pump**– Total head is the sum of the following:
  - Pressure measured by discharge gauge at pump discharge flange
  - Velocity head at the discharge
  - Distance to the supply water level
  - Discharge gauge elevation correction to centerline of discharge

- **Electrical Input** – Voltage and amperes read directly from the external digital screen on the controller, and reading compared to motor nameplate full-load amperes.
- **Correction to Rated Speed***– Capacity, head, and power should be corrected from test values at test speed to the rated speed of the pump.
  - Corrections are made as follows:
    - **Capacity: $Q_2 = (N_2 \div N_1) \times Q_1$**
      - Q_1 = capacity at test speed in GPM
      - Q_2 = capacity at rated speed in GPM
      - N_1 = test speed in RPM
      - N_2 = rated speed in RPM

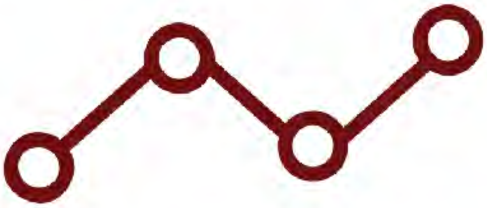
    - **Head: $H_2 = (N_2 \div N_1)^2 \times H_1$**
      - H_1 = head at test speed in ft.
      - H_2 = head at rated speed in ft.

    - **Horsepower: $hp_2 = (N_2 \div N_1)^3 \times hp_1$**

  - hp_1 = horsepower at test speed
  - hp_2 = horsepower at rated speed

Step 8

Plot Test Points



The final step in the test calculation is a plot of the test points.

A **head-capacity curve** is plotted, and an **ampere-capacity curve** is also plotted.

A study of these curves indicates the performance picture of the pump as it was tested.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Using the formula, **$Q_2 = (N_2 \div N_1) \times Q_1$**, find the capacity at rated speed (Q_2) given the following information:

Capacity of test speed = 716 gpm

Test speed = 1700 rpm

Rated speed = 1780 rpm

○ 700

○ 716

○ 750

○ 800

SUBMIT

Before starting the pump, which of the following should be done? (Select all that apply)

☐ Check that the hose and nozzles are secured.

☐ Check that the hose valves are closed.

☐ Check for leakage.

☐ Partially open one or two hose valves.

☐ Slightly open the meter discharge valve.

☐ Close the valve on the discharge side of the meter, if a test meter is used

SUBMIT

Which of the following curves are plotted after the test calculations are made?

- ○ **A.** Head-capacity curve
- ○ **B.** Ampere-capacity curve
- ○ **C.** Discharge-pressure curve
- ○ **D.** Both A and B
- ○ **E.** Both B and C

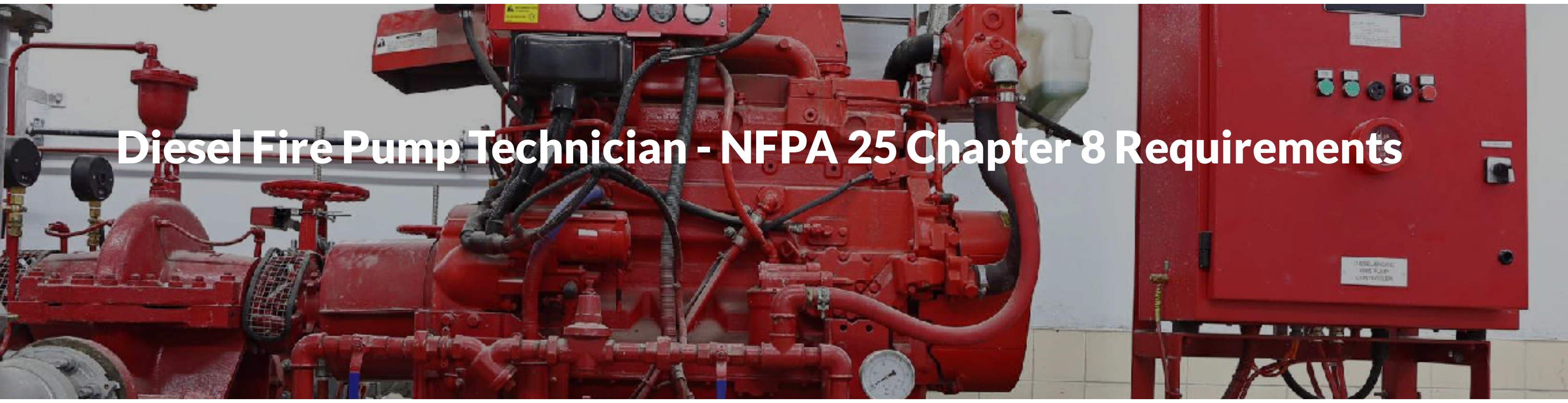
SUBMIT

Complete the knowledge checks above before moving on.

After completing this module, you should now have a better understanding of the acceptance, testing, performance, and maintenance of diesel engines.

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.

Diesel Fire Pump Technician - NFPA 25 Chapter 8 Requirements



When you are ready to begin, click on the "**Begin**" button to start.

By the end of this module, you will be able to do the following:

- Identify fire pump inspection and testing frequencies.
- Follow proper test procedures when conducting no-flow and flow tests, and interpret the test results.
- Describe diesel fuel testing requirements.

Key References for this module:

- *NFPA* 25 – *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2014
- *NFPA* 20 - *Standard for the Installation of Stationary Pumps for Fire Protection*, 2016

NFPA 25 Chapter 8 Periodic Inspection and Testing

Lesson 1 of 1

NFPA 25 Chapter 8 Periodic Inspection and Testing

Goals for this Lesson:

- Identify fire pump inspection and testing frequencies.
- Follow proper test procedures when conducting no-flow and flow tests, and interpret the test results.
- Describe diesel fuel testing requirements.

PERIODIC INSPECTION, TESTING, AND MAINTENANCE

Periodic Inspection, Testing, and Maintenance

NFPA 20 2016, Section 14.4

Fire pumps are required to be inspected, tested, and maintained in accordance with *NFPA* 25 2014 - *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

Chapter 8 of *NFPA* 25 contains the majority of the fire pumps requirements. Review this portion of the standard, if you are not familiar with it already.

COMPONENT REPLACEMENT

Component Replacement

NFPA 20 2016, Section 14.5

Critical path components include the following features of the pump equipment:

- Fire Pumps
  - Impeller, casing
  - Gear drives
- Fire pump controllers (electric or diesel): total replacement
- Electric motor, steam turbines, or diesel engine drivers

Another table for your reference is ***NFPA* 25 2014, Table 8.6.1**, which provides a summary of component replacement testing requirements, containing requirements found in *NFPA* 20 and *NFPA* 25.

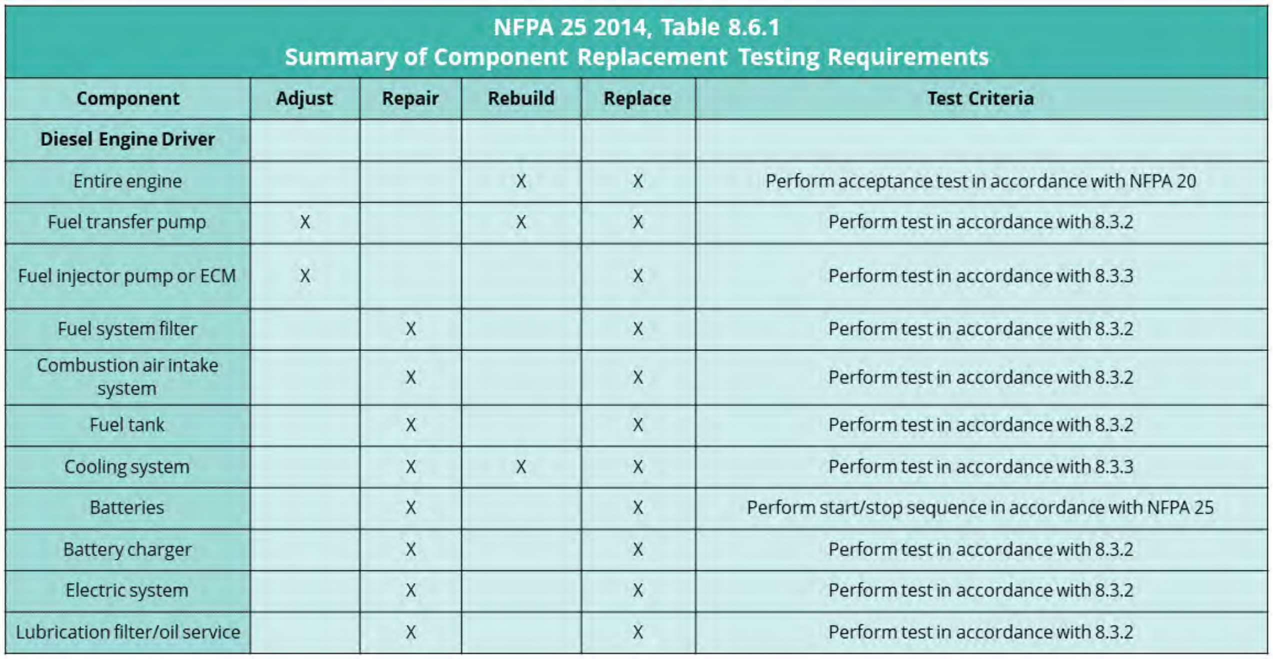
Table 8.6.1 provides a summary of component replacement testing requirements, containing requirements found in *NFPA* 20 and *NFPA* 25. Click the arrows to see all of the sections of the table.

NFPA 25 2014, Table 8.6.1
Summary of Component Replacement Testing Requirements

Component	Adjust	Repair	Rebuild	Replace	Test Criteria
Fire Pump System					
Entire pump assembly				X	Perform acceptance test in accordance with NFPA 20
Impeller/rotating assembly		X		X	Perform acceptance test in accordance with NFPA 20
Casing		X		X	Perform acceptance test in accordance with NFPA 20 with alignment inspection
Bearings				X	Perform annual test in accordance with 8.3.3
Sleeves				X	Perform annual test in accordance with 8.3.3
Wear rings				X	Perform annual test in accordance with 8.3.3
Main shaft		X		X	Perform annual test in accordance with 8.3.3
Packing	X			X	Perform test in accordance with 8.3.2

NFPA 25 2014, Table 8.6.1
Summary of Component Replacement Testing Requirements

Component	Adjust	Repair	Rebuild	Replace	Test Criteria
Mechanical Transmission					
Gear right angle drives		X	X	X	Perform acceptance test in accordance with NFPA 20
Drive coupling	X	X	X	X	Perform acceptance test in accordance with 8.3.3 with alignment inspection (ROC 112)
Pump House and Miscellaneous Components					
Baseplate		X			Perform test in accordance with 8.3.2 with alignment inspection
Baseplate				X	Perform test in accordance with 8.3.3 with alignment inspection
Foundation		X	X	X	Perform test in accordance with 8.3.2 with alignment inspection
Suction/discharge pipe		X		X	Perform visual inspection in accordance with 8.2.2
Suction/discharge fittings		X		X	Perform visual inspection in accordance with 8.2.2
Suction/discharge valves		X	X	X	Perform operational test in accordance with 13.3.3.1



NFPA 25 2014, Table 8.6.1 Summary of Component Replacement Testing Requirements					
Component	**Adjust**	**Repair**	**Rebuild**	**Replace**	**Test Criteria**
Diesel Engine Driver					
Entire engine			X	X	Perform acceptance test in accordance with NFPA 20
Fuel transfer pump	X		X	X	Perform test in accordance with 8.3.2
Fuel injector pump or ECM	X			X	Perform test in accordance with 8.3.3
Fuel system filter		X		X	Perform test in accordance with 8.3.2
Combustion air intake system		X		X	Perform test in accordance with 8.3.2
Fuel tank		X		X	Perform test in accordance with 8.3.2
Cooling system		X	X	X	Perform test in accordance with 8.3.3
Batteries		X		X	Perform start/stop sequence in accordance with NFPA 25
Battery charger		X		X	Perform test in accordance with 8.3.2
Electric system		X		X	Perform test in accordance with 8.3.2
Lubrication filter/oil service		X		X	Perform test in accordance with 8.3.2

GENERAL REQUIREMENTS

General Requirements

NFPA 25 2014, Sections 8.1 and A.8.1

A fire pump assembly along with the water supply provides waterflow and pressure to a fire protection system so that the system demand requirements can be met. The pump assembly includes:

- The water supply suction and discharge piping and valves
- The pump
- The driver and controller (electric motor, diesel engine, or steam turbine)
- Any auxiliary equipment

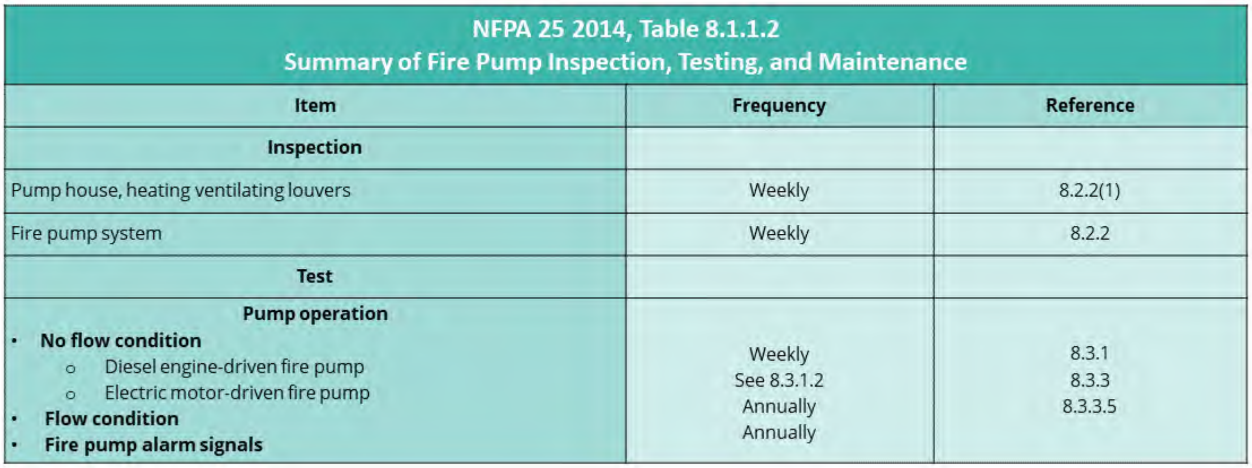
COMPONENT REPLACEMENT TESTING REQUIREMENTS

Component Replacement Testing Requirements

NFPA 25 2014, Sections 8.6

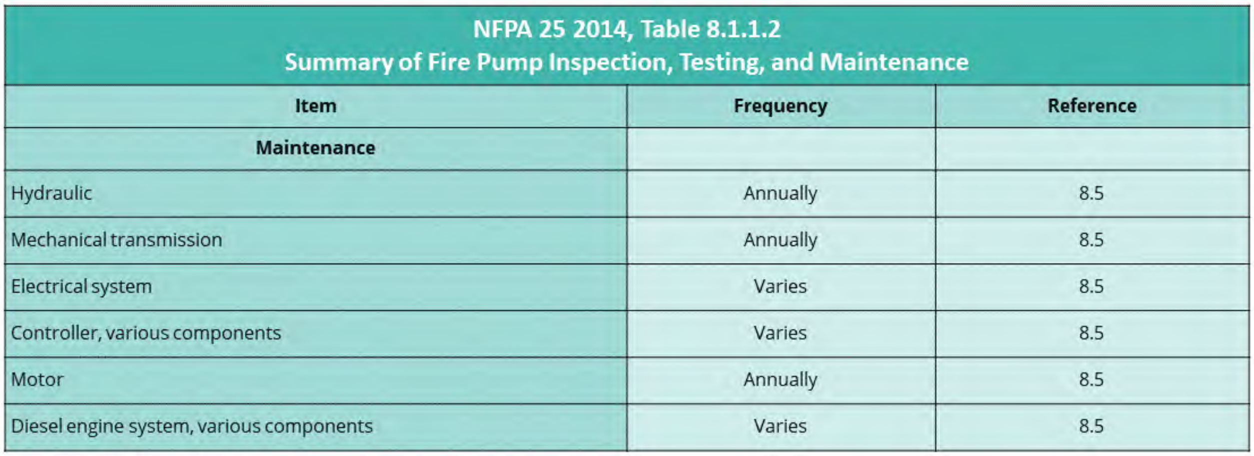
When a fire pump component is adjusted, repaired, rebuilt, or replaced, it is required to be tested to ensure the system is restored to service, in accordance with **Table 8.6.1**.

Table 8.1.1.2 shows the required inspection, testing, and maintenance frequencies for fire pumps. Click the arrows to see all of the sections of the table.



NFPA 25 2014, Table 8.1.1.2
Summary of Fire Pump Inspection, Testing, and Maintenance

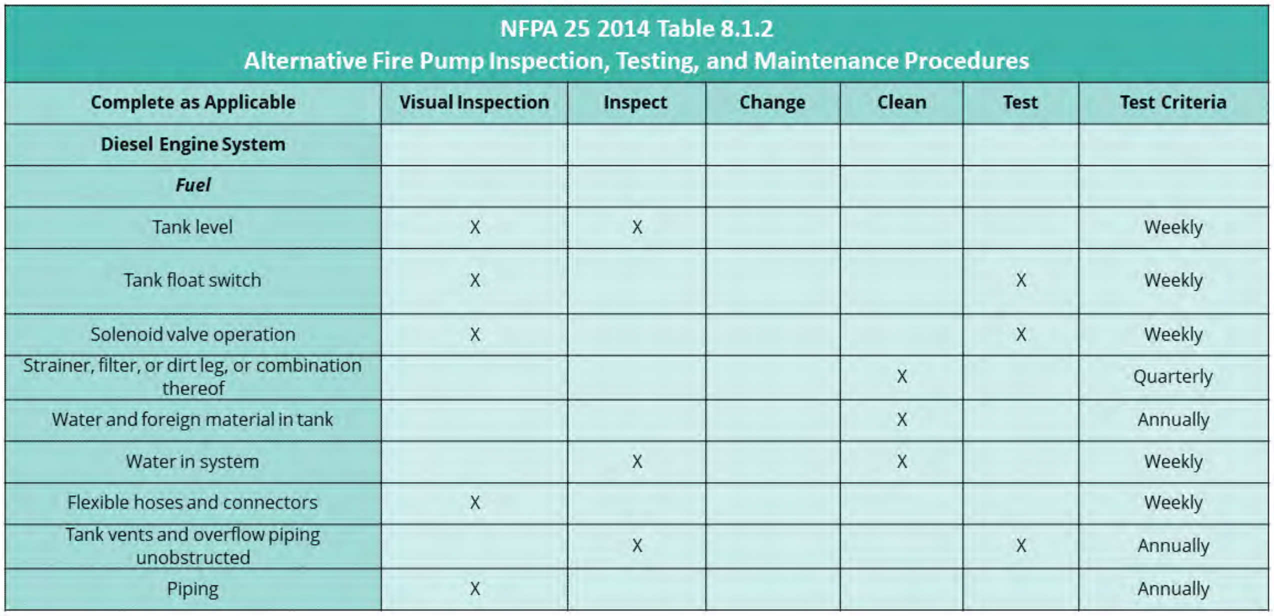
Item	Frequency	Reference
Inspection		
Pump house, heating ventilating louvers	Weekly	8.2.2(1)
Fire pump system	Weekly	8.2.2
Test		
Pump operation • **No flow condition** o Diesel engine-driven fire pump o Electric motor-driven fire pump • **Flow condition** • **Fire pump alarm signals**	Weekly See 8.3.1.2 Annually Annually	8.3.1 8.3.3 8.3.3.5



NFPA 25 2014, Table 8.1.1.2
Summary of Fire Pump Inspection, Testing, and Maintenance

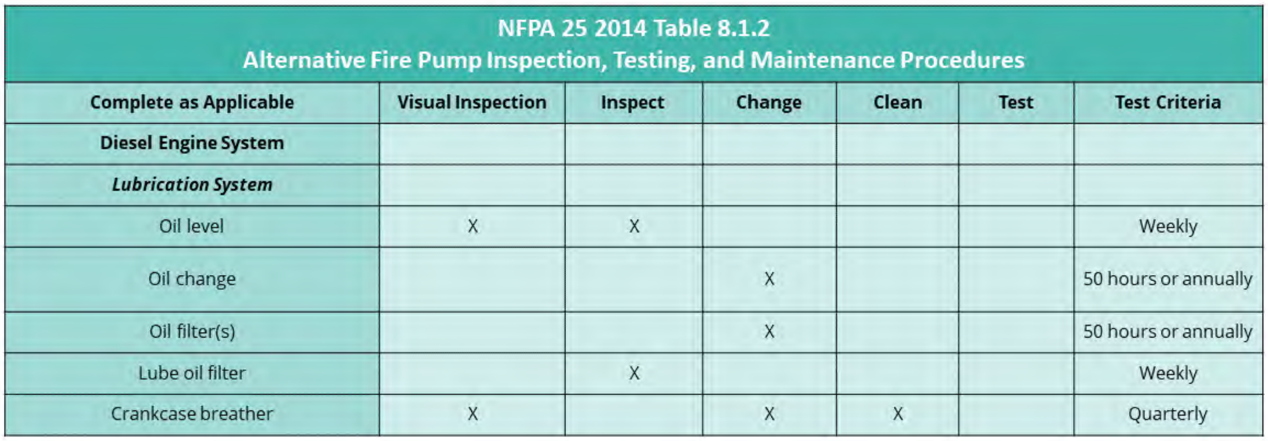
Item	Frequency	Reference
Maintenance		
Hydraulic	Annually	8.5
Mechanical transmission	Annually	8.5
Electrical system	Varies	8.5
Controller, various components	Varies	8.5
Motor	Annually	8.5
Diesel engine system, various components	Varies	8.5

Table 8.1.2 is permitted to be used if the manufacturer's recommendations for preventative maintenance are not provided. Click the arrows to see all of the sections of the table.



NFPA 25 2014 Table 8.1.2
Alternative Fire Pump Inspection, Testing, and Maintenance Procedures

Complete as Applicable	Visual Inspection	Inspect	Change	Clean	Test	Test Criteria
Diesel Engine System						
Fuel						
Tank level	X	X				Weekly
Tank float switch	X				X	Weekly
Solenoid valve operation	X				X	Weekly
Strainer, filter, or dirt leg, or combination thereof				X		Quarterly
Water and foreign material in tank				X		Annually
Water in system		X		X		Weekly
Flexible hoses and connectors	X					Weekly
Tank vents and overflow piping unobstructed		X			X	Annually
Piping	X					Annually



NFPA 25 2014 Table 8.1.2
Alternative Fire Pump Inspection, Testing, and Maintenance Procedures

Complete as Applicable	Visual Inspection	Inspect	Change	Clean	Test	Test Criteria
Diesel Engine System						
Lubrication System						
Oil level	X	X				Weekly
Oil change			X			50 hours or annually
Oil filter(s)			X			50 hours or annually
Lube oil filter		X				Weekly
Crankcase breather	X		X	X		Quarterly

NFPA 25 2014 Table 8.1.2
Alternative Fire Pump Inspection, Testing, and Maintenance Procedures

Complete as Applicable	Visual Inspection	Inspect	Change	Clean	Test	Test Criteria
Diesel Engine System						
Cooling System						
Level	X	X				Weekly
Antifreeze protection level					X	Semiannually
Antifreeze		X				Annually
Adequate cooling water to heat exchanger		X				Weekly
Rod out heat exchanger				X		Annually
Water pump(s)	X					Weekly
Condition of flexible hoses and connections	X	X				Weekly
Jacket water heater		X				Weekly
Inspect duct work, clean louvers (combustion air)	X	X	X			Annually
Water strainer				X		Quarterly

NFPA 25 2014 Table 8.1.2
Alternative Fire Pump Inspection, Testing, and Maintenance Procedures

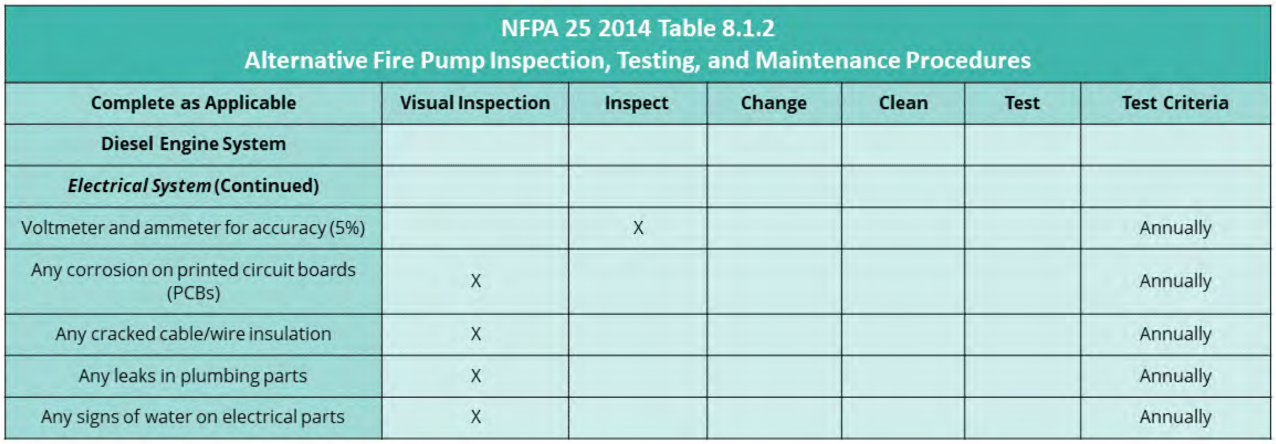
Complete as Applicable	Visual Inspection	Inspect	Change	Clean	Test	Test Criteria
Diesel Engine System						
Exhaust System						
Leakage	X	X				Weekly
Drain condensate trap		X				Weekly
Insulation and fire hazards	X					Quarterly
Excessive back pressure					X	Annually
Exhaust system hangers and supports	X					Annually
Flexible exhaust section	X					Semiannually

NFPA 25 2014 Table 8.1.2
Alternative Fire Pump Inspection, Testing, and Maintenance Procedures

Complete as Applicable	Visual Inspection	Inspect	Change	Clean	Test	Test Criteria
Diesel Engine System						
Battery System						
Electrolyte level		X				Weekly
Terminals clean and tight	X	X				Quarterly
Case exterior clean and dry	X	X				Monthly
Specific gravity or state of charge					X	Monthly
Charger and charge rate	X					Monthly
Equalize charge		X				Monthly
Clean terminals				X		Annually
Cranking voltage exceeds 9 volts on a 12 volt system or 18 volts on a 24 volt system		X				Weekly

NFPA 25 2014 Table 8.1.2
Alternative Fire Pump Inspection, Testing, and Maintenance Procedures

Complete as Applicable	Visual Inspection	Inspect	Change	Clean	Test	Test Criteria
Diesel Engine System						
Electrical System						
General inspection	X					Weekly
Tighten control and power wiring connections		X				Annually
Wire chafing where subject to movement	X	X				Quarterly
Operation of safeties and alarms		X			X	Semiannually
Boxes, panels, and cabinets				X		Semiannually
Circuit breakers or fuses	X	X				Monthly
Circuit breakers or fuses			X			Biennially



NFPA 25 2014 Table 8.1.2 Alternative Fire Pump Inspection, Testing, and Maintenance Procedures						
Complete as Applicable	**Visual Inspection**	**Inspect**	**Change**	**Clean**	**Test**	**Test Criteria**
Diesel Engine System						
***Electrical System* (Continued)**						
Voltmeter and ammeter for accuracy (5%)		X				Annually
Any corrosion on printed circuit boards (PCBs)	X					Annually
Any cracked cable/wire insulation	X					Annually
Any leaks in plumbing parts	X					Annually
Any signs of water on electrical parts	X					Annually

LET'S REVIEW

Let's do a quick check about what has been covered so far.

If the entire engine for a diesel engine driver is replaced, a(n) _____ test per *NFPA* 20 2016 requirements needs to be conducted.

Type your answer here

SUBMIT

How often should a diesel engine tank float switch should be visually inspected and tested per *NFPA* 25 2014?

○ Weekly

○ Monthly

○ Quarterly

○ Annually

SUBMIT

Complete the knowledge checks above before moving on.

Auxiliary Equipment

The pump assembly auxiliary equipment includes:

- Pump accessories, such as pump shaft coupling, automatic air release valve, pressure gauges, and circulation relief valve (**not** used in conjunction with diesel engine drive with a heat exchanger)
- Pump test device(s)
- Pump relief valve and piping
- Alarm sensors and indicators
- Right-angle gear sets (for engine-driven vertical shaft turbine pumps)
- Pressure maintenance (jockey) pump and accessories

WATER SUPPLY TO PUMP SUCTION

Water Supply to Pump Suction

The suction supply for the fire pump is to provide the **required flow at a gauge pressure of 0 psi or higher** at the pump suction flange to meet system demand.

Driver

The pump driver is **not** permitted to overload beyond its rating when delivering the necessary brake horsepower.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Fire pump alarm signals are required to be tested _____.

○ Weekly

○ Monthly

○ Quarterly

○ Semi annually

○ Annually

SUBMIT

How frequently should the tank fuel be checked if no manufacturer recommendations are provided?

○ Weekly

○ Monthly

○ Quarterly

○ Semiannually

○ Annually

SUBMIT

Complete the knowledge checks above before moving on.

Inspection

NFPA 25 2014, Section 8.2

Inspections are performed to confirm the pump assembly appears to be in operating condition and has no physical damage. The following observations are required to be conducted on a weekly basis.

Pump hose conditions:

☐ Heat is adequate, **at least 40°F for a pump room** with diesel engine-driven pumps with engine heaters.

☐ Heat is adequate, **at least 70°F for a pump room** with diesel engine-driven pumps without engine heaters.

☐ Ventilating louvers operate freely.

Pump system conditions:

☐ Pump suction and discharge and bypass valves are **fully open**.

☐ Piping has **no leaks**.

☐ Suction line and system line pressure gauge readings are **within an acceptable range**.

☐ Suction reservoir has the **required water level**.

☐ Wet pit suction screens are in place and are **free of obstructions**.

☐ Waterflow test valves are in the **closed position**.

CONTINUE

Diesel engine system conditions:

☐ Fuel tank is at least 2/3 full.

☐ Controller selector switch is in the auto position.

☐ Batteries (2) voltage readings and charging current readings are within an acceptable range.

☐ Batteries’ pilot lights are on or battery failure pilot lights are off.

☐ All alarm pilot lights are off.

☐ Engine running time meter is reading.

☐ Oil level in right angle gear drive is within an acceptable range.

☐ Crankcase oil level is within an acceptable range.

☐ Cooling water level is within an acceptable range.

☐ Electrolyte level in batteries is within an acceptable range.

☐ Battery terminals are free from corrosion.

☐ Water-jacket heater is operating.

TESTING

Testing

NFPA 25 2014, Sections 8.3.1 and 8.3.2

No-flow testing for diesel engine-driven fire pumps is required to be conducted weekly without recirculating water back to the pump suction. Fire pump assemblies are required to be tested by starting the pump automatically. **Run the diesel pump for at least 30 minutes**. This allows the pump and driver to reach operating temperature and will reveal any overheating problems.

The 30-minute operating time is also intended to consume fuel. This prevents the fuel from stagnating and prevents wet stacking in the exhaust system.

Qualified personnel are to be present when the pump is operating. NFPA defines a qualified person *as a competent and capable person or company that has met the requirements and training for a given field acceptable to the AHJ*.

The following observations listed in **Section 8.3.2.8** shall be made during the test while the pump is idle:

- Record the system suction and discharge pressure gauge readings.
- For pumps that use electronic pressure sensors to control the fire pump operation, record the current pressure and the highest and the lowest pressure shown on the fire pump controller event log.
- If the highest or lowest pressure is outside of the expected range, record all information from the event log that helps identify the abnormality.

CONTINUE

The following observations are required during the test while the pump is running:

Pump system procedure as follows:

☐ Record the pump starting pressure from the pressure switch or pressure transducer.

☐ Record the system suction and discharge pressure gauge readings.

☐ Check the pump packing glands for slight discharge.

☐ Adjust gland nuts if necessary.

☐ Check for unusual noise or vibration.

☐ Check packing boxes, bearings, or pump casing for overheating.

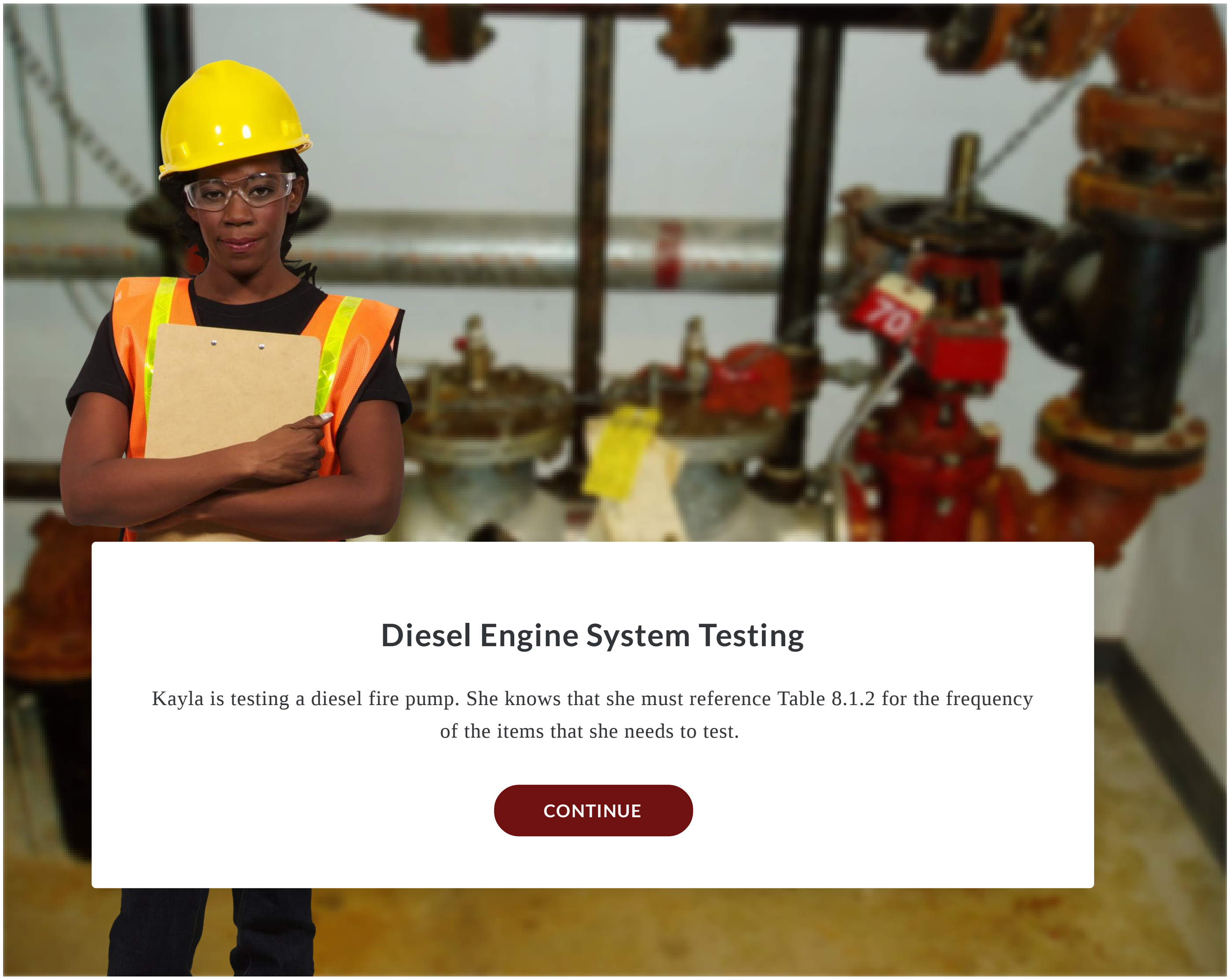
☐ Record pressure switch or pressure transducer reading and compare to the pump discharge gauge.

☐ For pumps that use electronic pressure sensors to control the fire pump operation, record the current pressure and the highest and the lowest pressure shown on the fire pump controller event log.

☐ For electric motor and radiator cooled diesel pumps, check the circulation relief valve for operation to discharge water.

CONTINUE

The following scenario will provide an example of the testing frequencies for the components of a diesel engine system.

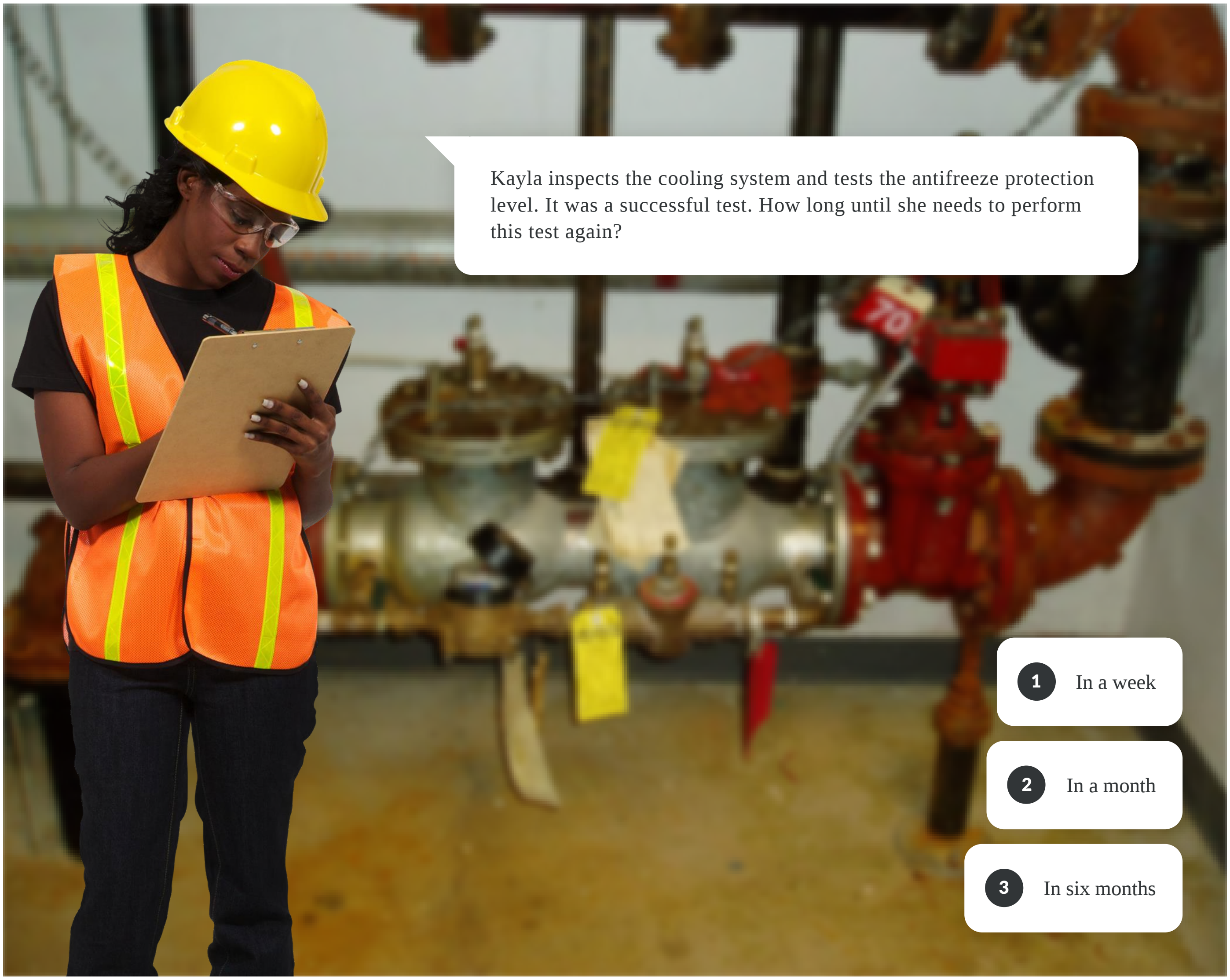


Diesel Engine System Testing

Kayla is testing a diesel fire pump. She knows that she must reference Table 8.1.2 for the frequency of the items that she needs to test.

Scene 1 Slide 1

Continue → Next Slide



Kayla inspects the cooling system and tests the antifreeze protection level. It was a successful test. How long until she needs to perform this test again?

1 In a week

2 In a month

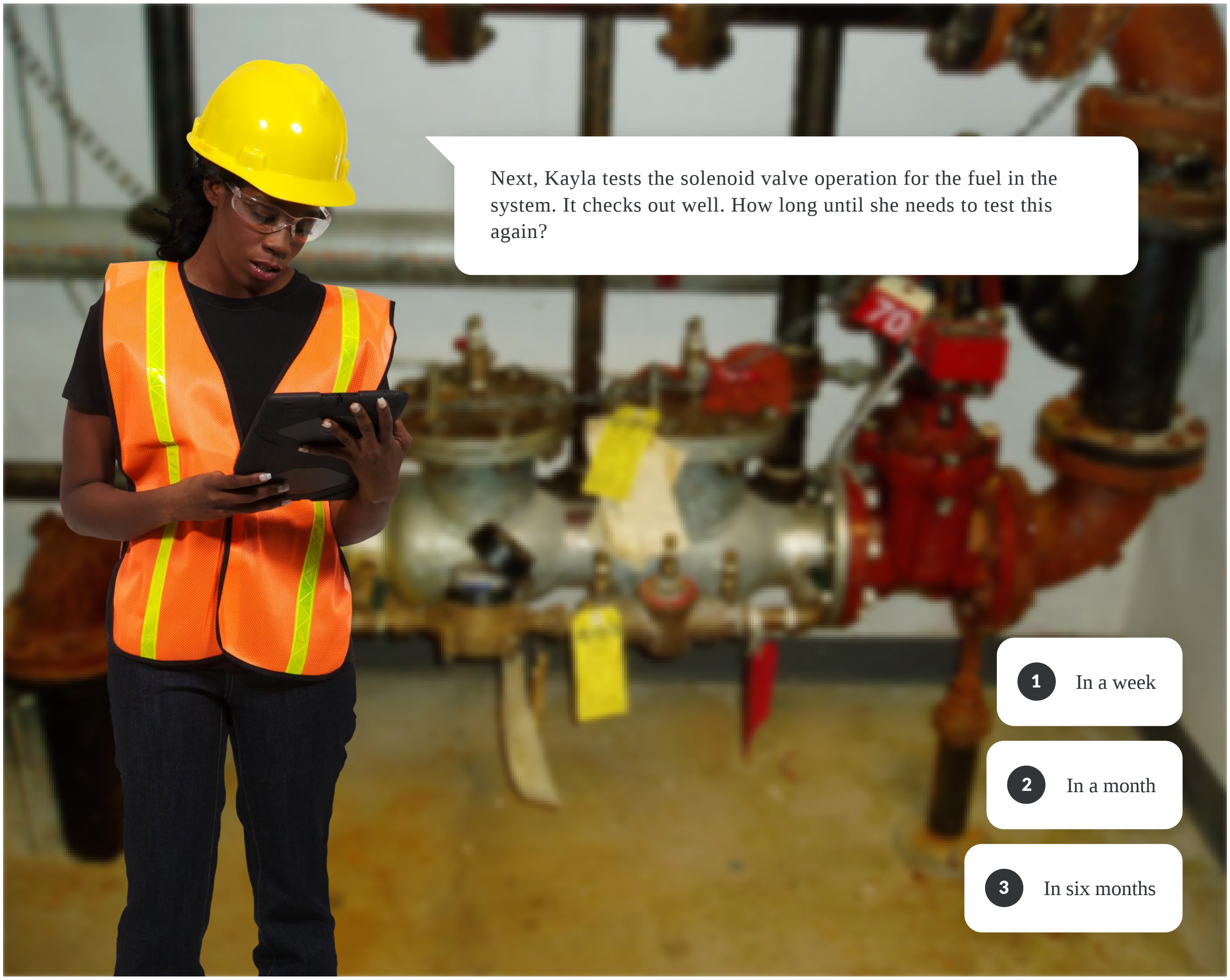
3 In six months

Scene 1 Slide 2

0 → Next Slide

1 → Next Slide

2 → Next Slide



Next, Kayla tests the solenoid valve operation for the fuel in the system. It checks out well. How long until she needs to test this again?

1 In a week

2 In a month

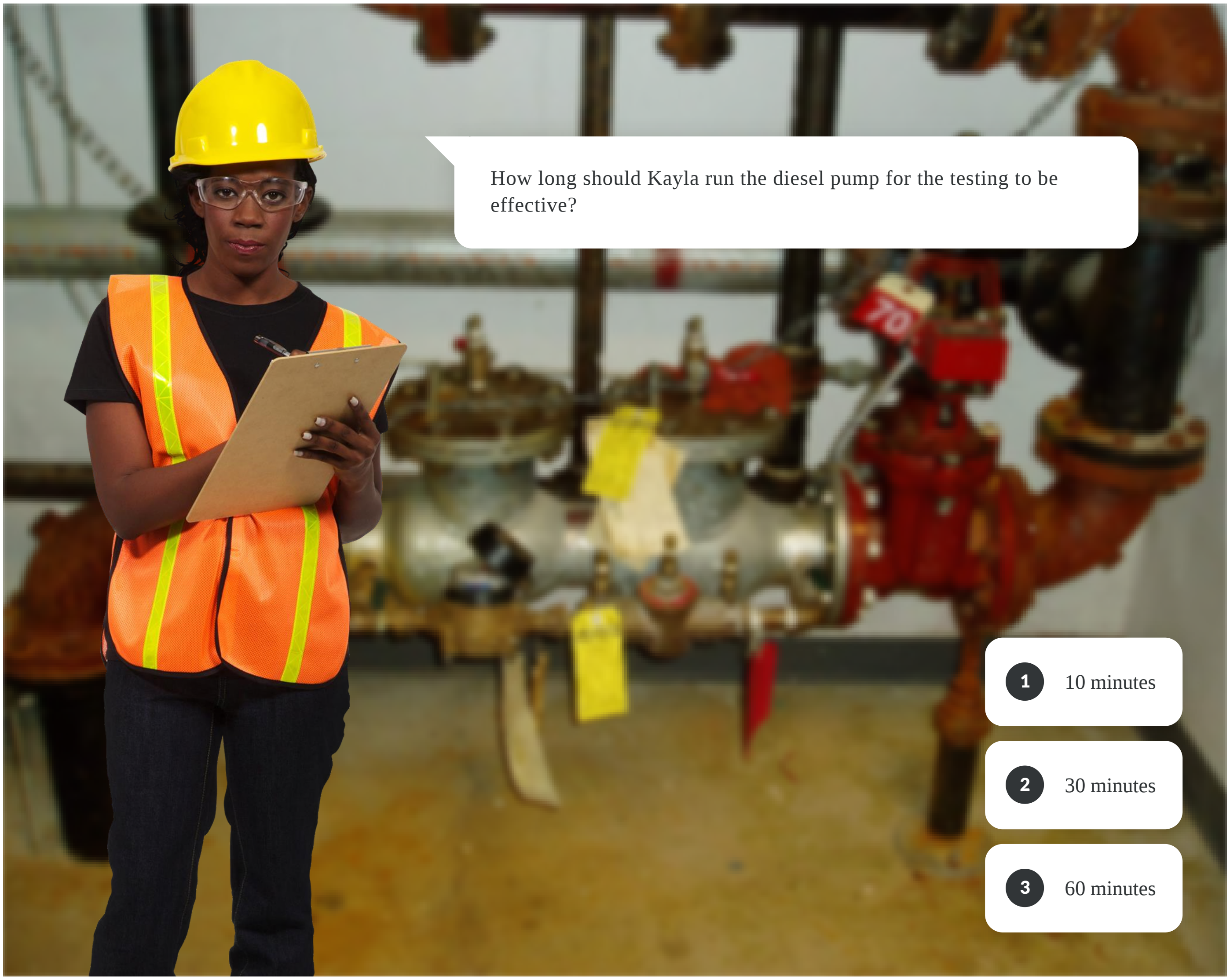
3 In six months

Scene 1 Slide 3

0 → Next Slide

1 → Scene 1 Slide 1

2 → Next Slide



How long should Kayla run the diesel pump for the testing to be effective?

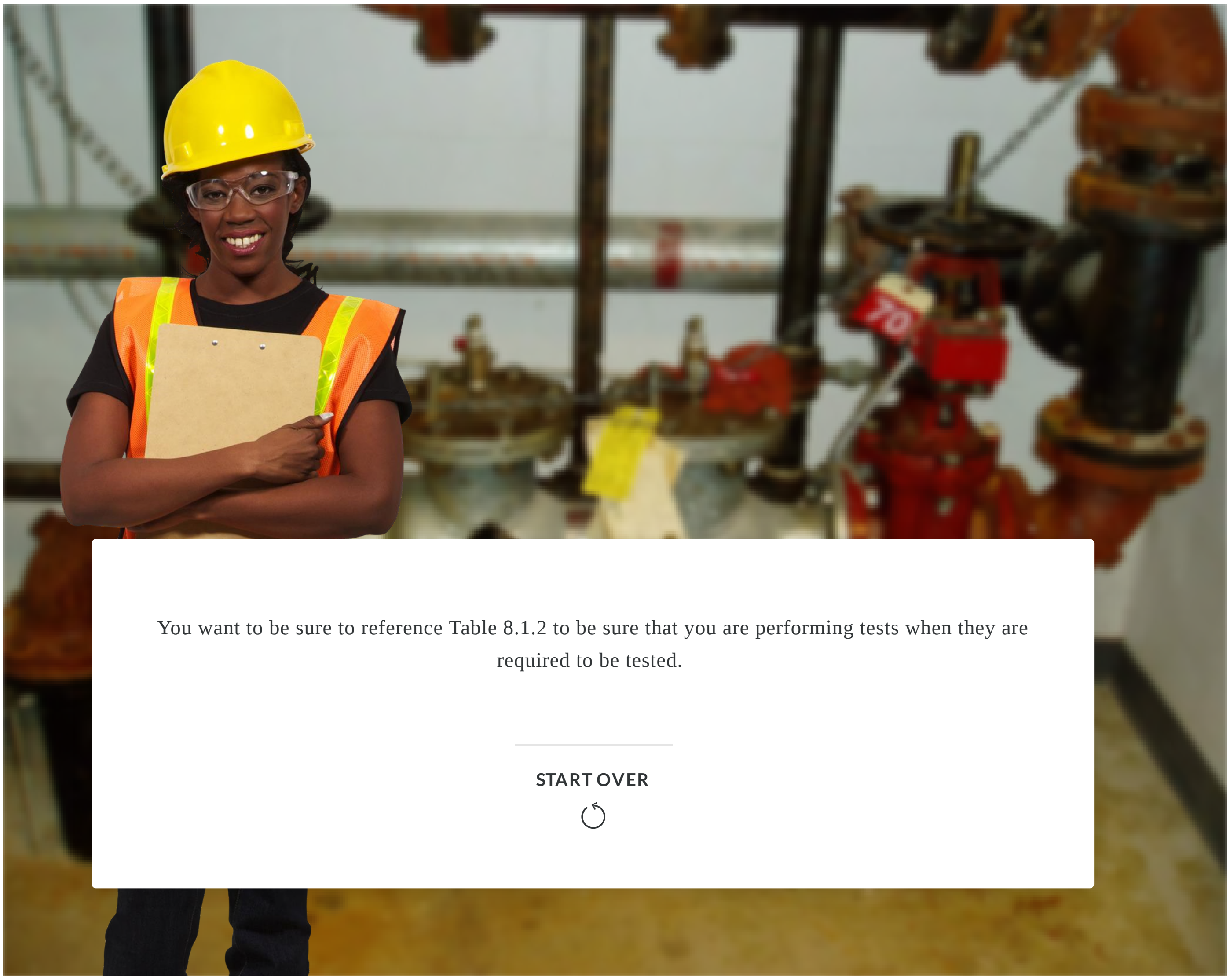
1 10 minutes

2 30 minutes

3 60 minutes

Scene 1 Slide 4

0 → Next Slide
1 → Next Slide
2 → Next Slide



You want to be sure to reference Table 8.1.2 to be sure that you are performing tests when they are required to be tested.

START OVER

Scene 1 Slide 5

Continue → End of Scenario

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Complete the scenario above before moving on.

Diesel engine system procedure as follows:

☐ Observe the time for engine to crank.

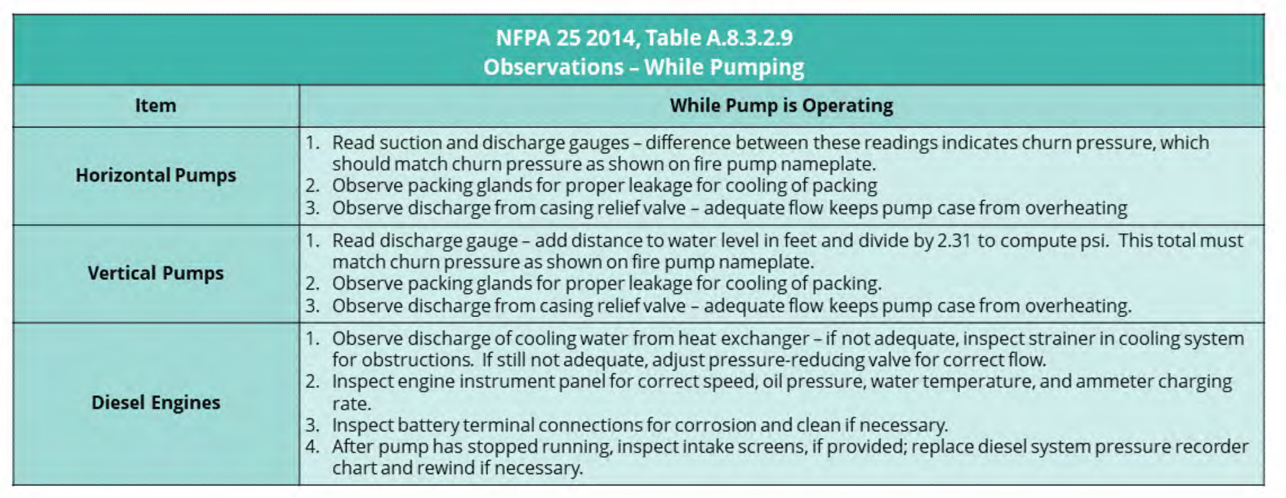
☐ Observe the time for engine to reach running speed.

☐ Observe the engine oil pressure gauge, speed indicator, water, and oil temperature indicators periodically while engine is running.

☐ Record any abnormalities.

☐ Check the heat exchanger for cooling waterflow.

Table A.8.3.2.9 lists additional observations to be made while the pump is running:



NFPA 25 2014, Table A.8.3.2.9
Observations – While Pumping

Item	While Pump is Operating
Horizontal Pumps	1. Read suction and discharge gauges – difference between these readings indicates churn pressure, which should match churn pressure as shown on fire pump nameplate. 2. Observe packing glands for proper leakage for cooling of packing 3. Observe discharge from casing relief valve – adequate flow keeps pump case from overheating
Vertical Pumps	1. Read discharge gauge – add distance to water level in feet and divide by 2.31 to compute psi. This total must match churn pressure as shown on fire pump nameplate. 2. Observe packing glands for proper leakage for cooling of packing. 3. Observe discharge from casing relief valve – adequate flow keeps pump case from overheating.
Diesel Engines	1. Observe discharge of cooling water from heat exchanger – if not adequate, inspect strainer in cooling system for obstructions. If still not adequate, adjust pressure-reducing valve for correct flow. 2. Inspect engine instrument panel for correct speed, oil pressure, water temperature, and ammeter charging rate. 3. Inspect battery terminal connections for corrosion and clean if necessary. 4. After pump has stopped running, inspect intake screens, if provided; replace diesel system pressure recorder chart and rewind if necessary.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Which of the following is **not correct** when conducting a weekly inspection of a diesel engine system?

○ All alarm pilot lights are off

○ Battery terminals are corrosion free

○ The fuel tank is at least 1/2 full

○ The controller switch is in auto position

SUBMIT

While conducting a no-flow test for a diesel engine-driven fire pump, confirm the discharge of cooling water from the _______ is adequate.

Type your answer here

SUBMIT

A weekly no-flow test for diesel engine-driven fire pumps is required to be conducted while recirculating water back to the pump section.

○ True

○ False

SUBMIT

🔒 Complete the knowledge checks above before moving on.

Annual Flow Test

NFPA 25 2014, Sections 8.3.1

An annual flow test of the fire pump system is required. The test is performed at no-flow (churn), rated flow, and **150% of the pump rated capacity flow** of the fire pump by controlling the quantity of water discharged through approved test devices.

If available suction supplies **do not allow the flowing of 150% of the rated pump capacity**, the fire pump shall be tested to the maximum allowable discharge.

OBSERVATIONS AND MEASUREMENTS

Observations and Measurements

NFPA 25 2014, Sections 8.3.1

The following observations and measurements shall be made during the test.

- At no flow (churn)
  - Inspect the circulation relief valve for operation to discharge water
  - Inspect the pressure relief valve (if installed) for proper operation
- At each flow condition
  - Record the electric motor voltage and current (all lines)
  - Record the pump speed in rpm
  - Record the simultaneous (approximately) readings of pump suction and discharge pressures and pump discharge flow
  - Do not shut down an electric motor pump until it has run for 10 minutes, or a diesel motor pump until it has run for 30 minutes.

Closely observe installations that have a pressure relief valve during each flow condition to confirm if the pump discharge pressure exceeds the normal operating pressure of the system components and if the relief valve closes at the correct pressure.

CONTINUE

For engines that have electronic management control systems, annual tests are required for the backup electronic control module (ECM) and the primary and redundant sensors for the ECM.

The Annex explains recommended steps to conduct an ECM test:

1 Move the ECM selector switch to the alternate ECM position to verify the operation of the alternate ECM with the stop. *This should result in an alarm on the fire pump controller*.

2 Next, start the engine. *This should operate normally with all functions*.

3. Shut down the engine, switch back to the primary ECM, and **restart** the engine briefly to confirm the correct switchback has occurred.

To conduct the sensor test:

1. **Disconnect the wires** from the primary sensor while the engine is running. The engine operation should **not** change.
2. **Reconnect the wires** to the sensor, then disconnect them from the redundant sensor. Again, there should **not** be a change in the engine operation.
3. Next, **reconnect the wires** to the sensor.

Repeat this process for all primary and redundant sensors on the engines.

Take note, if disconnecting and reconnecting the wires to the sensors can be done while the engine is **not** running, then start the engine after each time the wires are disconnected and reconnected to confirm engine operation.

DIESEL FUEL TESTING AND MAINTENANCE

Diesel Fuel Testing and Maintenance

NFPA 25 2014, Sections 8.3.4

Diesel fuel is required to be tested for degradation at least annually. If the fuel is deficient, it is required to be reconditioned or replaced, the supply tank is to be cleaned internally, and the engine fuel filter(s) changed. Once the fuel and tank have been restored, **the fuel needs to be retested every 6 months until the tests indicate it can be safely stored for the 1-year minimum without degradation**.

OTHER TESTS

Other Tests

NFPA 25 2014, Sections 8.3.6

Engine generator sets supplying emergency or standby power to fire pump assemblies and automatic transfer switches are to be tested routinely per *NFPA* 110 requirements. Pump room conditions such as heating, ventilation, and illumination are to be conducted to ensure proper manual or automatic operation of the associated equipment.

TEST RESULTS AND EVALUATION

Test Results and Evaluation

NFPA 25 2014, Sections 8.3.7

The interpretation of the flow test performance, when compared to the manufacturer's performance data, is the basis for the pump assembly operation.

Qualified individuals shall interpret the test results.

Increasing the engine speed beyond the rated speed of the pump at rated conditions is not an acceptable method for meeting the rated pump performance.

The fire pump assembly shall be considered acceptable if either of the following conditions is shown during the test:

- The test is **no less than 95% of the pressure** at rated flow and rated speed of the initial unadjusted field acceptance test curve
- The fire pump is **no less than 95% of the performance characteristics** as indicated on the pump nameplate.

Degradation in **excess of 5%** of the pressure of the initial unadjusted acceptance test curve or nameplate shall require an investigation to reveal the cause of degraded performance.

Current and voltage readings whose product **does not** exceed the product of the rated voltage and rated full-load current multiplied by the permitted motor service factor shall be considered acceptable.

If the **pump test fails** to meet the criteria listed above, **the owner is to be notified immediately**.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

When interpreting flow test performance, degradation in excess of _____% of the pressure of the initial unadjusted acceptance test curve requires an investigation.

Type your answer here

SUBMIT

When conducting an annual ECM test, an alarm should be displayed on the fire pump controller.

○ True

○ False

SUBMIT

If diesel fuel is found to be deficient during an annual test, which of the following is/are required? (Select all that apply)

☐ Recondition or replace the fuel

☐ Clean the supply tank internally

☐ Change the engine fuel filter

☐ Retest every 6 months until no degradation is found

SUBMIT

If the entire engine for a diesel engine driver is replaced, a(n) _____ test per *NFPA* 20 2016 requirements needs to be conducted.

Type your answer here

SUBMIT

Complete the knowledge checks above before moving on.

After completing this module, you should now have a better understanding of the periodic inspection and testing of diesel engines.

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.

Diesel Fire Pump Technician - Ohio Building Code & Ohio Fire Code

When you are ready to get started, click on the "**Begin**" button.

This module will provide information on SOME of the Ohio Building Code and Ohio Fire Code requirements for diesel fire pumps.

It is not meant as a Building and Fire Code course, but to familiarize you with a few of the requirements.

Many of the requirements are the same or very similar to requirements from *NFPA* 20, *Standard for Installation of Stationary Pumps for Fire Protection*, 2016 edition.

In other instances, the Ohio Building Code and Ohio Fire Code will refer you back to *NFPA* 20 2016 and *NFPA* 25 2014 for the necessary requirements, inspection, testing, and maintenance of fire pumps.

You can reference the Ohio Building Code at:
https://codes.iccsafe.org/content/OHBCU2017/cover

You can reference the Ohio Fire Code at: http://codes.ohio.gov/oac/1301:7-7-09.

Key References for this module:

- Ohio Building Code - Fire Protection Systems

  - https://codes.iccsafe.org/content/OHBCU2017/chapter-9-fire-protection-systems

- Ohio Fire Code - Fire Protection Systems
  - https://codes.iccsafe.org/content/OHFCJAN2019E/ohio-administrative-code-1301-7-7-09-fire-protection-systems

Section 901 Fire Protection Systems

Ohio Building Code and Ohio Fire Code

Lesson 1 of 2

Section 901 Fire Protection Systems

Goals for this lesson:

- Gain a working knowledge of the Ohio Building Code and Ohio Fire Code general requirements for fire protection.
- Identify NFPA standards associated with different types of fire protection systems.
- Recognize acceptance testing and related documentation requirements.
- Follow the correct procedures for all system impairments.

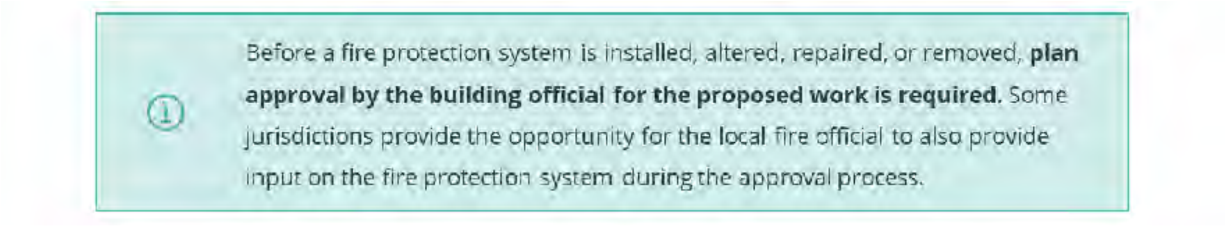
LET'S GET STARTED

Section 901

Fire Protection Systems

The Ohio Building Code and the Ohio Fire Code provide numerous requirements pertaining to fire protection systems. While the **majority of the requirements are found in Chapter 9** of the Ohio Building Code and Section 7-7-09 of the Ohio Fire Code, **Chapter 4 of the Ohio Building Code also contains special requirements to use for fire protection-related systems**, including high-rise buildings, malls, and atriums. We encourage you to be familiar with the requirements in both of these Codes.

Chapter 9 of the Ohio Building Code and **Section 901 of the Ohio Fire Code** apply to the **design**, **installation**, and **operation** of fire protection systems. These systems are to be **installed, repaired, operated, and maintained** per the Ohio Building Code and the Ohio Fire Code requirements.



Before a fire protection system is installed, altered, repaired, or removed, **plan approval by the building official for the proposed work is required.** Some jurisdictions provide the opportunity for the local fire official to also provide input on the fire protection system during the approval process.

ACCEPTANCE TESTING

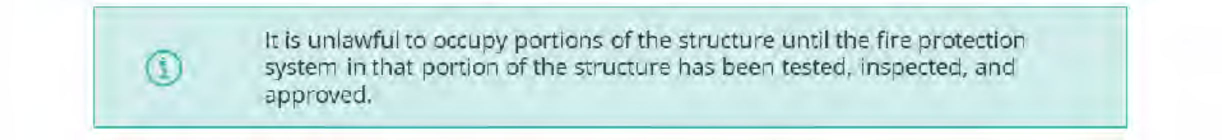
Acceptance Testing

Advanced coordination for all acceptance testing is to be provided to the building official, in the event the building official or the fire official requires a certified building inspector or certified fire protection system inspector to be present to witness these tests.

Note: The Ohio Fire Code requires at least 48 hours advanced notification of the test schedule to be provided to the fire official.

- Acceptance tests are to **follow Ohio Building Code and Fire Code requirements**, as well as the **applicable NFPA standards** for the portion of the fire protection system undergoing acceptance testing.
- All tests are to be **conducted at the owner's expense**, in the presence of either those who installed the equipment or their company's representative.

- The test **results are to be documented** and completed certificates are submitted to the building official and the fire official.
- Copies of the test **records are to be maintained on-site** and readily available to the inspector during the final inspection.



It is unlawful to occupy portions of the structure until the fire protection system in that portion of the structure has been tested, inspected, and approved.

Neither modification to nor removal of the fire protection system is permitted without advanced consent of the building official with input from the fire official.

CONTINUE

The Ohio Fire Code requires fire protection systems to be inspected, tested, and maintained per the requirements of their associated NFPA standard, as shown in **Table 901.6.1**.

Ohio Fire Code Table 901.6.1
Fire Protection Systems Maintenance Standards

System	Standard (As Listed in Rule 1301:7-7-80 of the Administrative Code)
Portable fire extinguishers	NFPA 10

Ohio Fire Code Table 901.6.1 Fire Protection Systems Maintenance Standards	
Carbon dioxide fire-extinguishing systems	NFPA 12
Halon 1301 fire-extinguishing systems	NFPA 12A
Dry-chemical extinguishing systems	NFPA 17
Wet-chemical extinguishing systems	NFPA 17A
Water-based fire protection systems	NFPA 25
Fire alarm systems	NFPA 72
Smoke and heat vents	NFPA 204
Water-mist systems	NFPA 750
Clean-agent extinguishing systems	NFPA 2001

ACCEPTANCE TESTING RECORDS

Acceptance Testing Records

Maintain records of all system inspections, tests, and maintenance tasks. Initial records shall be maintained for the life of the installation and include the following:

☑ Installation contractor ________

☑ Component manufacturers ________

☑ Location & number of components installed per floor ________

☑ Manufacturer's operation & maintenance instruction manuals

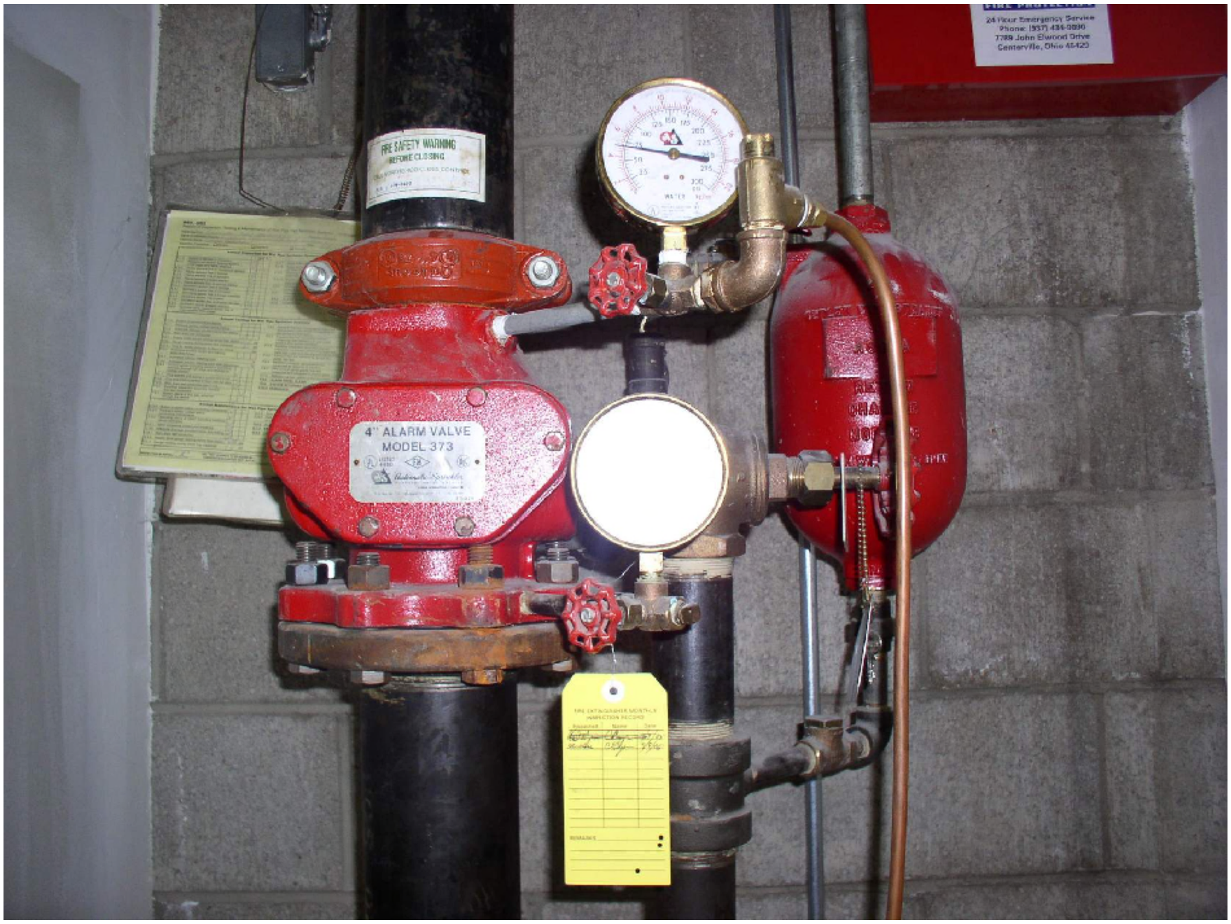
- Name of the installation contractor
- Component manufacturers
- Location and number of components installed per floor
- Manufacturer’s operation and maintenance instruction manuals

Acceptance testing records are required to be retained for the life of the system.

CONTINUE

The Ohio Fire Code additionally requires inspection tags to be attached to each fire protection system near the main control valve, main panel, or other appropriate visible locations as determined by the fire official. The annual inspection tag contains the following:

- The individual performing the work and the state fire marshal installer certification number(s) (if applicable)
- Date of test
- Results of inspection and test
- Deficiencies or impairments noted (yes or no)
- For sprinkler or standpipe systems, this tag requirement includes an impairment tag per NFPA 25



4" ALARM VALVE
MODEL 373
FIRE SAFETY WARNING
24 Hour Emergency Service

When a fire protection system is out of service, the fire department and fire official are to be notified immediately, and the building evacuated or an approved fire watch provided, per the discretion of the fire official, until the fire protection system is returned to service.

An impairment coordinator is to be assigned to the building and a tag is posted at each fire department connection, system control valve, fire alarm control unit, fire alarm annunciator, and fire command center indicating that the system (or portion thereof) has been removed from service. The fire official shall determine tag placement.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

It is acceptable to occupy the structure prior to approval by the fire code official as long as the acceptance test is complete.

○ True

○ False

SUBMIT

Initial records shall be maintained for the life of the installation and include the following:

☐ Component manufacturers

☐ Manufacturer’s operation and maintenance instruction manuals

☐ Name of the installation contractor

☐ Name and identification number of the AHJ

☐ Location and number of components installed per floor

SUBMIT

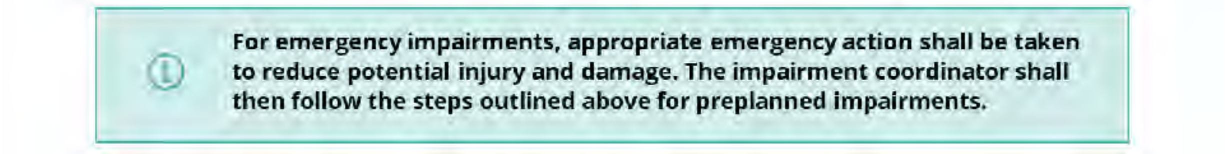
PREPLANNED IMPAIRMENTS

Preplanned Impairments

Preplanned impairments require prior authorization by the impairment coordinator. Prior to approval, the following procedures shall be implemented and verified:

- **Determine the extent** and expected duration of the impairment

- **Inspect the areas** of the building involved to assess the increased risks
- **Submit recommendations** to management or the building owner
- **Notify** the fire department, the insurance carrier, the alarm company, the building owner, and other appropriate AHJs
- **Notify any supervisors** in the affected areas
- **Implement** a tag impairment system
- **Confirm** all needed tools and materials are on-site



For emergency impairments, appropriate emergency action shall be taken to reduce potential injury and damage. The impairment coordinator shall then follow the steps outlined above for preplanned impairments.

CONTINUE

Once the impaired equipment is ready to be restored to normal operations, the impairment coordinator needs to confirm the following procedures have been implemented:

- **Verify** by inspection and test that the affected systems are operational
- **Notify** supervisors that the system has been restored
- **Notify** the fire department, building owner, insurance carrier, alarm company and other appropriate parties that the system has been restored

- **Remove** the impairment tag

Note that it is unlawful to remove, tamper with, or disturb any of the following, except when extinguishing a fire, during training, or when recharging/repairing a system:


Fire hydrant


Fire detection and alarm system


Fire suppression system

Other fire appliances

When supervisory services are terminated, the fire official is required to be notified within 24 hours.

FIRE PUMPS

Fire Pumps

Section 901.8 – Pump and Riser Room Ohio Building Code and Section 901.4.6 Ohio Fire Code

Automatic sprinkler system riser rooms and fire pump rooms are required to have sufficient room for all needed equipment, allowing ample working space around the stationary equipment. Clearance around the equipment needs to be adequate to permit inspection, service, repair, or replacement to successfully occur without having to remove or disassemble portions of the systems. These rooms are required to have doors and a large enough unobstructed passageway to allow the removal of the largest piece of equipment.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Once the impaired equipment is ready to be restored to normal operations, the impairment coordinator needs to confirm the following have been notified:

☐ Supervisors

☐ Fire Department

☐ Building owner

☐ Insurance carrier

SUBMIT

Preplanned impairments require prior authorization by the impairment coordinator.

○ True

○ False

SUBMIT

CONTINUE TO NEXT LESSON: OHIO BUILDING CODE AND OHIO FIRE CODE

Lesson 2 of 2

Ohio Building Code and Ohio Fire Code

Goal for this Lesson:

- Gain a working knowledge of the Ohio Building Code and Ohio Fire Code requirements for fire pumps.

LET'S GET STARTED

Introduction

This lesson will provide information on **some** of the Ohio Building Code and Ohio Fire Code requirements for fire pumps.

It is not meant as a Building and Fire Code course, but to **familiarize** you with a few of the requirements.

Many of the requirements are the **same or very similar** to requirements from *NFPA* 20, Installation of Stationary Pumps for Fire Protection, 2016 edition.

In other instances, the Ohio Codes will refer you back to *NFPA* 25 2014 for the necessary requirements, inspection, testing, and maintenance of fire pumps.

Fire Protection Systems portion

You can reference the Ohio Building Code and use this button to take you to the fire protection systems portion of the Building Code.

CLICK HERE

Fire Protection Systems portion

You can reference the Ohio Fire Code and use this button to take you to the fire protection systems portion of the Fire Code.

CLICK HERE

CONTINUE

The **Ohio Building Code** lists all of the sections that deal with fire pumps in **Chapter 35**, Referenced Standards. Similarly, the **Ohio Fire Code** lists all the sections that deal with fire pumps in **Section 1301:7-7-80**.

Referenced Standards Table

You can take a look at the table by clicking on this button.
The information we are looking for is on the NFPA table under the "Standard Reference Number" column and titled "20-16."

CLICK HERE

Per the NFPA table, the sections of the Fire Code covering fire pumps are:

- Section 913.1
- Section 913.2

- Section 913.5.1

We will not cover every section listed above but will provide information so that you **get a feel for what both the Ohio Building Code and the Ohio Fire Code entail**.

SECTION 913

Ohio Building Code and Ohio Fire Code, Section 913

As listed above, Section 913 contains fire pump requirements. Fire pumps are to be installed per *NFPA* 20 2016 requirements.

Ohio Environmental Protection Agency

The Ohio Environmental Protection Agency requires one of the following be installed to ensure a **minimum 10 psi is maintained in the suction line** when the pump is running:

- Low pressure cut-off
- Low suction throttling valve
- Variable speed suction line

NFPA 20 2016

Per *NFPA* 20 2016, the fire pump, driver, and fire pump controller are required to be **protected against the possible interruption** of service that could be caused by the following:

- Explosion
- Fire, flood, or earthquake
- Rodents or insects
- Windstorms or freezing
- Vandalism or other adverse conditions

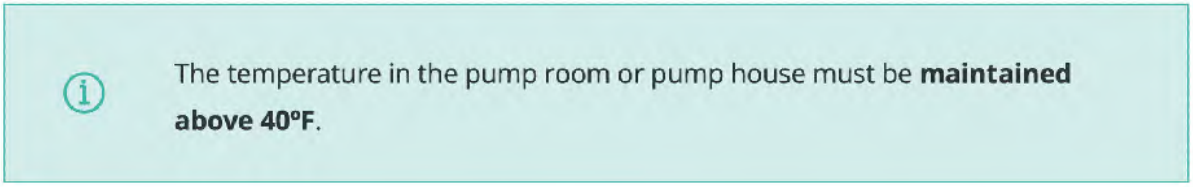
CONTINUE

Fire Pump Location

Fire pumps are to be located in rooms separated from all other areas of the building by a **2-hour barrier** as defined in Section 707, **2-hour assemblies** constructed per Section 711, or both.

There are exceptions for non-high-rise buildings, which requires a **1-hour fire barrier or horizontal assembly (or both)** in buildings that are protected by an automatic sprinkler system.

Cables used for circuit survivability are required to be listed **per UL 2196**.



The temperature in the pump room or pump house must be **maintained above 40ºF**.

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LET'S REVIEW

Let's do a quick check about what has been covered so far.

The Ohio Environmental Protection Agency requires which of the following be installed to ensure a minimum 10 psi is maintained in the suction line when the pump is running? (Select all that apply)

- ☐ Backflow preventer
- ☐ Low pressure cut-off
- ☐ Low suction throttling valve
- ☐ Fire barrier
- ☐ Variable speed suction line

SUBMIT

As defined by Section 707, a ___-hour barrier is required to separate the fire pumps from all other areas of the building.

Type your answer here

SUBMIT

🔒 Complete the knowledge checks above before moving on.

Backflow Prevention

Fire pump suction, discharge and bypass valves, and isolation valves on a backflow prevention device or assembly are required to be **supervised by one of the following**:

- Central station, proprietary, or remote-station signaling service
- Local signaling service that will sound an audible signal at a constantly attended location
- Locking valves open
- Sealing of valves and approved weekly recorded inspection where valves are located within fenced enclosures under the control of the owner

Fire pump test outlet valves are required to be **supervised, sealed, or locked in the closed position**.

CONTINUE

Acceptance Testing

All acceptance testing is required to follow ***NFPA* 20 2016 requirements and Section 901.5 of the Ohio Building Code (OBC)**. Section 901.5 requires acceptance tests to be conducted in accordance with the requirements of the following at the expense of the owner or the owner's representative:

- The OBC
- The OH Fire Code
- The applicable referenced standards

Additionally, the building official may require acceptance tests be conducted in the **presence of a certified building inspector or certified fire protection system inspector**.

The Ohio Fire Code, Section 901.5 provides additional requirements:

1. The fire code official shall be notified by the responsible person of any scheduled acceptance testing of a fire protection system **not less than 48 hours prior to the start of the test**.
2. When required by the fire code official, all acceptance testing shall be **conducted in the presence of the fire code official**.
3. When required by the fire code official, all acceptance testing shall be **conducted in the presence of the person who installed the equipment** or, if it is not possible for the actual installer to be present, the acceptance testing shall be conducted in the presence of another qualified representative of the company that installed the equipment.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Fire pump test outlet valves are required to be supervised, sealed, or locked in the _____ position.

○ open

○ closed

SUBMIT

If required by the building official, acceptance tests are to be conducted in the presence of whom?

○ **A.** A certified building inspector

○ **B.** A certified fire protection system inspector

○ **C.** Both A and B

○ **D.** Either A or B

SUBMIT

🔒 Complete the knowledge checks above before moving on.

After completing this module, you should now have a better understanding of the Ohio Building Code and the Ohio Fire Code.

Please press the button to proceed.

Glossary - Diesel Fire Pump Technician

This is the glossary for the Diesel Fire Pump Technician course. Click on a letter below to see each term and its definition.

- A
- C
- D
- E
- F
- H
- I
- J
- L
- M

N

P

Q

R

S

T

V

W

Lesson 1 of 18

A

Approved

Acceptable to the authority having jurisdiction. (*NFPA* 20 2016, Section 3.2.1)

Authority Having Jurisdiction (AHJ)

An organization, office, or individual responsible for enforcing requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure. (*NFPA* 20 2016, Section 3.2.2)

C

Centrifugal Pump

A pump in which the pressure is developed principally by the action of centrifugal force. (*NFPA* 20 2016, Section 3.3.44.3)

Circulation Relief Valve

A valve used to cool a pump by discharging a small quantity of water. This valve is separate from and independent of the main relief valve. (*NFPA* 20 2016, Section 3.3.67.5.1)

Control Valve

A valve controlling flow to water-based fire protection systems. (*NFPA* 25 2014, Section 3.5.1)

D

Diesel Engine

An internal combustion engine in which the fuel is ignited entirely by the heat resulting from the compression of the air supplied for combustion. (*NFPA* 20 2016, Section 3.3.15.1)

The oil-diesel engine operates on fuel oil injected near the top dead center of the compression stroke. The combustion is effected within the working cylinder and not in external chambers.

E

Electric Motor

A motor that is classified according to mechanical protection and methods of cooling. (*NFPA* 20 2016, Section 3.3.35.4)

End Suction Pump

A single suction pump having its suction nozzle on the opposite side of the casing from the stuffing box and having the face of the suction nozzle perpendicular to the longitudinal axis of the shaft. (*NFPA* 20 2016, Section 3.3.44.4)

F

Fire Pump

A pump that is a provider of liquid flow and pressure dedicated to fire protection. (*NFPA* 20 2016, Section 3.3.44.5)

Fire Pump Controller

A group of devices that serve to govern, in some predetermined manner, the starting and stopping of the fire pump driver and to monitor and signal the status and condition of the fire pump unit. (*NFPA* 20 2016, Section 3.3.19)

H

Head

A quantity used to express a form (or combination of forms) of the energy content of water per unit weight of the water referred to any arbitrary datum. (*NFPA* 20 2016, Section 3.3.25)

Horizontal Pump

A pump with the shaft normally in a horizontal position. (*NFPA* 20 2016, Section 3.3.44.8)

Horizontal Split-Case Pump

A centrifugal pump characterized by a housing that is split parallel to the shaft. (*NFPA* 20 2016, Section 3.3.44.9)

I

In-Line Pump

A centrifugal pump whose drive unit is supported by the pump having its suction and discharge flanges on approximately the same centerline. (*NFPA* 20 2016, Section 3.3.44.10)

J

Jockey (Pressure Maintenance or Make-Up) Pump

A pump designed to maintain the pressure on the fire protection system(s) between preset limits when the system is not flowing water. Also known as a Pressure Maintenance Pump. (*NFPA* 20 2016, Section 3.3.44.15)

Lesson 9 of 18

L

Listed

Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose. (*NFPA* 20 2016, Section 3.2.3)

M

Main Drain

The primary drain connection located on the system riser. (*NFPA* 25 2014, Section 3.3.10.1)

Maximum Pump Brake Horsepower

The maximum brake horsepower required to drive the pump at rated speed. The pump manufacturer determines this by shop test under expected suction and discharge conditions. Actual field conditions can vary from shop conditions. (*NFPA* 20 2016, Section 3.3.34)

N

No Flow (Churn, Shutoff)

The condition of zero flow when the fire pump is running but the only water passing through the pump is a small flow that is discharged through the pump circulation relief valve or supplies the cooling for a diesel engine driver. (*NFPA* 20 2016, Section 3.3.38)

Lesson 12 of 18

P

Pressure Control Valve

A pilot-operated pressure-reducing valve designed for the purpose of reducing the downstream water pressure to a specific value under both flowing (residual) and non-flowing (static) conditions. (*NFPA* 20 2016, Section 3.3.67.3)

Pressure Maintenance (Jockey or Make-Up) Pump

A pump designed to maintain the pressure on the fire protection system(s) between preset limits when the system is not flowing water. (*NFPA* 20 2016, Section 3.3.44.15)

[Pressure] Relief Valve

> A device that allows the diversion of liquid to limit excess pressure in a system. (*NFPA* 25 2014, Section 3.5.6)

Lesson 13 of 18

Q

Qualified

A competent and capable person or company that has met the requirements and training for a given field acceptable to the AHJ. (*NFPA* 25 2014, Section 3.3.34)

R

Rated Flow

The capacity of the pump at rated speed and rated pressure as marked on the manufacturer's nameplate. (*NFPA* 20 2016, Section 3.3.47)

Rated Speed

The speed for which the fire pump is listed and that appears on the fire pump nameplate. (*NFPA* 20 2016, Section 3.3.57.3)

Relief Valve

A device that allows the diversion of liquid to limit excess pressure in a system. (*NFPA* 20 2016, Section 3.3.67.5)

S

Shall

Indicates a mandatory requirement. (*NFPA* 20 2016, Section 3.2.4)

Should

Indicates a recommendation or that which is advised but not required. (*NFPA* 20 2016, Section 3.2.5)

Sprinkler System

A system that consists of an integrated network of piping designed in accordance with fire protection engineering standards that includes a water supply source, a water control valve, a waterflow alarm, and a drain and is commonly activated by heat from a fire, discharging water over the fire area. The portion of the sprinkler system above ground is a network of specifically sized or hydraulically designed piping installed in a building, structure, or area, generally overhead, and to which sprinklers are attached in a systematic pattern. The system is commonly activated by heat from a fire and discharges water over the fire area. (*NFPA* 25 2014, Section 3.6.4)

Standard

An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides. (*NFPA* 20 2016, Section 3.2.6)

Supervisory Signal

A signal that results from the detection of a supervisory condition. (*NFPA* 72 2016, Section 3.3.253.9)

Lesson 16 of 18

T

Testing

A procedure used to determine the operational status of a component or system by conducting periodic physical checks, such as waterflow tests, fire pump tests, alarm tests, and trip tests of dry pipe, deluge, or preaction valves. (*NFPA* 25 2014, Section 3.3.47)

Total Head (H), Horizontal Pumps

The measure of the work increase, per pound of liquid, imparted to the liquid by the pump, and therefore the algebraic difference between the total discharge head and the total suction head. Total head, as determined on test where suction lift exists, is the sum of the total discharge head and total suction lift. Where positive suction head exists, the total head is the total discharge head minus the total suction head. (*NFPA* 20 2016, Section 3.3.25.3.1)

Refer to *NFPA* 20 2016, Figure A.3.3.25.3.1

Total Head (H), Vertical Turbine Pumps

The distance from the pumping liquid level to the center of the discharge gauge plus the total discharge head. (*NFPA* 20 2016, Section 3.3.25.3.2)

Refer to *NFPA* 20 2016, Figure A.3.3.25.3.2

Lesson 17 of 18

V

Velocity Head

The kinetic energy of a unit weight of fluid moving with velocity (v) determined at the point of the gauge connection. (*NFPA* 20 2016, Section 3.3.25.6)

Velocity Head may be indicated as h_v

Vertical Lineshaft Turbine Pump

A vertical shaft centrifugal pump with rotating impeller or impellers and with discharge from the pumping element coaxial with the shaft. The pumping element is suspended by the conductor system, which encloses a system of vertical shafting used to transmit power to the impellers, the prime mover being external to the flow stream. (*NFPA* 20 2016, Section 3.3.44.18)

Lesson 18 of 18

W

Water Supply

A source of water that provides the flows (gal/min) and pressures (psi) required by the water-based fire protection system. (*NFPA* 25 2014, Section 3.3.51)

File Attachments for Item:

EC-5 Ohio Fire Alarm and Detection Equipment (Fire Tech Productions)

All certifications (11 hours)

Ohio | Department of Commerce
Mike DeWine, Governor
Jon Husted, Lt. Governor
Sheryl Maxfield, Director

Board of Building Standards

APPLICATION FOR CONTINUING EDUCATION APPROVAL
COURSE CONDITIONS AND GUIDELINES

The Ohio Board of Building Standards is committed to the ongoing education and professional development of board-certified personnel through the delivery of high-quality, accurate and engaging professional continuing education content. To this end, the Board reviews and approves Continuing Education Courses for building department personnel.

Board approval is granted for course instruction on current codes and standards, including the OBC, OMC, OPC, and RCO, and any other content areas directly related to the responsibilities of the certification for which credit is being requested.

Promotion: Any person or organization promoting an approved course is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, categories 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 may not falsely state BBS approval before approval is granted. Course providers may state that BBS approval is pending.

Application Submission: All Applications and associated materials shall be submitted by email in .pdf format. Instructions for completing the application are attached.

Certificate of Completion: Course providers shall 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.

Any person or organization administering an approved course shall return a completed BBS Course Attendance form by email.

Participants: Participants must attend the complete course as presented by the instructor to receive credit hours approved by the Board. The organization or instructor of online courses shall plan and execute methods to verify the individual's attendance and completion of the course. No partial credit will be given to any participant who failed to complete the entire course as approved.

Board approval: All courses are approved for the calendar year in which application is made. Courses may be renewed so long as the referenced code is in effect, and the CEUs, certification and content remain unchanged. When the referenced code is updated, courses must be updated, and new approvals obtained.

Facility/training area: BBS Course may be delivered in person or online, or both, at the sponsor's option.
Course facilities shall include the following:

In Person Classes:	**Online Classes:**
Sufficient seating capacity	Web-accessible
ADA accessible facilities	ADA accessible delivery
Appropriate Audio/Visual devices for delivery	Tech support available
Writing surfaces for participants	Live and recorded courses permitted

In-person facilities shall comfortably and safely seat at least the number of attendees present in the room and shall be climate controlled, non-smoking, and sound controlled so that outside noise will not interfere with the training.

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Julie Miller

Organization: Fire Tech Productions

Address: 7976 Clyo Rd., Centerville, OH 45459

E-mail: julie@firetech.com Telephone: 937.434.3473

Website: firetech.com

Conference Sponsor (if applicable)________ Conference Email:________

Check here if Course Renewal:________ Prior course number ________ (*i.e. BBS2018-429*)

Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: Ohio Fire Alarms and Detection Equipment - NFPA 72 2016 - FAOH 102

Course instructor: Bill Ford

Course description: Understand general requirements of Fire Alarm and Detection Equipment per NFPA 72 2016.
This course provides the knowledge to:
Apply basic installation requirements for fire alarm systems, including wiring, components, and devices
Properly locate and space devices
Maintain household fire alarm systems

Instructional hours per session: 11.0 Number of Sessions:________

Course Date(s) and Location:________

Special Content:

Code Administration:______
Existing Buildings: ______
Electrical Instruction: ______
Plumbing Instruction:______

Conference Course: ________
Conference Name: ________
Conference location:________

Course to be offered online? X **On Demand** X **Webinar**______

Course Website: firetech.com

Detail online course participation confirmation method *(i.e. test, quizlets, participant activity confirmation)*:
100% completion/review of all lessons/knowledge checks and 70% passing on all quizzes/exams

Course applicable for the following certifications

Residential Certifications Only: ______ Commercial Certifications: X
Administrative Course, All Certifications: ______

Application materials included:

______ Course Outline or Course Learning Objectives
______ Presentation Materials/Slides (not required for roundtable courses)
______ Assessment Materials (for online courses)
______ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Instructions for new Continuing Education Approval form

Provider Information

1. Please include all contact information.
2. If course is not part of a conference, leave conference sponsor and email blank.

Course Renewal

1. Indicate if the course is being submitted for renewal. Include prior approval letter and write in prior course number.
2. Certification approval for courses has now changed: all existing courses being renewed will be approved within the new classification system.
   a. Courses previously approved for only residential certifications will be approved for all residential certifications.
   b. Courses previously approved for at least on commercial certification will now be approved for all commercial certifications and all residential certifications.
   c. Courses on required instruction topics, Ohio Ethics, Code Administration and Existing Buildings, will be noted as Administrative Courses and be approved for all certifications.
3. Courses being renewed should skip the New Course information section and are not required to submit outline, agenda, slides or other instructional materials for review. Skip to Special Content, and mark any item that applies to the course.

New Course Information

1. Enter course title, name of instructor, and a brief description of the course content. Learning objectives may be substituted for course description, if desired.
2. Number of instructional hours per session is the length of instructional time.
3. Number of sessions: can be 1 or the number of sessions planned.
4. Course date(s) and location: not necessary at this time, enter if known.

Special Content

1. Indicate if the course will meet instructional time in Code Administration or Existing Buildings.
2. Indicate if the course is a plumbing or electrical course, for ESIAC review and trainee course tracking.
3. If the course is associated with a conference, indicate the conference name and location, as this will allow BBS to coordinate approvals with the conference provider.
4. If the course will be offered online, specify whether it will be on demand or offered as a virtual webinar, or both. Include website where the course will be provided.

Course applicable for the following certifications

This section represents a major change from previous BBS course approval forms.

1. If the course is only for residential certifications, check 'Residential Certifications Only'. The course, if approved, will be approved for all residential certifications.
2. If the course is appropriate for any commercial certifications, check Commercial Certifications. The course, if approved, will be approved for all commercial certification **AND** all residential certifications.
3. If the course is intended to meet required instruction in Code Administration (Chapter 1) or Existing Buildings (commercial or residential) check 'Administrative Course, All Certifications'.

Application Materials Included

This is a checklist for the course submitter's use, to be sure all materials necessary for review are included with the application. All materials should be submitted in .pdf format, along with the application, via email to Michael.Lane@com.ohio.gov or BBS@com.ohio.gov

Ohio Course Submission

Included in this document: Course Outline, Instructor resume(s)

Course: Ohio Fire Alarms and Detection Equipment - NFPA 72 2016 - FAOH 102

Course Outline:

- **01.**

Course Navigation Video (Optional)
  - Course Navigation Video (Optional)

- **02.**

Ohio Fire Alarms and Detection Equipment - NFPA 72 2016
  - Introduction
  - Fire Alarm Basics and Wiring
  - Detection Devices
  - Location and Spacing
  - Notification Appliances
  - Household Fire Alarm Systems
  - Inspection, Testing, and Maintenance
  - Emergency Control Functions and Interfaces
  - Ohio Building Code and Ohio Fire Code

- **03.**

Practice Exam
  - Practice Exam

Instructor Resume:

Charles William Ford

OBJECTIVE

To utilize my strong administrative and people skills in combination with my technical background, to eliminate or reduce the incidence of unfriendly fire and the resulting losses through motivation, education, behavior modification and engineering principles where applicable.

EDUCATION

EASTERN KENTUCKY UNIVERSITY, Richmond, Kentucky,
B. S. Degree in Fire Prevention and Control, 1982.
Minor Studies Law Enforcement

EXPERIENCE

KETTERING HEALTH NETWORK (2021-Present)

Operation Coordinator

- Manage seven technicians who hold sprinkler technician, fire alarm technician and portable extinguisher certifications
- Responsible for the inspection/testing of fire protection systems owned and operated by Kettering Health

KETTERING FIRE DEPARTMENT (2008-2021)

Fire Marshal

- Manage the fire investigation program
- Conduct plan reviews and field fire protection system acceptance tests for the Kettering Building Department
- Conduct fire safety code enforcement inspections

HUBER HEIGHTS FIRE DIVISON (2002- 2008)

Fire Chief

- Managed 51 person paid fire department with paramedic service with two stations
- Administered a 7.4 million dollar budget
- Developed City Emergency Operations Plan
- NIMS Compliance Coordinator
- Served as acting City Manager in the absence of the manager
- Authored FEMA Fire Act Grant for City Traffic Signal Pre-emption System

DAYTON AIRPORT FIRE DEPARTMENT (2000-2002)

Airport Fire Chief

- Managed 30 person paid fire department with paramedic service
- Responsible for budgeting, planning and policy development
- Administered 3 million dollar budget, including capital equipment
- Responsible for airport disaster planning and functional exercises
- Responded to aircraft emergencies, EMS calls, and structural alarms serving as incident command

CITY OF DAYTON FIRE DEPARTMENT (1982-2000)

Fire Protection Engineer/Fire Marshal

- Bureau head of Fire Prevention Bureau – responsible for planning, organizing and evaluation of fire prevention and hazard abatement programs and activities
- Responsible for budgeting and supervisory activities for 13 employees

- Served as acting Assistant Chief of Administration
- Sector commander at scene of major incidents
- Fire Investigator Regional Fire Investigation Unit
- Instructor - Dayton Fire Training Center and Dayton Police Academy
- Qualified fire investigation expert, Montgomery County Common Pleas Court

CITY OF DAYTON FIRE DEPARMENT (1979-1982)

Firefighter/EMT-A

- Graduate of Dayton Fire Academy, assigned to Operations Division and Fire Prevention Bureau
- Engaged in fire suppression activities and staffed ambulances serving as an EMT-A
- Conducted fire safety inspections and served as plans examiner

SINCLAIR COMMUNITY COLLEGE, (1989-2014)

Instructor – Lecturer II

- Instruct courses in Fire Science Technology Program, Department of Engineering Technologies

MONTGOMERY COUNTY SHERRIFF'S OFFICE, (1990-2015)

Commissioned Law Enforcement Officer (Deputy)

- Assigned commission as Fire Marshal for City of Dayton

SPECIAL INFORMATION

- Graduate Dayton Fire Academy, certified by the Ohio Division of Public Safety, 1979
- Graduate Dayton Police Academy, certified by the Ohio Peace Officers' Training Council, 1990
- State of Ohio Level II certified firefighter
- State of Ohio Fire Safety Inspector
- State of Ohio Fire Safety Inspector Instructor, Fire Fighter Instructor
- Hazardous Materials Operations certified
- Basic and Advanced Aircraft Rescue Firefighter certification, - American Association of Airport Executives
- Certified Fire Service and Fire Safety Inspector Instructor, State of Ohio
- Ohio Board of Building Standards, Fire Protection Inspector, Interim Fire Protection Plans Examiner certifications.
- National Fire Academy attendee
  - ✓ Strategic Analysis of Community Risk Reduction
  - ✓ Codes and Ordinances
  - ✓ Fire Prevention Specialist II
  - ✓ Microcomputers for Arson Squad Managers

PROFESSIONAL AFFILIATIONS

- Southwest Fire Safety Council
- International Code Council

Ohio Fire Alarm and Detection Equipment- Introduction

FIRETECH
PRODUCTIONS

Welcome to the Introduction for the Ohio Fire Alarm and Detection Equipment course.

When you are ready to get started, click on the "**Begin**" button.

This introduction provides a brief overview of what will be covered in the course.

You can come back to this module and reference this information anytime in your menu.

Topics that are covered in this introduction are as follows:

- State of Ohio Important References
- Preparing for the Exam
- Study Tips
- Ohio Codes
- NFPA Codes
- *NFPA* 72 2016 Definitions

Overview

Glossary

Lesson 1 of 2

Overview

Welcome

Please review this introduction before getting started on the course.

We will look at key references and study tips. In addition, we will highlight key vocabulary terms in the glossary.

LET'S GET STARTED!

Key References

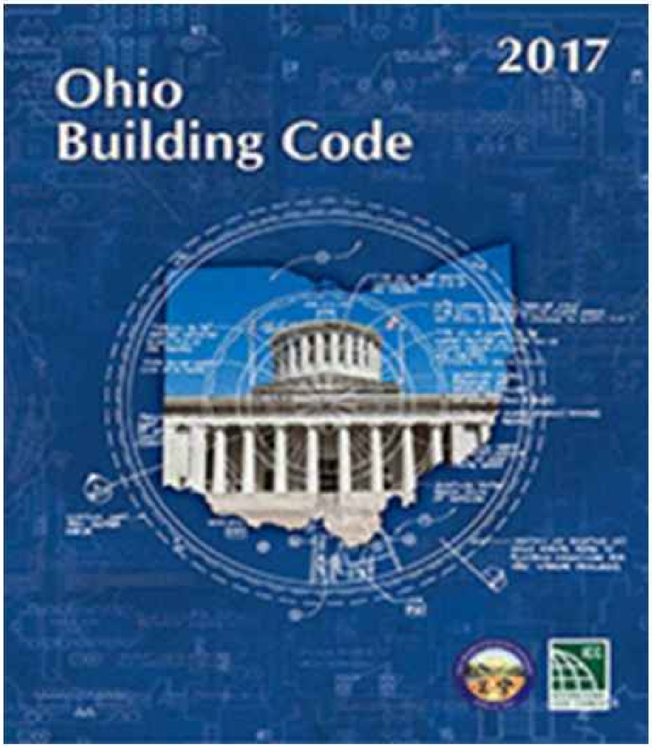
As you work through this course, it is important to refer to your standards and codes as the following references will be discussed.

OHIO BUILDING CODE

OHIO FIRE CODE

NFPA 72

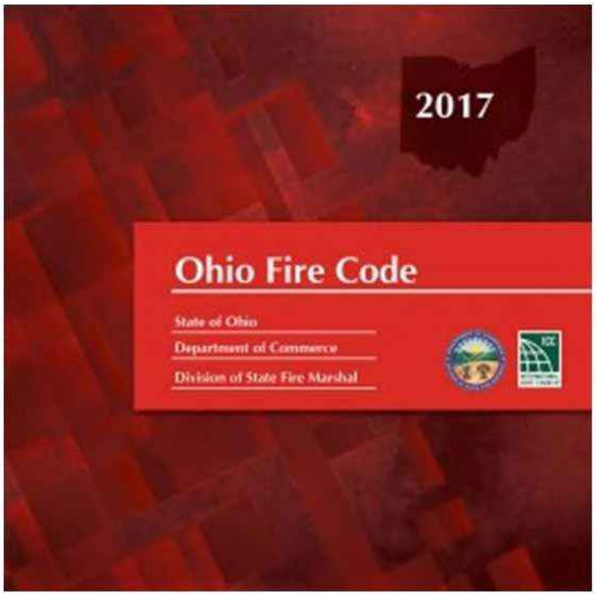
The ***Ohio Building Code,* 2017** establishes uniform minimum requirements for building construction, repair, alteration, and maintenance. These rules govern the intended use and occupancy of the buildings with respect to performance, extent of use, and standardization. The ***Ohio Building Code,* 2017** can be accessed through this link:
https://codes.iccsafe.org/content/OHBCU2017



OHIO BUILDING CODE | OHIO FIRE CODE | NFPA 72

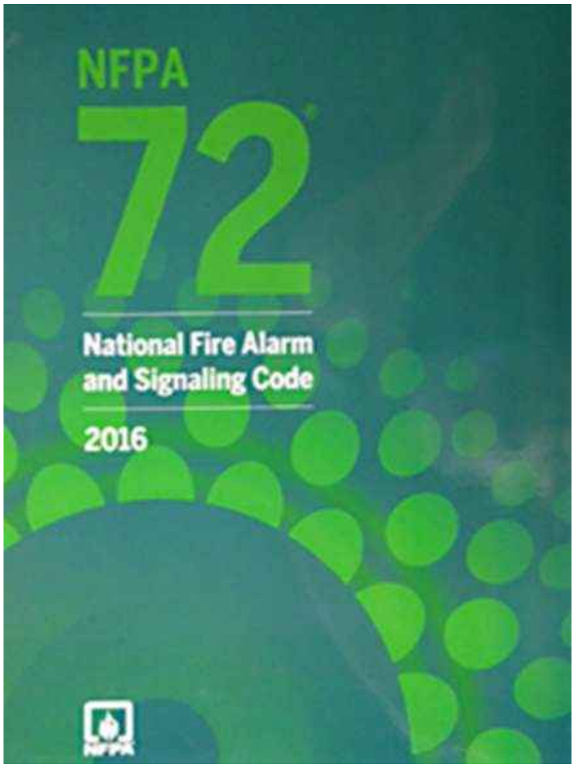
The ***Ohio Fire Code,* 2017**, establishes state fire marshal rules for the administration and enforcement of authorities. These rules govern the occupancy and maintenance of all structures and premises for precautions against fire and the spread of fire and general requirements of fire safety.

The Ohio Fire Code can be accessed through this link: https://codes.iccsafe.org/content/OHFCJAN2019E/ohio-administrative-code-1301-7-7-09-fire-protection-systems



OHIO BUILDING CODE | OHIO FIRE CODE | NFPA 72

NFPA 72 – National Fire Alarm and Signaling Code, 2016



ⓘ Each *NFPA* standard contains several Annexes with valuable examples and information. It is recommended you study this material as well.

OHIO CODES

Ohio Codes

The Ohio Fire Protection Exams are prepared from the Ohio Building Code Chapter 9, 2017 edition, the Ohio Administrative Code Section 1301:7-7-09 (Ohio Fire Code) 2017 edition, as well as the pertinent NFPA standard previously discussed. This course will focus on those referenced sections found in the Ohio Building Code and the Ohio Fire Code.

The Ohio Fire Code states that fire protection systems shall be installed, inspected, tested, and maintained per *NFPA* 72 2016 and *NFPA* 70 2017 (NEC). The code also defines specific rules for Ohio as well as reinforce some of the *NFPA* 72 2016 requirements.

- One of these requirements is to be certified and licensed by the state of Ohio.

- The only exception is for a provisional person in an approved formal apprenticeship program. They are permitted to work under the constant supervision of a certified person. The certified person is only allowed to supervise one provisional person.

ADDITIONAL RESOURCES

Additional Resources

Below is additional information and resources for the Ohio exam.

Ohio Department of Commerce – Division of State Fire Marshal:

Ohio Department of Commerce

To access the Ohio Department of Commerce – Division of State Fire Marshal, click on this "Click Here" button.

CLICK HERE

Ohio Department of Commerce phone: **(614) 752-7126**

The following downloadable PDF is for the Fire Protection Exam Application through the Ohio Department of Commerce:

PDF **FireProtectionExamApplication.pdf**
548.9 KB ↓

PSI Candidate Information Bulletin

A very important source of information is the PSI Candidate Information Bulletin from PSI Services LLC. Take time to read it below in its **ENTIRETY**.

PDF **OhioCertificationExaminationBulletin.pdf**
230.9 KB ↓

PSI Online Exams

To check for the most updated information on PSI Services, visit their website by clicking on this "Click Here" button.

CLICK HERE

NFPA CODES

NFPA Codes

NFPA 70 2017 (NEC) covers the wiring requirements for fire alarm systems

- General wiring practices and codes apply
- Article 760 covers fire alarm systems specifically

NFPA 72 2016 is the National Fire Alarm Code

- **Chapter 1** (Administration) – Defines the scope, purpose, and administration of *NFPA* 72 2016.
- **Chapter 2** (Referenced Publications) – Lists all referenced NFPA and ANSI specifications and codes.

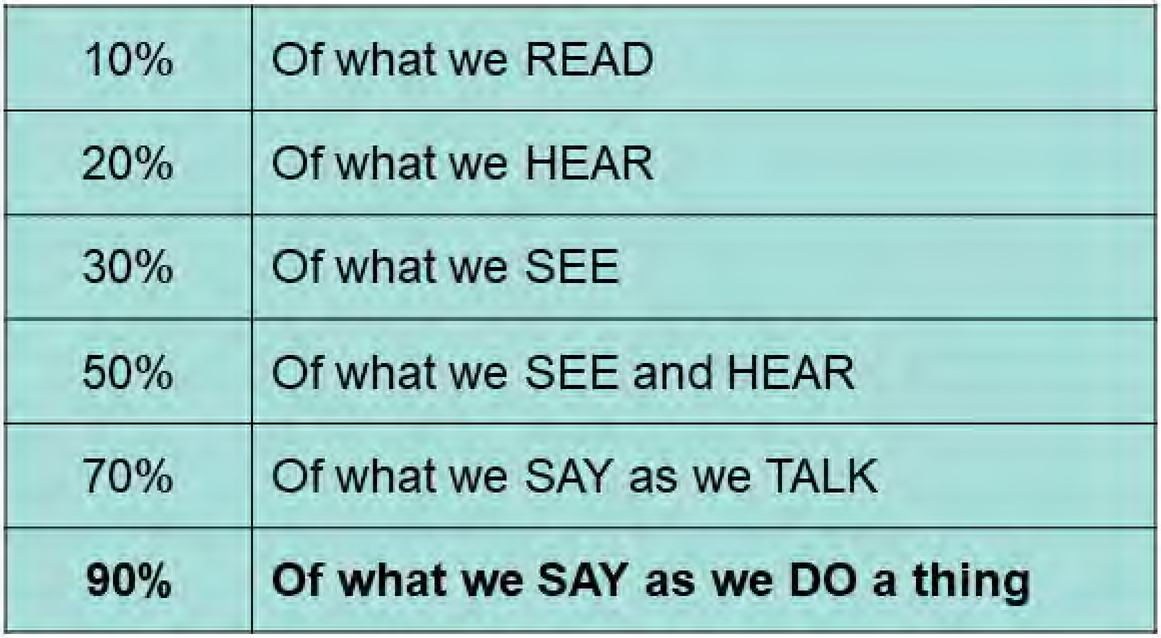
- **Chapter 3** (Definitions) – Has a brief explanation of almost every fire alarm term.
- **Chapter 10** (Fundamentals of Fire Alarm Systems) – This large chapter includes power supplies, installation, equipment, and documentation.
- **Chapter 12** (Circuits and Pathways) – This relatively small chapter includes information on capabilities of types of circuits or system pathways.
- **Chapter 14** (Inspection, Testing and Maintenance) – Covers the requirements for the inspection, testing, and maintenance for all devices and systems.
- **Chapter 17** (Initiating Devices) – Contains all of the requirements for signaling devices, such as smoke and heat detectors.
- **Chapter 18** (Notification Appliances) – Covers the requirements for alarm bells, sirens, lights, and any device that indicates an alarm.
- **Chapter 21** (Emergency Control Functions and Interfaces) – Covers the requirements for emergency control function interfaces.
- **Chapter 23** (Protected Premises Fire Alarm Systems) – Covers system performance and integrity requirements.

- **Chapter 24** (Emergency Communications Systems (ECS)) – Covers the requirements of communications and mass notification systems.
- **Chapter 26** (Supervising Station Fire Alarm Systems) – Covers the requirements between a continuously attended supervising station and the protected premises.
- **Chapter 27** (Public Reporting Fire Alarm Systems) – Covers the requirements for municipal fire alarm systems.
- **Chapter 29** (Single- and Multiple-Station Alarms and Household Fire Alarm Systems) – Covers requirements for dwellings, hotels, day care, and nursing facilities.

ⓘ ***NFPA* 72 2016** also **contains several Annexes and supplements** that have very **valuable examples and information.** It is **recommended you study this material** as well.

HOW WE LEARN

Thinking About How We Learn



10%	Of what we READ
20%	Of what we HEAR
30%	Of what we SEE
50%	Of what we SEE and HEAR
70%	Of what we SAY as we TALK
90%	**Of what we SAY as we DO a thing**

Source: ***Skill With People*** by Les Giblin

Different people learn in different ways.

It is important to discover what works **best for you** and use your strengths to ensure you retain the material.

TRAINING MODULES

Training Modules

Be prepared to **refer to your copy of the referenced NFPA standards constantly** throughout these modules. Be comfortable with the technical material.

Each **training module** is carefully planned and designed to **highlight areas of the standards that you need to know in order to increase your chances of success on the exam**. The goal of these training modules is to help you become knowledgeable of important areas of the standards and to gain a working understanding of how to apply these requirements.

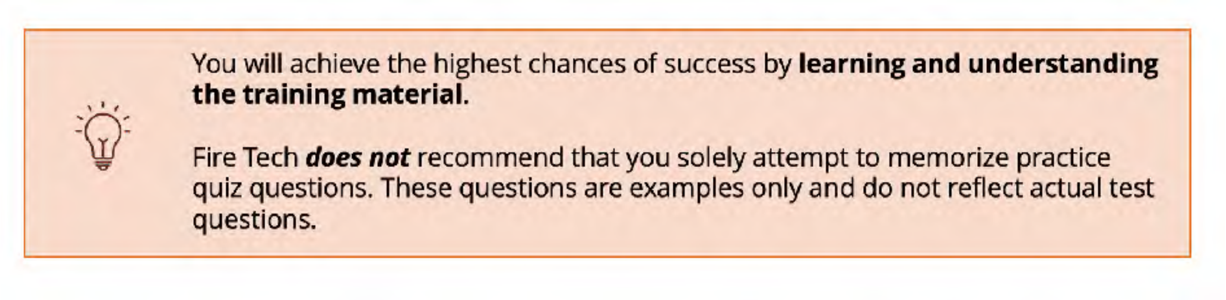
Take notes as you are studying, and **highlight** areas of the standards that are important to know.

The more familiar you are with the requirements, tables, and figures, the better your chances of success on the exam.

QUIZZES

The Quizzes

Fire Tech provides a practice quiz associated with each training module, which should be taken following completion of the module. As you take each practice quiz, use your copy of the referenced *NFPA* standards to **look up every answer to each quiz question**. This will assist you in **becoming more familiar with the requirements and where they are located** in each of the codes and standards.



You will achieve the highest chances of success by **learning and understanding the training material.**

Fire Tech ***does not*** recommend that you solely attempt to memorize practice quiz questions. These questions are examples only and do not reflect actual test questions.

Additionally, **read each question carefully**. Sift through what is pertinent to the question and what is irrelevant information that may be included as a distractor.

You will achieve the highest chances of success by learning and understanding the training material. Fire Tech does **not** recommend that you solely attempt to memorize practice quiz questions.

KNOWLEDGE CHECKS

Knowledge Checks

To help you apply course material and prepare for the quizzes, **knowledge checks** are sprinkled throughout each course.

Completing these knowledge checks is **required** to proceed further in the lesson. If you're stuck on a question, refer to previous lesson material and use your NFPA standard to find the answer.

Knowledge checks will help you apply course material and prepare for course quizzes.

○ True

○ False

SUBMIT

Complete the knowledge check above before moving on.

Practice Exam

Once you have read all of the lessons in this course and passed all of the quizzes, you will be ready to take the **Practice Exam**.

The Practice Exam consists of questions from the quizzes and is presented in a randomized manner.

LEARNING STRATEGIES

Learning Strategies

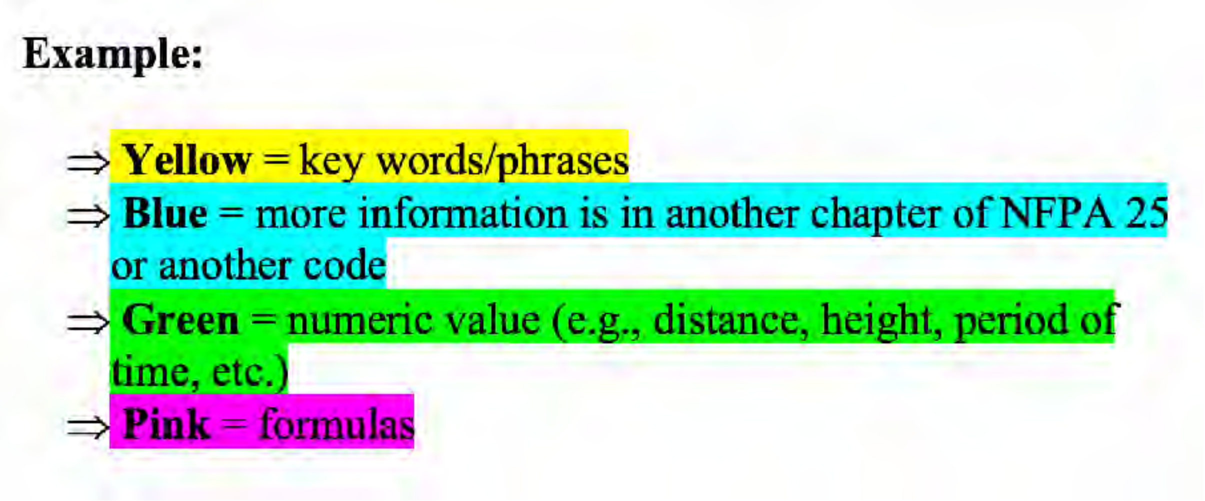
Click each of the strategies below and begin to incorporate them as you prepare for the Practice Exam.

Learning Strategies

Use these strategies to help you utilize the course materials.

Strategy 1

Create a color-coded highlighting system



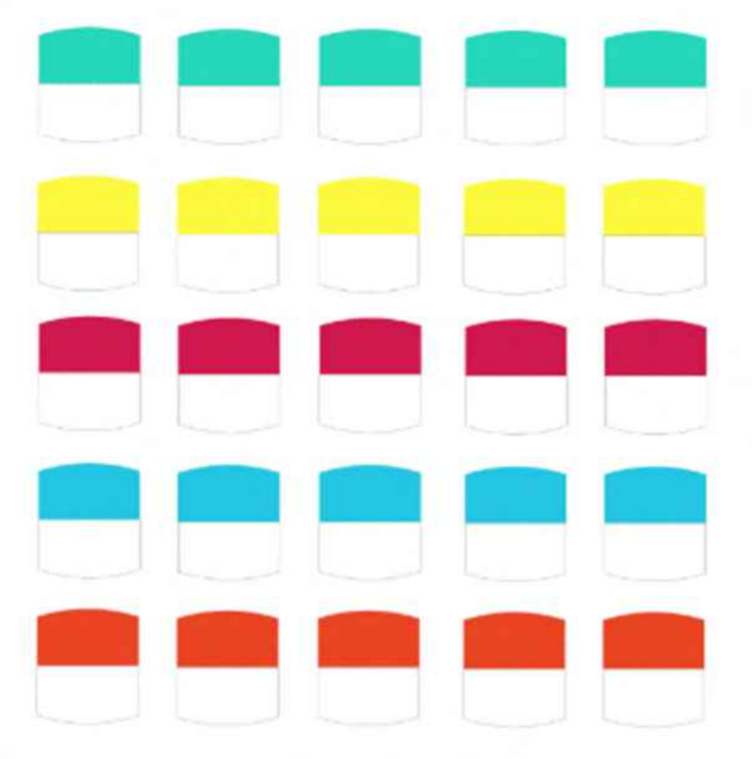
Example:

⇒ **Yellow** = key words/phrases
⇒ **Blue** = more information is in another chapter of NFPA 25 or another code
⇒ **Green** = numeric value (e.g., distance, height, period of time, etc.)
⇒ **Pink** = formulas

Fire Tech recommends highlighting important areas of the code. Some customers use up to four colors and different methods of highlighting. A simple strategy is to highlight based on type of information. Use one color for major sections or topics and another color for details and exceptions.

Strategy 2

Use tabs on your standards



Helps you look things up much faster! This can be especially helpful if you are looking up a reference for a customer.

Add tabs yourself or:

- purchase pre-tabbed standards from Fire Tech Productions
- purchase labeled tabs to add to your standard from Fire Tech Productions

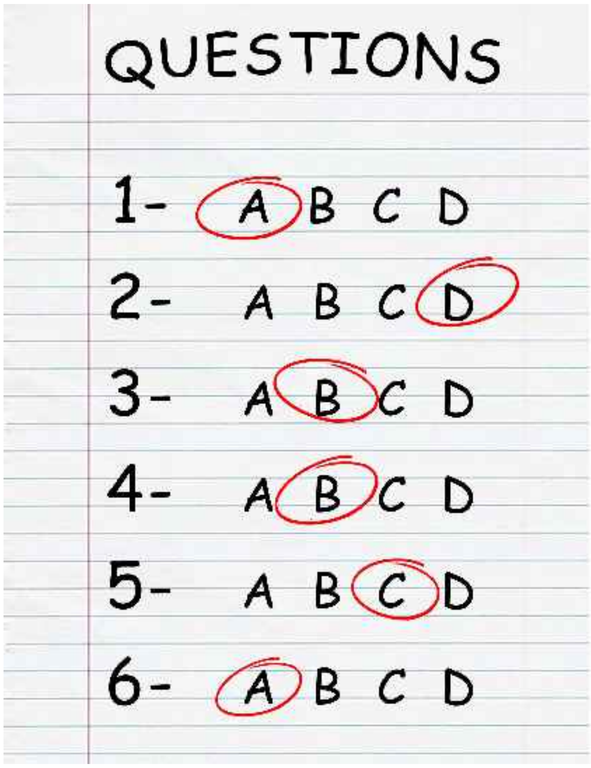
Strategy 3

Find a learning partner or a mentor

Have someone hold you accountable or quiz you, even if they’re not taking the course themselves. Driving to and from a job site with a co-worker is a great opportunity to do this.

Strategy 4

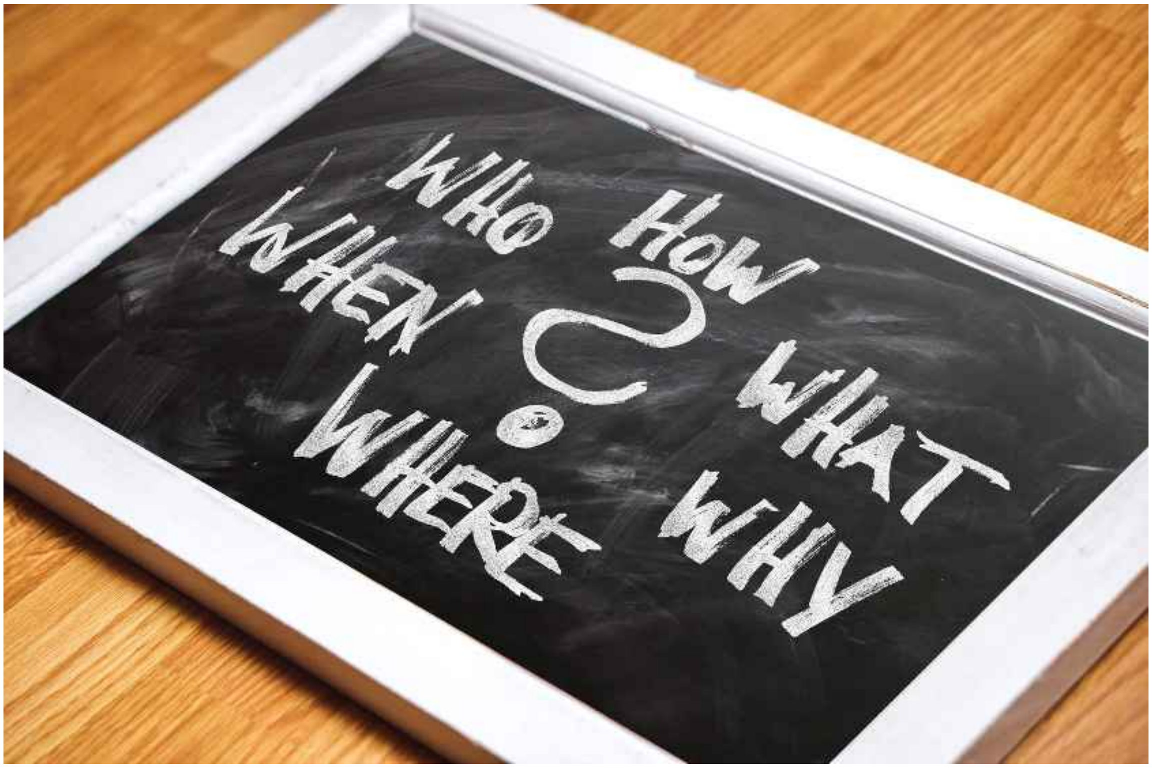
Practice



Take the practice quizzes and tests in the Fire Tech online course. Many studies show that recalling information helps to “make it stick”.

Strategy 5

Write your own questions



As you go through the material, turn the information into possible questions that you can go back and answer later. This will help you check how well you are retaining the information in the course.

Strategy 6

Make time for your course

Work on your course for at least **20 minutes** every day. Spreading out the course material over time is a much more effective way to learn.

Strategy 7

Make up songs

Our brains remember music really well. Put those formulas, definitions, or requirements to music.

Strategy 8

Teach someone else

It will solidify ideas in your brain and improve your understanding.

GLOSSARY

Lesson 2 of 2

Glossary

CONTINUE

Common Acronyms

Every industry has its own unique terms and acronyms. Here are some common acronyms related to fire alarm systems that you will see throughout this course. Click on each "**+**" sign below to learn more about common acronyms you will see in this module and in the field. For now, take a moment to become familiar with them, and see what the letters stand for.

AHJ —

Authority Having Jurisdiction

CFPS —

Certified Fire Protection Specialist

FACU —

Fire Alarm Control Unit (also called a Fire Alarm Control Panel (FACP)

FAS —

Fire Alarm System

IBC —

International Building Code

IDC —

Initiating Device Circuit

IFC

International Fire Code

NAC

Notification Appliance Circuit

NEC

National Electrical Code

NFPA

National Fire Protection Association

NICET

National Institute for Certification in Engineering Technologies

SLC –

Signaling Line Circuit

Glossary

Click on each "**+**" symbol to see the definition for each word below. These words are also linked throughout the course. Remember **all** of the definitions that may be on the exam are in *NFPA* 72 2016, Chapter 3.

Addressable Fire Alarm System –

A system in which the fire alarm control unit and its associated devices are connected and communicate digitally. Each device is separately addressed.

Alarm Signal –

A signal that results from the manual or automatic detection of an alarm condition. (*NFPA* 72 2016, Section 3.3.253.1)

Authority Having Jurisdiction (AHJ)

An organization, office, or individual responsible for enforcing requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure. (*NFPA* 72 2016, Section 3.2.2)

Automatic Fire Detector

A device designed to detect the presence of a fire signature and to initiate action. For the purpose of this Code, automatic fire detectors are classified as follows:

- automatic fire extinguishing or suppression system operation detector
- heat detector
- radiant energy-sensing fire detector
- fire-gas detector
- other fire detector
- smoke detector

(*NFPA* 72 2016, Section 3.3.66.2)

Beam Construction

Ceilings that have solid structural or solid nonstructural members projecting down from the ceiling surface more than 4 in. (100 mm) and spaced more than 36 in. (910 mm), center to center. (*NFPA* 72 2016, Section 3.3.38.1)

Carbon Monoxide Alarm Signal

A signal indicating a concentration of carbon monoxide at or above the alarm threshold that could pose a risk to the life safety of the occupants and that requires immediate action. (*NFPA* 72 2016, Section 3.3.253.2)

Coded

An audible or visible signal that conveys several discrete bits or units of information. (*NFPA* 72 2016, Section 3.3.48)

Combination System

A fire alarm system in which components are used, in whole or in part, in common with a non-fire signaling system. Examples of non-fire systems are security, card access control, closed circuit television, sound reinforcement, background music, paging, sound masking, building automation, time, and attendance. (*NFPA* 72 2016, Section 3.3.103.1)

Control Unit (Fire Alarm Control Unit-FACU)

A component of the fire alarm system, provided with primary and secondary power sources, which receives signals from initiating devices or other fire alarm control units, and processes these signals to determine part or all of the required fire alarm system output function(s). (*NFPA* 72 2016, Section 3.3.100)

Also known as the **Fire Alarm Control Panel** (FACP), **control panel**, or **control unit**.

Conventional Fire Alarm System

A fire alarm system that consists of a control panel employing one or more initiating circuits, wired in parallel. The system is not capable of identifying the device that is in alarm, supervisory, or trouble status.

Detector

A device suitable for connection to a circuit that has a sensor that responds to a physical stimulus such as heat or smoke. (*NFPA* 72 2016, Section 3.3.66)

Dwelling Unit

A single unit, providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation. (*NFPA* 72 2016, Section 3.3.79)

Emergency Communication Systems

A system for the protection of life by indicating the existence of an emergency situation and communicating information necessary to facilitate an appropriate response and action. (*NFPA* 72 2016, Section 3.3.85)

Evacuation Signal

A distinctive alarm signal intended to be recognized by the occupants as requiring evacuation of the building. (*NFPA* 72 2016, Section 3.3.253.4)

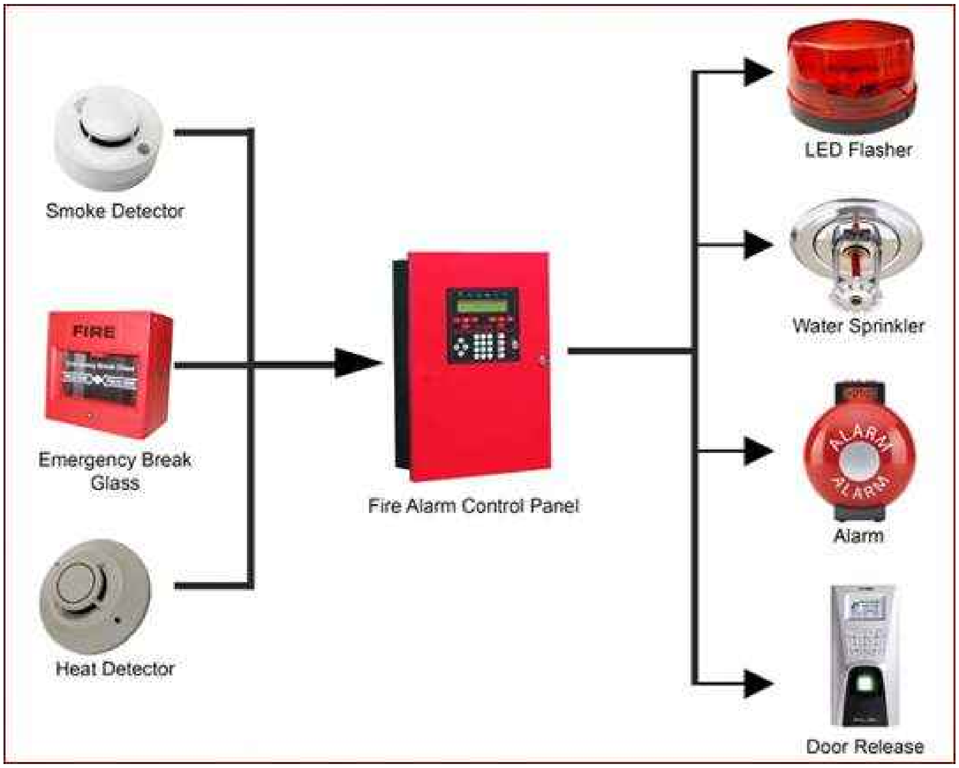
Fire Alarm Control Unit (FACU)

A component of the fire alarm system, provided with primary and secondary power sources, which receives signals from initiating devices or other fire alarm control units, and processes these signals to determine part or all of the required fire alarm system output function(s). (*NFPA* 72 2016, Section 3.3.100)

Also known as the **Fire Alarm Control Panel** (FACP), **control panel**, or **control unit**.

Fire Alarm System

A system or portion of a combination system that consists of components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal-initiating devices and to initiate the appropriate response to those signals.) (Section 3.3.103)



Household Fire Alarm System

A system of devices that uses a fire alarm control unit (panel) to produce an alarm signal in the household for the purpose of notifying the occupants of the presence of a fire so that they will evacuate the premises. (*NFPA* 72 2016, Section 3.3.103.2)

Initiating Device

A system component that originates transmission of a change-of-state condition, such as in a smoke detector, manual fire alarm box, or supervisory switch. (*NFPA* 72 2016, Section 3.3.131)

Initiating Device Circuit

A circuit to which automatic or manual initiating devices are connected where the signal received does not identify the individual device operated. (*NFPA* 72 2016, Section 3.3.132)

Inspection Personnel

Individuals who conduct a visual examination of a system or portion thereof to verify that it appears to be in operating condition, in proper location, and is free of physical damage or conditions that impair operation. (*NFPA* 72 2016, Section 3.3.190.1)

Lableled

Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner. (*NFPA* 72 2016, Section 3.2.4)

Level Ceiling

Ceilings that have a slope of less than or equal to 1 in 8 (*NFPA* 72 2016, Section 3.3.36.1)

Listed

Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose. (*NFPA* 72 2016, Section 3.2.5)

Malicious Alarm

An unwanted activation of an alarm initiating device caused by a person acting with malice. (*NFPA* 72 2016, Section 3.3.304.1)

Manual Fire Alarm Box

A manually-operated device used to initiate a fire alarm signal. (*NFPA* 72 2016, Section 3.3.12.3)

Multiple-Station Alarm Device

Two or more single station alarm devices that can be interconnected so that actuation of one causes all integral or separate audible alarms to operate; or one single station alarm device having connections to other detectors or to a manual fire alarm box. (*NFPA* 72 2016, Section 3.3.161)

Multiplexing

A signaling method characterized by simultaneous or sequential transmission, or both, and reception of multiple signals on a signaling line circuit, a transmission channel, or a communications channel, including means for positively identifying each signal. (*NFPA* 72 2016, Section 3.3.162)

Notification Appliance

A fire alarm system component such as a bell, horn, speaker, light, or text display that provides audible, tactile, or visible outputs, or any combination thereof. (*NFPA* 72 2016, Section 3.3.172)

Notification Appliance Circuit (NAC)

A circuit or path directly connected to a notification appliance(s). (*NFPA* 72 2016, Section 3.3.173)

Nuisance Alarm

An unwanted activation of a signaling system or an alarm initiating device in response to a stimulus or condition that is not the result of a potentially hazardous condition. (*NFPA* 72 2016, Section 3.3.304.2)

Private Operating Mode

Audible or visible signaling only to those persons directly concerned with the implementation and direction of emergency action initiation and procedure in the area protected by the fire alarm system. (*NFPA* 72 2016, Section 3.3.183.1)

Public Operating Mode

Audible or visible signaling to occupants or inhabitants of the area protected by the fire alarm system. (*NFPA* 72 2016, Section 3.3.183.2)

Record of Completion

A document that acknowledges the features of installation, operation (performance), service, and equipment with representation by the property owner, system installer, system supplier, service organization, and the Authority Having Jurisdiction. (*NFPA* 72 2016, Section 3.3.229)

Service Personnel

Individuals who perform those procedures, adjustments, replacement of components, system programming, and maintenance as described in the manufacturer's service instructions that can affect any aspect of the performance of the system. (*NFPA* 72 2016, Section 3.3.190.2)

Shall

Indicates a mandatory requirement. (*NFPA* 72 2016, Section 3.2.6)

Should

Indicates a recommendation or that which is advised but not required. (*NFPA* 72 2016, Section 3.2.7)

Signal —

An indication of a condition communicated by electrical, visible, audible, wireless, or other means. (*NFPA* 72 2016, Section 3.3.253)

Signaling Line Circuit —

A circuit or path between any combination of circuit interfaces, control units, or transmitters over which multiple system input signals or output signals, or both, are carried. (*NFPA* 72 2016, Section 3.3.255)

Single-Station Alarm Device —

An assembly that incorporates the detector, the control equipment, and the alarm-sounding device in one unit operated from a power supply either in the unit or obtained at the point of installation. (*NFPA* 72 2016, Section 3.3.260)

Sloping Ceiling —

A ceiling that has a slope of more than 1 in 8. (*NFPA* 72 2016, Section 3.3.36.2)

Sloping Peaked-Type Ceiling

A ceiling in which the ceiling slopes in two directions from the highest point. Curved or domed ceilings can be considered peaked with the slope figured as the slope of the chord from highest to lowest point. (*NFPA* 72 2016, Section 3.3.36.3)

Sloping Shed-Type Ceiling

A ceiling in which the high point is at one side with the slope extending toward the opposite side. (*NFPA* 72 2016, Section 3.3.36.4)

Smoke Detector

A device that detects visible or invisible particles of combustion. (*NFPA* 72 2016, Section 3.3.66.20)

Smooth Ceiling

A ceiling surface uninterrupted by continuous projections, such as solid joists, beams, or ducts, extending more than 4 in. (100 mm) below the ceiling surface. (*NFPA* 72 2016, Section 3.3.38.3)

Solid Joist Construction

Ceilings that have solid structural or solid nonstructural members projecting down from the ceiling surface for a distance of more than 4 in. (100 mm) and spaced at intervals of 36 in. (910 mm) or less, center to center. (*NFPA* 72 2016, Section 3.3.38.4)

Supervising Station

A facility that receives signals and at which personnel are in attendance at all times to respond to these signals. (*NFPA* 72 2016, Section 3.3.280)

Supervisory Signal

A signal indicating the need for action in connection with the supervision of guard tours, the fire suppression systems or equipment, or the maintenance features of related systems. (*NFPA* 72 2016, Section 3.3.253.9)

System Designer

Individual responsible for the development of fire alarm and signaling system plans and specifications in accordance with this Code. (*NFPA* 72 2016, Section 3.3.190.3)

System Installer

Individual responsible for the proper installation of fire alarm and signaling systems in accordance with plans, specifications, and manufacturer's requirements. (*NFPA* 72 2016, Section 3.3.190.4)

Testing Personnel

Individuals who perform procedures used to determine the status of a system as intended by conducting acceptance, reacceptance, or periodic checks on systems. (*NFPA* 72 2016, Section 3.3.190.5)

Trouble Signal

A signal that results from the detection of a trouble condition. (*NFPA* 72 2016, Section 3.3.253.10)

Unintentional Alarm

An unwanted activation of an alarm initiating device caused by a person acting without malice. (*NFPA* 72 2016, Section 3.3.304.3)

Unknown Alarm

An unwanted activation of an alarm initiating device or system output function where the cause has not been identified. (*NFPA* 72 2016, Section 3.3.304.4)

Unwanted Alarm –

Any alarm that occurs that is not the result of a potentially hazardous condition. (*NFPA* 72 2016, Section 3.3.304)

CONTINUE

Please press the button to proceed.

Ohio Fire Alarm and Detection Equipment-Fire Alarm Basics and Wiring

Welcome to the Fire Alarm Basics and Wiring module of the Ohio Fire Alarm and Detection Systems Course.

By the end of this module, you will be able to do the following:

- Distinguish between conventional and addressable fire alarm systems and related subsystems
- Identify a fire alarm system
- Identify wiring requirements from Article 760 of *NFPA 70 (National Electrical Code) 2017*
- Define various pathway class designations
- Recognize capacity requirements for back-up and secondary power supply operations and alarm conditions
- Include a 20% safety margin for battery amp-hour calculations
- Identify three different types of fire alarm circuits
- Clarify the difference between Class A redundant circuits and Class B non-redundant circuits

- Describe the differences between two-wire and four-wire detectors

Key References for this module are:

- *NFPA* 70 – National Electric Code, Article 760, 2017
- *NFPA* 72 – National Fire Alarm and Signaling Code, Chapter 10 and Chapter 12, 2016

When you are ready to begin, click on the button above to start the course.

Lesson 1 of 5

Conventional vs Addressable Fire Alarm Systems

This section will clarify the differences between **conventional** and **addressable** fire alarm systems.

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Distinguish between conventional and addressable fire alarm systems and related subsystems

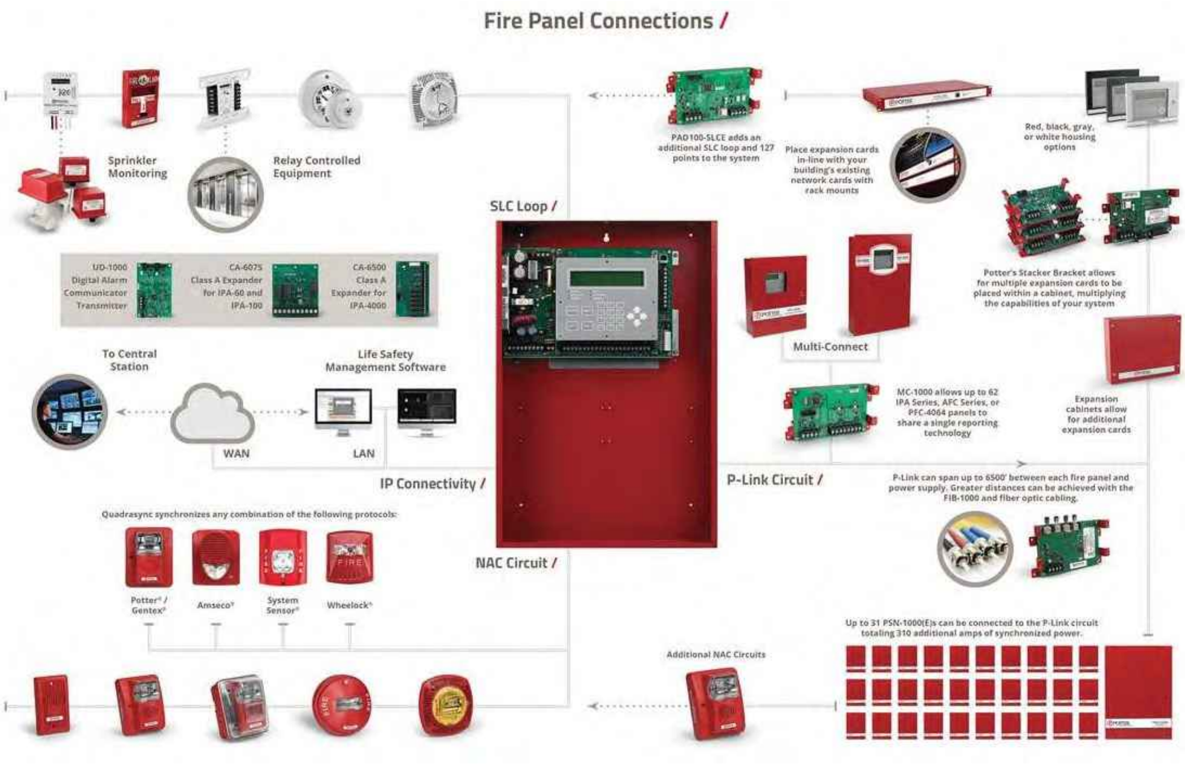
2 Identify a fire alarm system

CONTINUE

ⓘ **Key Reference: *NFPA 72* 2016, Section 3.3.103**

What is a fire alarm system?

Per *NFPA* 72 2016, Section 3.3.103, a **fire alarm system** is *"a system or portion of a combination system that consists of components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal-initiating devices and to initiate the appropriate response to those signals."*



(Click to enlarge)

To state it simply: a fire alarm system is a network of **wiring, appliances, devices, power, and control**, including **supervision**, intended to **warn** people of a fire condition, encourage **evacuation**, and **notify** emergency personnel and/or organizations.

CONTINUE

Watch the video below to learn more about a fire alarm and detection system.

Video run time 1:36

Systems that have positive alarm features shall be permitted if approved by the AHJ. ***NFPA 72*** **2016, Section 23.8.1.2.1**

CONTINUE

Conventional vs. addressable fire alarm systems

There are two common types of fire alarm systems: **conventional fire alarm systems** and **addressable fire alarm systems**.

Both systems monitor circuits for **opens**, **shorts**, and **grounds**. They both also monitor primary and secondary **power supplies** for abnormal conditions. But they do have some important differences.

Watch the video below for an explanation about the differences between conventional and addressable fire alarm systems.

Video run time 1:44

CONVENTIONAL FIRE ALARM SYSTEMS

Conventional fire alarm systems

Conventional fire alarm systems consist of three subsystems:

CONTROL UNIT	INITIATING DEVICE CIRCUIT (ID...	NOTIFICATION APPLIANCE CIRCUI...

Comprised of primary and secondary power supplies; monitors circuits for open, shorts, or grounds; activates notification appliances and control outputs as necessary.

CONTROL UNIT | INITIATING DEVICE CIRCUIT (ID... | NOTIFICATION APPLIANCE CIRCUI...

Provides inputs to the control unit.
Initiating Device Circuits (IDCs) are the input circuits to the fire alarm control unit, which initiate action. The IDCs are comprised of initiating devices such as:

- Heat detectors
- Smoke detectors
- Manual pull stations
- Waterflow switches

- Sprinkler valve tamper switches

CONTROL UNIT

INITIATING DEVICE CIRCUIT (ID...

NOTIFICATION APPLIANCE CIRCUI...

Warns occupants of the condition detected and/or solicits assistance to rectify that condition.
Notification Appliance Circuits (NACs) are the audio, visual, or other means by which the fire alarm system **informs** occupants and/or supervising stations about fire emergencies or other abnormal conditions. The NACs are connected to devices such as horns, strobe lights, speakers, bells, or combinations thereof.

CONTINUE

Conventional fire alarm systems use **Initiating Device Circuits (IDCs)**. These circuits make up "zones" consisting of multiple initiating devices (e.g., heat detectors, smoke detectors, or manual pull stations), which are connected to the control unit.

Conventional fire alarm systems identify the zone that has a trouble signal, alarm signal, or supervisory signal. If needed, notification appliances on a **Notification Appliance Circuit (NAC)** are then activated to warn occupants or emergency personnel to take appropriate action.

LET'S TAKE A CLOSER LOOK

1


COMM. FAIL
AC POWER
BATT. FAULT
ALARM
SYSTEM TRBL.
SUPERVISORY
FIRE WATCH
411UDAC
FIRE ALARM COMMUNICATOR

Control Unit

The **control unit** (also known as a control panel, fire alarm control panel [FACP] or fire alarm contol unit [FACU]) is the **"brain" of the fire alarm system.**

When an initiating device detects a fire condition (heat, smoke, flame, etc.) or manual activation, the device **produces a short circuit** on the circuit.

CONTINUE

Watch the video below for an overview of the Fire Alarm Control Panel.

Video run time 0:44

The **control unit** makes decisions based on programming to:

- activate notification appliances
- activate relays
- provide auxiliary output

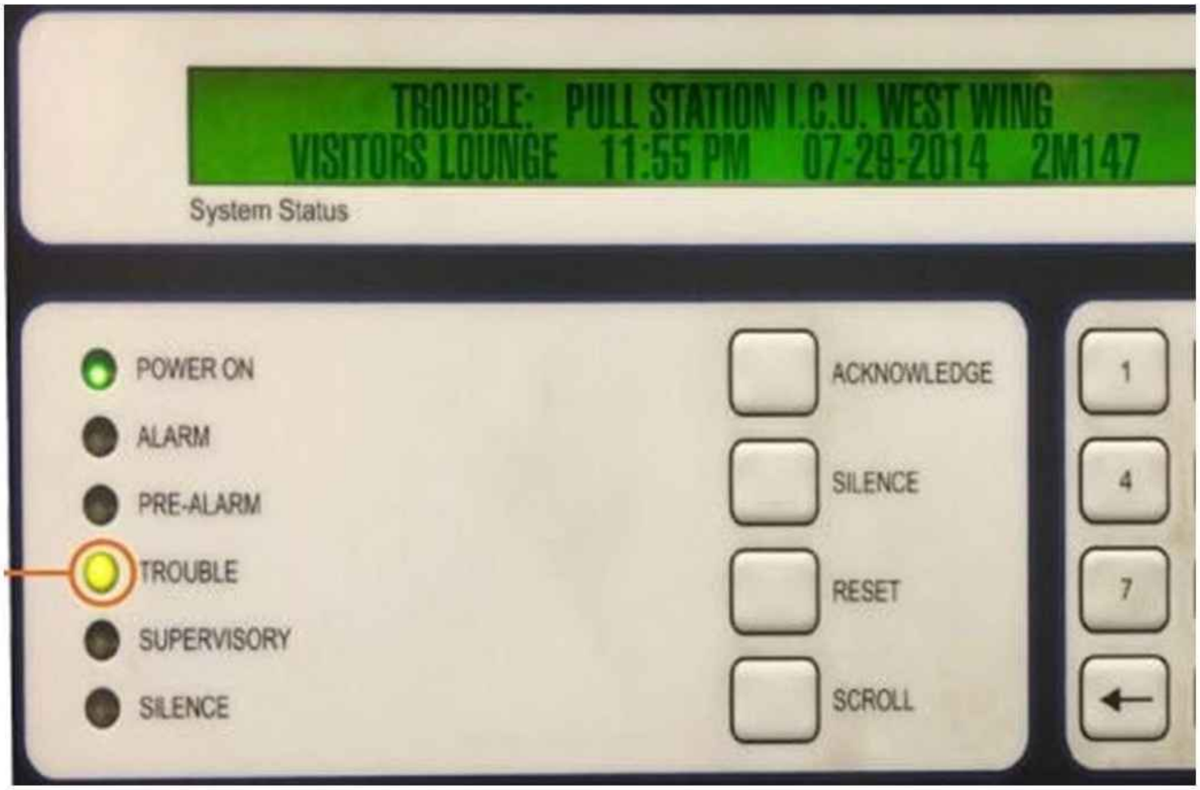
CONTINUE

Trouble signals

The control unit also generates **trouble signals** to tell us when the integrity of any portion of the fire alarm system has been compromised and requires **immediate action**.

Problems may pertain to:

- The **initiating device circuits**
- The **notification appliance circuits**
- Any portion of the control unit
- Anything associated with power supplies



Trouble signal image

The **trouble circuits** monitor:

- All wiring for opens or shorts to ground
- The control unit and power supplies for system integrity

The trouble circuits trigger a **trouble signal** at the **control unit**. They then activate any required signals and report the condition to the appropriate persons when required.

2

Initiating Device Circuits (IDCs)

IDC Diagram

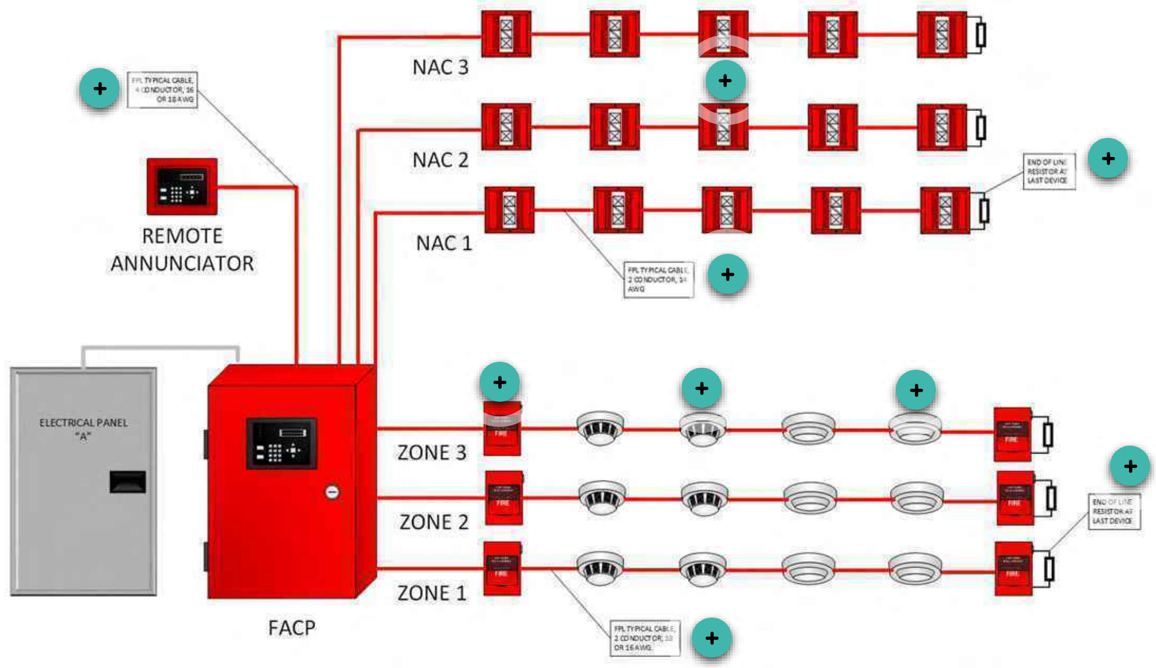
IDCs **monitor device status** and **report it to the control unit** for the appropriate action. These actions include:

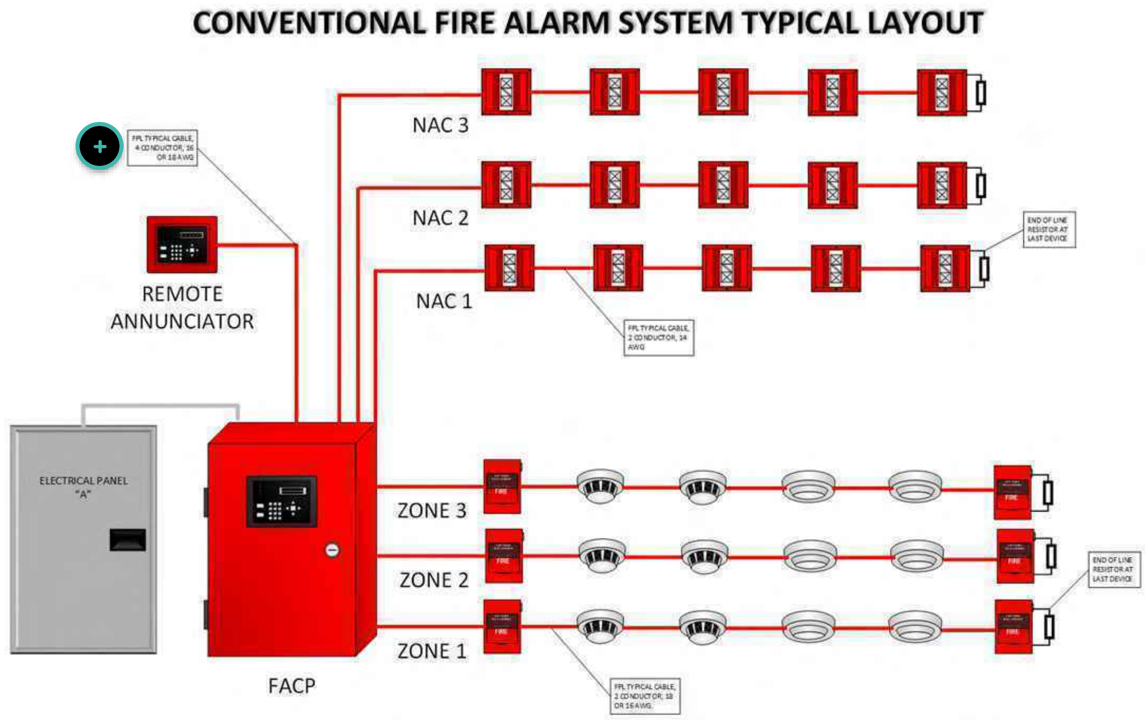
- Sounding an evacuation alarm
- Displaying a **supervisory condition**
- Reporting the alarm or supervisory conditions to the appropriate persons when required

Detectors report alarms in an **ON or OFF state** on an IDC.

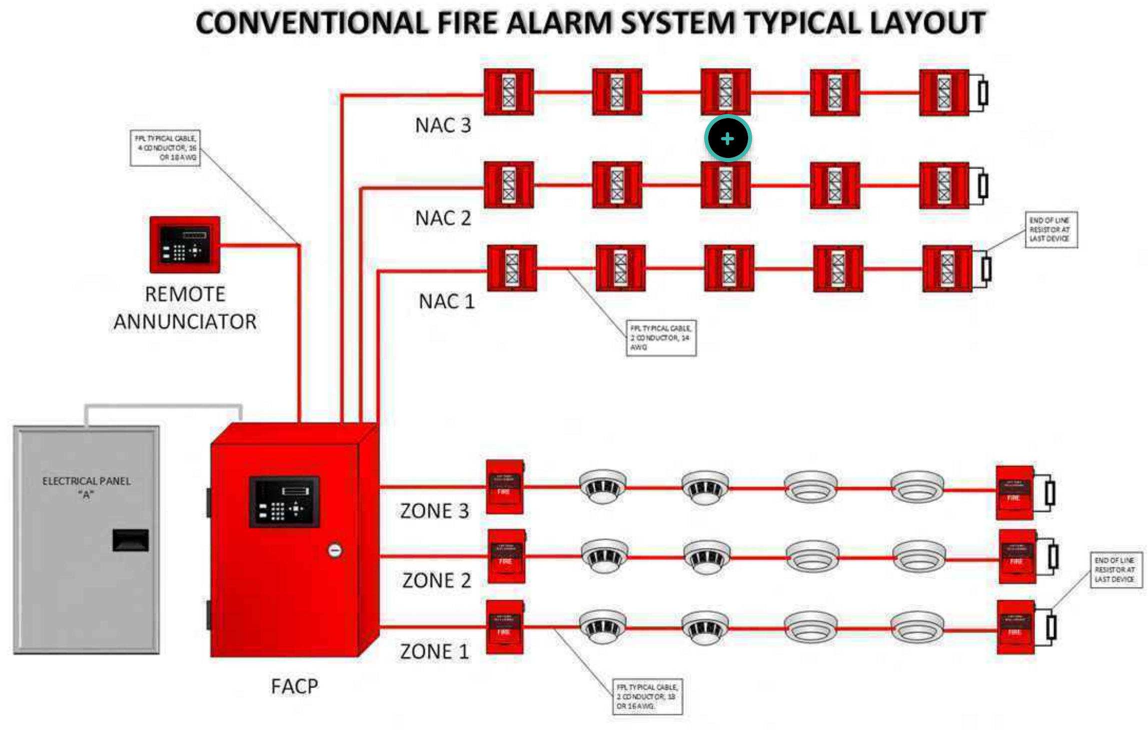
CONTINUE

CONVENTIONAL FIRE ALARM SYSTEM TYPICAL LAYOUT

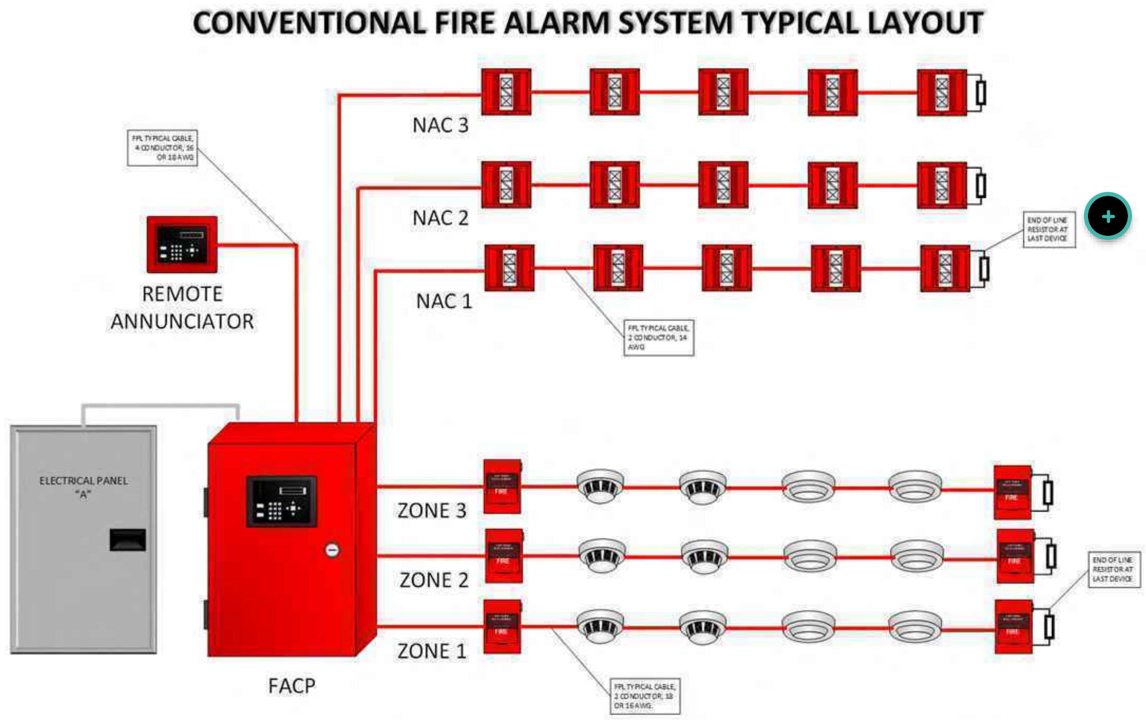




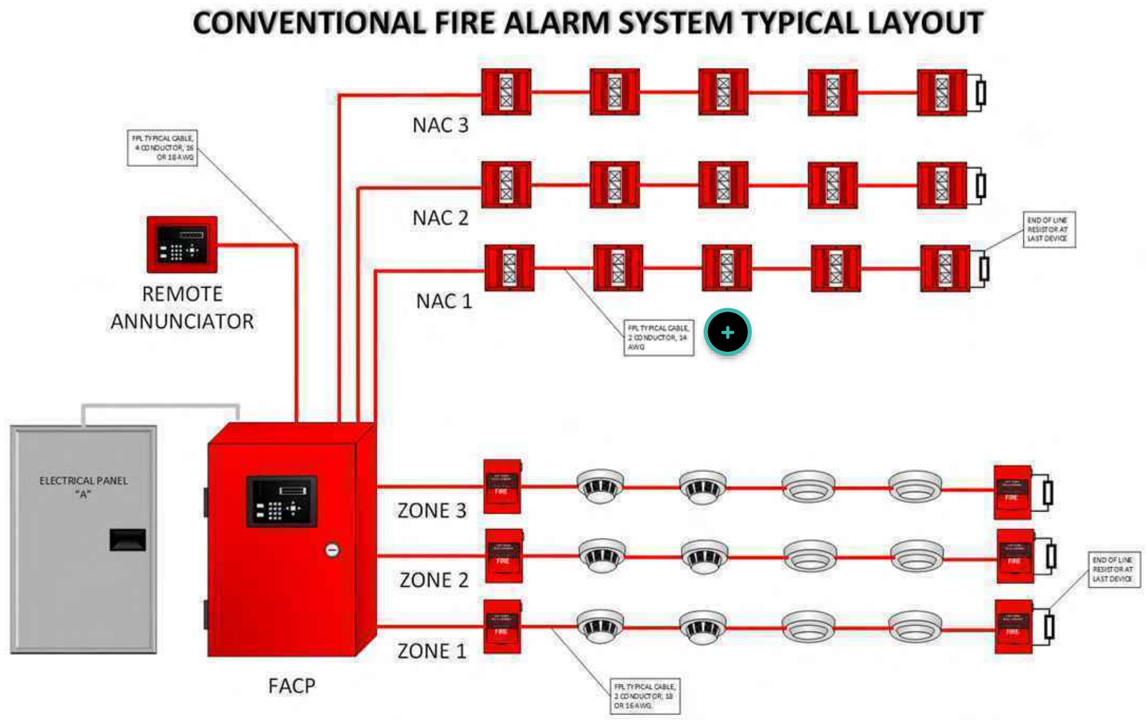
FPL Typical Cable, 4 conductor, 16 or 18 AWG



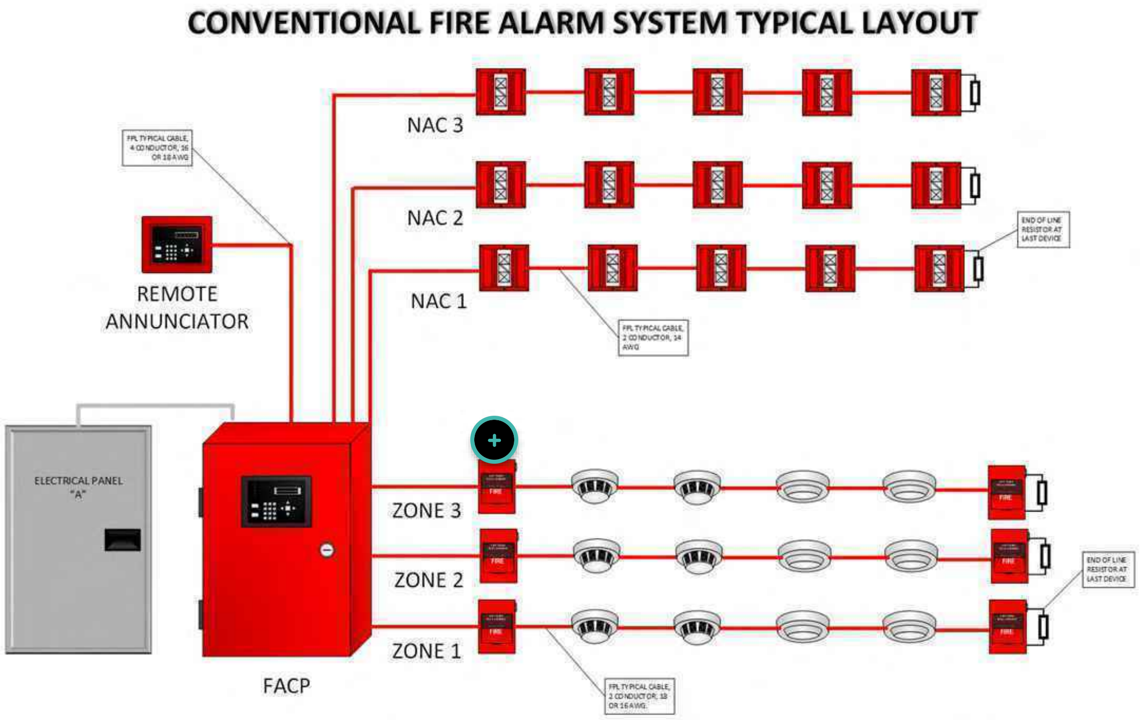
Notification Device



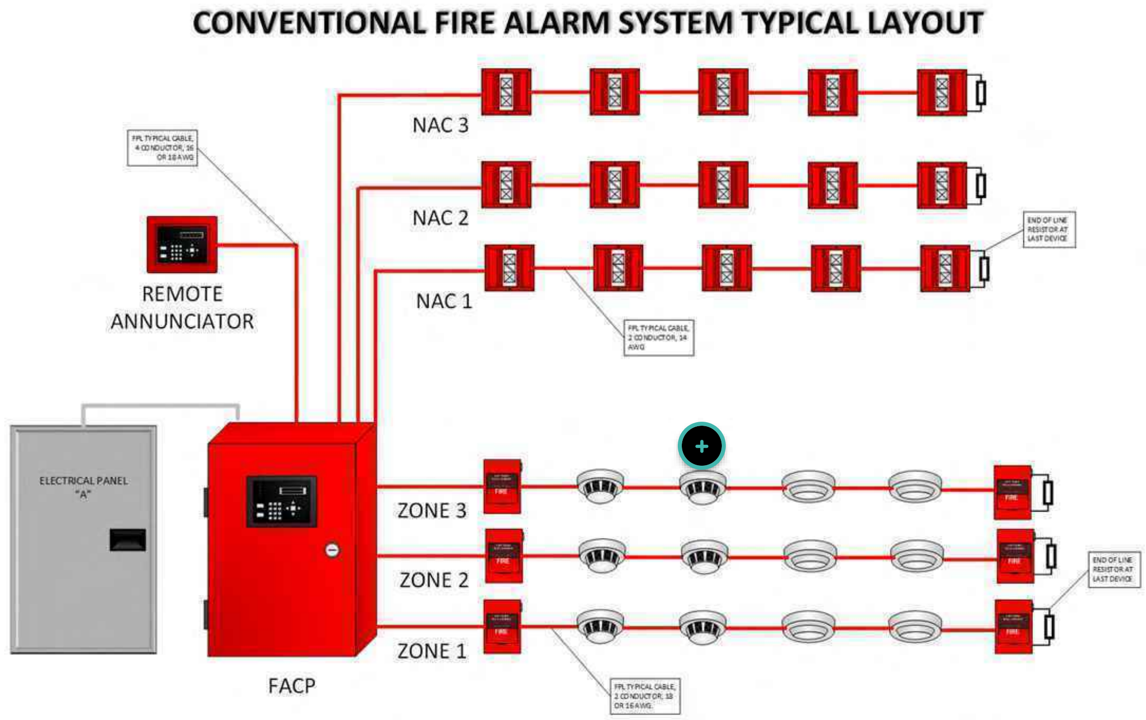
End of Line Resistor at last device



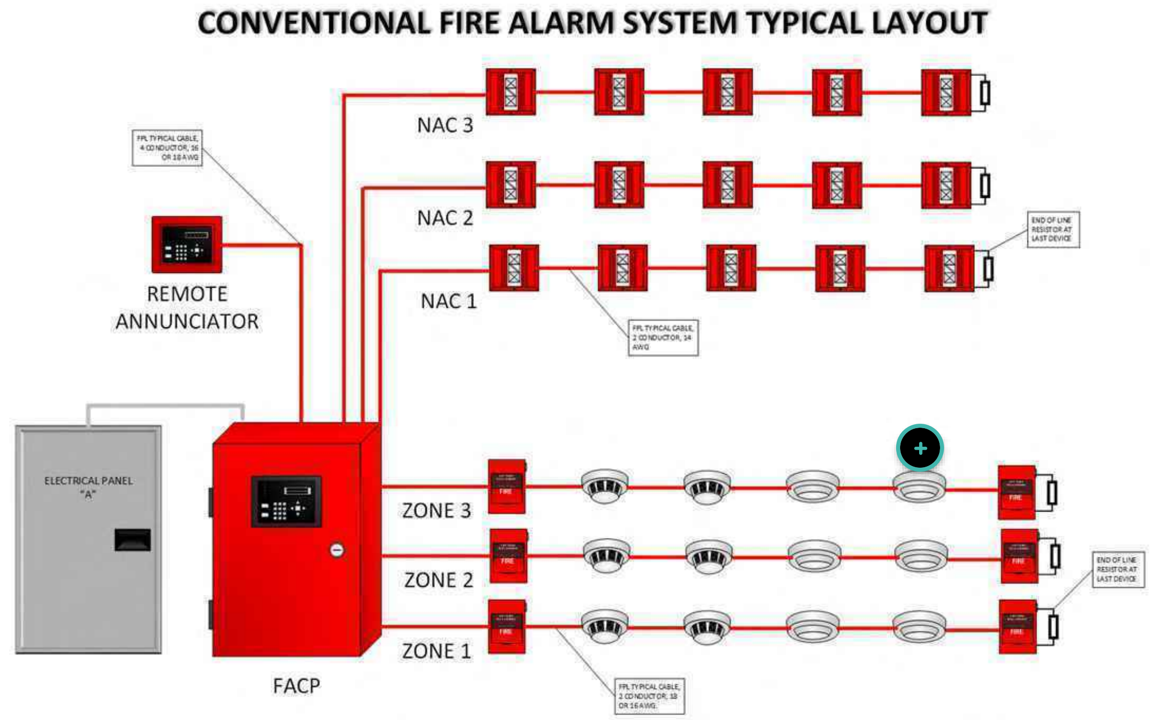
FPL Typical Cable, 2 conductor, 14 AWG



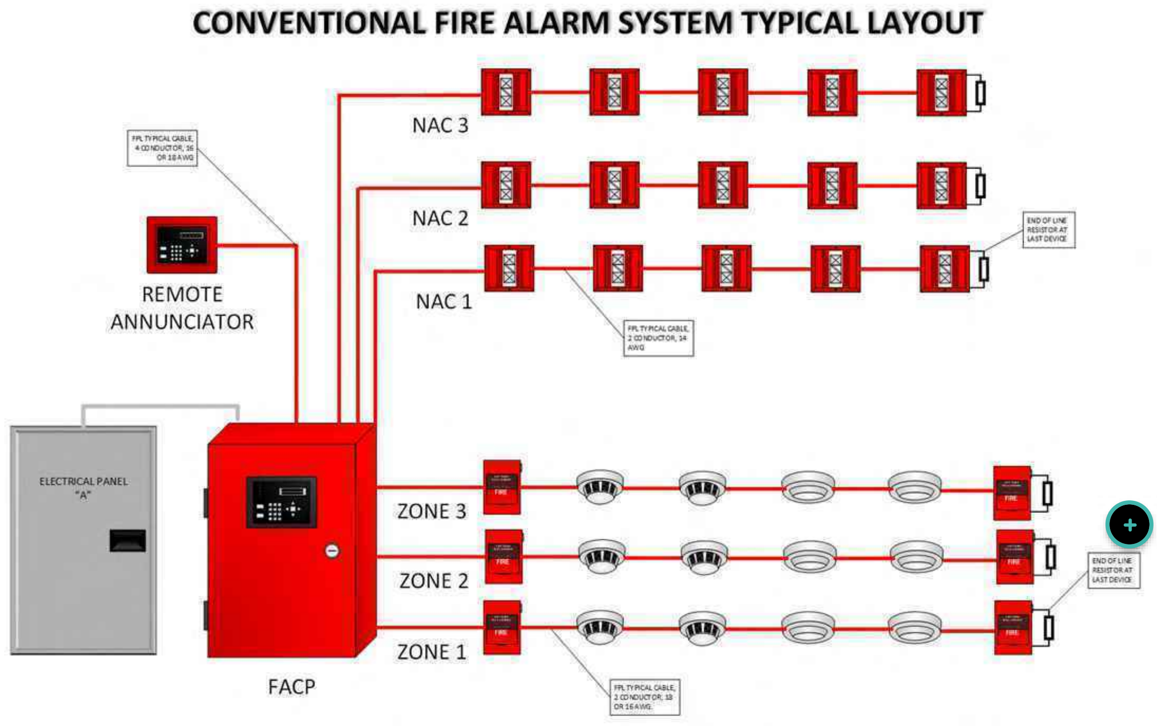
Manual fire alarm box



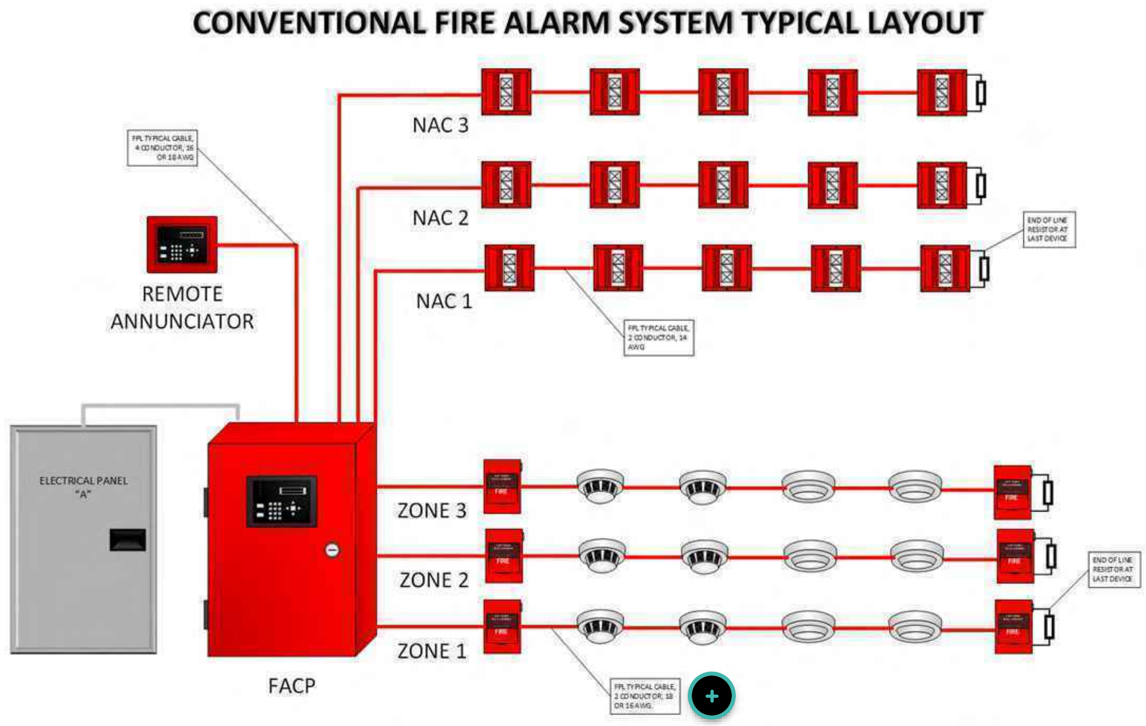
Heat detector



Smoke detector



End of Line Resistor at Last Device



FPL Typical Cable, 2 Conductor 18 or 16 AWG

3

Notification Appliance Circuits

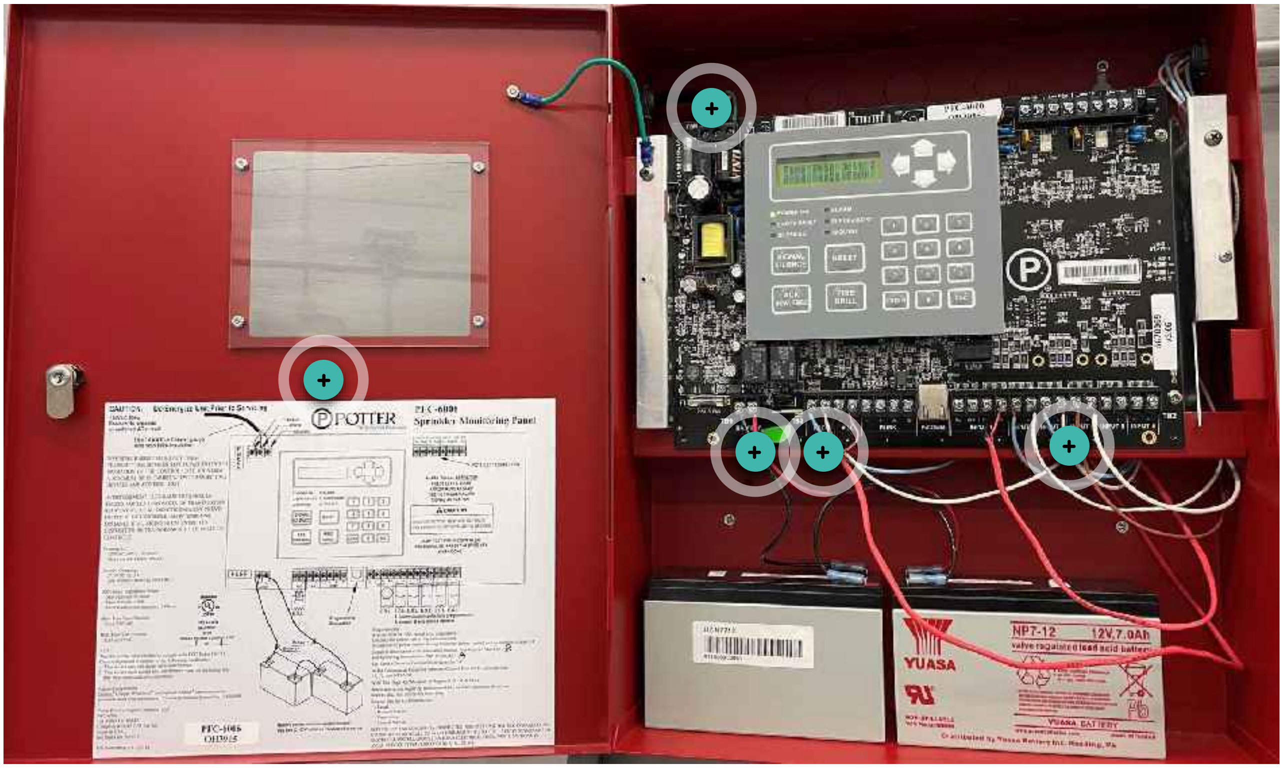
Notification Appliance Circuits (NACs) are the audio, visual, or other means by which the fire alarm system **informs** occupants and/or supervising stations about fire emergencies or other abnormal conditions. The NACs are connected to devices such as horns, strobe lights, speakers, bells, or combinations thereof.

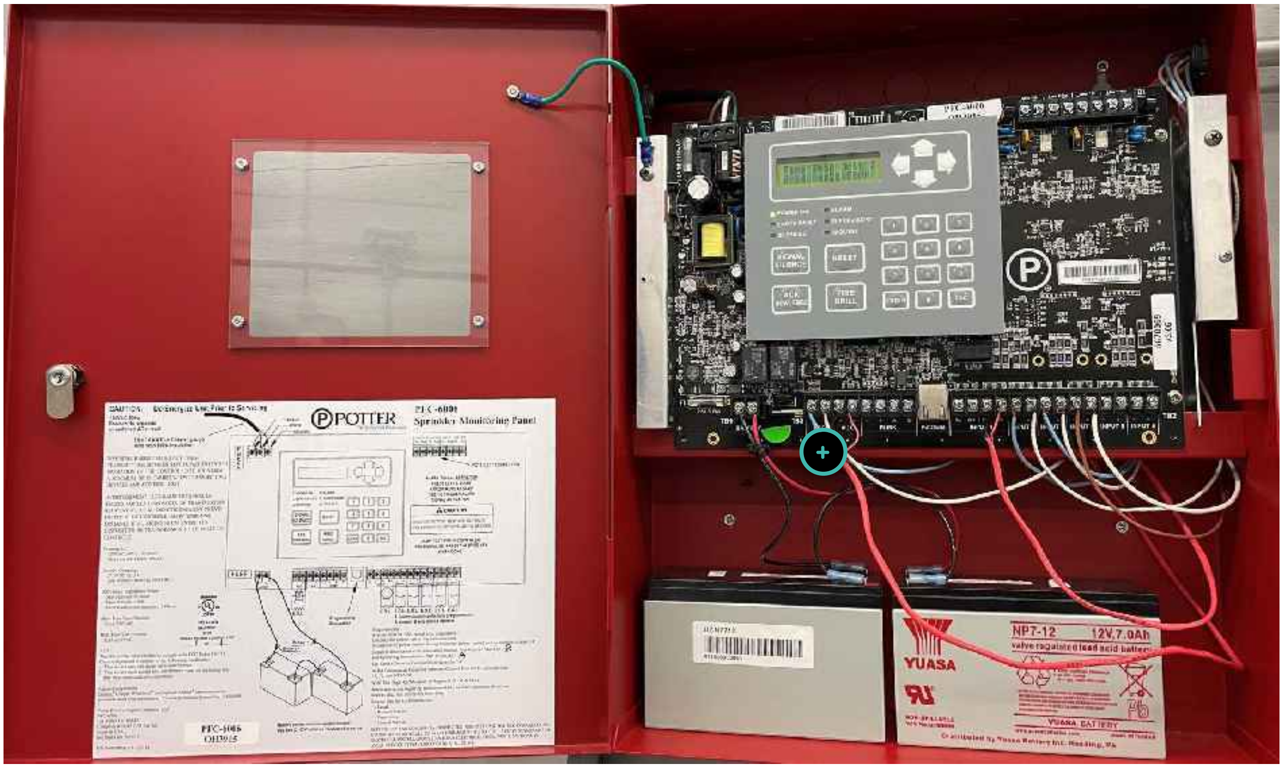
NACs are connected to the **output side** of the control unit.

CONTINUE

Conventional FACU

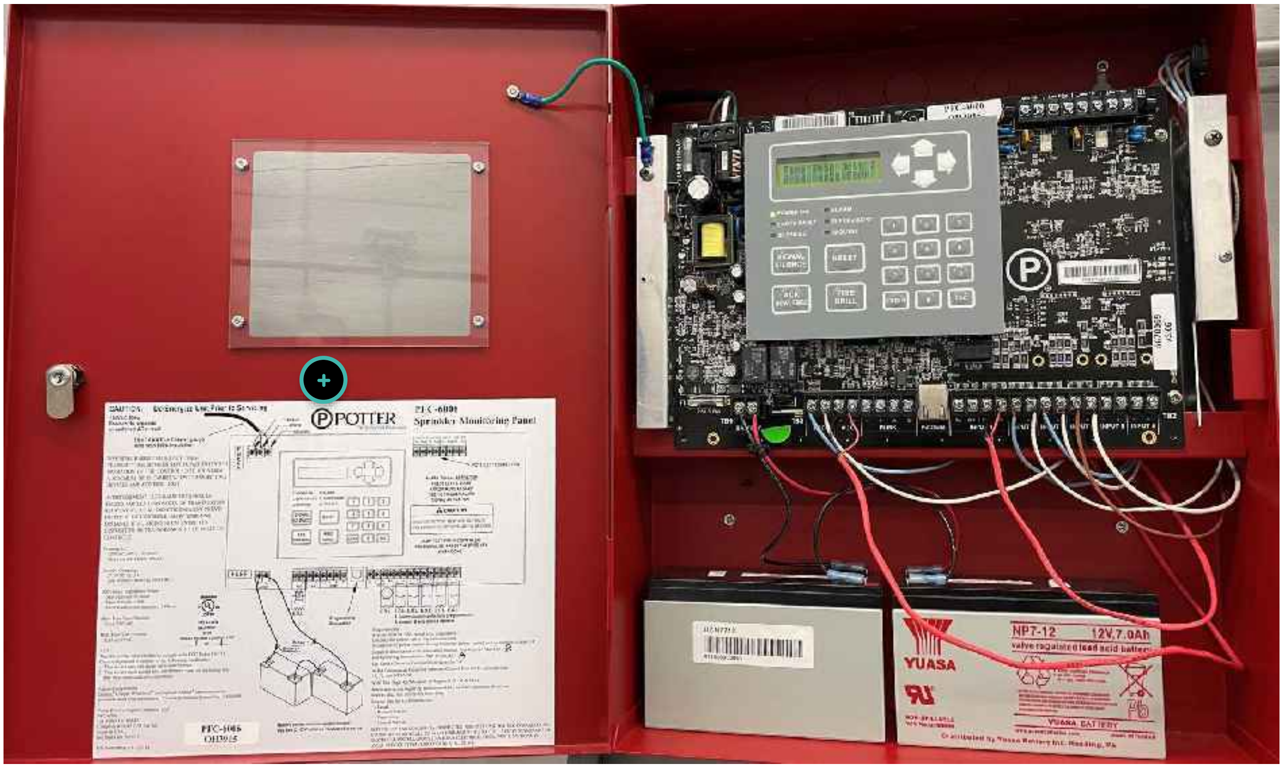
Click on each "+" symbol below to learn about each component or subsystem.


POTTER
PFC-6006
Sprinkler Monitoring Panel
YUASA
NP7-12
12V,7.0Ah



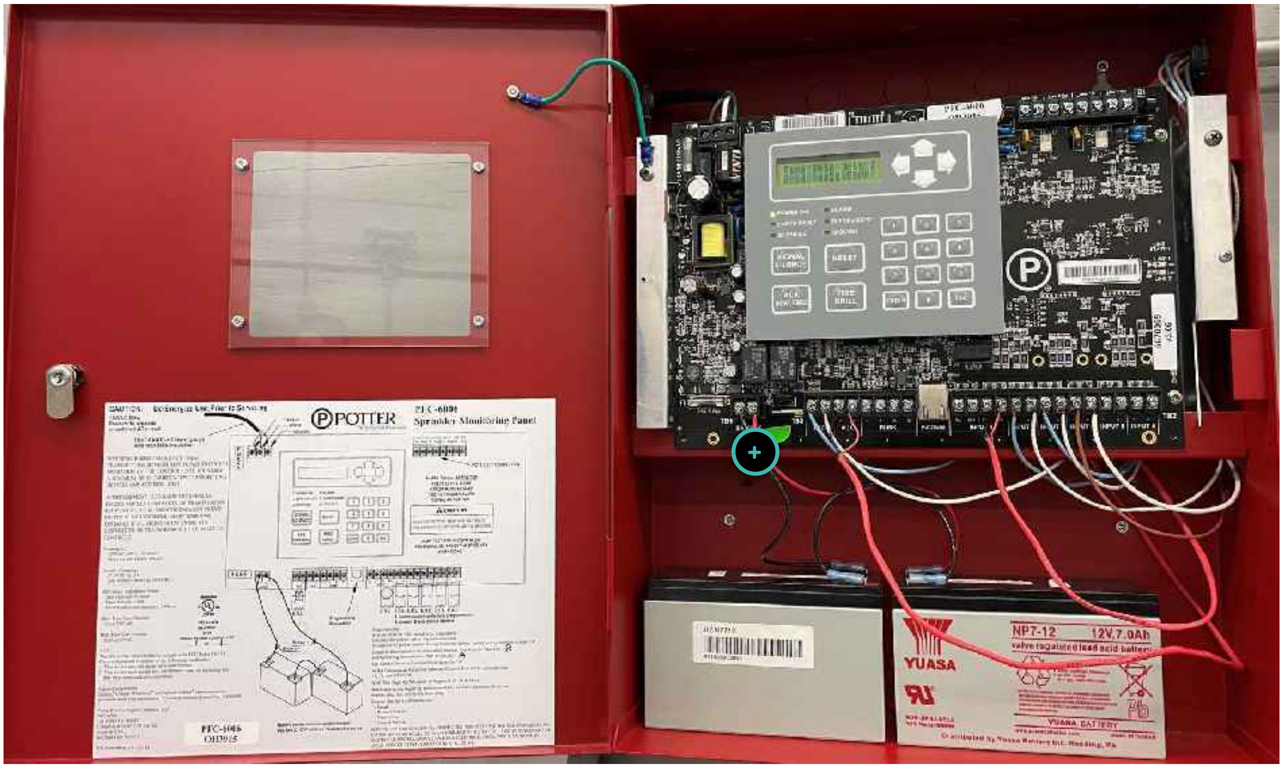
NAC

Notification Appliance Circuit connections are located here where it is labeled "NAC."



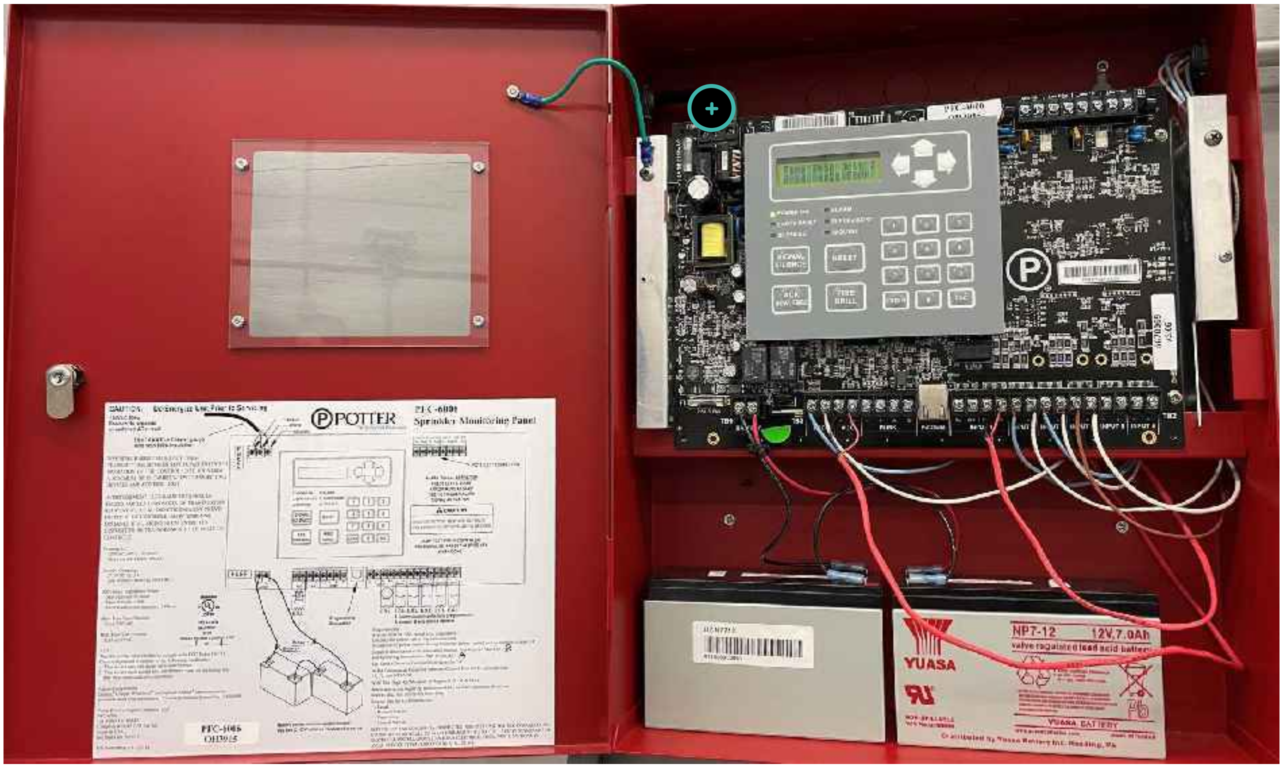
FACU Diagram

The diagram is like a quick reference guide. Not all FACUs have one inside the door, and even if they do, it is still best to reference the manual to the FACU.



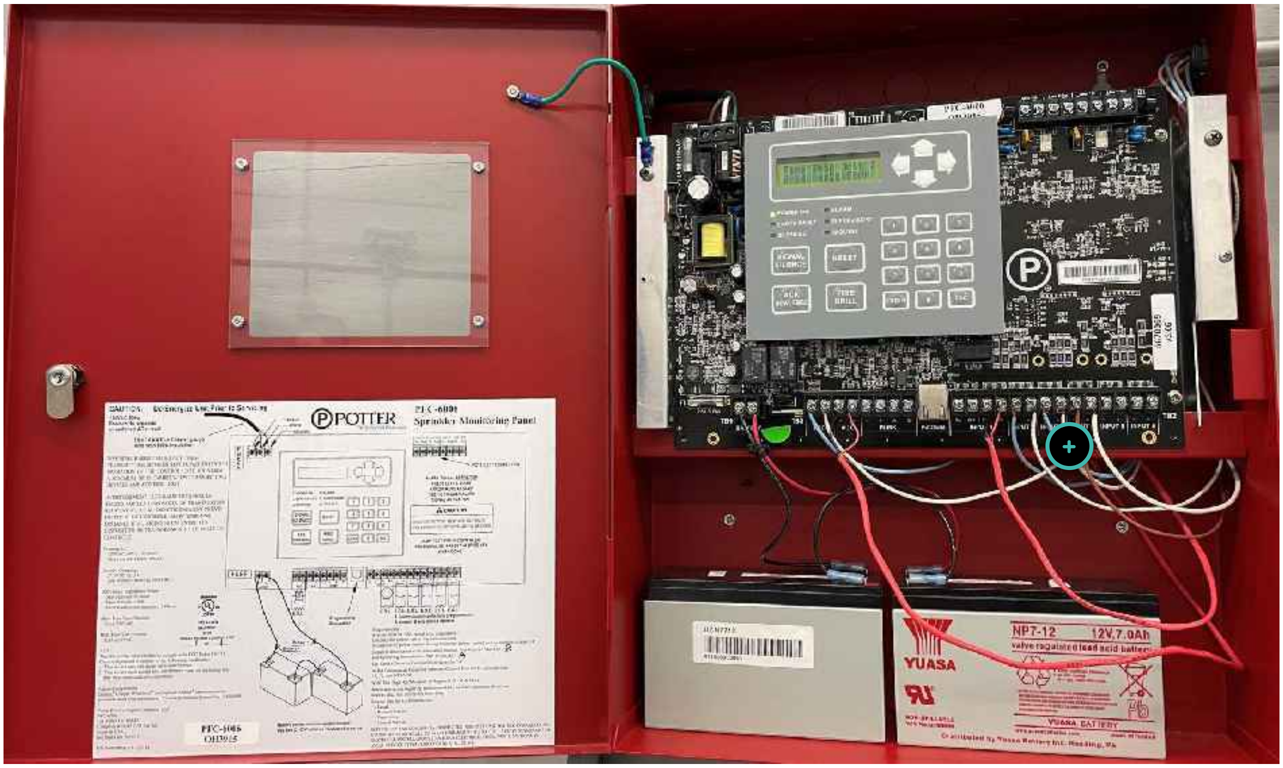
Secondary Power Source

This is where the secondary power source (battery back-up) is connected to the panel.



Primary Power Source

The primary power source for the FACU is connected here.



IDC

Initiating Device Circuits connections are here where it is labeled "Input."

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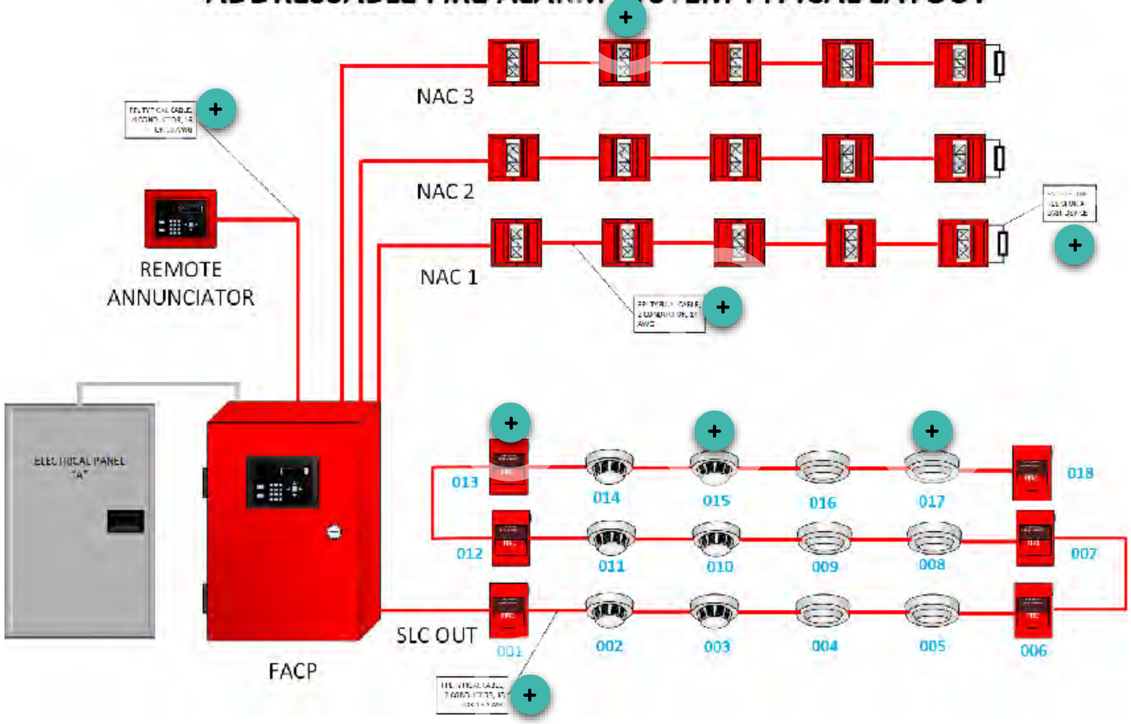
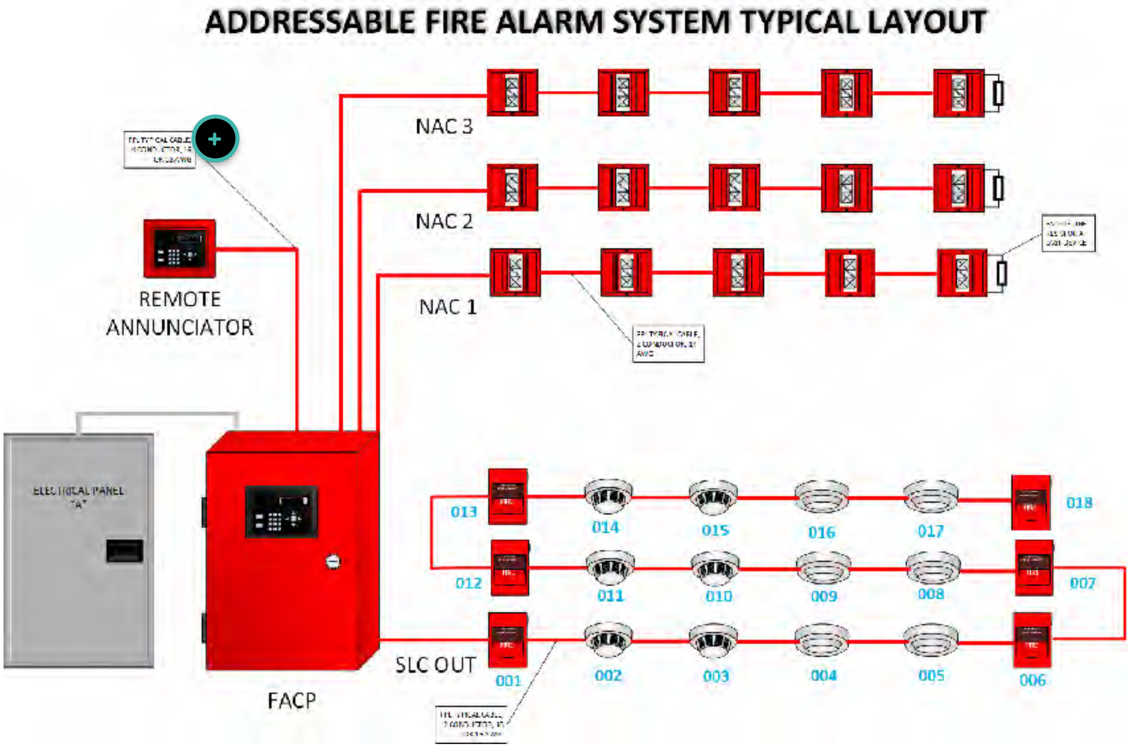
ADDRESSABLE FIRE ALARM SYSTEMS

Addressable fire alarm systems

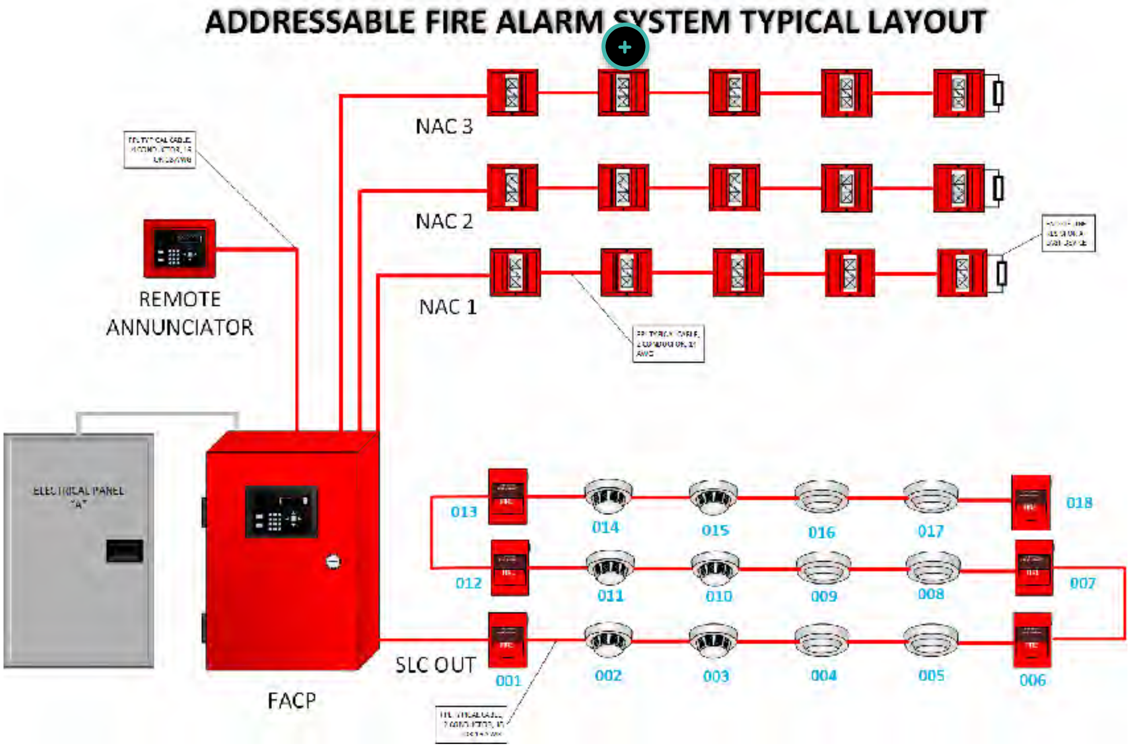
In an addressable fire alarm system, detectors report alarms using **digital communications protocols** in a **Signaling Line Circuit (SLC)** instead of reporting to an IDC. In most cases, the notification appliances are wired to **Notification Appliance Circuits (NACs)**, just as they are on conventional systems.

ADDRESSABLE FIRE ALARM SYSTEM TYPICAL LAYOUT

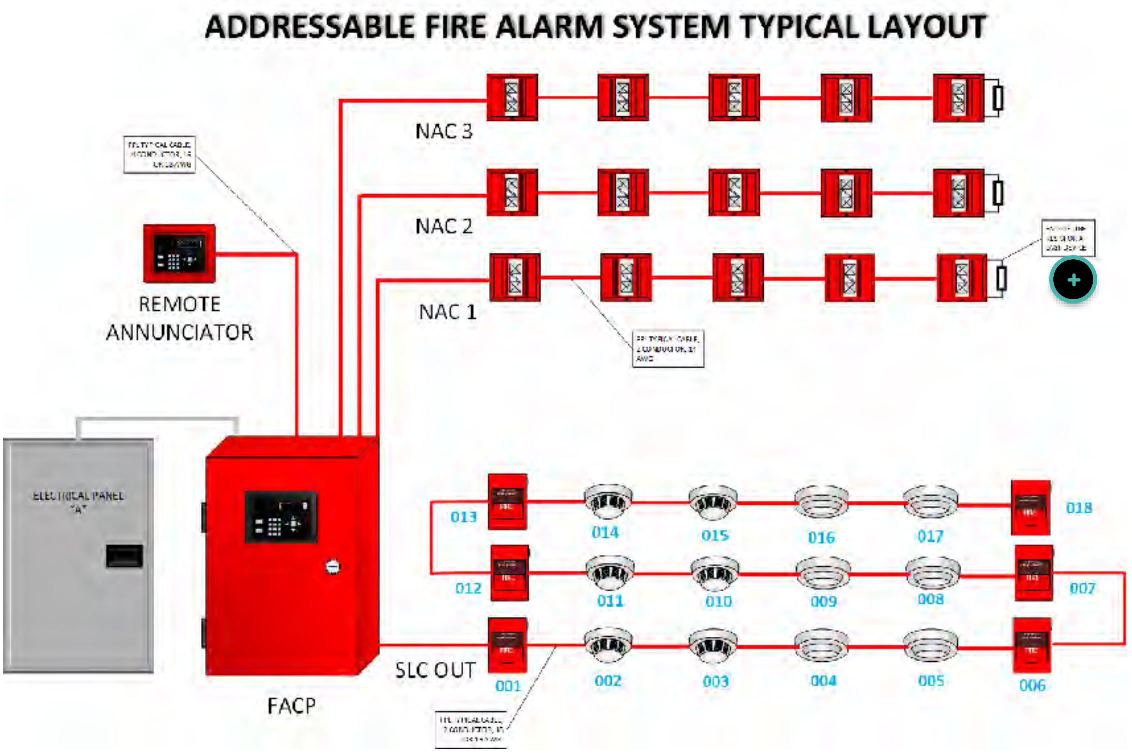




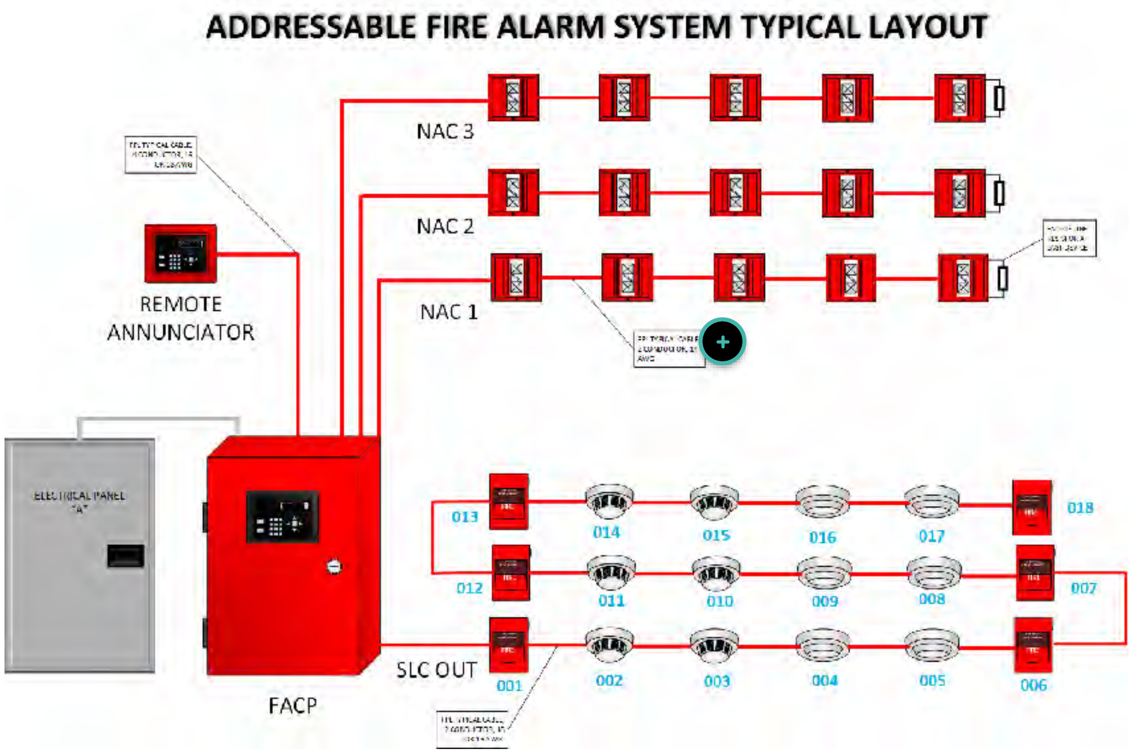
FPL typical cable, 4 conductor, 16 or 18 AWG



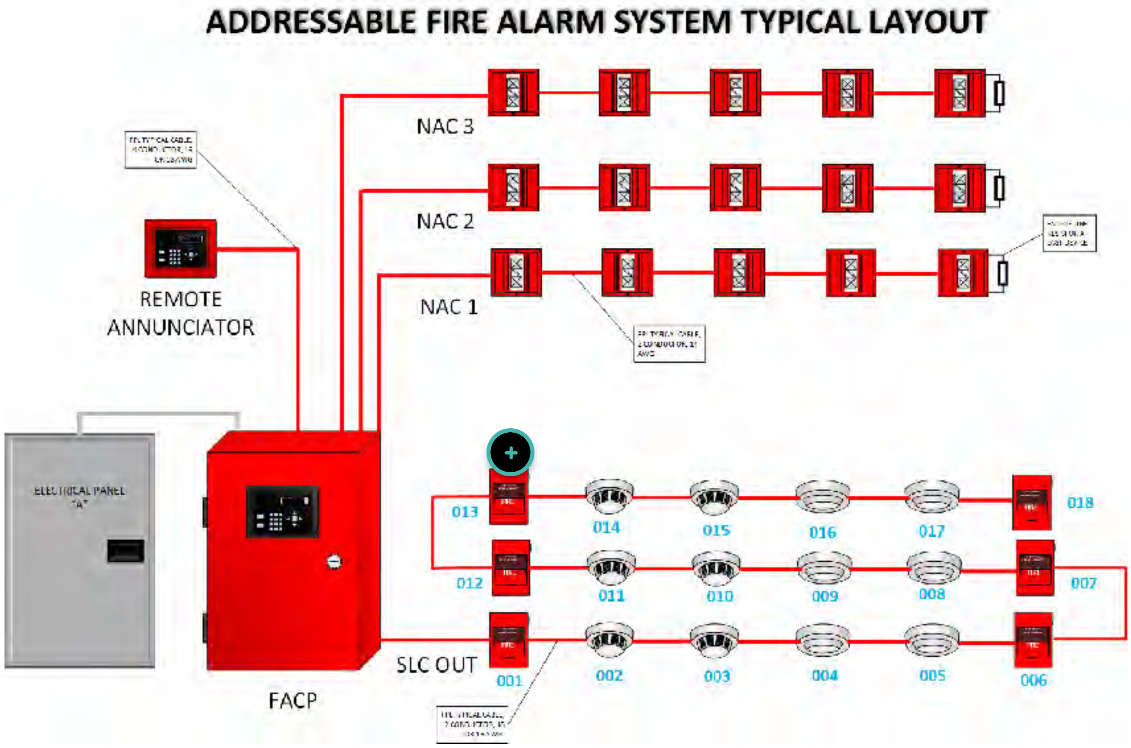
Notification Appliance



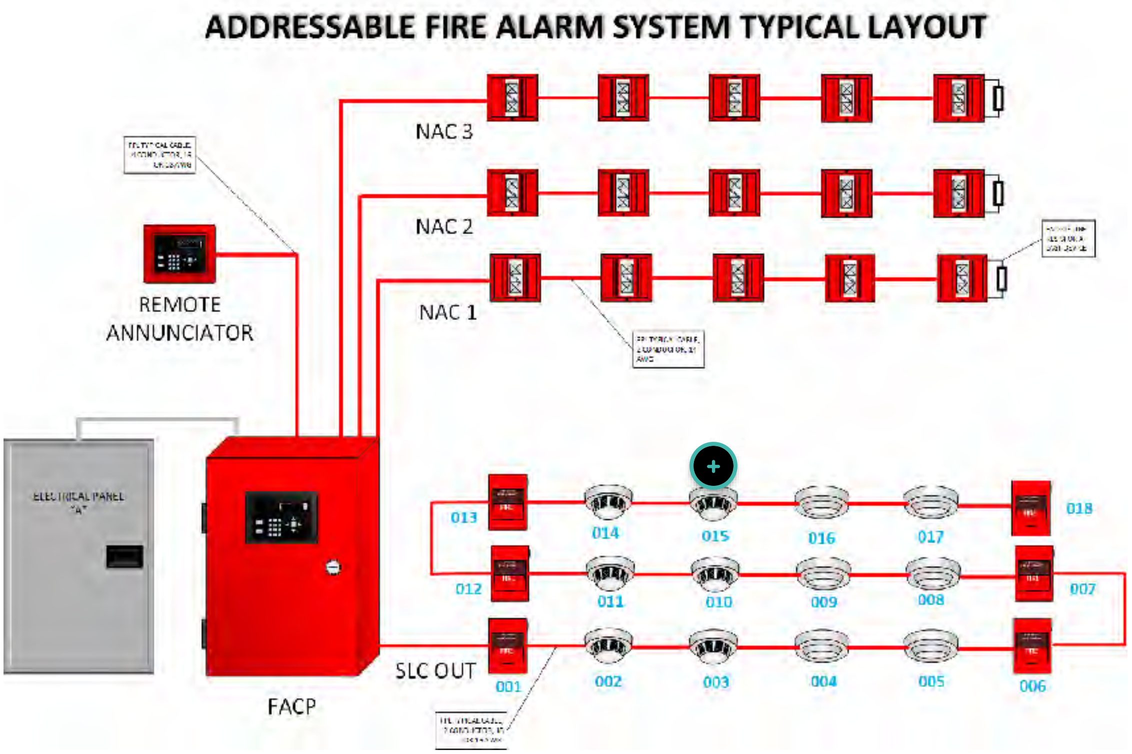
End of Line, resistor at last device



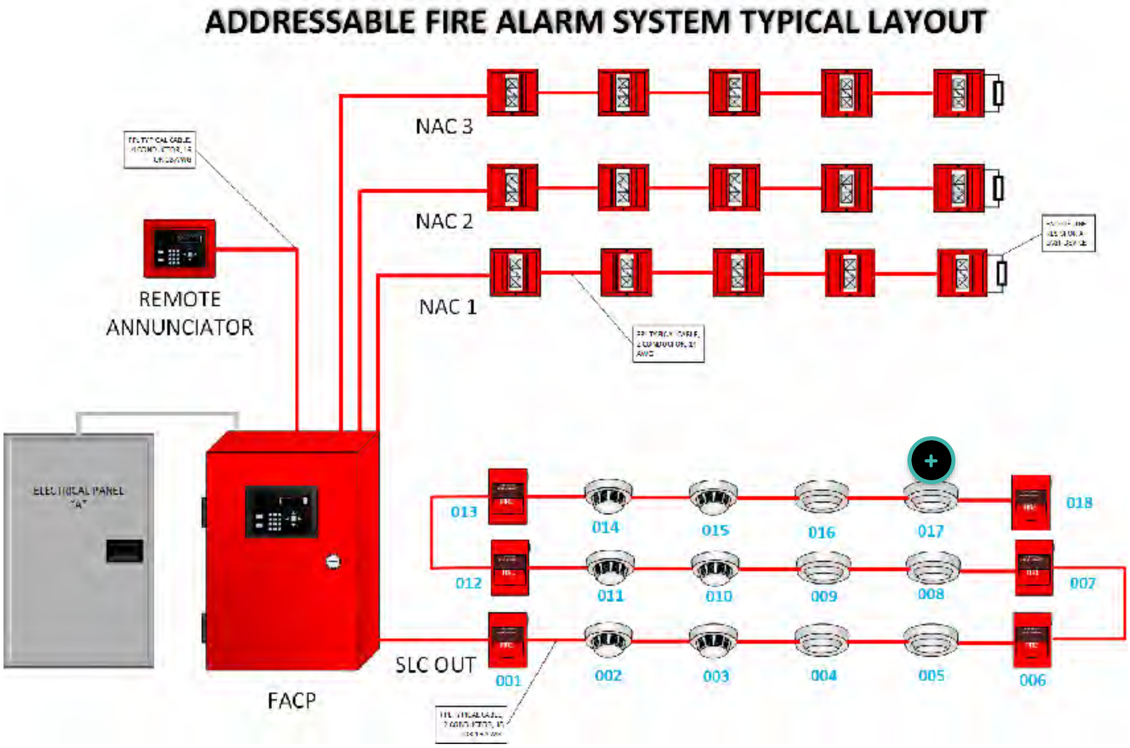
FPL typical cable, 2 conductor, 14 AWG



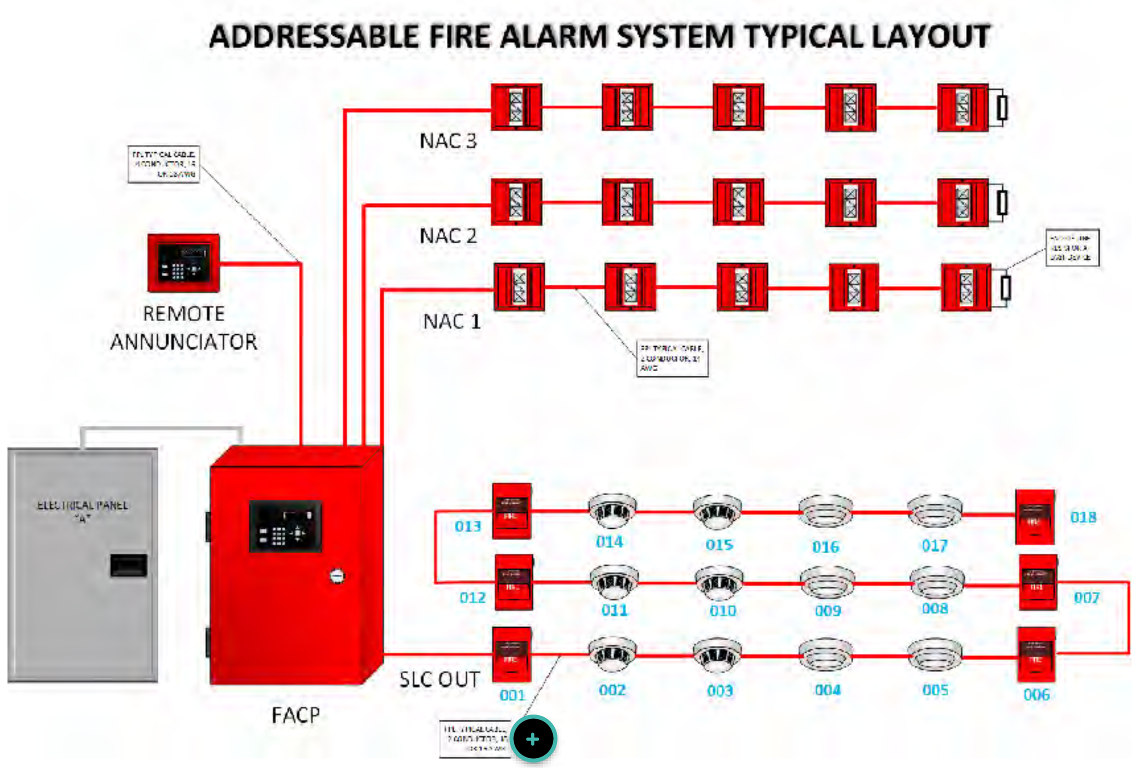
Manual Fire Alarm Box



Heat Detector



Smoke Detector



FPL typical cable, 2 conductor, 18 or 16 AWG

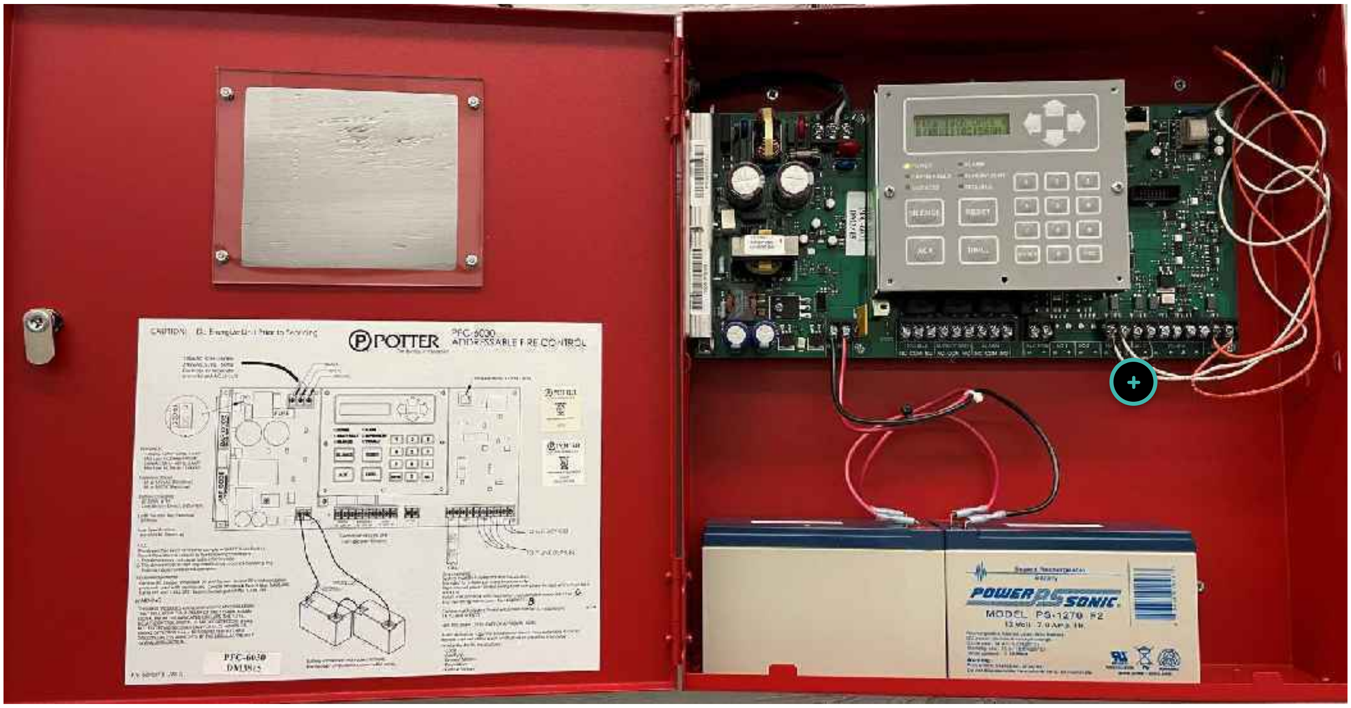
Unlike in conventional fire alarm systems, each addressable initiating device has an **individual address**. That means that addressable systems can identify the **specific device** that has an alarm signal, supervisory signal, or trouble signal.

Newer devices and systems are also able to provide additional data, such as **ambient temperature** or **smoke concentration** in an area.

CONTINUE

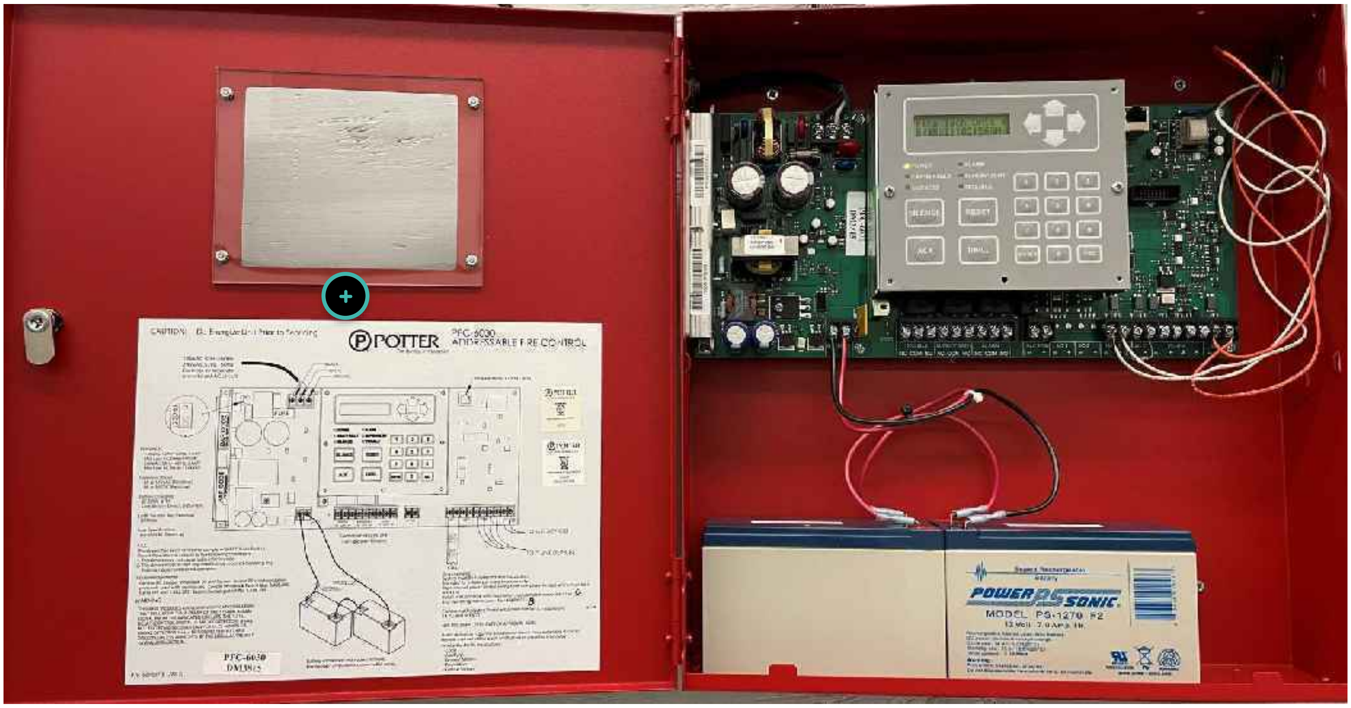
Addressable FACU

Click on each "+" symbol below to learn about each component or subsystem.



NAC

Notification Appliance Circuit connections are located here where it is labeled "NAC 1" and "NAC 2."



FACU Diagram

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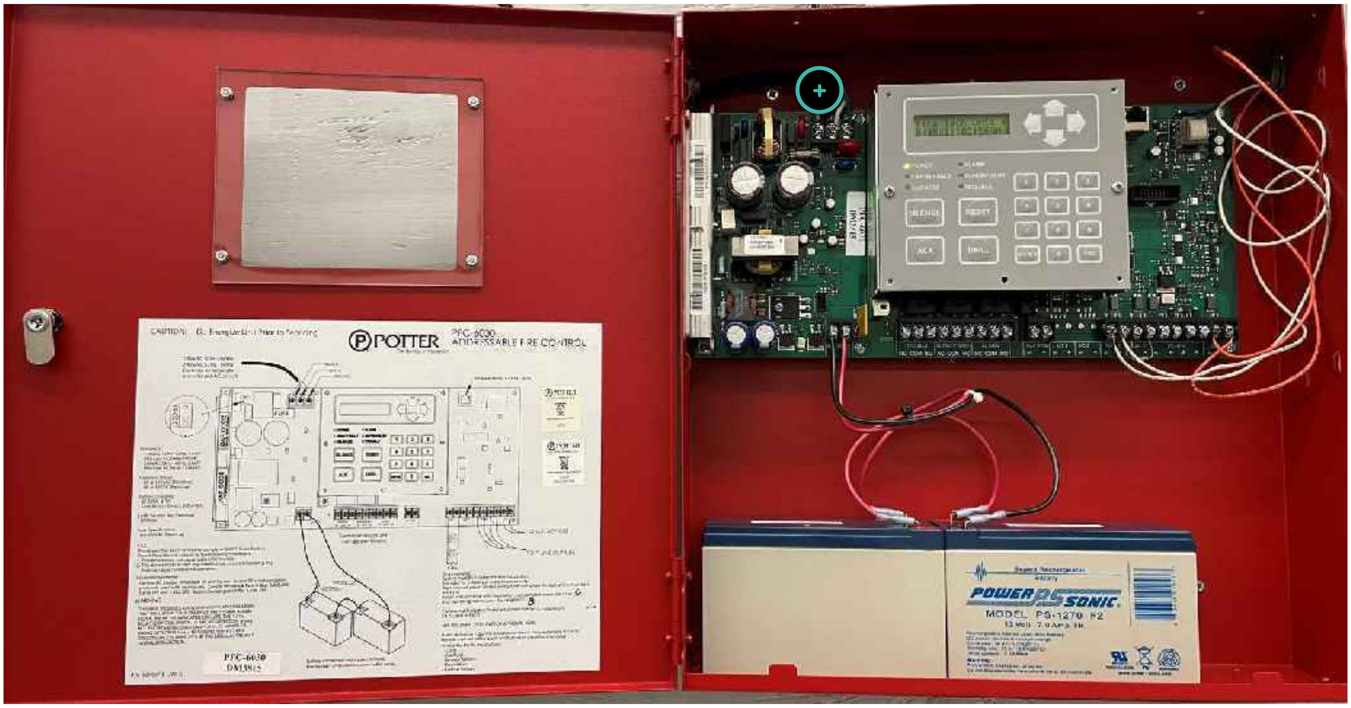
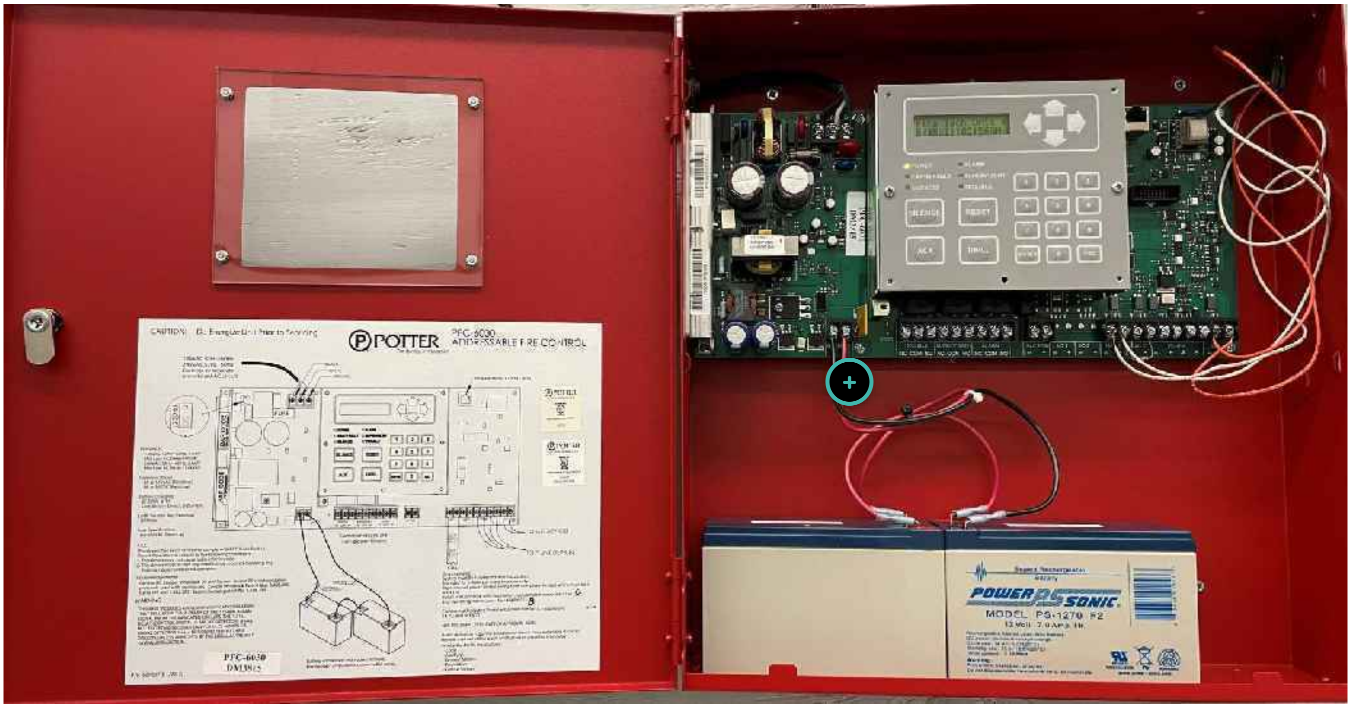


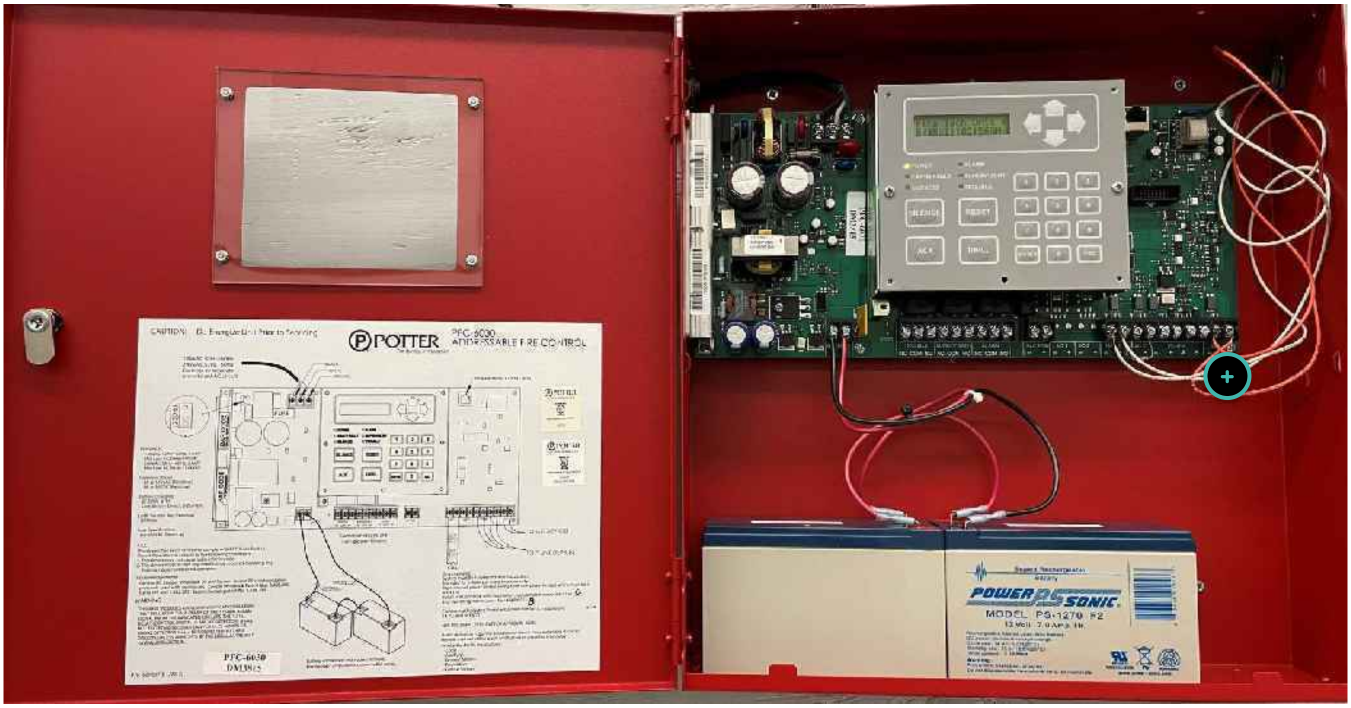
Primary Power Source

The primary power source for the FACU is connected here.



Secondary Power Source

This is where the secondary power source (battery back-up) is connected to the panel.



SLC

Initiating devices are connected to the circuit labeled SLC (Signaling Line Circuit) because on an addressable device the initiating devices can be identified specifically as to which devices are detecting fire or trouble.

LET'S REVIEW

Drag and drop the stack of cards below into the correct categories.

Conventional Fire Alarm Systems

Consists of 3 subsystems

Detectors report alarms in ON or OFF state on an IDC

Alarm, trouble, or supervisory condition indicated by circuit or zone

Addressable Fire Alarm Systems

Each initiating device has an individual address

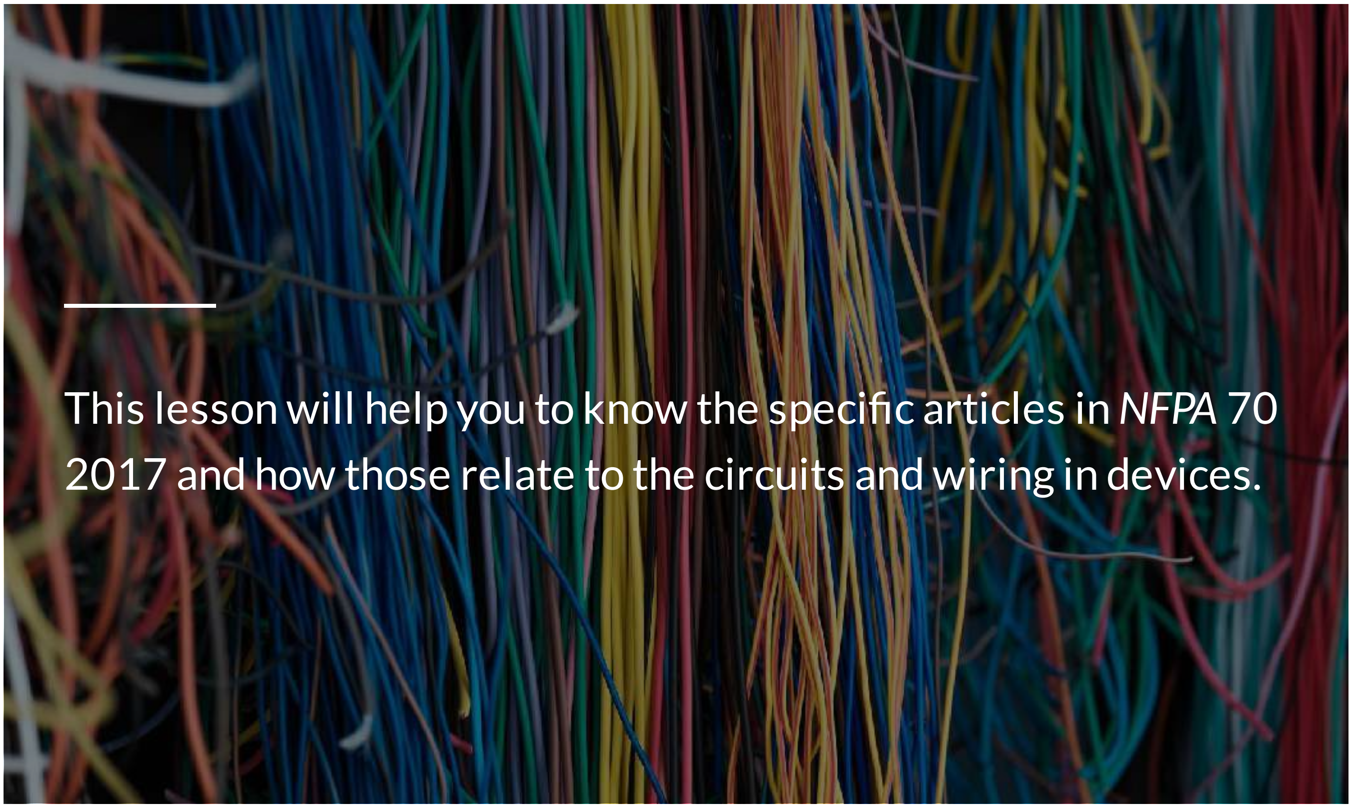
Initiating device and modules are wired to an SLC

Identify the specific device that has an alarm, supervisory, or trouble signals

Complete the card sort above before moving on.

Lesson 2 of 5

Articles and Circuits



This lesson will help you to know the specific articles in *NFPA* 70 2017 and how those relate to the circuits and wiring in devices.

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Identify wiring requirements from Article 760 of *NFPA* 70 2017 *(National Electrical Code)*

2 Define various pathway class designations

CONTINUE

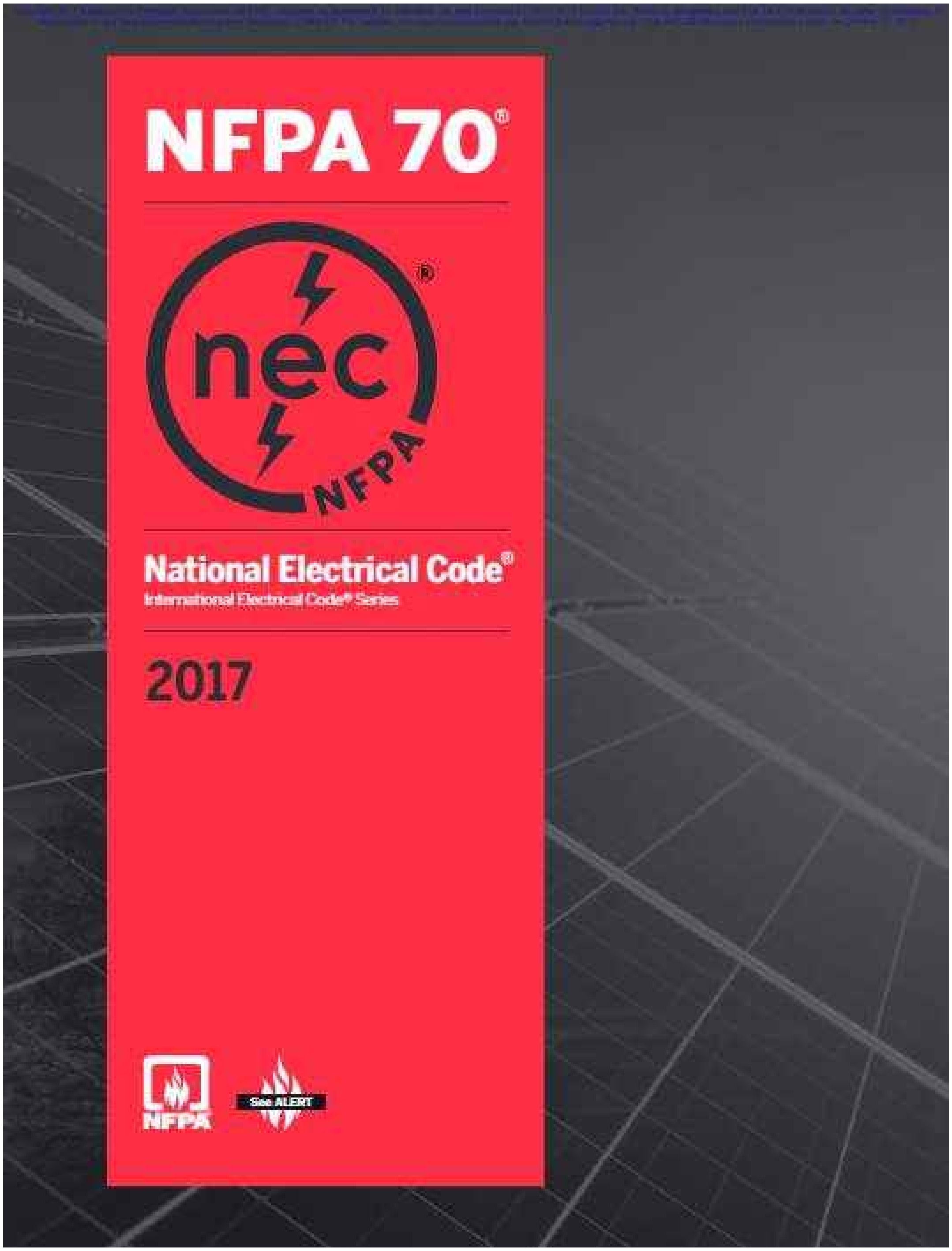
ⓘ Key Reference: ***NFPA 70 (National Electrical Code)*, 2017, Article 760**

NFPA 70 2017— National Electrical Code (NEC)

NFPA* 70 2017 — *National Electrical Code (NEC) is a **model code**, which means it is developed and managed by a standards organization independent of the jurisdiction enforcing the code.

***NFPA* 70 2017** is one of the few standards not configured in the typical NFPA fashion.

Its intent is **purely advisory** by the NFPA.



NFPA 70®

National Electrical Code®

International Electrical Code® Series

2017

FIRE ALARM CIRCUITS

Fire alarm circuits

Per ***NFPA* 70 2017**, a **fire alarm circuit** is the portion of the wiring system between the **load side** of the overcurrent device or the power-limited supply and the **connected equipment** of all circuits powered and controlled by the fire alarm system.

Basically, the code says all wiring ***from*** the **power source** and ***to*** the **fire alarm control unit** and **all of the devices** are considered a **fire alarm circuit**.

CONTINUE

Watch the video below about a fire alarm panel.

Video run time 0:54

NFPA 70 2017 ARTICLES

Introduction

Be aware that *NFPA* 70 2017 has many other articles, covering the following (among other topics):

Additional Topic 1

Article 300.21

Spread of Fire or Products of Combustion (Fire Stopping)

Additional Topic 2

Article 300.22

Ducts, Plenums, and Other Air-Handling Spaces

Additional Topic 3

Article 500

Hazardous/Corrosive Environments is covered in Article 500, however this also applies to Articles 511-555

NFPA 70 2017 defines **dusttight** as "Constructed so that dust will not enter the enclosing case under specified test conditions."

Additional Topic 4

Article 300.5

NFPA 70 2017, Table 300.5
Minimum Cover Requirements, 0 to 1000 Volts, Nominal, Burial in Inches

Location of Wiring Method or Circuit	Direct Burial Cables or Conductors	Rigid Metal Conduit or Intermediate Metal Conduit	Nonmetallic Raceways Listed for Direct Burial Without Concrete Encasement or Other Approved Raceways	Residential Branch Circuits (120 V or less with GFCI Protection and Max Overcurrent Protection of 20 amps	Circuits for Control of Irrigation and Landscape Lighting
All locations not specified below	24 in.	6 in.	18 in.	12 in.	6 in.
Under a building	0 in	0 in	0 in	0 in	0 in
Under streets, highways, roads, alleys, driveways, and parking lots	24 in.	24 in.	24 in.	24 in.	24 in.
One- and two-family dwelling driveways and outdoor parking areas, and use only for dwelling-related purposes	18 in.	18 in.	18 in.	12 in.	18 in.

Damp or Wet Locations (any cable, raceway, enclosure installed underground is considered to be damp or wet location)

Table 300.5 applies to underground installations. The columns define requirements for specific conductor/raceway types. The rows define the characteristic of the underground installation, showing the depth that the corresponding cable/raceway needs to be installed.

Additional Topic 5

Articles 600-770

Building Control Circuits-Articles 600-770 (there are a broad number of building control circuits-examples are electric charging systems, elevators, fire pumps etc.)

Additional Topic 6

Article 770

Install optical fiber cables in a neat and workmanlike manner. Support exposed cables on the surface of ceilings and sidewalls so the cable will not be damaged by normal use. Cables are permitted to be secured by straps, staples, cable ties, hangers, or similar fittings. - NFPA 70 2017, Article 770.24

Additional Topic 7

Article 300.3 (C)

Installation of Conductors with Other Systems

***NFPA* 70 2017** defines the **requirements to wire a fire alarm system**. Contained in this code is **Article 760,** entitled "Fire Protective Signaling Systems."

Article 760 is short; however, it references **other chapters or articles** in ***NFPA* 70 2017**. For example, in one instance, it refers to Chapter 3 of the *NEC*, which is quite long.

Article 760 is divided into 3 parts:

Part I

General:
Part I covers the **installation and wiring** of all equipment used for fire protective signaling systems (fire alarm systems).

Part II

Non-Power-Limited Fire Alarm (NPLFA) Circuits-
A non-power-limited circuit is a **common circuit**, similar to a

home receptacle or lighting circuit, that is **protected by a fuse or circuit breaker**.

Part III

Power-Limited Fire Alarm (PLFA) Circuits-

Power-limited circuits are circuits which have a power source that is a **Class 3 transformer** or a **Class 3 DC power supply** that limits the amount of

Click on each of the cards above for a summary of each of the three parts.

We'll go through each of these three parts individually in more detail.

If a bold and italic ***N*** appears next to an Article, that indicates the material is **new to the 2017** edition of the ***NEC***.

NFPA 70 2017, ARTICLE 760 PART I

1

NFPA 70 2017, Article 760 Part I: General

Part I covers the **installation and wiring** of all equipment used for fire protective signaling systems (fire alarm systems).

It references other articles in *NFPA* 70 2017 which may apply. For example:

- Section 300.22 is designated for applications such as duct work.
- Articles 500 – 516 are referenced within Part 1. These involve hazardous locations and the definition of those hazardous locations, such as corrosive, damp, or wet locations.

CONTINUE

Some other areas covered in Part I are:

- Definitions
- Other related sections of the code
- Fire alarm circuit identification
- Abandoned cables

ⓘ New to the **2017 edition** is the inclusion of **cable routing assemblies** and **communications raceways** covered in **760.3(L)** and **760.3(M)**, respectively.

NFPA 70 2017, ARTICLE 760 PART II

2

NFPA 70 2017, Article 760 Part II: Non-Power-Limited Fire Alarm Circuits

A non-power-limited circuit is a **common circuit**, similar to a home receptacle or lighting circuit, that is **protected by a fuse or circuit breaker**.

If this circuit is shorted, the short circuit current surge in the wiring can be **much larger** than the rating of the over-current protection device.

A 20-amp circuit could have hundreds or thousands of amps of short circuit current for a period of microseconds. **That is long enough to damage the fire alarm system and/or its components.**

Part II

CONTINUE

ground fault circuit interrupter (GFCI)

Fire alarm system branch circuits **can never be protected at the source** by a ground fault circuit interrupter or arc fault circuit interrupter.

- This may cause the breaker to trip during an actual fire.
- The idea is to keep the notification appliances operating **as long as possible** during a fire.
- If the circuit breaker trips during a fire condition and the batteries are not in good condition, **the appliances would cease to operate** during this critical period.

CONTINUE

Part II of Article 760 states non-power-limited circuits must comply with **Chapters 1 through 4 of *NFPA* 70 2017.** This means that fire alarm wiring is treated as most other common wiring with regards to insulation and wiring methods.

Part II covers:

- branch circuit supply wiring and overcurrent protection
- conductors of different circuits in same enclosure or raceway
- NPLFA circuit conductors and cables
- wiring methods

LISTED NPLFA CABLES

Listed NPLFA Cables

The cable shall have insulation suitable for **600 volts.** All conductors must be 18 AWG or larger solid or stranded copper.

There are three types of cables installed as wiring within buildings:

- **NPLFP** — Non-Power-Limited Fire Alarm Plenum cable
- **NPLFR** — Non-Power-Limited Fire Alarm Riser cable
- **NPLF** — Non-Power-Limited Fire Alarm cable

These cables possess a hierarchy of fire resistance and low-smoke-producing material. Hence, **NPLFP can be used in all applications,** although the cable is higher priced. Similarly, **NPLF** can only be used for **general purpose** fire alarm use, but **NOT** for **risers, plenums,** and **environmental air spaces**.

Exceptions apply, but the standard usage is shown on the following table:

Wire Marking Description	Characteristics	Name	Description
NPLFP	Adequate fire resistance and low smoke producing	Non-Power-Limited Fire Alarm circuit cable for other spaces used for environmental air	Cables used for other spaces used for environmental air
NPLFR	Fire resistant characteristics to prevent carrying of fire between floors	Non-Power-Limited Fire Alarm Circuit Riser Cable	Cables for use in a vertical run in a shaft or from floor to floor
NPLF	Resistant to the spread of fire	Non-Power-Limited Fire Alarm circuit cable	Cables installed for general purpose fire alarm use with exceptions for riser, ducts, plenums and environmental air spaces
xxxx-CI* *additional suffix to above descriptions	Survivability	Fire Alarm Circuit Integrity (CI)	Cables used for survivability of critical circuits

Cables shall be marked with the description shown in the above chart. The **-CI marking** shall be added for **2-hour circuit integrity cables**.

3

Part III: Power-Limited Fire Alarm Circuits

Part III

- Wiring methods on the supply side of the PLFA power source
- Wiring methods on the load side of the PLFA power source
- Separation from other circuit conductors
- PLFA conductors and cables

Power-Limited Circuits

Power-limited circuits are circuits which have a power source that is a **Class 3 transformer** or a **Class 3 DC power supply** that limits the amount of available current in a short circuit condition. If the power supply is rated at 0.002 amps, it will never deliver more than 0.002 amps.

These circuits must be **specially marked** and are afforded certain installation considerations.

Power-limiting is accomplished by circuit characteristics. A power-limited circuit is inherently limited by its design.

- A power-limiting component in a circuit is a transformer or power supply, which by design, is only capable of providing so much energy.
- The power supply for a PLFA system must be a Class 3 transformer or power supply.
- A simple fuse is **not** an acceptable power-limiting component.

Above is a sample of a Class 2 transformer which can be a Class 3 when installed in a wet location. A Class 2 or Class 3 Transformer is used in a fire alarm to convert the 120 VAC power from the dedicated circuit from the fire alarm. This transformer converts this power to the 24VDC power to power the circuits on the fire alarm panel for notification and initiation circuits.

LISTED PLFA CABLES

Listed PLFA cables

The cable shall have **insulation suitable for 300 volts**. All conductors must be solid or stranded copper.

Multiconductor cable must not be smaller than **26 AWG**. A single conductor shall not be smaller than **18 AWG**.

There are three types of cables installed as wiring within buildings:

1. FPLP-A 16 AWG 2 conductor FPLP cable assembly. Most manufacturers will print on the jacket the cable type, as well as footage left on the spool or box.
2. FPLR-A 16 AWG 2 conductor FPLR cable assembly. Most manufacturers will print on the jacket the cable type, as well as the footage left on the spool or box.
3. FPL

FPLP Cable

FPLR Cable

Standard usage is shown on the following table:

Wire Marking Description	Characteristics	Name	Description
FPLP	Adequate fire resistance and low smoke producing	Power-Limited Fire Alarm circuit cable for other spaces used for environmental air	Cables used for duct, plenums and other spaces used for environmental air
FPLR	Fire resistant characteristics to prevent carrying of fire between floors	Power-Limited Fire Alarm Circuit Riser Cable	Cables for use in a vertical run in a shaft or from floor to floor
FPL	Resistant to the spread of fire	Power-Limited Fire Alarm circuit cable	Cables installed for general purpose fire alarm use with exceptions for riser, ducts, plenums, and environmental air spaces
xxxx-CI* *additional suffix to above descriptions	Survivability	Fire Alarm Circuit Integrity (CI)	Cables used for survivability of critical circuits

ⓘ **Key References: *NFPA 70* (2017), Articles 760.41 and 760.121**

LET'S REVIEW

Let's do a quick check over what we just covered.

In addition to covering the installation and wiring of all equipment used for fire protective signaling systems (fire alarm systems), what other topics are covered in *NFPA* 70 2017, Article 760 Part I? Select all that apply.

☐ Definitions

☐ Fire alarm circuit identification

☐ Power limited circuits

☐ Abandoned cables

SUBMIT

Based on the table in Part II of *NFPA* 70 2017, Article 760, which cables (insulation suitable for **600 volts)** should be used for environmental air?

○ NPLF

○ NPLFA

○ NPLFP

○ NPLFR

SUBMIT

Based on the table in Part III of NFPA 70 2017, Article 760, which cables (insulation suitable for **300 volts)** should be installed for general purpose fire alarm use with exceptions for riser, ducts, plenums, and environmental air spaces

○ FPL

○ FPLG

○ FPLP

○ FPLR

SUBMIT

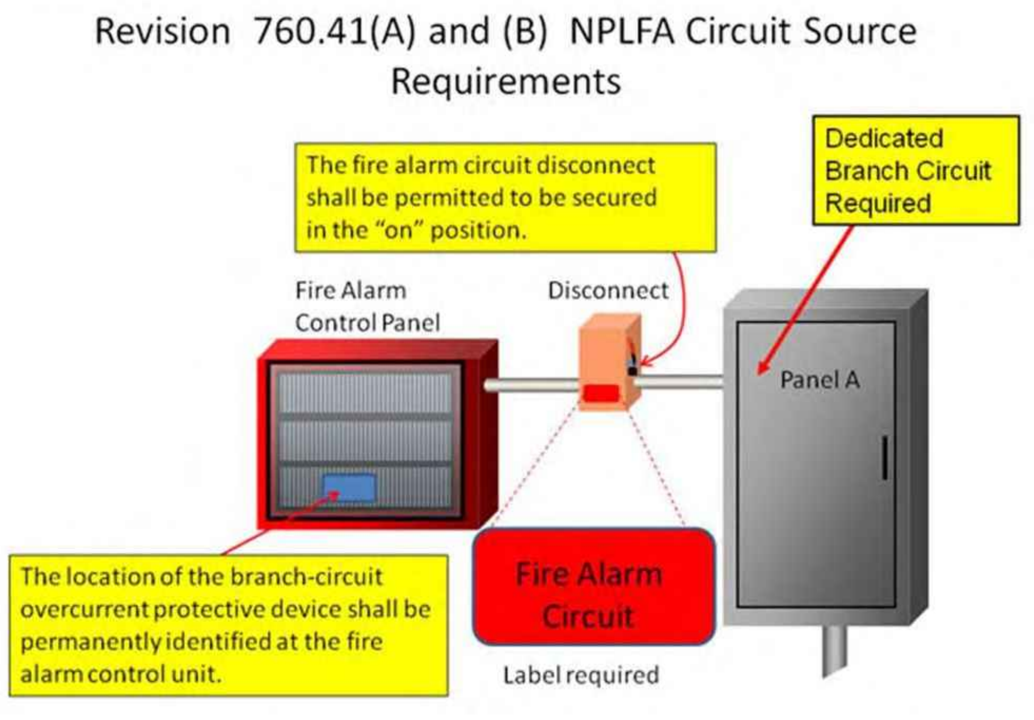
Complete the knowledge check above before moving on.

Power and branch circuit requirements

The NEC defines the power and branch circuit requirements for fire alarm systems in Articles 760.41 and 760.121.

Requirement 1

Dedicated circuit



Revision 760.41(A) and (B) NPLFA Circuit Source Requirements

The fire alarm circuit disconnect shall be permitted to be secured in the "on" position.

Dedicated Branch Circuit Required

The location of the branch-circuit overcurrent protective device shall be permanently identified at the fire alarm control unit.

What is shown is the operation of an NPLFA circuit as defined in Article 760.41 of the NEC. Panel A is the electrical panel that contains the dedicated circuit (or branch circuit) that will provide the FACP with its primary power. The dedicated circuit can be in the locked position at a disconnection point that is not in the electrical panel location as shown. Generally, this disconnection point is in the panel that provides the FACP with its primary power.

Requirement 2

Location identification

The branch circuit supplying the fire alarm equipment(s) shall supply no other loads (dedicated circuit). The location of the branch-circuit overcurrent protective device shall be **permanently identified** at the fire alarm control unit.

Requirement 3

Circuit disconnecting means identification

The circuit disconnecting means shall have **red** identification, shall be accessible **only to qualified personnel**, and shall be identified as “**FIRE ALARM CIRCUIT**.” The red identification **shall not damage the overcurrent protective devices** or obscure the manufacturer’s markings.

Requirement 4

Circuit interrupters

This branch circuit shall not be supplied through ground-fault circuit interrupters or arc-fault circuit interrupters.

Requirement 5

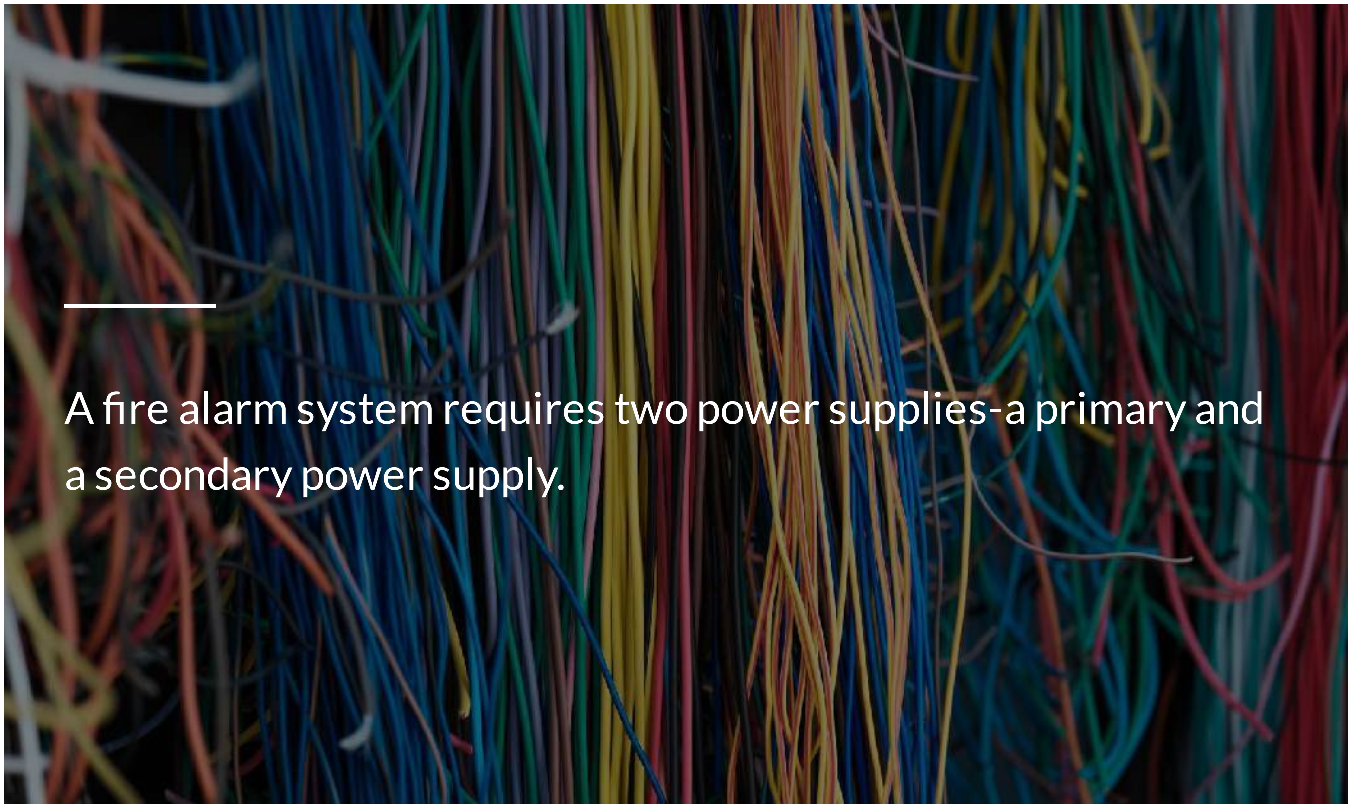
Fire alarm circuit disconnect

The location of the branch circuit must be identified in the FACP, the dedicated circuit disconnect locked in the "on" position, and marked red at the disconnecting means. The fire alarm circuit disconnect shall be permitted to be secured in the “on” position.

CONTINUE TO NEXT LESSON: POWER SUPPLIES AND GENERATORS

Lesson 3 of 5

Power Supplies and Generators



A fire alarm system requires two power supplies-a primary and a secondary power supply.

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Recognize capacity requirements for back-up and secondary power supply operations and alarm conditions

2 Include a 20% safety margin for battery amp-hour calculations

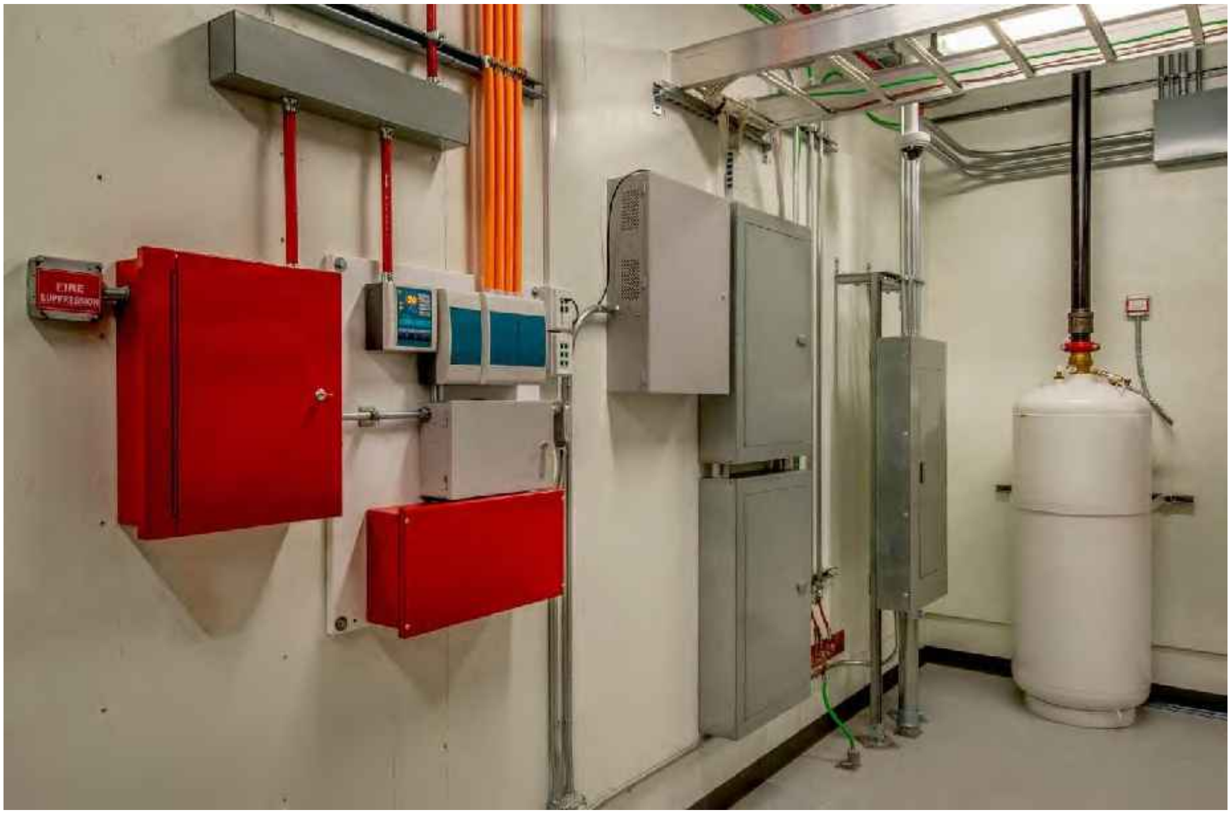
ⓘ **Key Reference: *NFPA* 72 2016, Section 10.6**

POWER SUPPLIES

Power Supplies

At least two power supplies are required for a fire alarm system. Both must have **adequate capacity for the intended application**. They are designated as **primary** and **secondary supplies.**

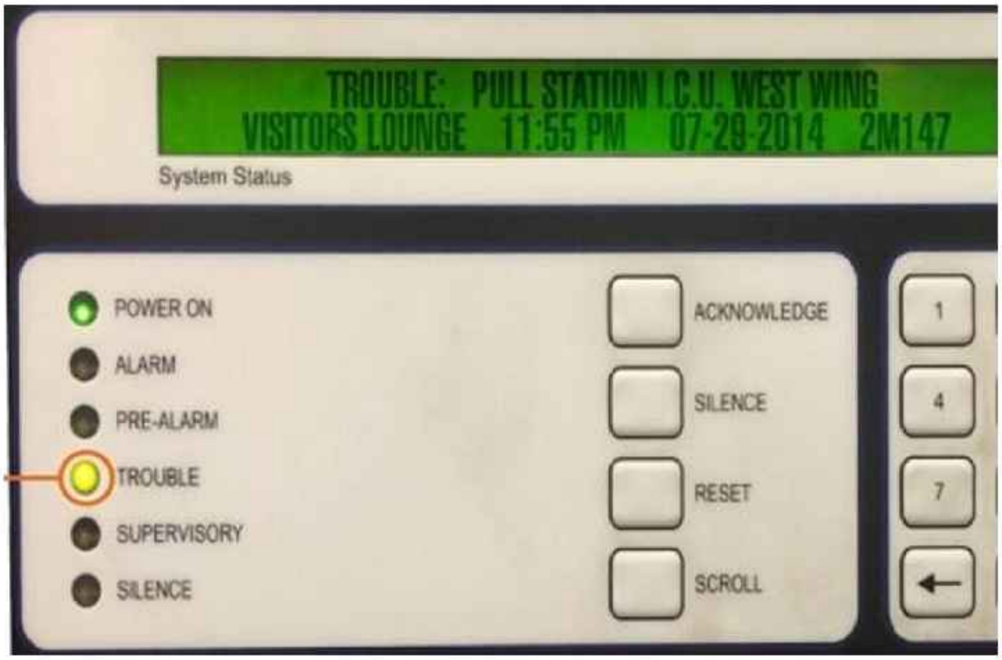
Power supplies must be monitored per ***NFPA* 72 2016, Section 10.6.9**. All power supplies shall be monitored for voltage at their connection to the system.



UNINTERRUPTABLE POWER SUPPLIES

Uninterruptable Power Supplies (UPS)

NFPA 72 2016, Section 10.6



UPSs must be configured in compliance with *NFPA 111: Standard on Stored Electrical Energy Emergency and Standby Power Systems.*

They must be set up for **Type O, Class 24, Level 1** system and must be supplied by a **dedicated branch circuit** per Section 10.6.5.

Failure of the UPS shall result in a **trouble signal**.

PRIMARY POWER SUPPLY

Primary Power Supply

NFPA 72 2016, Section 10.6.5

The primary power supply shall be a commercial power and light service or an engine driven generator. This is required to assure adequate reliability and capacity. It must be supplied by a dedicated branch circuit.

The **dedicated branch circuit** must be identified as "**Fire Alarm Circuit.**"

> ⓘ **If a circuit breaker is the disconnecting means, an approved breaker locking device is required to be installed. — *NFPA 72* 2016, Section 10.6.5.4**

CONTINUITY OF POWER SUPPLIES

Continuity of Power Supplies

NFPA 72 2016, Section 10.6.6

secondary power supply

For **fire alarm systems**, the **secondary power supply** shall automatically supply power **within 10 seconds** of when the primary power fails to provide the minimum system voltage required for proper operation.

For **supervising station** **facilities and equipment**, the secondary power supply shall automatically supply power **within 60 seconds** of when the primary power fails to provide the minimum system voltage required for proper operation.

Any required signals shall not be lost, interrupted, or delayed by more than **10 seconds** because of primary power failure.

CAPACITY

Capacity

NFPA 72 2016, Section 10.6.7

The **fire alarm backup supply** must operate the system for **24 hours** and then, at the end of that period, **support a full alarm condition of the system for 5 minutes**.

The **secondary power supply for an emergency voice/alarm communications system** must operate for **24 hours** and then operate for **15 minutes in a fire or other emergency condition.**

Battery amp-hour calculations for fire alarm or emergency voice/alarm communications systems must include an additional **20% safety margin**.

LET'S REVIEW

Let's see what you remember about power supplies.

The fire alarm system must have both a primary and secondary power supply. The secondary power supply must provide standby power for 24 hours followed by _____ minutes in full alarm.

○ 5 minutes

○ 10 minutes

○ 15 minutes

○ 30 minutes

SUBMIT

If the system is an emergency voice communication system, the secondary power supply must provide standby power for 24 hours followed by _____ minutes in full alarm.

- ○ 5 minutes
- ○ 10 minutes
- ○ 15 minutes
- ○ 30 minutes

SUBMIT

🔒 Complete the knowledge check above before moving on.

Engine-Driven Generators

Engine-driven generators can supply either **primary** or **secondary** power.

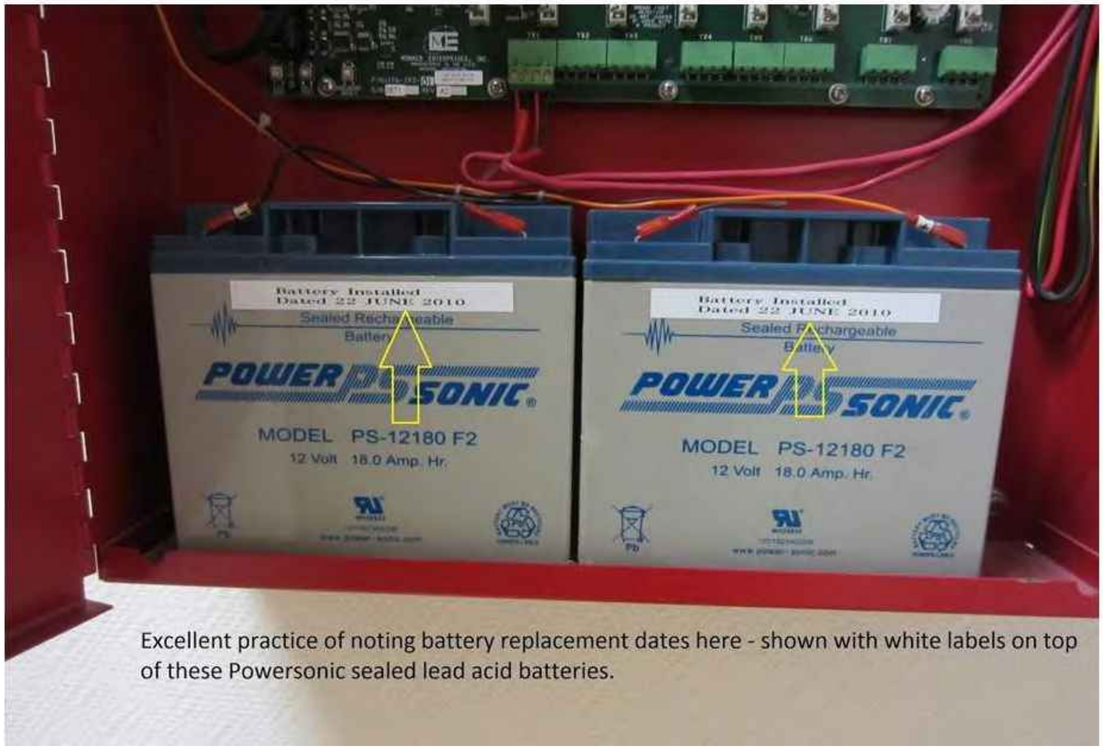
A Diesel-powered generator for electrical service is shown below. If this is a primary power source for a fire alarm, there are additional points requiring supervision to minimize power loss.

A **trained operator** must be on **duty at all times** for manually started generators.

Installation must be in compliance with **NFPA 110, Standard for Emergency and Standby Power Systems.**

A **separate** starter battery and automatic charger are also **required**.

18 amp hour batteries installed in a FACP for secondary power. These are 12 volt batteries, there are 2 batteries because the panel power supply is 24 volts. The battery size shall be calculated to provide 20% spare capacity in addition to running the fire alarm in a normal condition for 24 hours, or in alarm for 5 minutes in a non-voice evacuation system. Although it is prudent to provide the date of installation as shown, NFPA 72 2016 requires the date of MANUFACTURE to be provided on the batteries.



Excellent practice of noting battery replacement dates here - shown with white labels on top of these Powersonic sealed lead acid batteries.

LET'S REVIEW

Let's see what you remember about power supplies.

Engine-driven generators can supply what type(s) of power?

○ Primary

○ Secondary

○ Both primary or secondary power

SUBMIT

The battery size (for the secondary power of a FACP) shall be calculated to provide 20% spare capacity in addition to running the fire alarm in a normal condition for __ hours, or in alarm for 5 minutes in a non-voice evacuation system.

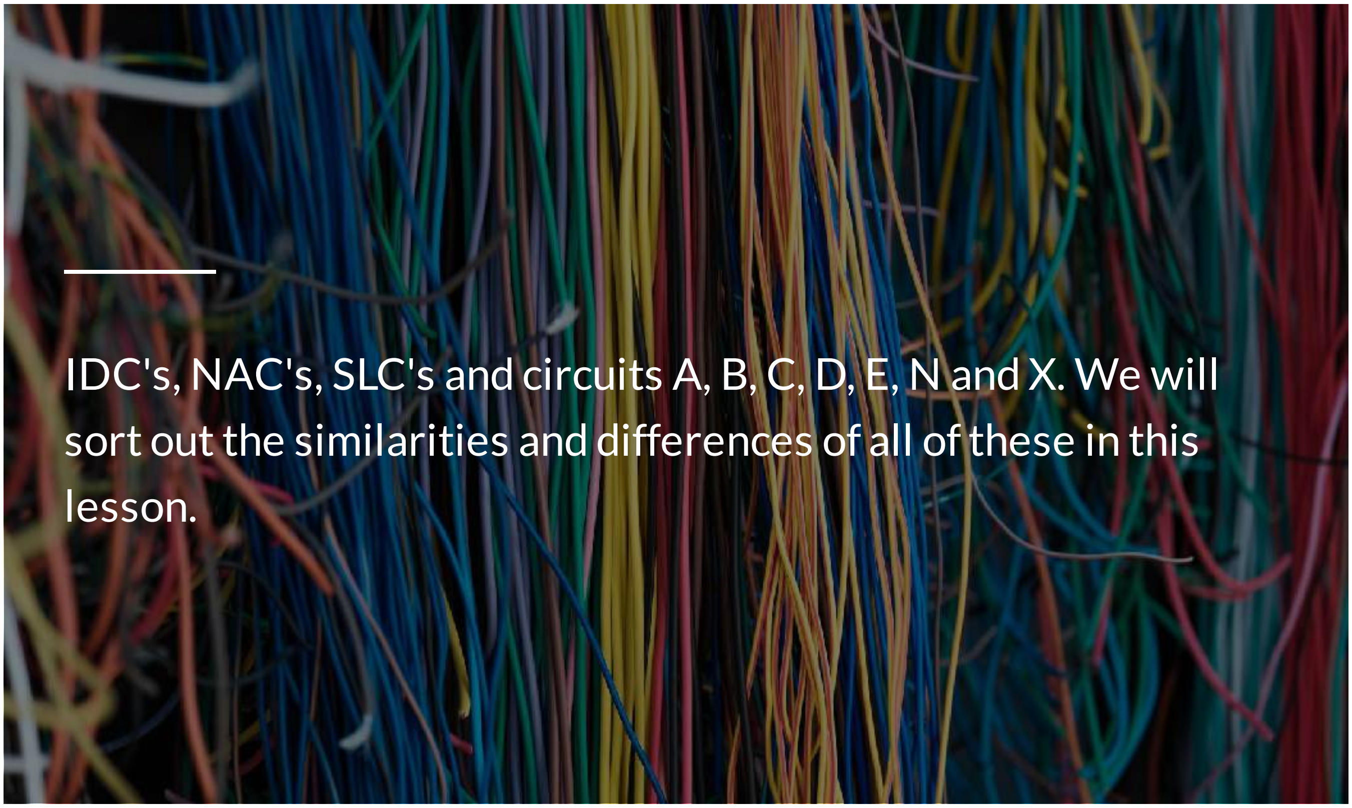
Type your answer here

SUBMIT

Complete the knowledge check above before moving on.

Lesson 4 of 5

Circuits and Pathways



IDC's, NAC's, SLC's and circuits A, B, C, D, E, N and X. We will sort out the similarities and differences of all of these in this lesson.

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Define various pathway designations
2. Identify three different types of fire alarm circuits

3 Clarify the difference between Class A redundant circuits and Class B non-redundant circuits

CONTINUE

Circuits and pathways

This chapter covers the performance capabilities of circuits (or pathways) that are used with fire alarm systems. **Circuits** typically refer to copper wiring interconnection methods. **Pathways** typically refer to non-copper interconnection such as fiber optic, internet, or wireless.

CONTINUE

The following are important definitions related to Chapter 12:

Path (Pathways)

Any circuit, conductor, optic fiber, radio carrier, or other

Pathway Survivability

The ability of any conductor, optic fiber, radio carrier, or other means for transmitting system information to means connecting two or more locations. (Section 3.3.187)

remain operational during fire conditions. (Section 3.3.188)

TYPES OF FIRE ALARM CIRCUITS

Types of fire alarm circuits

Earlier in this module, we looked at three different types of fire alarm circuits: initiating device circuits (IDCs), signaling line circuits (SLCs), and notification appliance circuits (NACs).

Take a moment to review their definitions. Click each card below to see the definitions and take a moment to compare the similarities and differences.

Initiating Device Circuit (IDC)

A fire alarm circuit that is connected directly to initiating devices such as automatic detectors and/or manual pull boxes.

The signal received by the control

Signaling Line Circuit (SLC)

A fire alarm circuit that provides a path between any combination of circuit interfaces, control units, or transmitters.

The term **interface** simply means **a connection to another circuit or device** such as initiating devices.

Notification Appliance Circuit (NAC)

A fire alarm circuit that is connected directly to notification appliances such as bells, horns, strobe lights, and speakers.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Match the words below to their descriptions.

Circuits	Typically refer to copper wiring interconnection methods
Pathways	Typically refer to non-copper interconnection such as fiber optic, internet, or wireless

SUBMIT

Complete the knowledge check above before moving on.

Pathway class designations

Fire alarm circuits are designated by class depending on their ability to perform during specified fault conditions. Fault conditions include:

- Single open conductor
- Single grounded conductor
- Wire-to-wire shorts

Before we go into detail, here is a brief overview of each type of circuit.

Class A

Section 12.3.1

Redundant path; the physical conductors **are monitored for integrity.**

Class B

Section 12.3.2

Non-redundant path; the physical conductors **are monitored for integrity.**

Class C

Section 12.3.3

May be **redundant or non-redundant path**; the circuit **is monitored for integrity** via loss of end-to-end communications.

Class D

Section 12.3.4

Non-redundant path; supplementary circuit such as magnetic door holder; the circuit is **not monitored for integrity.**

Class E

Section 12.3.5

Non-redundant path; supplementary circuit for nonrequired circuits such as a lighted status board that does not affect the operation of the fire alarm system; the circuit is **not monitored for integrity.**

Class N

Section 12.3.6

Network system with **redundant path**; redundant path to each device is **verified by end-to-end communications** between network switch and endpoint device(s).

Class X

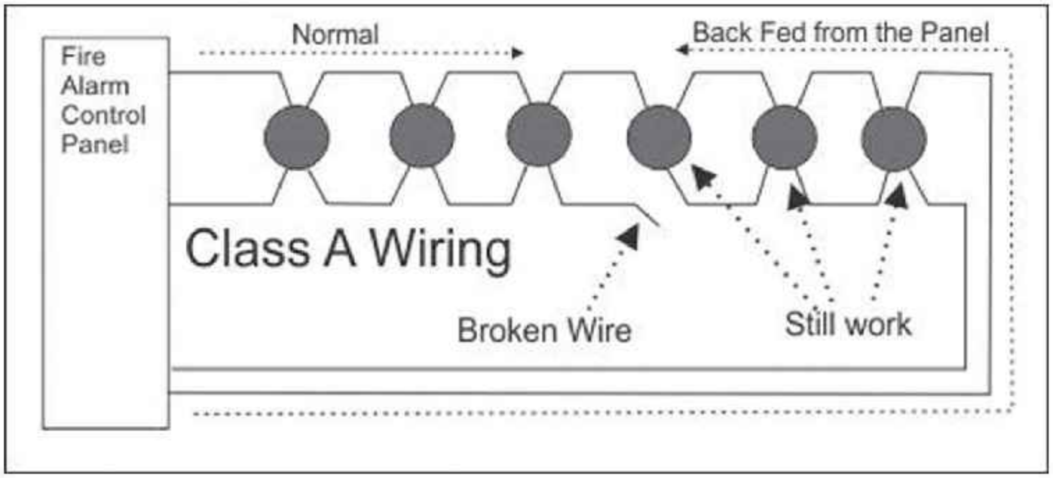
Section 12.3.7

Redundant path; conductive circuit **is monitored for integrity similar** to Class A or B circuits; nonconductive circuits such as fiber optics or wireless **also monitored for integrity.**

IDCs FOR CONVENTIONAL SYSTEMS

ⓘ Key References: *NFPA 72* (2016), Sections 12.3.1 – 12.3.2

IDCs for conventional systems



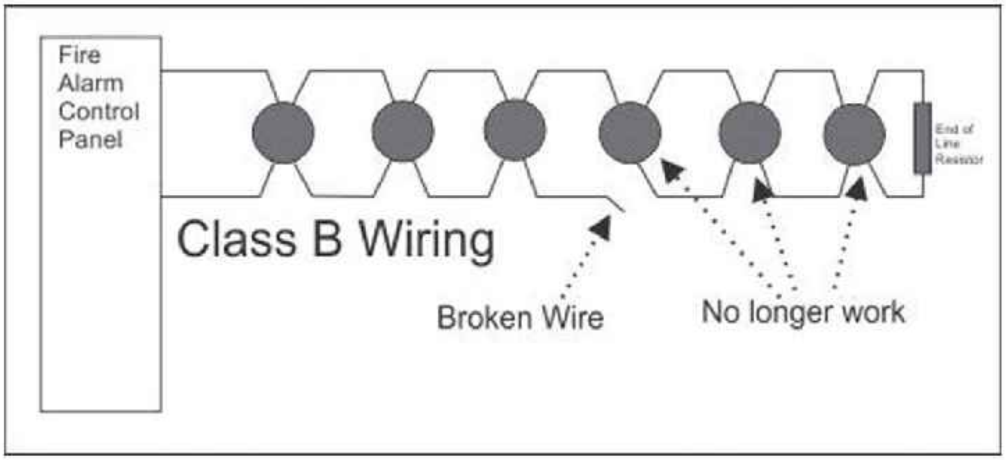
Class A Circuit

Class A IDCs **(Section 12.3.1)** for conventional systems are **redundant circuits.** Any devices past the single open will continue to receive power from the control unit and will be able to send an alarm signal to the control unit.

- With a ground fault on the circuit, the unit will still be able to receive an alarm signal from any device.
- In the case of an open or ground, the control unit will indicate a trouble condition.

Class B IDCs (Section 12.3.2) for conventional systems are **not redundant circuits.** Any devices past the single open will not receive power from the control unit and will be unable to send an alarm signal to the control unit.

- With a ground fault on the circuit, the unit will still be able to receive an alarm signal from any device **that is not past an open.**
- In the case of an open or ground, the control unit will indicate a trouble condition.



Class B Circuit

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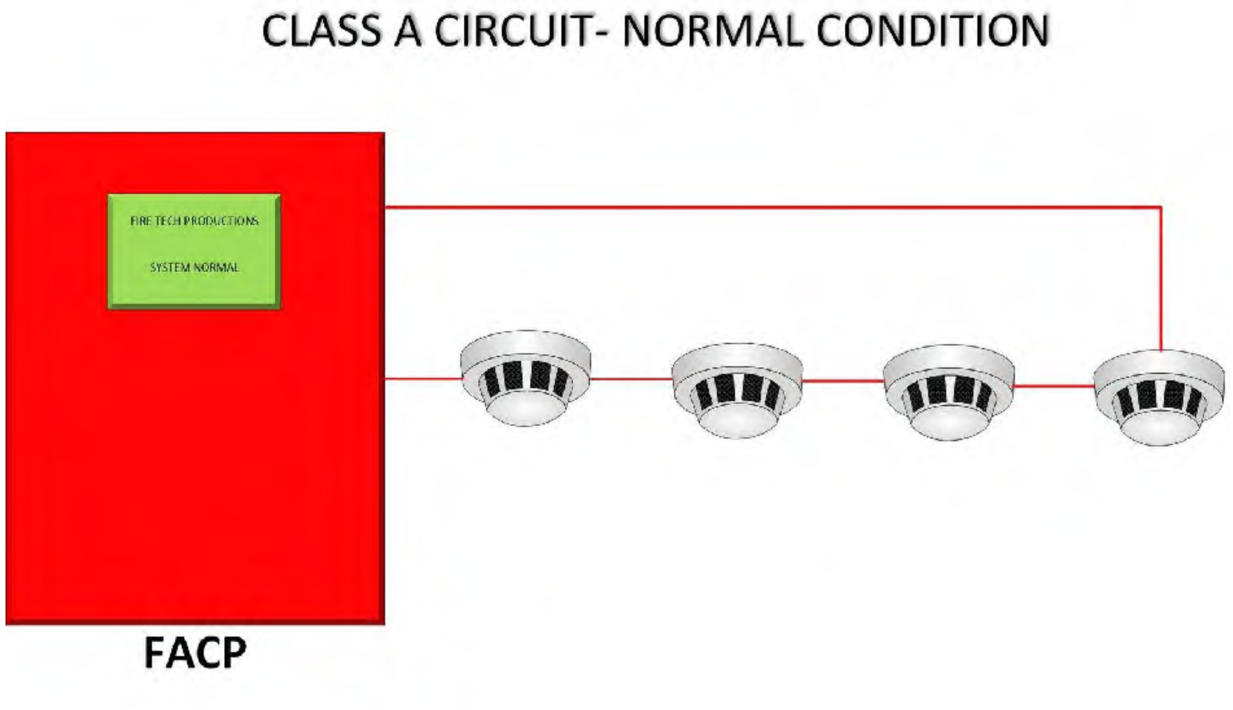
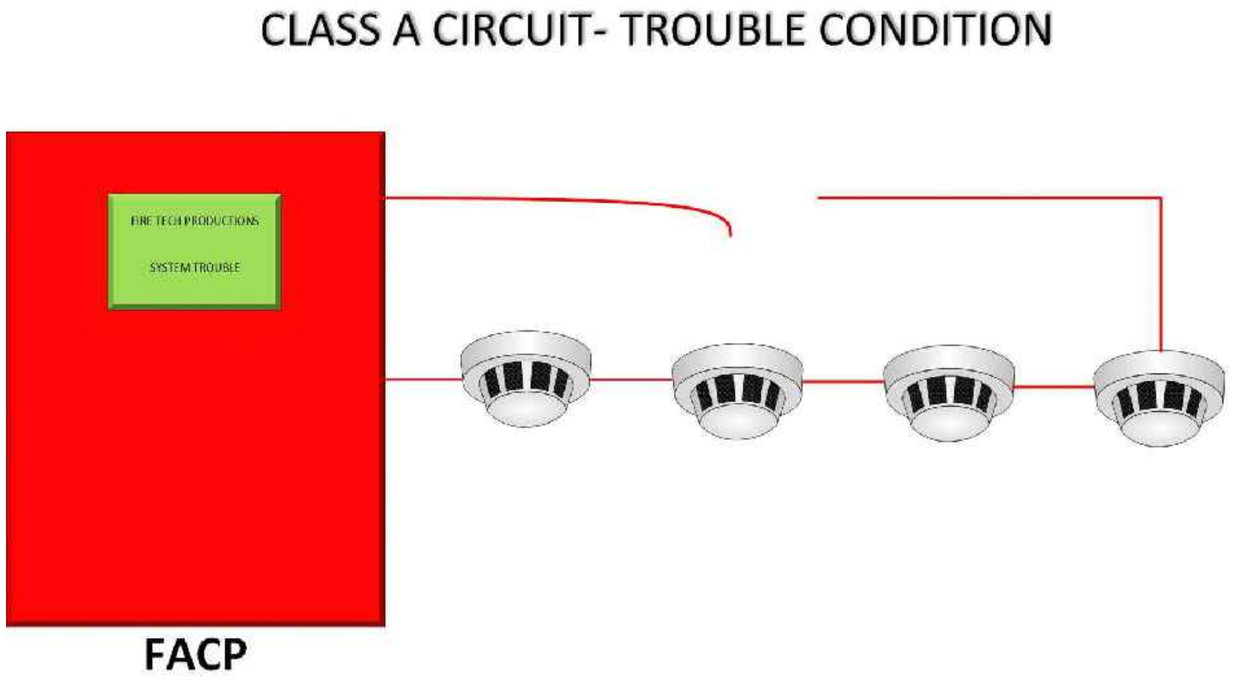
CLASS A



Class A Circuit

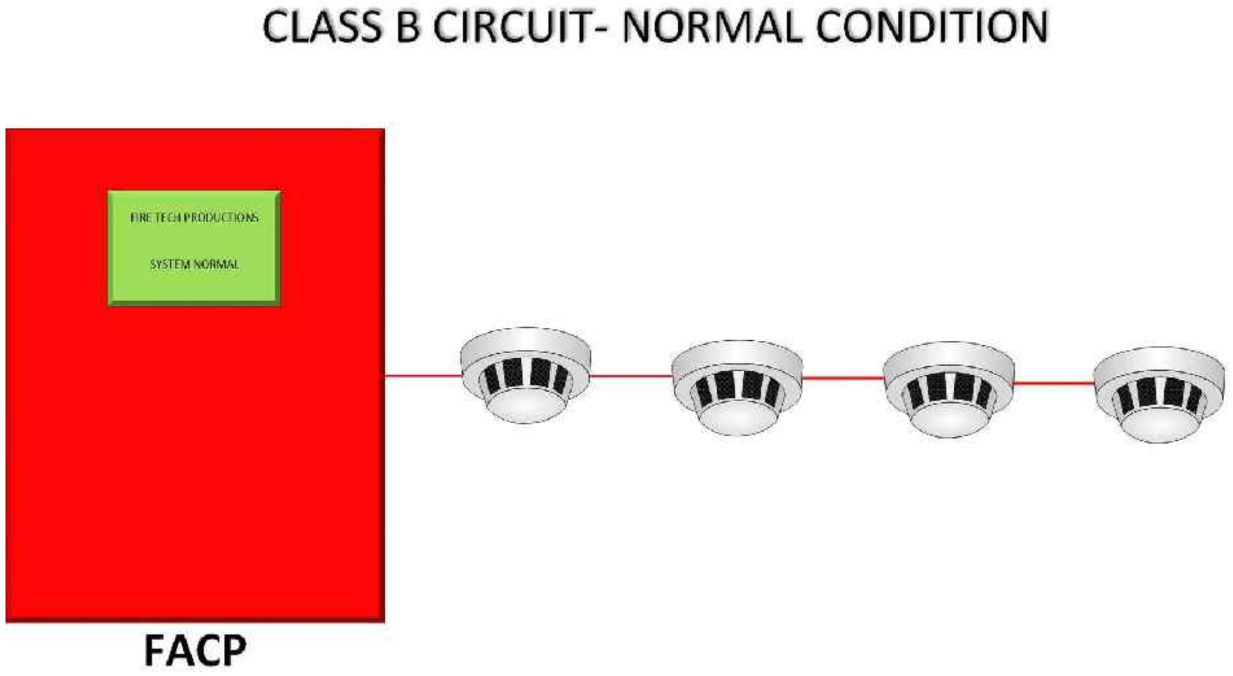
A Class A pathway can be installed for NACs, IDCs, or SLCs. A Class A circuit requires the use of a redundant path from the field devices back to the FACP. The redundant path of the Class A circuit (inbound from the last device on the circuit) cannot be in the same raceway system, as the path that leaves (outbound from the FACP) to ensure circuit integrity. If there is a single-open or break in the circuit, the devices on the circuit will still operate.

When there is a **break or open** in a **Class A circuit** as shown, the FACP shall **annunciate a trouble condition**.



Class A Circuit-Trouble Condition

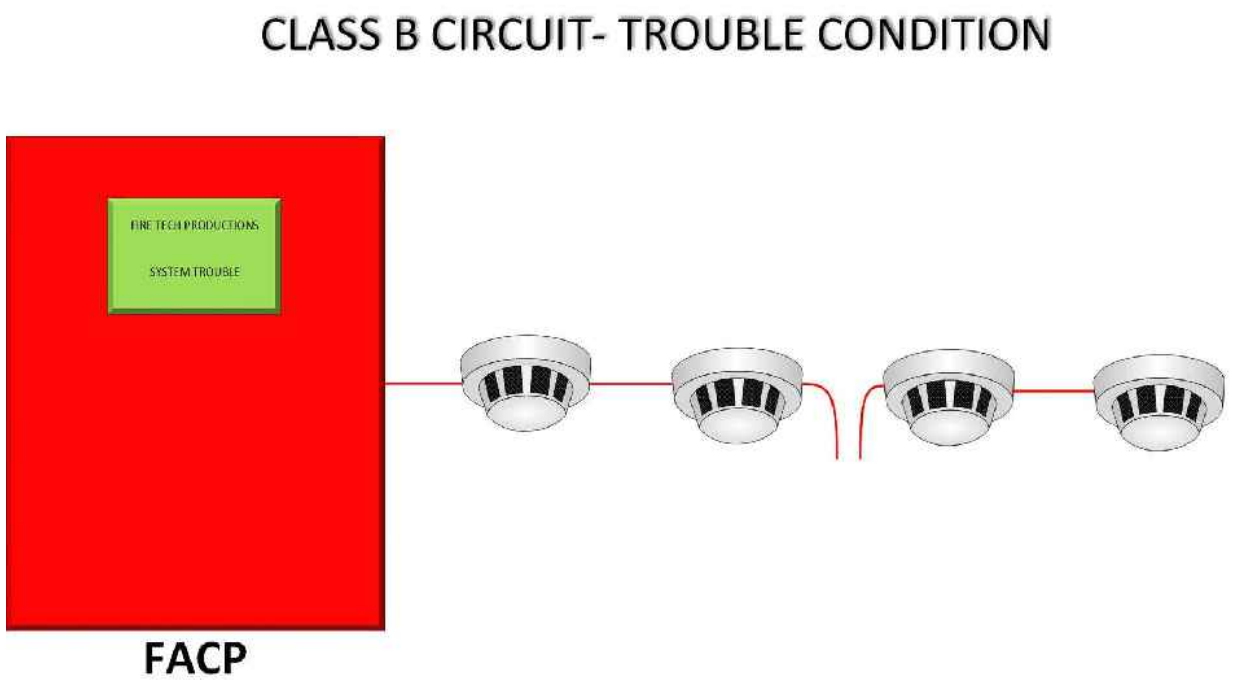
CLASS B



Class B Circuit

A **Class B pathway** can be installed for NACs, IDCs, or SLCs. A Class B circuit has no requirement for redundant paths from the FACP to the field devices. The downfall of this pathway is if there is an open or break in the circuit the devices past the break or open in the circuit will no longer operate.

When there is a break or open in a **Class B circuit** as shown, the FACP shall annunciate a trouble condition. Additionally, in this image devices 1 and 2 will operate, however devices 3, and 4 will not.



Class B Circuit-Trouble Condition

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Sort the following pathway class designation cards below as to whether they are Redundant Paths or Non-Redundant Paths.

Redundant Paths

Class A Section 12.3.1

Class N Section 12.3.6

Class X Section 12.3.7

Non-Redundant Paths

Class B Section 12.3.2

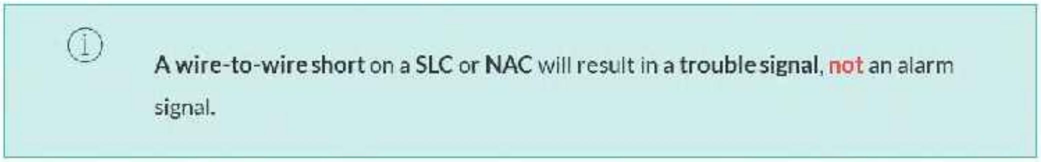
Class D Section 12.3.4

Class E Section 12.3.5

Complete the card sort above before moving on.

What about wire-to-wire shorts?

At this point you may have noticed that we have not discussed what happens to Class A or Class B initiating device circuits when we have a wire-to-wire short on the circuit. As discussed, an open or ground fault results in a trouble signal. However, **a wire-to-wire short is what causes an alarm condition on these two circuits.**



A wire-to-wire short on a **SLC** or **NAC** will result in a **trouble signal**, **not** an alarm signal.

Once an automatic fire detector (heat, smoke, flame, etc.) senses a fire, or when we activate a manually actuated device (pull station), a set of electrical contacts will close, which produces a wire-to-wire short. The control unit reads this wire-to-wire short on the IDC and will go into alarm mode.

SLCs for addressable systems

Class A SLCs for addressable systems are **redundant circuits**, just like Class A IDCs. The control unit can back feed the circuit in case of an open in the wiring. All devices will continue to receive power (with a single open).

With a single open or ground on the circuit, the control unit will still be able to receive an alarm signal from any device or pull station on the circuit. In the case of a wire-to-wire short, or a wire-to-wire short with an open, the control unit **may or may not** be able to receive an alarm signal.

Class B SLCs for addressable systems are **not redundant circuits**. Any devices past the single open will **not** receive power from the control unit.

With an open in the circuit, the control unit **will not be able to receive an alarm signal from any device past the open**. The control unit will still be able to receive an alarm signal from all devices with a **single ground** on the circuit.

In the case of an open, short, ground, or loss of a carrier signal, the control unit will indicate a **trouble condition**.

NACs

Class A NACs are **redundant circuits**. The control unit can back feed the circuit in case of an open in the wiring. All notification appliances **will continue to receive power and operate during an alarm condition** (with a single open).

With **a single open on the circuit or a ground** on the circuit, the control unit **will still be able** to send power to all notification appliances to let the occupants know to evacuate.

With a wire-to-wire short, the entire circuit **will not operate.**

In the case of an open, ground, or wire-to-wire short, the control unit will indicate a **trouble condition**.

Class B NACs are **not redundant circuits**. Any notification appliance past the single open will **not** receive power from the control unit and will be unable to operate during an alarm condition.

With a **single ground** on the circuit, the control unit **will still be able** to send power to all notification appliances to let the occupants know to evacuate.

With a wire-to-wire short, the entire circuit **will not operate** if the control unit goes into alarm mode. The existing wire-to-wire short will cause a fuse to blow, making the entire circuit inoperable.

In the case of an open, ground, or wire-to-wire short, the control unit will indicate a **trouble condition**.

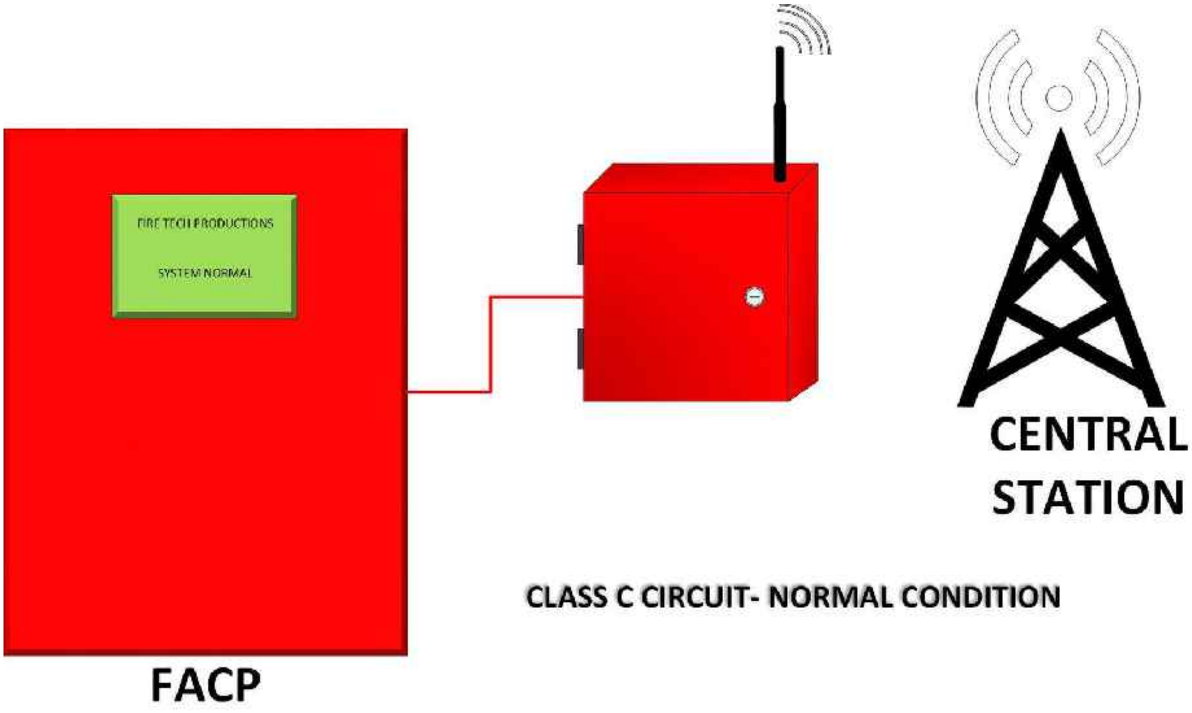
CLASS C CIRCUITS

ⓘ **Key References: NFPA 72 (2016), Sections 12.3.3 and A.12.3.3**

Class C Circuits

Class C circuits describe fire alarm system circuits that perform as follows:

1. They include one or more pathways where **operational capability is verified via end-to-end communication**, but the integrity of individual paths is **not** monitored.
2. A loss of end-to-end communication is **annunciated**.



Class C Circuits

Per **Section A.12.3.3**, Class C is intended to describe technologies that supervise the communication pathway by **polling or continuous communication “handshaking”** such as the following:

1. Fire alarm control unit or supervising station connections to a wired or wireless LAN, WAN, or Internet

2. Fire alarm control unit or supervising station connections to a wireless (proprietary communications)

3. Fire alarm control unit digital alarm communicator transmitter or supervising station digital alarm communicator receiver connections to the public switched telephone network

A Class C circuit is a circuit that for all intents and purposes is not supervised for circuit integrity. These circuits are generally used for communication purposes, from an FACP to a DACT (Digital Alarm Communication Transmitter) or Cellular dialer.

These devices are wired to FACPs; however, their system trouble occurs when the communication device does not operate properly in their communication protocols (SIA, Contact ID), or if the communicator or DACT is not programmed correctly within the FACP.

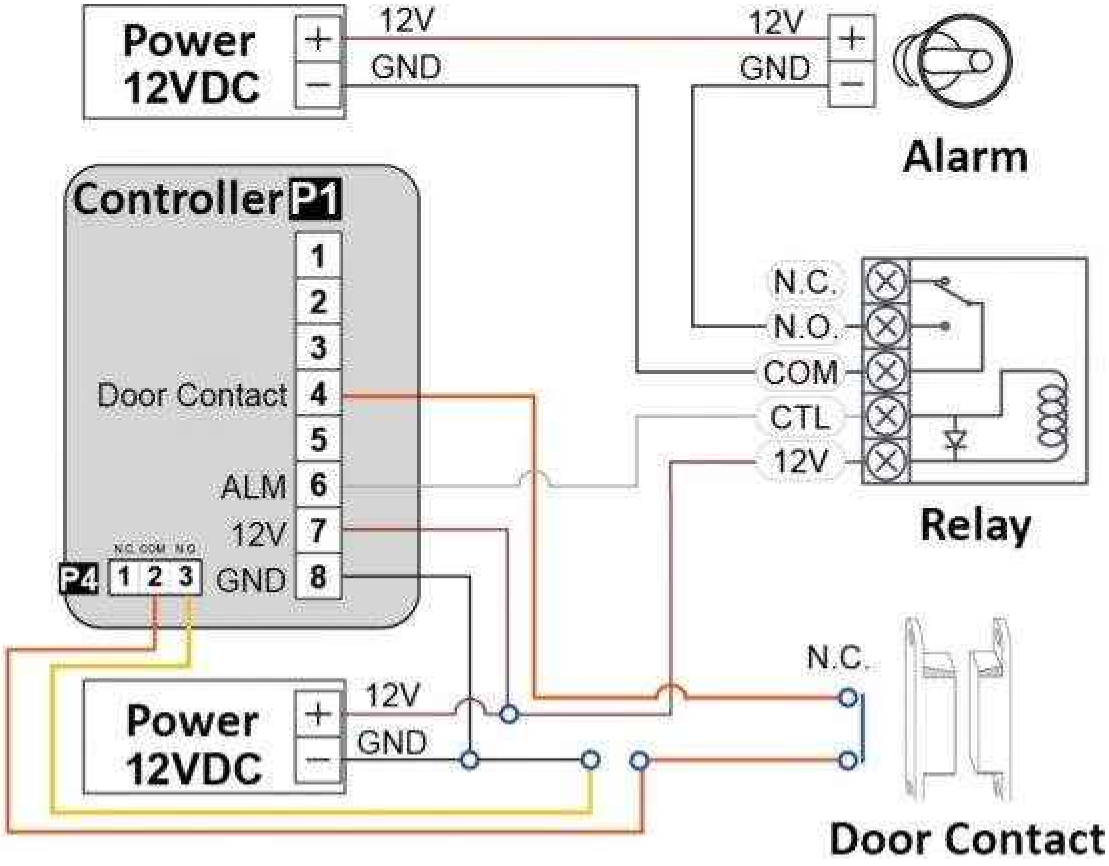
Fire Alarms, by code are required to perform a “Handshake” and “Kiss-off” every 24-hours to ensure the protected premise fire alarm system communicates to the supervising station. The “handshake” process begins with the receiver at the supervising station sending a signal to the system DACT or cellular dialer. If the DACT acknowledges this signal this is a handshake; when the DACT/cellular dialer sends the signal back, this process is known as a kiss-off.

If these signals are missed/ignored this is where the trouble results, generally as a “communication loss” trouble.

CLASS D CIRCUITS

ⓘ Key References: *NFPA 72* 2016, Sections 12.3.4 and A.12.3.4

Class D Circuits



Class D Circuit

Class D circuits describe fire alarm system circuits that perform as follows:

- They have **fail-safe** operation, where **no fault is annunciated**, but the intended operation **is performed** in the event of a pathway failure.

Per **Section A.12.3.4**, Class D is intended to describe pathways that are **not supervised** but have a fail-safe operation that performs the intended function when the connection is lost.

Examples include the following:

1. Power to door holders where interruption of the power results in the door closing
2. Power to locking hardware that release upon an open circuit or fire alarm operation

Class D is a “fail-safe” pathway that is **not supervised** by the FACP.

This pathway is generally found in access control systems, fire doors, or fire smoke dampers. This is accomplished by using a relay that interfaces between the fire alarm and access control system, so when the system goes into fire alarm, doors that are normally locked will fail-safe open by the relay de-energizing the lock to the door.

The same principle applies to fire doors that are magnetically held open, or building dampers that are in an open position that need to close in alarm.

CLASS E CIRCUITS

ⓘ Key References: *NFPA 72* 2016, Sections 12.3.5 and A.12.3.5

Class E Circuits

Class E circuits describe fire alarm system circuits that are **not monitored for integrity**.

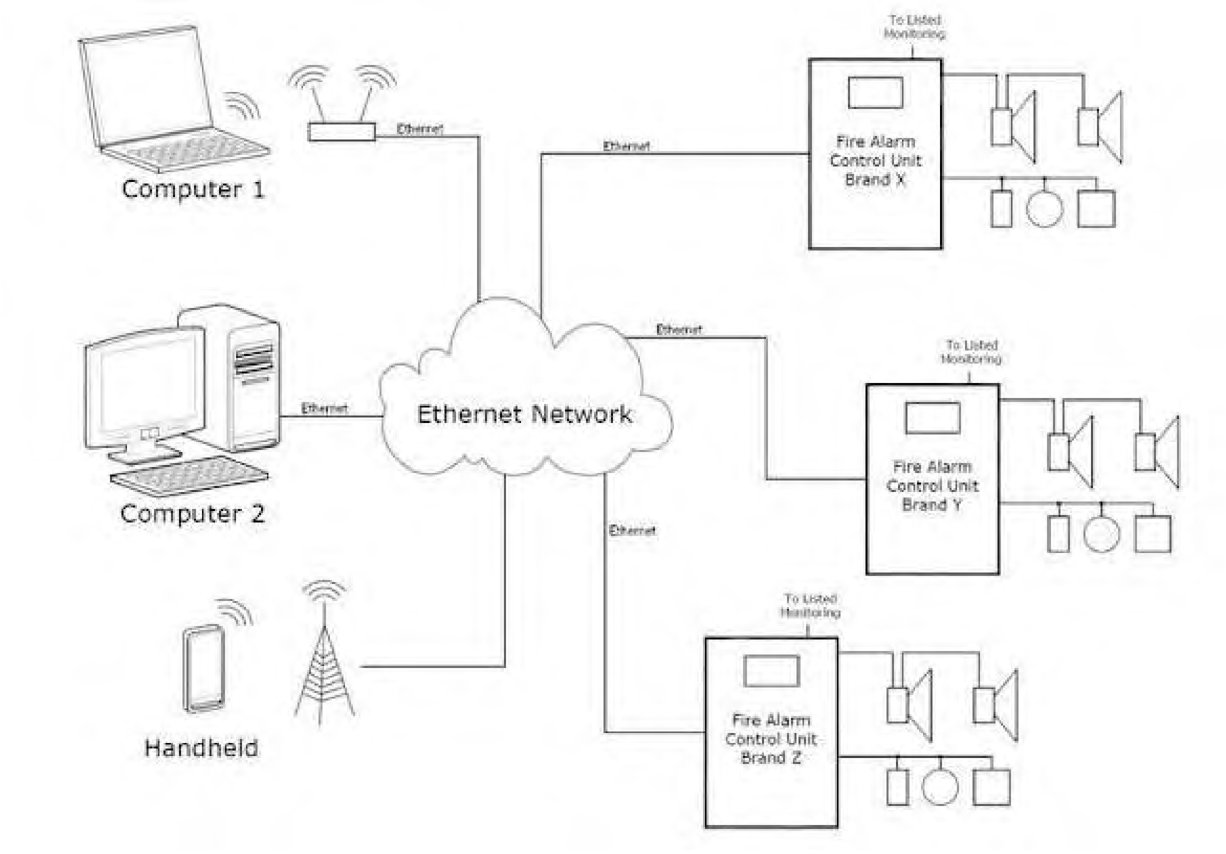
Per **Section A.12.3.5**, the Class E reference is intended to describe pathways that **do not require supervision** as described in Section 12.6.

CLASS N CIRCUITS

ⓘ Key Reference: *NFPA 72* 2016, Section 12.3.6

Class N Circuits

Class N is a network pathway requiring 2 or more redundant paths for networked campus/community fire alarms using an ethernet or fiber backbone network to network the systems together. There are limitations to this network based upon the backbone that is being used. Ethernet networks are generally limited to 325 ft. point-to-point, fiber can generally go further but is more costly.



Class N Circuit

Class N circuits describe fire alarm system (networked infrastructure) circuits that perform as follows:

1. It includes a **redundant path verified through end-to-end communications**.

2. A loss of intended communications between endpoints is annunciated as a **trouble signal**.

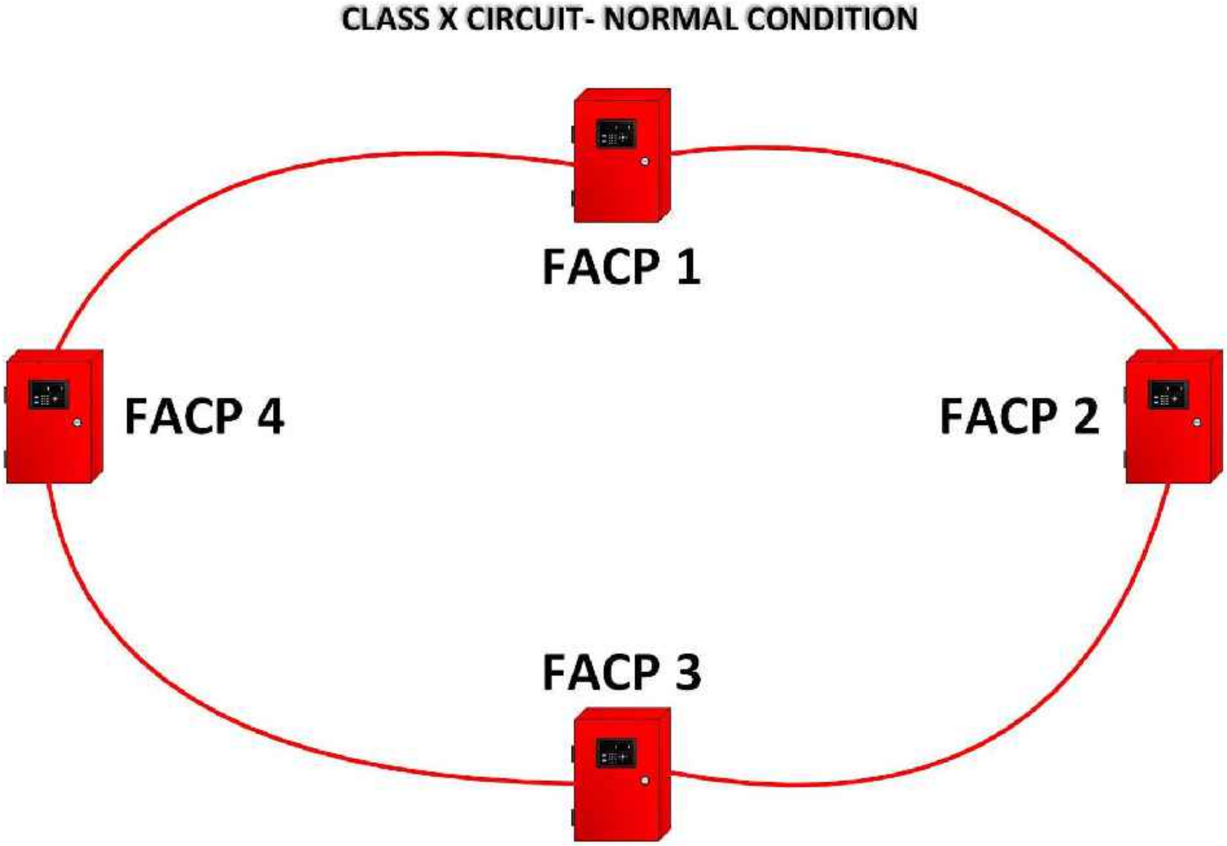
3. A single open, ground, or short, or combination of faults of one pathway **shall not affect any other pathway**.
4. Conditions that affect the intended operation of the path are annunciated as a **trouble signal**.
5. Primary and redundant pathways are **not permitted to share traffic** over the same physical segment.

CLASS X CIRCUITS

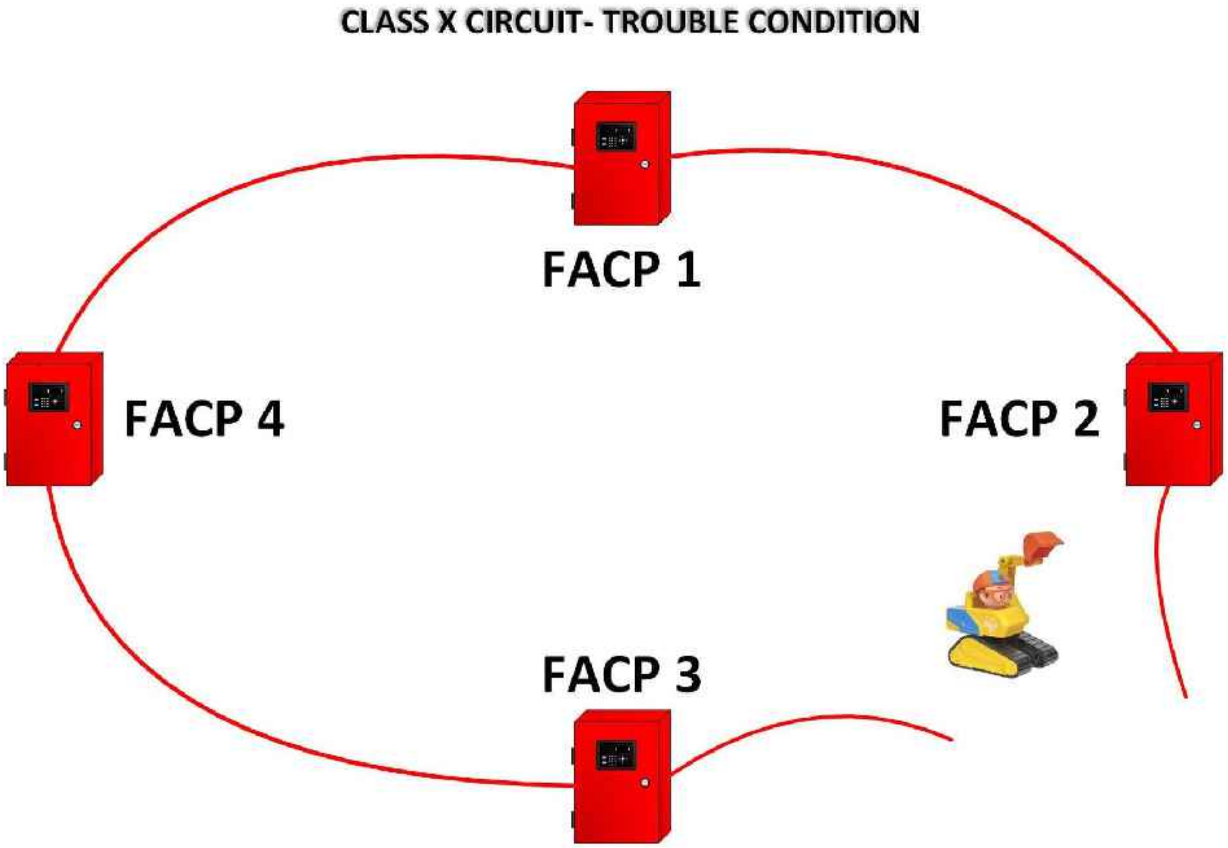
ⓘ Key Reference: *NFPA 72* 2016, Section 12.3.7

Class X Circuits

A **Class X circuit** is identical in principle to a **Class A network**, in the sense that there is a redundant path required, and that the redundant path is not in the same raceway as the outbound path. **Class X paths** are generally used to network systems similarly to **Class N in a campus/community layout**. This network pathway is generally more cost-inhibitive, because this uses circuit properties like FPLP, or FPLR (copper wiring). If the pathway between one FACP to the other is compromised the integrity of the network shall still operate because there is redundancy from the “Master” FACP to the remaining nodes in the network.



Class X circuit



Class X Circuit-Trouble Condition

When a Class X circuit is in trouble, the panel that is programmed as Master (likely communicates all conditions for all panels to supervising station) is the panel which annunciates this trouble.

In the example on the left, when Excavator Eric dug a trench between buildings 2 and 3 and severed the circuit between both buildings, all building systems still operate and communicate due to the redundancy in the circuit.

Class X circuits describe fire alarm system circuits that perform as follows:

1. They include a redundant path.
2. Operational capability continues past a single open or short circuit.
3. Conditions that affect the intended operation of the path are annunciated.

Class X pathways are meant for **SLCs for addressable systems only** and **do not apply to Class A IDCs** for conventional fire alarm systems.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Sort the following cards below into the two categories-Class A (Redundant Circuits) or Class B (Not Redundant Circuits).

Class A (Redundant Circuits)

Control unit can back feed the circuit in case of an open in the wiring. (NACs)

Devices past the single open will continue to receive power from the CU (IDCs)

Control unit can back feed the circuit in case of an open in the wiring. (SLCs)

Class B (Not Redundant Circuits)

Any notification appliance past the single open will not receive power. (NACs)

Devices past the single open will not receive power from the control unit (IDCs)

Devices past the single open will not receive power from the control unit (SLCs)

In the case of an open, ground, or wire-to-wire short, (Class A and Class B IDCs and NACs) the control unit will _____

○ not operate.

○ still be able to send power.

○ indicate a trouble condition.

○ not receive power.

SUBMIT

In the case of a wire-to-wire short, or a wire-to-wire short with an open, the control unit of a Class A SLC _______________ be able to receive an alarm signal.

○ may

○ may not

○ may or may not

SUBMIT

🔒 Complete the knowledge check above before moving on.

Lesson 5 of 5

Two-Wire vs. Four-Wire Detectors

Two-wire vs. four-wire detectors. Is one better than the other? How do you know which one to choose?

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

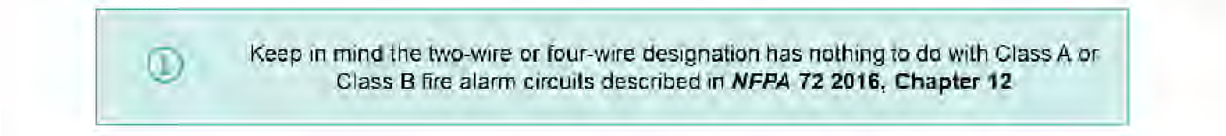
1. Describe the differences between two-wire and four-wire detectors.

CONTINUE

Two-Wire vs. Four-Wire Detectors

Now that we've described the types of circuits and pathways and their performance, we need to discuss **two-wire devices** and **four-wire devices**.

Occasionally technicians confuse the use of two- or four-wire devices with *NFPA* 72 2016's descriptions of Class A and Class B circuits. This can happen after a new technician sees a wiring diagram of Class A and Class B circuits.



Keep in mind the two-wire or four-wire designation has nothing to do with Class A or Class B fire alarm circuits described in ***NFPA* 72 2016, Chapter 12**

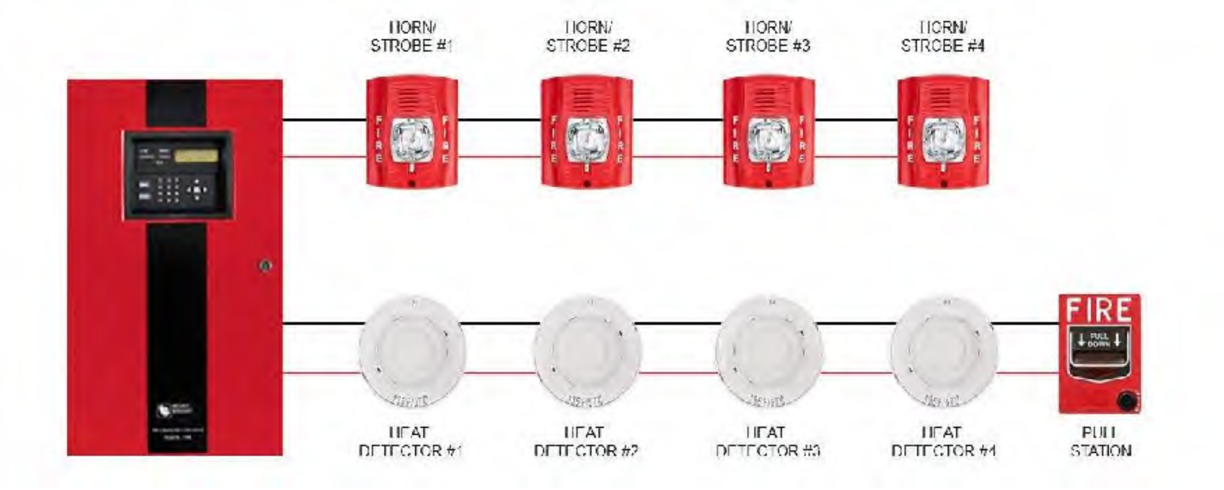
Two-wire or four-wire designation has to do with **how the device receives its power from the fire alarm control unit**. Two-wire devices and four-wire devices can be installed on the **same** Class A or Class B fire alarm circuit if the system design calls for it.

TWO-WIRE DETECTORS (CLASS B)

Two-wire detectors (Class B)

We will start with a **Class B** **IDC** since that is the easiest circuit to understand.

The image below shows what the circuit might look like pictorially. Each circuit has two wires going to each detector, pull station, or notification appliance. The detectors receive system power from the two wires that monitor the circuit.



two-wire IDC

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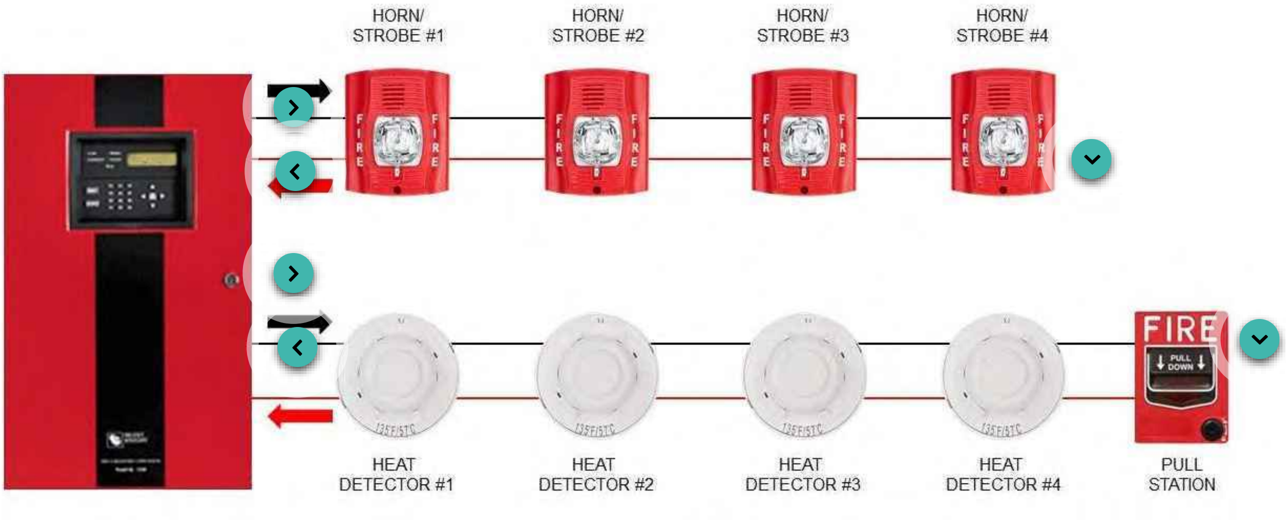
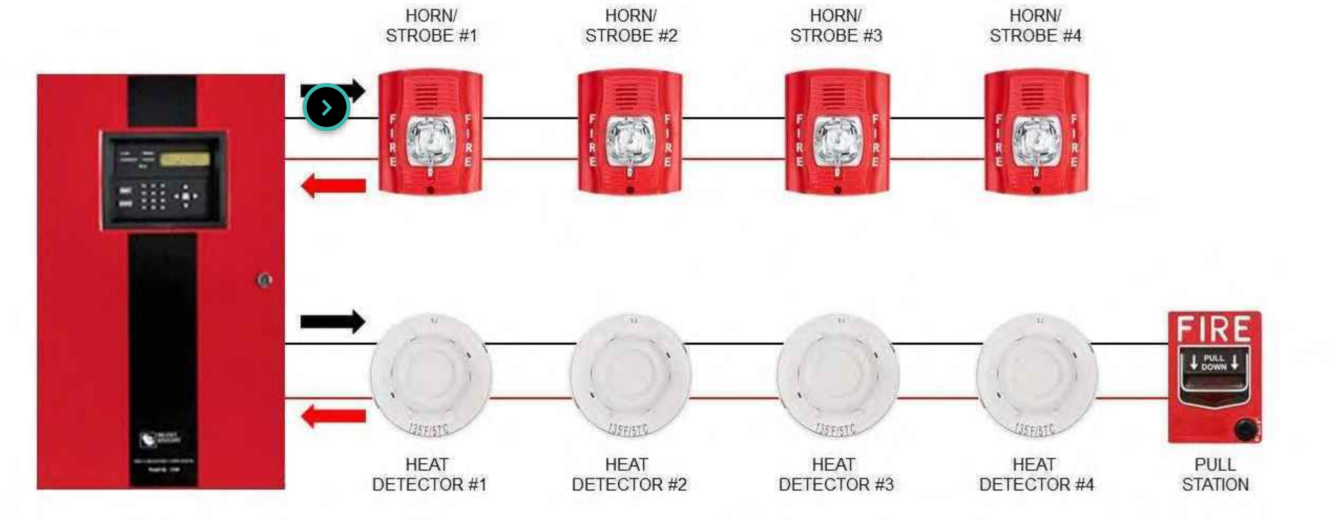
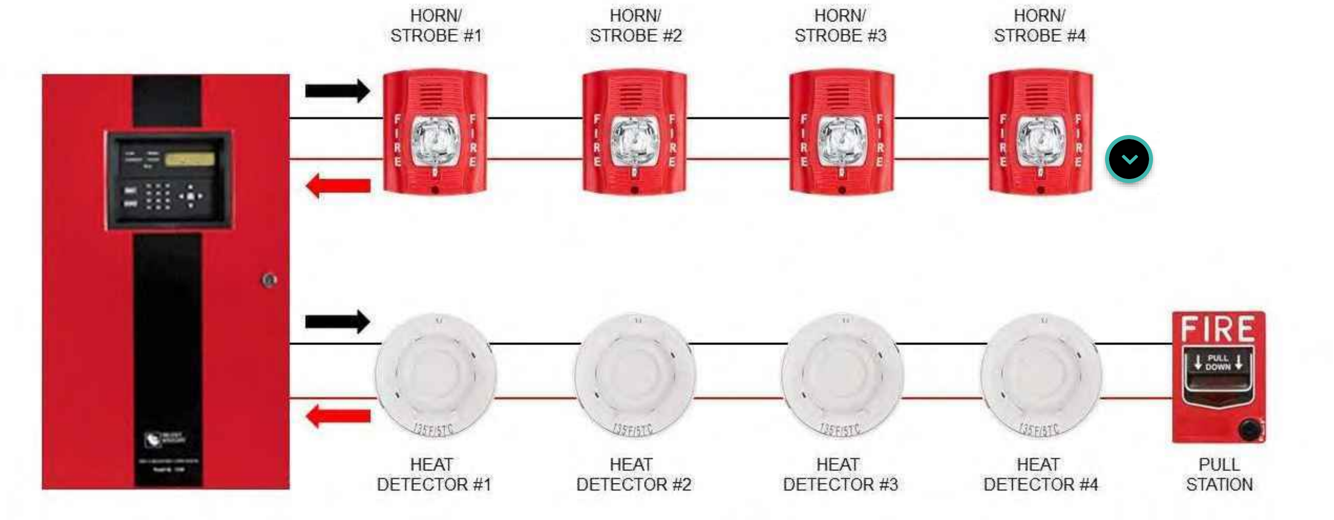
CONTINUE

Click the each of the markers in the diagram below to follow how the current flows through the circuit to the end-of-line resistor (EOLR), then returns to the control unit.

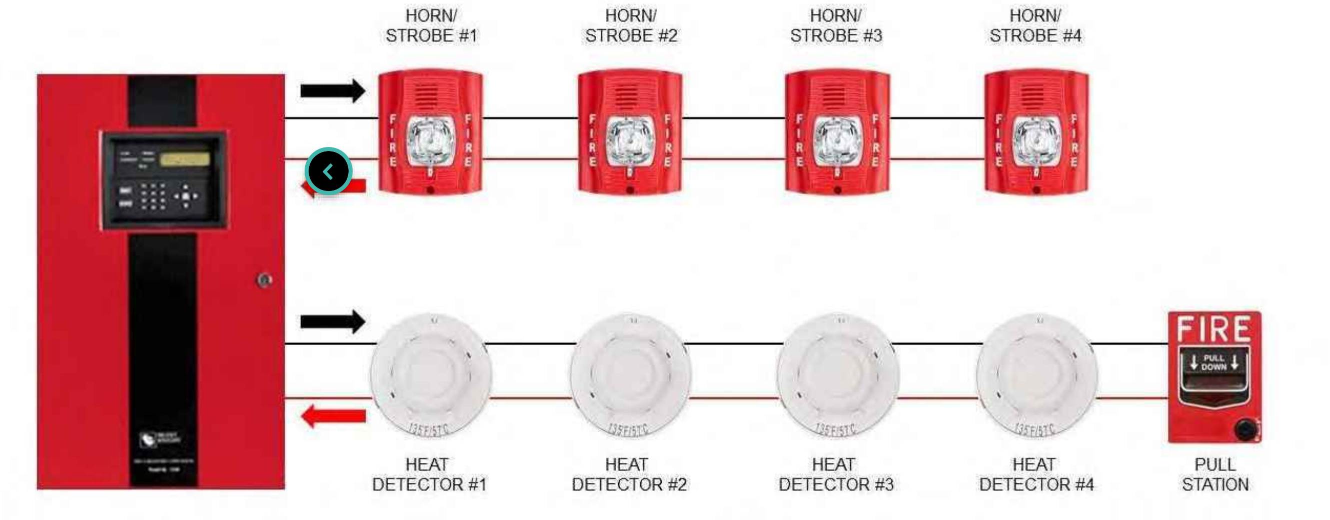

HORN/
STROBE #1
HORN/
STROBE #2
HORN/
STROBE #3
HORN/
STROBE #4
FIRE
PULL DOWN
HEAT
DETECTOR #1
HEAT
DETECTOR #2
HEAT
DETECTOR #3
HEAT
DETECTOR #4
PULL
STATION



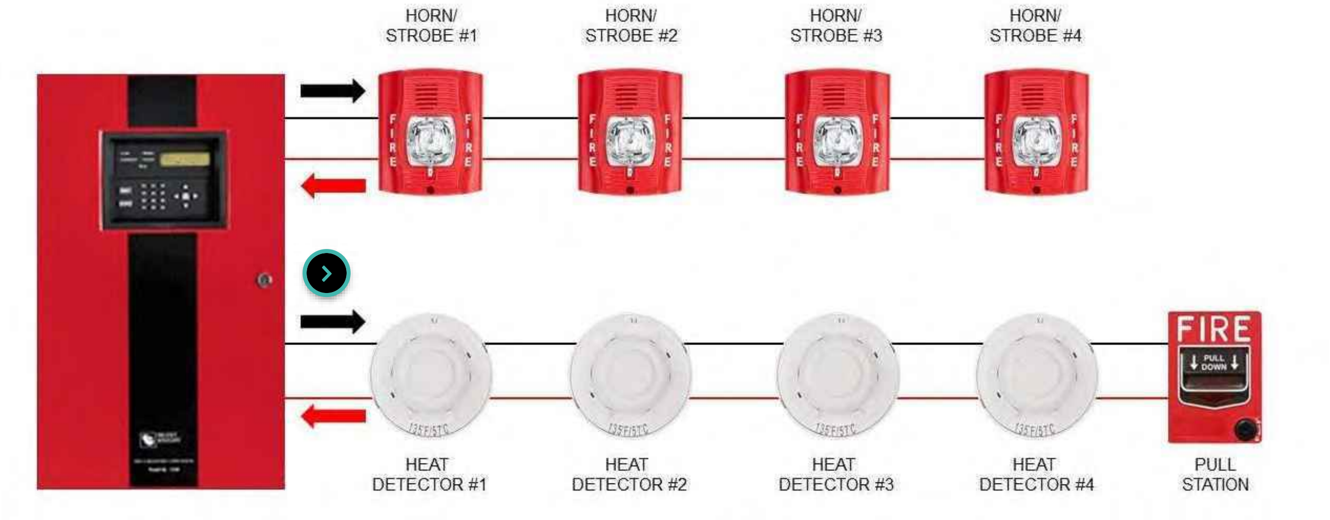
Current flows from the negative terminal (black wire) through the circuit to the end-of-line resistor (EOLR).



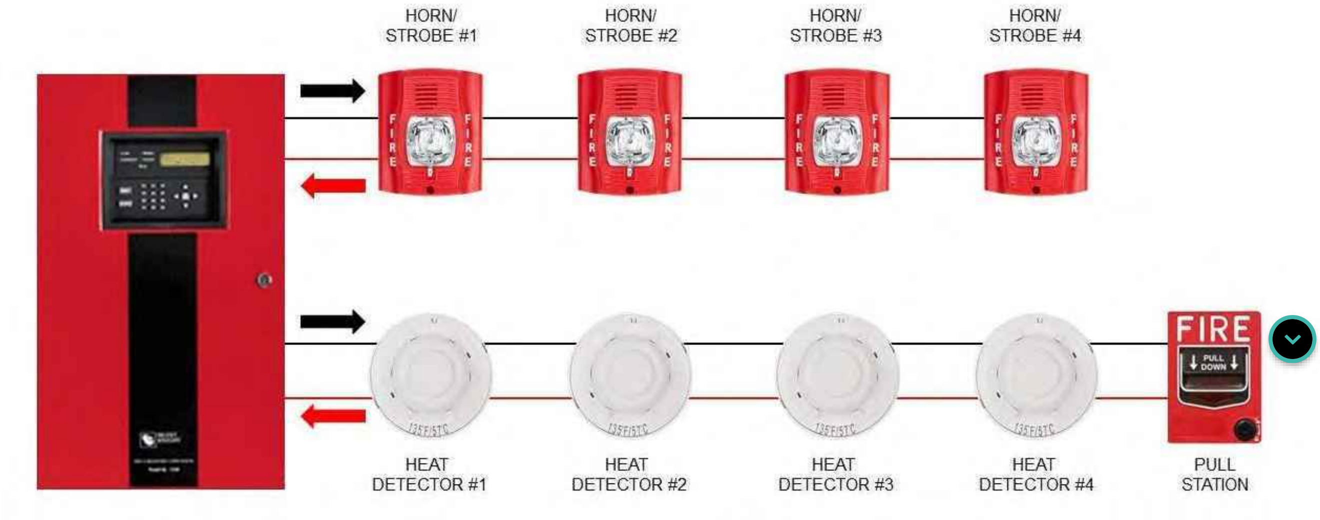
The EOLR limits the amount of current flow for supervision.



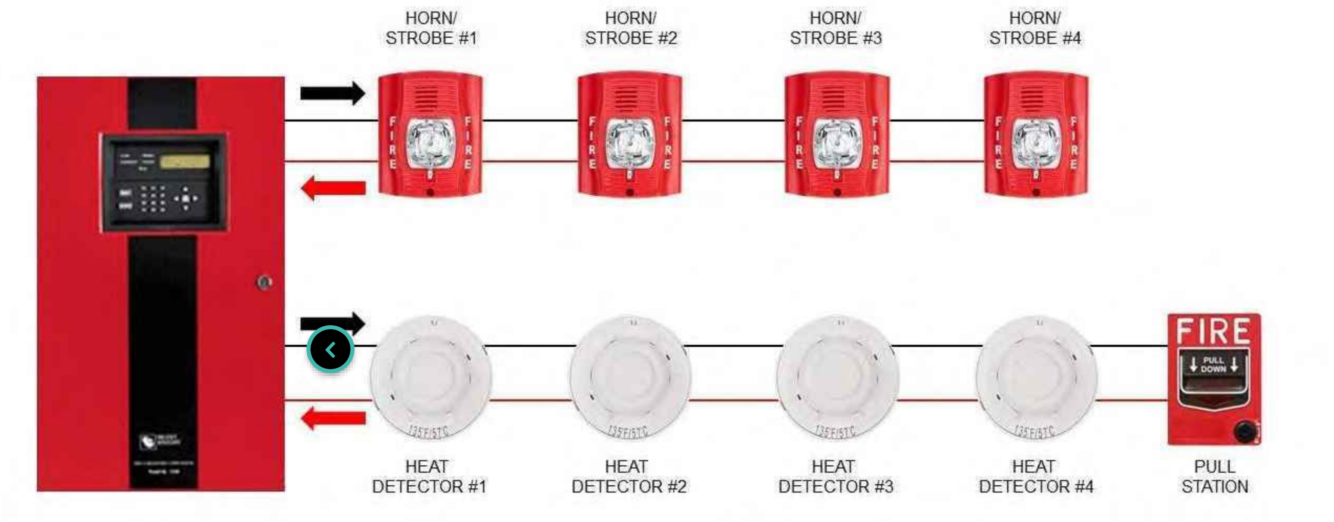
After going through the EOLR, the current returns to the control unit through the red wire to the positive terminal.



Current flows from the negative terminal (black wire) through the circuit to the end-of-line resistor (EOLR).



The EOLR limits the amount of current flow for supervision.



After going through the EOLR, the current returns to the control unit through the red wire to the positive terminal.

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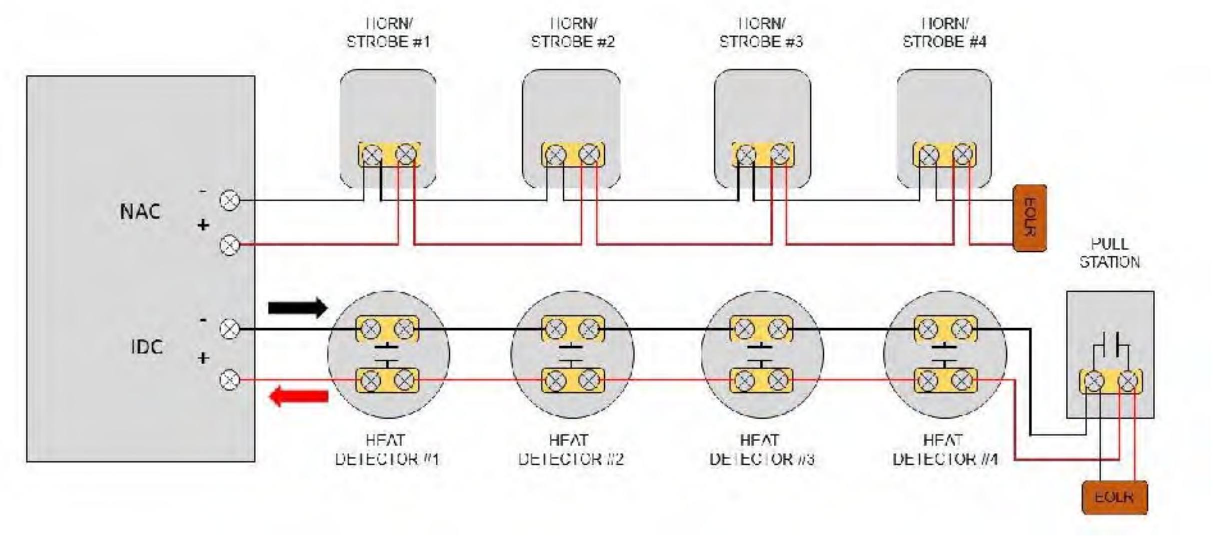
CONTINUE



2-wire detectors (Click on image to enlarge)

This is how the circuit might look electrically.

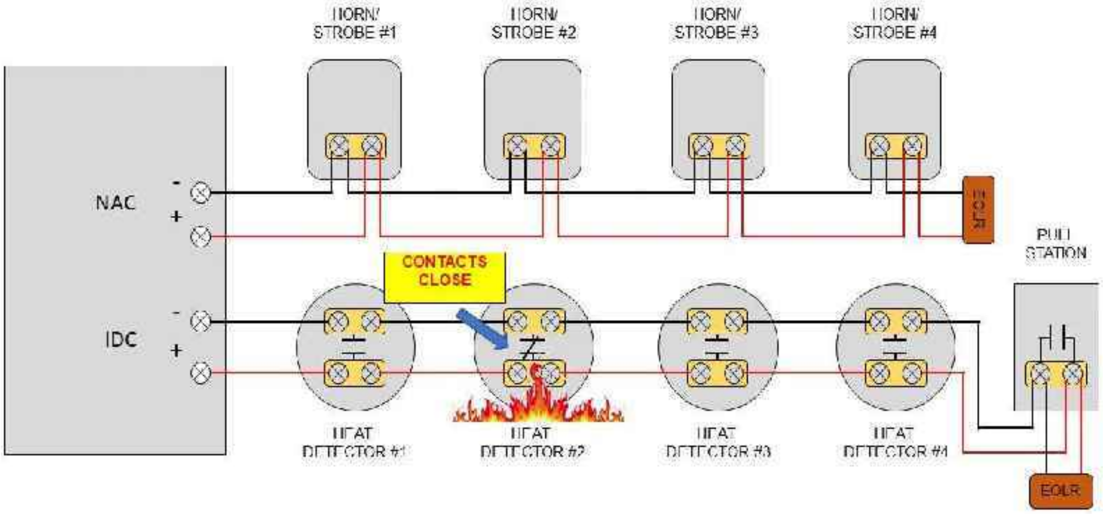
Each device has terminals for **power/circuit in** and **power/circuit out** to the next device or EOL device as applicable.

At the end of the circuit there will usually be an **EOL device, typically a resistor**. The value of the EOLR is determined by the unit manufacturer.

If one or more of the detectors on the IDC senses an alarm, or an occupant actuates the pull station, a set of electrical contacts will close and cause a **wire-to-wire short** between the black and red wires (negative and positive terminals).

The circuit current will bypass the EOLR, causing a rapid increase in current.

The control unit will read that short circuit and go into **alarm mode**, activating the appliances connected to the NAC.



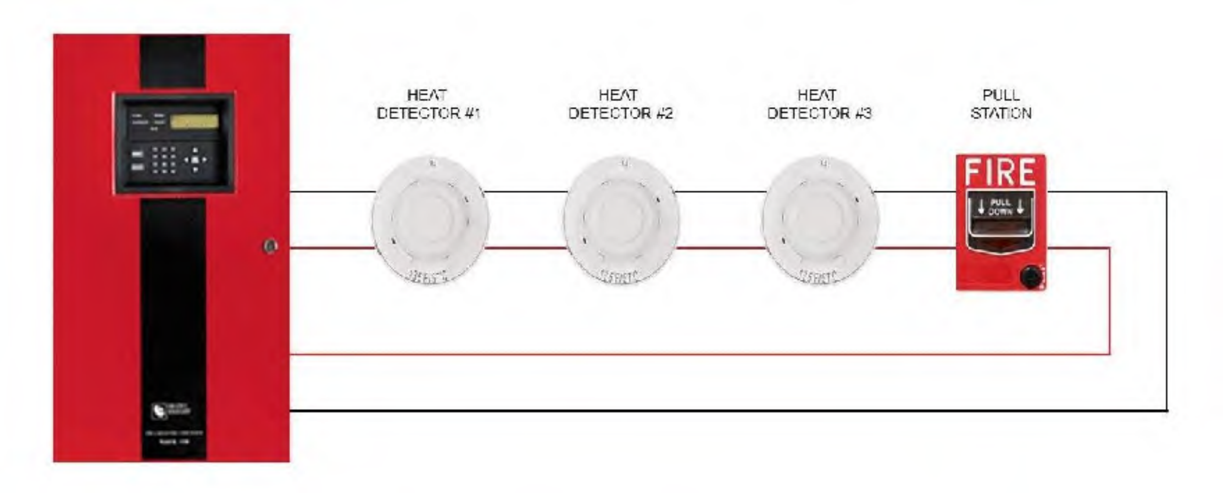
2-wire detector (Click on image to enlarge)

TWO-WIRE DETECTORS (CLASS A)

Two-wire detectors (Class A)

For simplicity, we will only use the IDC for our two-wire Class A circuit explanation.

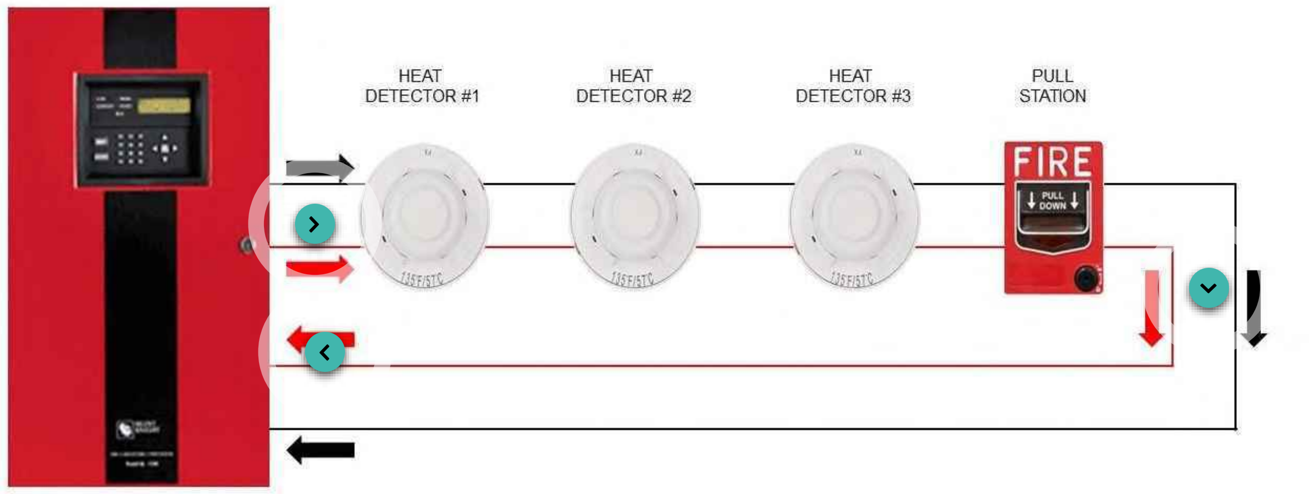
The picture below shows what the circuit might look like pictorially. Each circuit has two wires going to each detector or pull station. After the last device in the circuit, the wires return to the control unit.

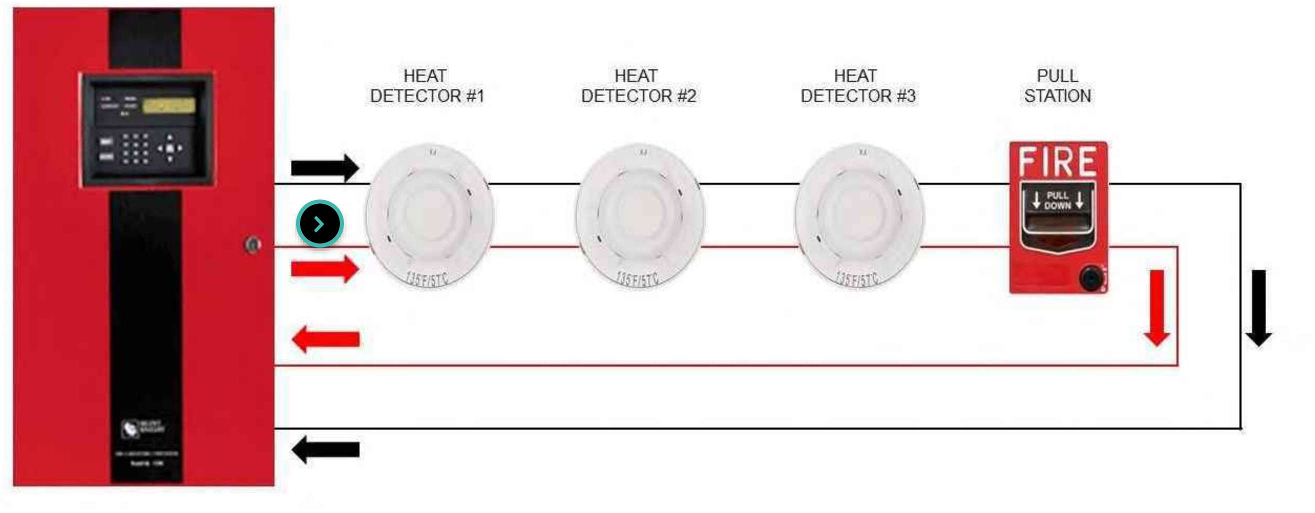


2-wire Class A detector (Click to enlarge image)

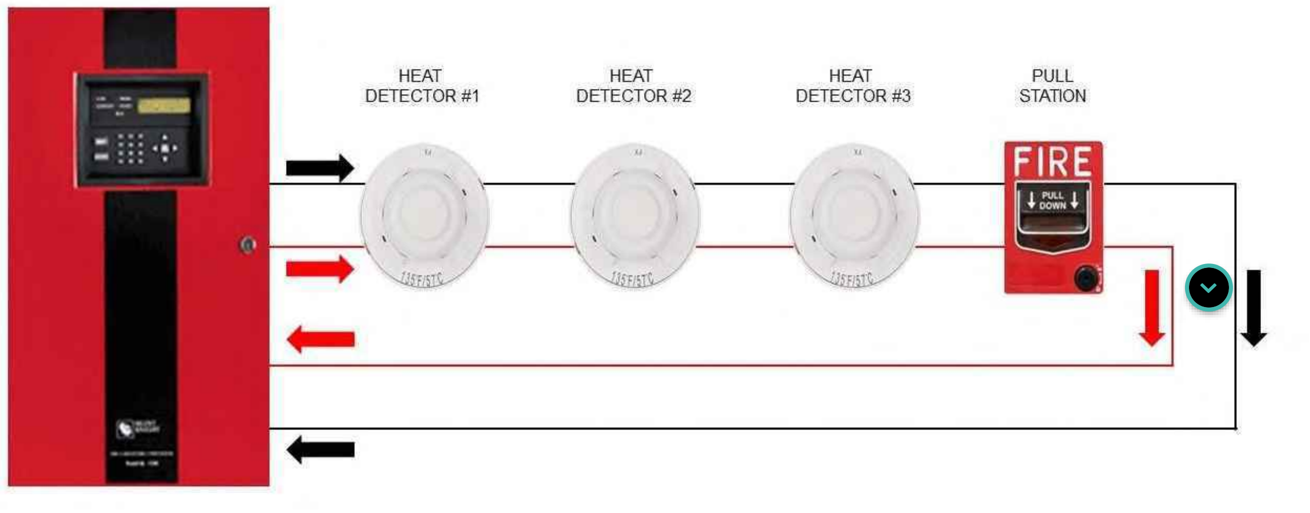
CONTINUE

Click the each of the markers in the diagram below to follow how the control unit monitors the circuit and “looks” for circuit voltage and current across the negative and positive terminals inside the control unit.

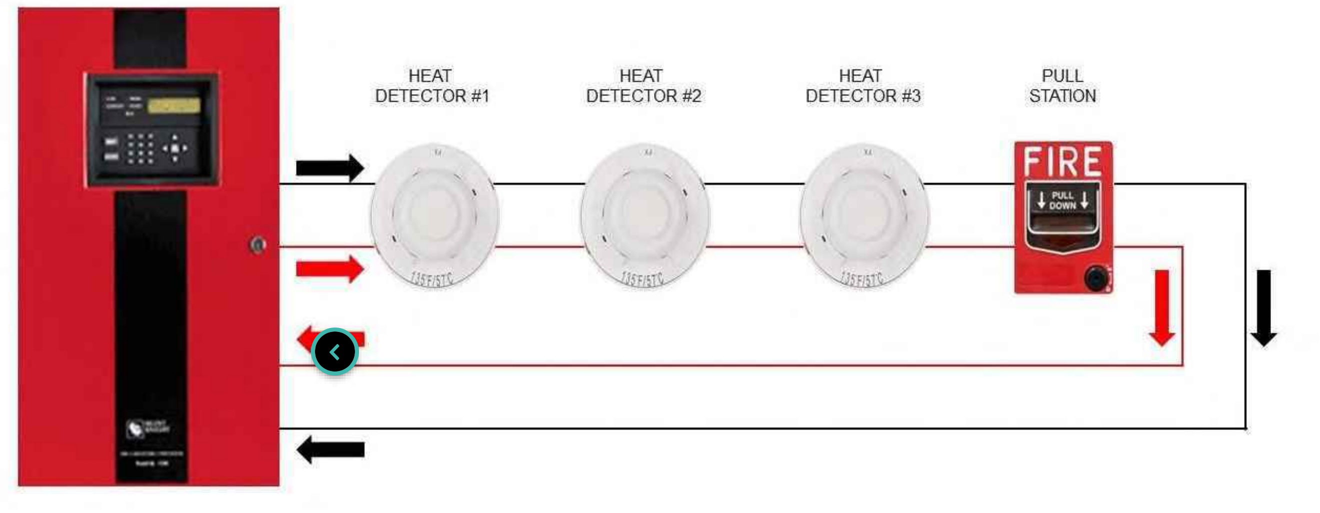

HEAT DETECTOR #1
HEAT DETECTOR #2
HEAT DETECTOR #3
PULL STATION
FIRE
PULL DOWN
135F/57C
135F/57C
135F/57C



In this case, **current flows through the entire circuit and back to the control unit** (there is **no** EOLR).



The control unit monitors the circuit and “looks” for circuit voltage and current across the negative and positive terminals inside the control unit.



If the control unit reads normal circuit voltage and current, it stays in **normal mode**.

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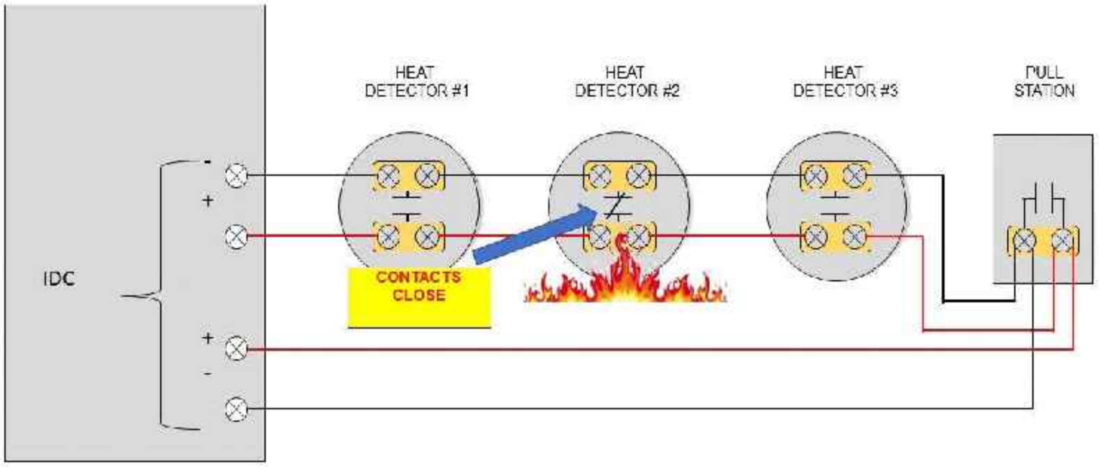
CONTINUE



(Click to enlarge image)

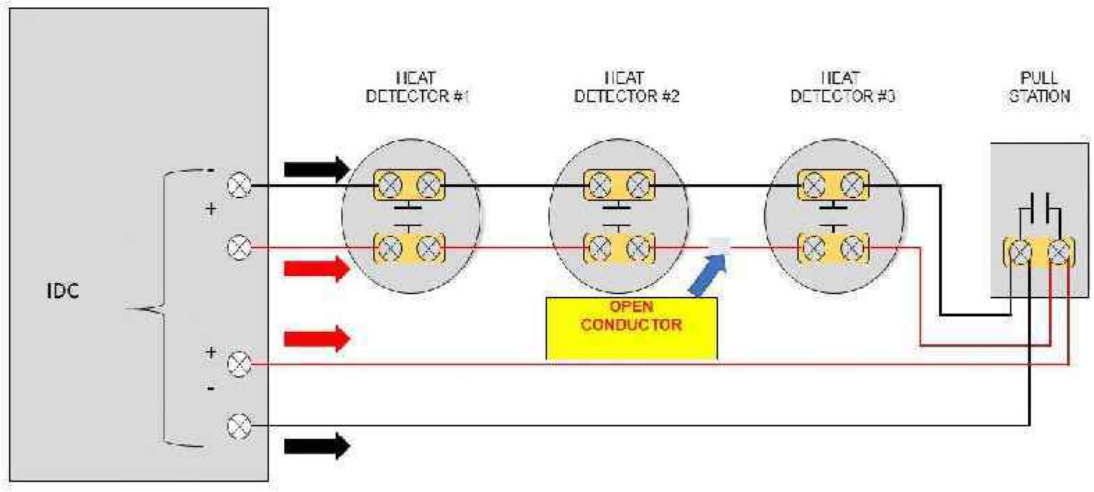
If one or more of the detectors on the IDC senses an alarm, or an occupant actuates the pull station, a set of electrical contacts will close and cause a **wire-to-wire short** between the red and black wires.

The control unit will read that short circuit across the terminals in the control unit and go into **alarm mode**, activating the appliances connected to the NAC.

If there is an open on the circuit, the control unit will sense a loss of power across the return terminals.

The control unit will indicate a **trouble signal**.

Then the control unit will back feed power through the return terminals so that all detectors are still able to receive power, and the control unit **can still sense a wire-to-wire short to go into alarm mode**.



(Click to enlarge image)

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LET'S REVIEW

Let's do a quick check about what has been covered so far.

Two-wire devices and four-wire devices can be installed on the same Class A or Class B fire alarm circuit if the system design calls for it.

○ True

○ False

SUBMIT

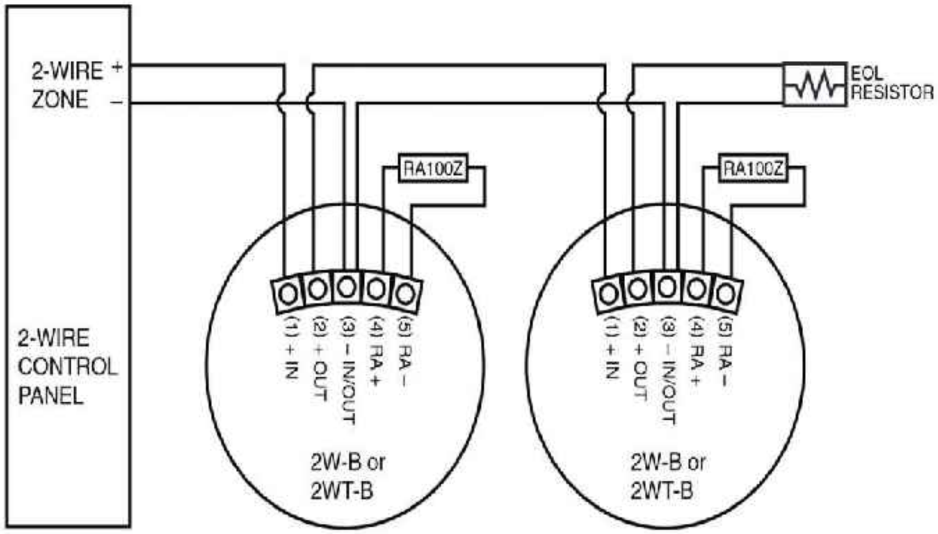
🔒 Complete the knowledge check above before moving on.

Two-wire detectors

The diagram to the right shows typical two-wire smoke detectors on a circuit.

Notice there are **more terminals for a remote annunciator** (terminals 4 and 5).

The remote annunciator will be powered from the detectors and the detectors receive power from the IDC.



2-wire detectors (Click to enlarge image)

TWO-WIRE DETECTORS: CLASS A AND CLASS B

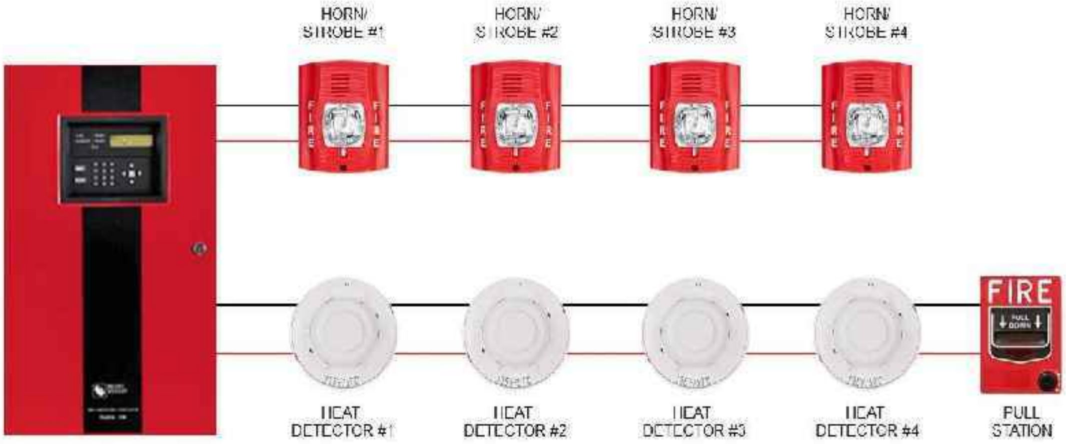
Two-wire detectors: Class A and Class B

Two-wire detectors: Class A and Class B

A summary…

Summary 1

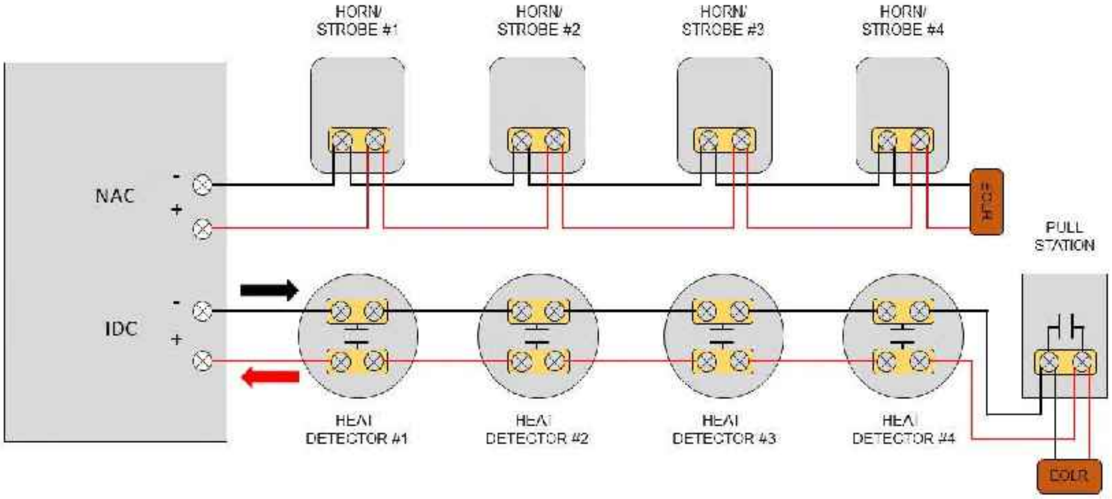
Two-Wire Detectors



Two-wire detectors receive their power from the **same two-wire** **fire alarm control unit** **alarm initiating device circuit** over which they report an alarm.

Summary 2

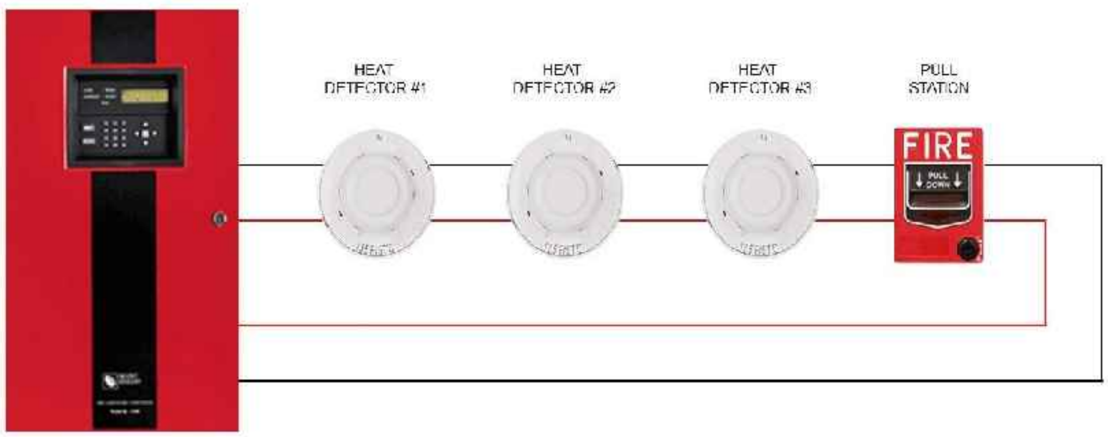
Two-Wire Detectors Class B



On two-wire Class B IDCs, the circuit **ends at the last device** and are typically monitored by an **EOLR**.

Summary 3

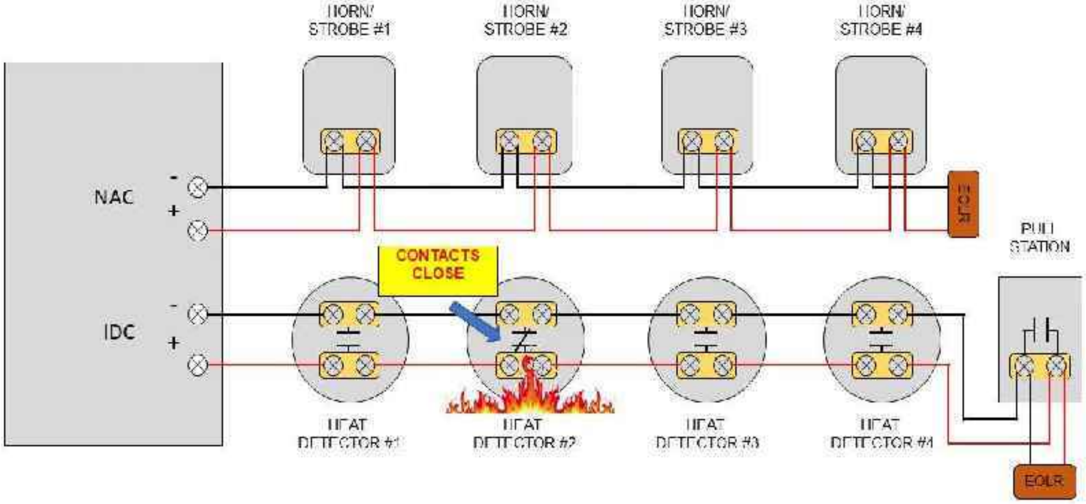
Two-Wire Detectors Class A



Two-wire Class A IDCs **have wires that return to the control unit** after the last device in the circuit.

Summary 4

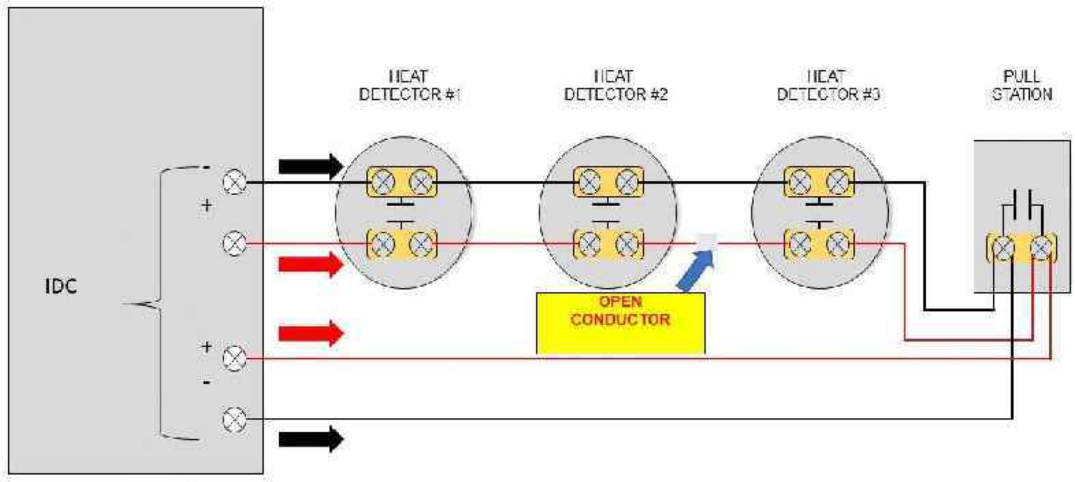
Class A and Class B IDCs



On both Class A and Class B IDCs, if the wires become shorted, **the current in the circuit will rapidly increase, causing the system to go into alarm.**

Summary 5

Class A and Class B Open Circuit



If an **open circuit** occurs, the current in the circuit will **decrease to zero**, causing the system to indicate a **trouble signal**.

Summary

Even though there are only two wires, care must be taken on wiring two-wire detectors to maintain the Class A or Class B functionality.

FOUR-WIRE DETECTORS

Four-wire detectors

Four-wire detectors on Class A or Class B circuits are **very similar to two-wire detectors** on Class A or Class B circuits.

The difference is that the four-wire detectors are **not powered from the Initiating Device Circuit (IDC)**.

An **additional two-wire power circuit** is run from an auxiliary circuit in the fire alarm control unit to supply operating power to the detectors.

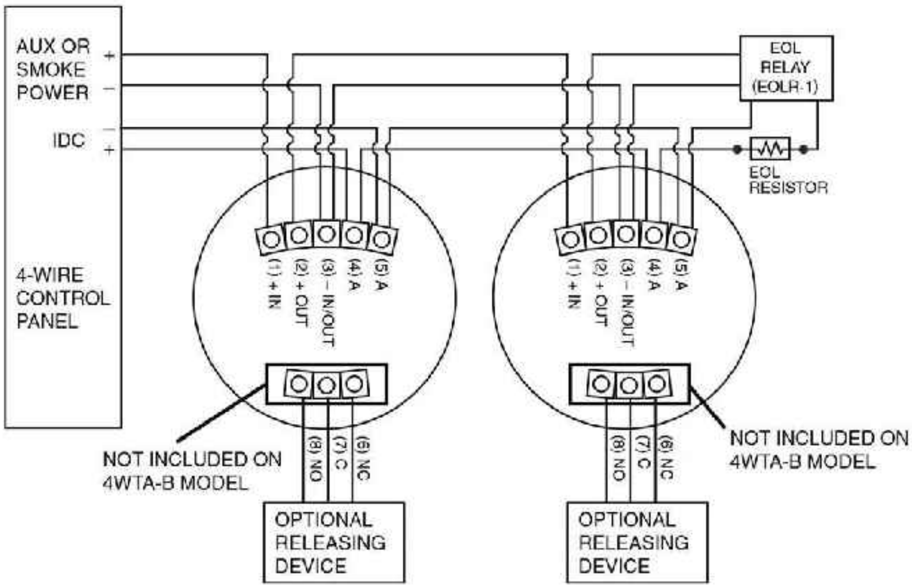
Four-wire detectors are used to provide **additional functions** such as relays to turn a safety function on or off, control smoke or fire doors, activate elevator recall, etc.

The auxiliary power circuit is needed because the IDC will not be able to support the added functions and still allow any two-wire detectors on that circuit to operate.

The diagram to the right shows typical four-wire smoke detectors on a circuit. Notice the additional terminals for relay contacts (terminals 6, 7, and 8).

The internal relay will be powered from the **auxiliary or smoke power**. The detector will report an **alarm** on the IDC terminals (terminals 1, 2, and 3).

To ensure the smoke detector and the IDC is monitored for integrity/supervised, **an EOL supervisory relay** is used to open the IDC if power is lost.



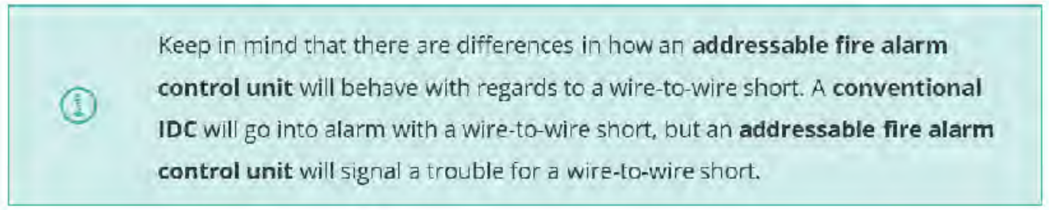
4-wire detector (click on image to enlarge)

ADDRESSABLE SYSTEM WIRING

Addressable System Wiring

The wiring and compatibility of addressable devices is **driven by the manufacturers of the devices and systems** due to signal levels and the proprietary software protocols used.

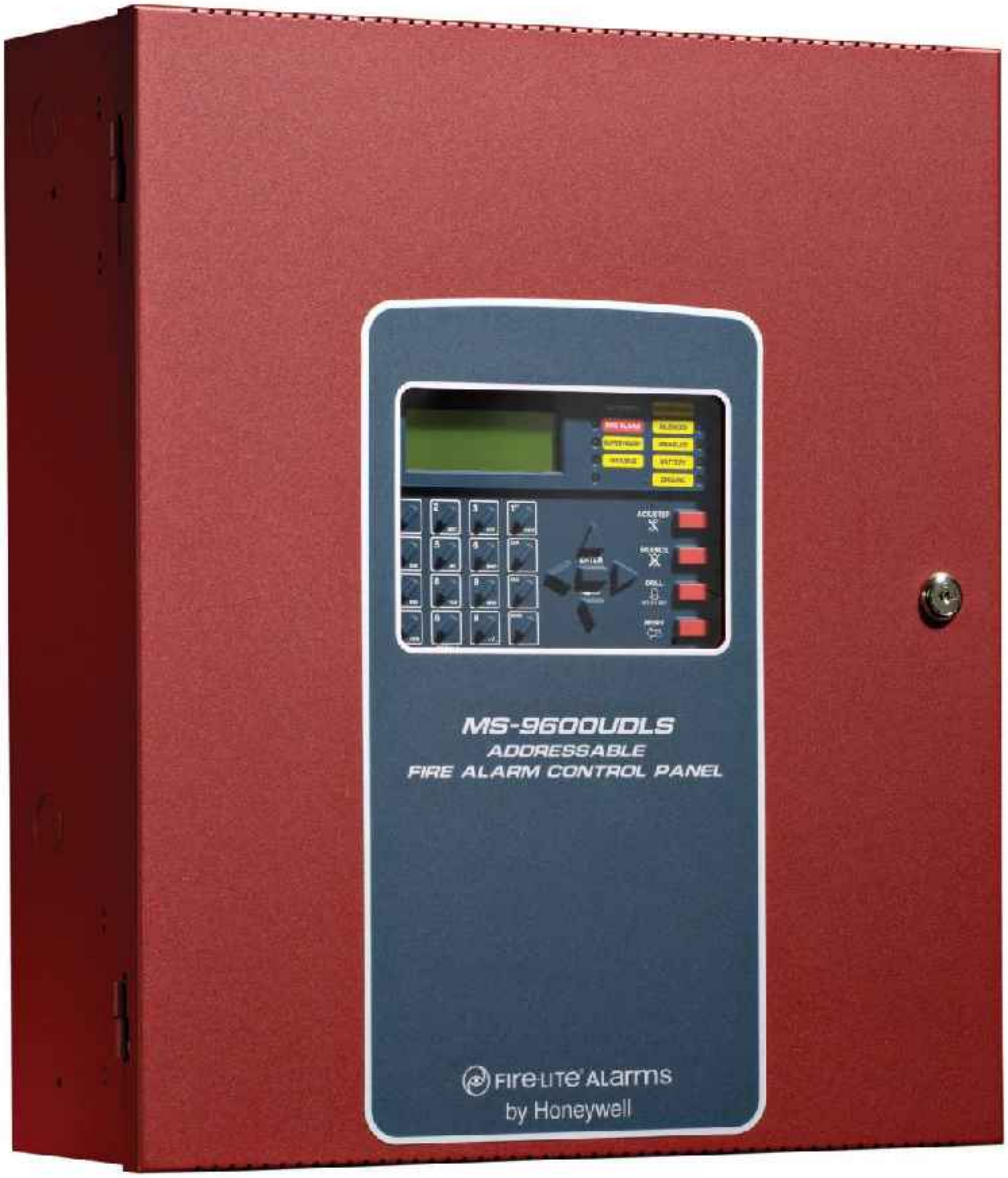
Most addressable devices are **two- or four-wire devices** that are **wired to SLCs** in **Class A, Class B, or Class X circuits.**



Keep in mind that there are differences in how an **addressable fire alarm control unit** will behave with regards to a wire-to-wire short. A **conventional IDC** will go into alarm with a wire-to-wire short, but an **addressable fire alarm control unit** will signal a trouble for a wire-to-wire short.

The notable difference, of course, is the fact that the devices in an addressable system have **unique identifiers** that may be programmed by computer, the control unit, or rotary switches on the devices themselves.

Although there are differences in the capabilities of conventional systems vs. addressable systems**, the wiring of the devices is very similar**.



Addressable Control Panel

Summary

A fire alarm system is made up of the fire alarm control unit, initiating devices and circuits, and notification appliances and circuits.

2

NFPA 70 2017 (*NEC*) defines the requirements for the wiring of fire alarm systems. **Article 760** of the *NEC* defines wiring for power limited and non-power limited circuits.

3

The fire alarm system must have both a **primary and secondary power supply**. The secondary power supply must provide standby power for **24 hours** followed by **5 minutes** in full alarm.

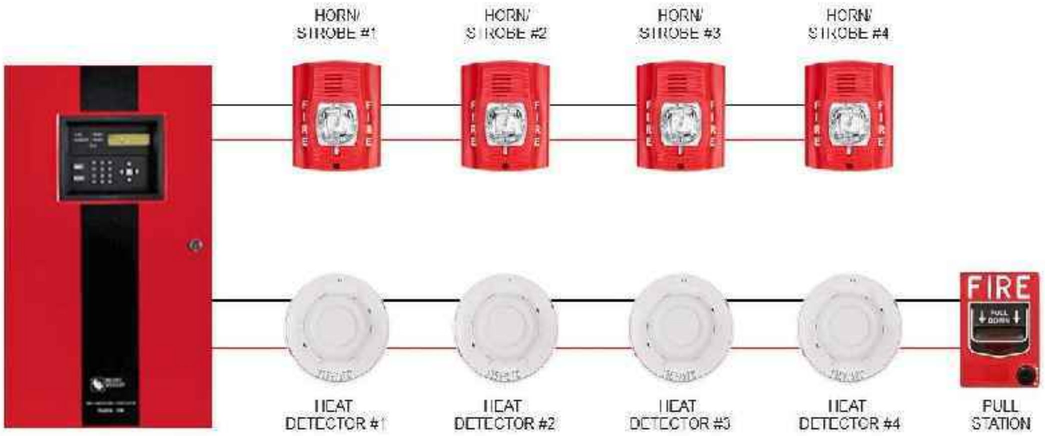
4

If the system is an emergency voice communication system, the secondary power supply must provide standby power for **24 hours** followed by **15 minutes** in full alarm.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Is the image below an example of a two-wire or a four-wire circuit?

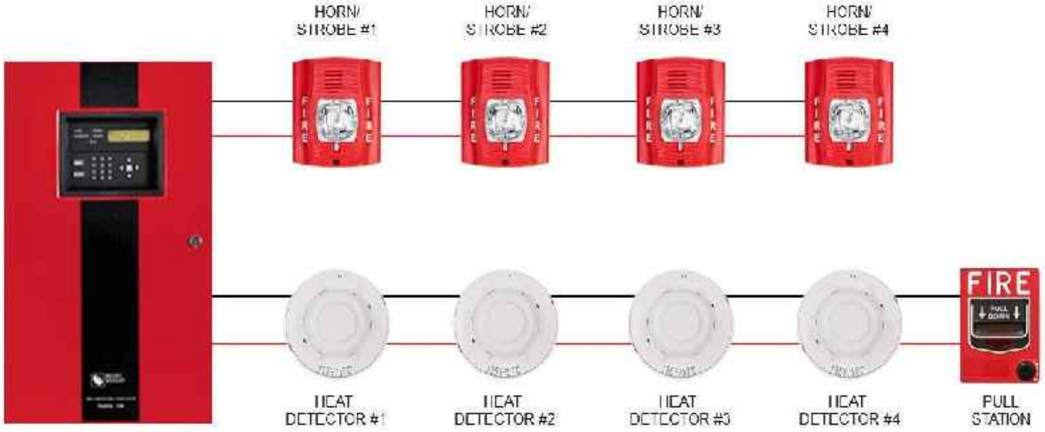


○ Two-wire

○ Four-wire

SUBMIT

Is the image below an example of a Class A or a Class B circuit?



○ Class A

○ Class B

SUBMIT

NFPA 70 (NEC) defines the requirements for the wiring of fire alarm systems. Article _______ of the NEC defines wiring for power limited and non-power limited circuits.

Type your answer here

SUBMIT

Complete the knowledge check above before moving on.

After completing this module, you should now have a better understanding of the fire alarm basics and different types of wiring and circuits for fire alarm systems.

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.

Ohio Fire Alarm and Detection Equipment-Detection Devices

Welcome to the Detection Devices module of the Ohio Fire Alarm and Detection Systems Course.

By the end of this module, you will be able to do the following:

- Identify design features for each type of heat detector.
- Compare advantages and disadvantages of restorable and non-restorable heat detectors.
- Recognize operational characteristics for different types of smoke detectors.
- Select the correct smoke detector for various installation environments.
- Properly locate smoke detectors in different construction configurations.
- Define methods required for duct detector installation.
- Explain the unique features of sprinkler waterflow alarms and their impact on a fire alarm system.
- Identify types and purpose of alarm-initiating supervisory devices.

- Describe the functionality of different types of manually-actuated alarm-initiating devices.

Key Reference for this module:
NFPA 72 - National Fire Alarm and Signaling Code, Chapter 17, 2016

When you are ready to begin, click on the button above to start the course.

- **Heat Detectors**
- **Smoke Detectors**
- **Location and Spacing**
- **Other Types of Detectors**

Lesson 1 of 4

Heat Detectors

What is the difference between a restorable and a non-restorable heat detector? Is one better to use than the other or does it depend on the situation?

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Identify design features for each type of heat detector.

2. Compare advantages and disadvantages of restorable and non-restorable heat detectors.

LET'S GET STARTED

Automatic Fire Detectors

The detector is designed to respond to different fire signatures. There are several different design types of automatic fire detectors, including:

1. Heat detector
2. Smoke detector
3. Radiant energy detector
4. Gas detector
5. Combination detector (heat & smoke, smoke and gas)

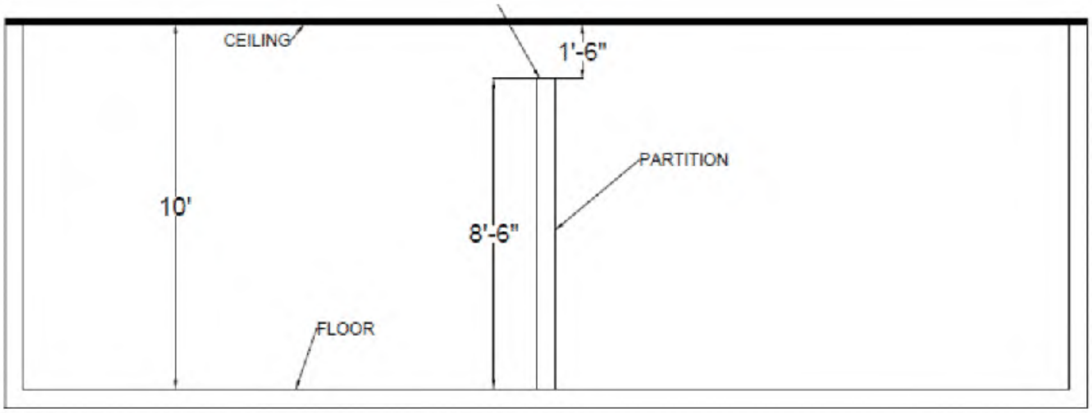
HEAT DETECTORS

Heat Detectors

Heat detectors are **triggered** by heat from the fire. Smoke causes more injuries and fatalities than the heat from the fire. This is one reason heat detectors are not used for life safety.

While smoke detectors are sensitive to contaminants in the air and the environment, heat detectors are rugged and fairly immune to these issues. Sometimes this makes them the best choice for an area or application.

Heat detectors have been made in many designs including **restorable, non-restorable, electronic, mechanical, fixed temperature,** and **temperature rate-of-rise.**



This dividing partition is within 15% of the total ceiling height of the room. Based upon the NFPA code reference provided, this space is considered 2 rooms, requiring 2 detectors. (Click image to enlarge)

> Unless tested and listed for recessed mounting, detectors shall not be recessed into the mounting surface. Where partitions extend to within 15% of the ceiling height, the spaces separated by the partitions shall be considered as separate rooms. **- *NFPA* 72 2016, Sections 17.5.1 and 17.5.2**

SPOT-TYPE HEAT DETECTOR

Spot-Type Heat Detector Operation

Spot-type heat detectors only detect heat at a single point or location. There are several versions of this type of detector.

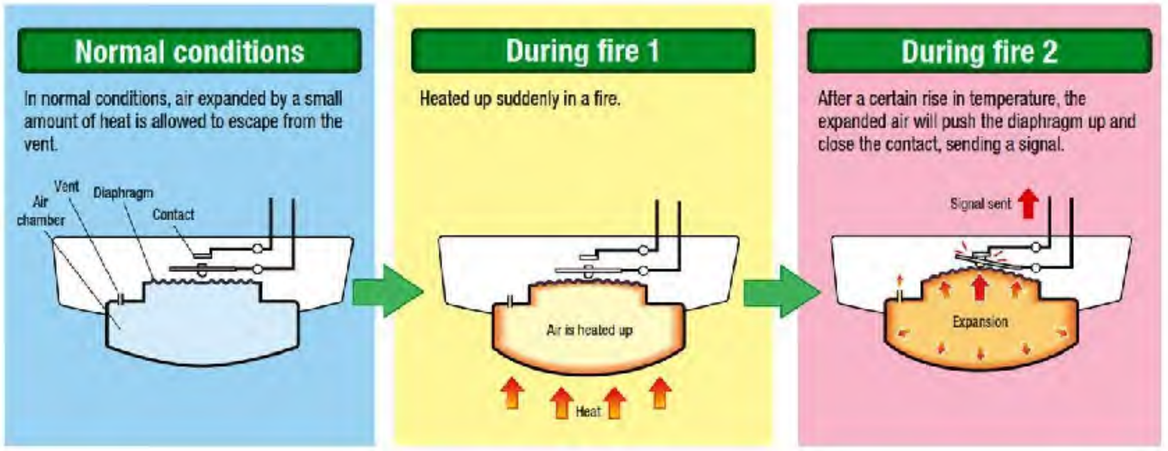
Spot-type heat detectors have been made in many designs including **restorable, non-restorable, electronic, mechanical, fixed temperature,** and **temperature rate-of-rise.**

RESTORABLE VS NON-RESTORABLE HEAT DETECTORS

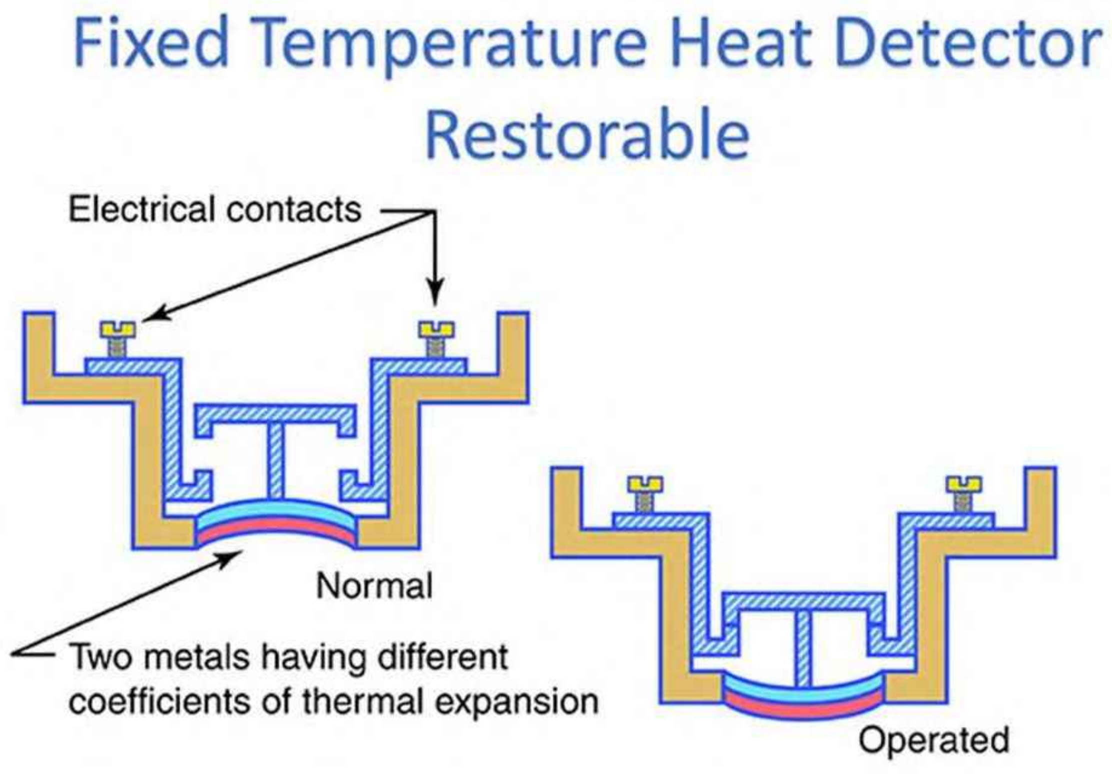
Restorable vs. Non-Restorable Heat Detectors

Restorable means that after the fire is over, or more accurately, after the heat has been reduced to an acceptable level, these detectors will normally **restore themselves to a condition where they are ready for action** again.

Rate-of-Rise Detector (Restorable)



This image visualizes how a rate-of-rise heat detector operates. A rate-of-rise detector is an example of a restorable detector, as this device will not typically be destroyed in a fire. (Click to enlarge image)



The restorable versions have 2 bi-metal plates that when heated cause the plates to expand causing the plunger to drop and go into alarm. (Click to enlarge image)

These devices **respond to rapid increases in temperature** (approximately 15° F per minute or faster) and generate a **pneumatic signal** from the increased air pressure. This pressure can be used directly to trigger an actuator, or indirectly to close an electrical contact.

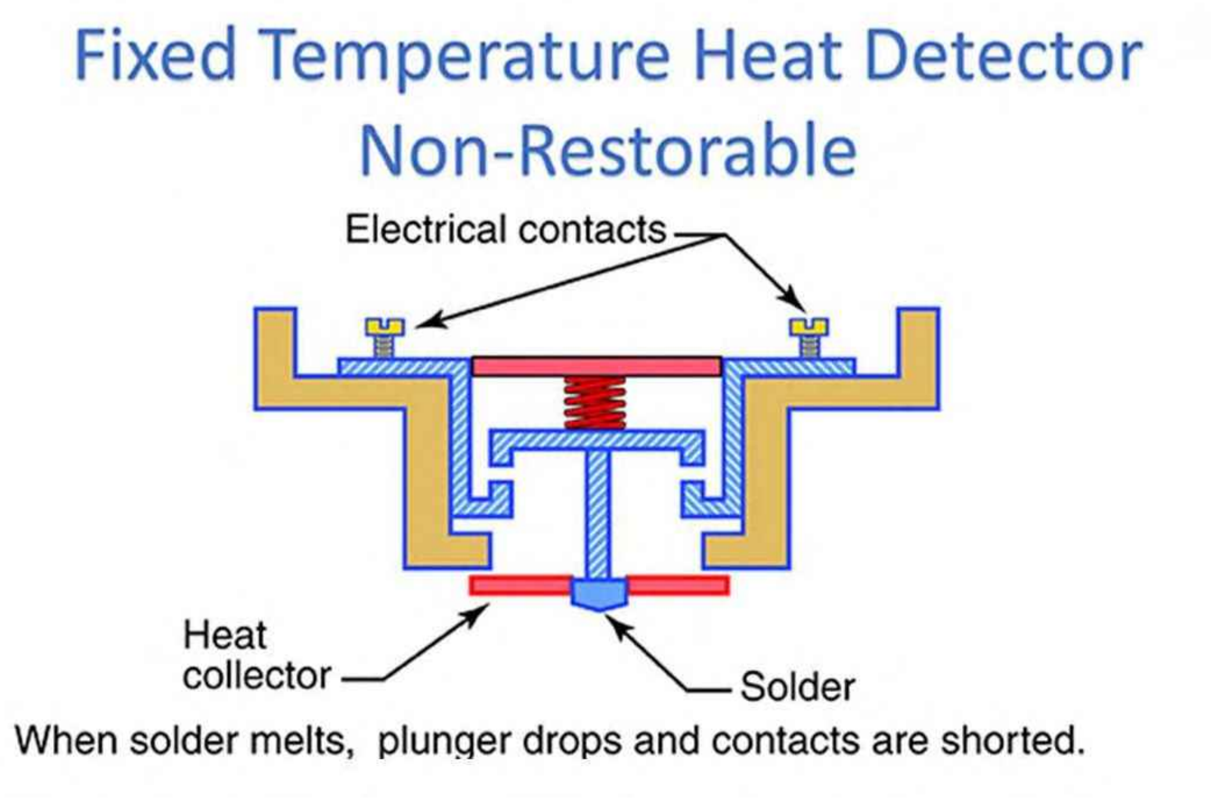
When the temperature is decreased, the air pressure decreases and the pneumatic signal vanishes. At this point, the rate-of-rise detector will generally restore itself to a ready condition.

If a **mechanical actuator** is part of the design, it is almost always necessary to **manually reset the actuator** prior to the system being put back into operation.

CONTINUE

Non-restorable designs **self-destruct** when exposed to their design temperature. These devices must be replaced in order to restore the detector to service. The most common example is the **fusible link**. The fusible link is two pieces of metal soldered together with an **eutectic solder**.

The **eutectic solder** is designed to **melt at a specified temperature**. The heat of the fire fuses, or melts, the eutectic solder. The metal parts held together by the solder will separate, causing the device to initiate an alarm.



When the detector reaches its listed temperature the solder melts causing the plunger to drop. When the plunger drops, this requires the detector to be replaced. This is the most common configuration with fixed temperature heat detectors. (Click to enlarge image)

Sample of quartzoid bulbs. Each color represents a certain temperature threshold that the bulb can withstand before it melts. (Click to enlarge image)

A **quartzoid bulb** is sometimes used in a non-restorable detector. It is comprised of a liquid inside of a glass or plastic vial that is similar to a sprinkler head. As the temperature increases to the design level of the detector:

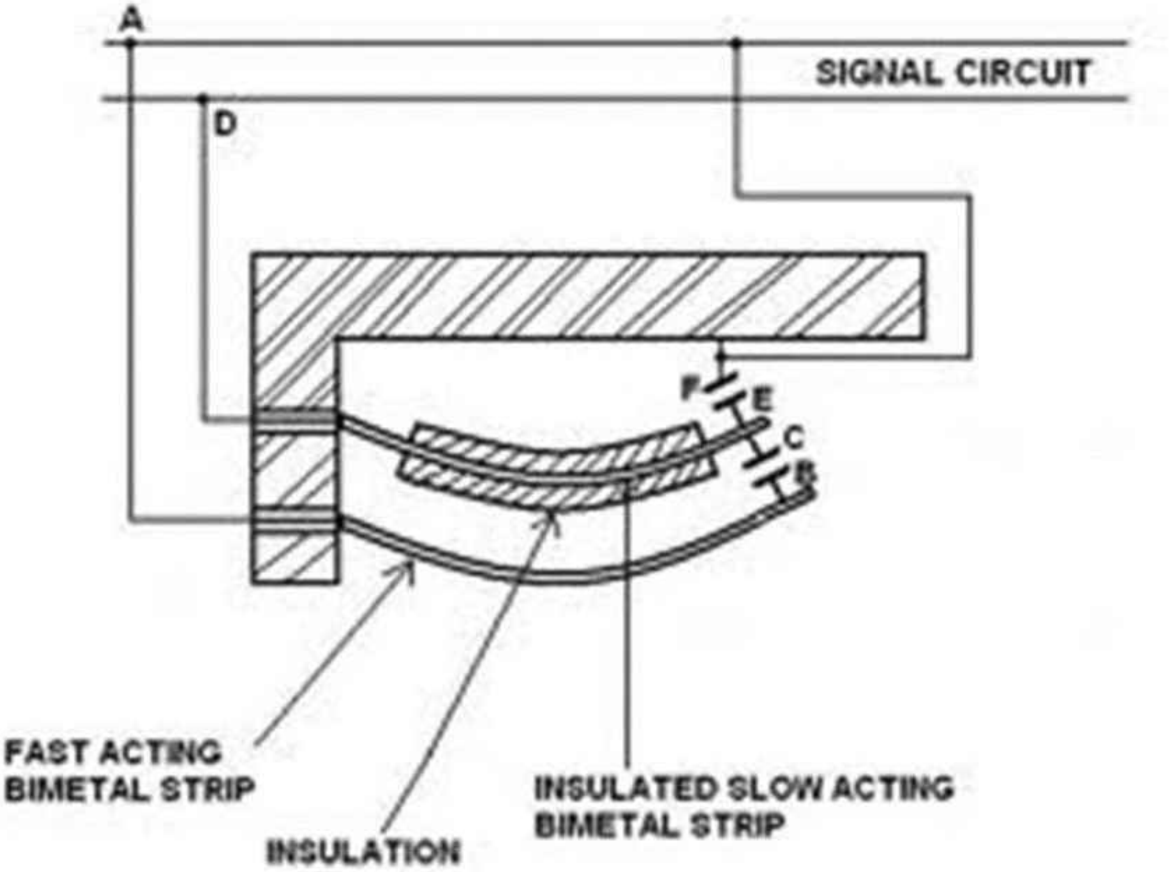
1. The liquid expands.
2. This expansion breaks the glass.
3. The mechanical portion of the detector actuates (releases).
4. This actuation provides slack in a tensioned cable, or some other form of mechanical signal according to its intended functions.

CONTINUE

Mechanical Heat Detectors (Non restorable)

Mechanical heat detectors are typically **lower in cost**, but are most often **not restorable**. The mechanical elements are destroyed or damaged, so these detectors cannot be field tested.

One type of mechanical restorable detector is a simple bimetallic device or thermistor (bottom right). A bimetallic device is one which has two different kinds of metals fused together. When they are exposed to heat, the metals **expand at different rates** which cause the bimetallic component to bend or twist. This physical phenomenon can be used to open or close an electrical contact.



ELECTRONIC HEAT DETECTORS

Electronic Heat Detectors

thermistor

Some heat detectors combine the rate-of-rise feature with a fixed temperature unit. In a rapid change of temperature from a fire, **the rate-**

of-rise will activate before the fixed temperature is reached. A **bi-metallic strip** or **thermistor** are sometimes used in restorable heat detectors.

Electronic heat detectors utilize thermistors that are resistors that change resistance based on the ambient temperature. By using electronic circuitry, it is not difficult to make a thermistor-based detector operate at a **fixed temperature or a rapid change in temperature**, improving the response time.

CONTINUE

Let's do a quick check about what has been covered so far.

The detector is designed to respond to different fire signatures. There are several different design types of automatic fire detectors, including: (Select all that apply)

☐ Heat detector

☐ Radiant energy detector

☐ Gas detector

☐ Carbon monoxide detector

SUBMIT

Heat detectors have been made in many designs including: (Select all that apply)

☐ manual

☐ non-restorable

☐ restorable

☐ temperature rate-of-rise

SUBMIT

Complete the knowledge check above before moving on.

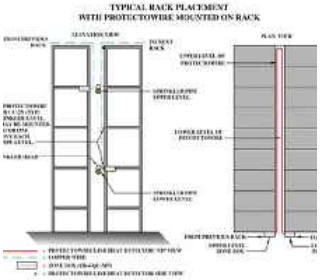
Line-Type Heat Detectors

All of the heat detectors we have discussed so far are referred to as "spot-type" detectors. There are also non-restorable, "line-type“ detectors. They can respond to the fire signature along its entire length.

These linear heat detection cables can be hundreds of feet in length, making them ideal for conveyor, rack storage, or cable tray applications.

They are **non-restorable** because **the insulation must melt away** in order to generate the electrical signal. At least the section of cable which has been exposed to the high temperature **must be replaced**.

(Click to enlarge image)



(Click to enlarge image)

CONTINUE

Sort the cards below to demonstrate what you have learned.

Restorable

rate-of-rise detector

pneumatic signal

mechanical actuator

electronic heat detector

Non-restorable

eutectic solder

quartzoid bulb

mechanical detector

line type

Complete the card sort above before moving on.

Lesson 2 of 4

Smoke Detectors

When we hear "smoke detector" probably an image of a round, white smoke detector in your house comes to mind, however there are many other types of smoke detectors which are designed for various surroundings.

Goals for This Lesson

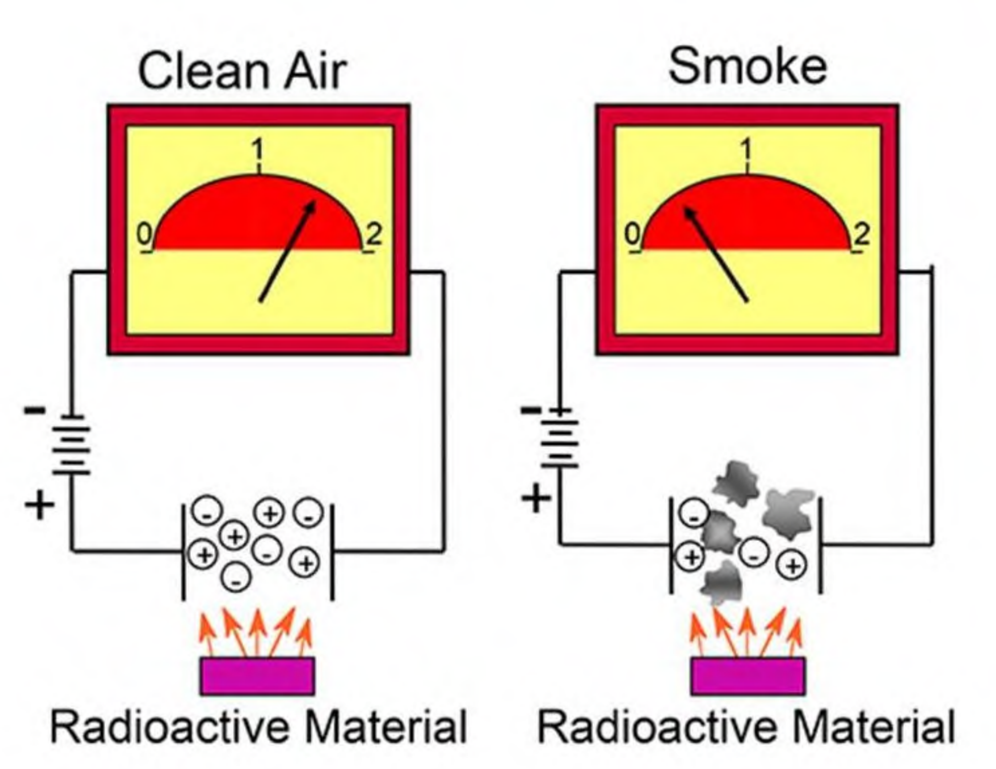
By the end of this lesson, you will be able to do the following:

1. Recognize operational characteristics for different types of smoke detectors.

2 Select the correct smoke detector for various installation environments.

SPOT-TYPE SMOKE DETECTORS

Ionization Smoke Detectors



Ionization detectors are the most common technology in the life safety industry. The detector has a chamber that contains ions (small radioactive particles), and as smoke enters the chamber these ions disappear causing the detector to go into alarm. These detectors are prone to nuisance alarms, as smoke as simple as toast burning in a toaster can cause these detectors to go in alarm. (Click to enlarge image)

Ionization smoke detectors operate on the principal of air in the detector being **ionized**, or given an electrical charge. **Ionized air easily conducts electricity**.

Smoke particles attach themselves to the ionized air. These combined particles create a larger mass which conducts current more slowly than does the clean ionized air.

This current reduction, or resistance, is sensed by the calibrated circuitry in the ionization detector. This results in an alarm signal to the control.

Ionization smoke detectors **will respond faster to flaming fires**. You may not want ionization detectors near a cooking area or bathroom area due to their **susceptibility of false alarms** from invisible smoke or high humidity.

Dirt or dust entering the chamber also reduce the amount of current in the ionized air and will make the unit more sensitive or create a false alarm.

Chambers must be **periodically cleaned** to maintain specified sensitivity rating.

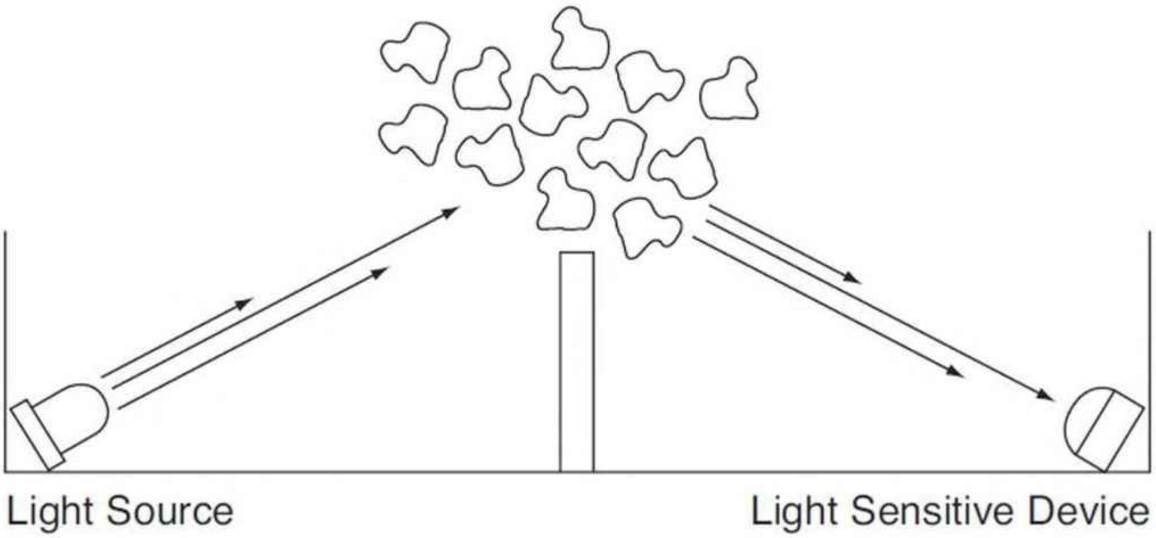
PHOTOELECTRIC SMOKE DETECTORS

Photoelectric Smoke Detectors

Photoelectric smoke detectors operate with the **light-scattering** concept.

There is a **light source** and a **light-sensitive** target. The target is NOT accustomed to receiving a significant amount of light from the light source because it is not directly in the path of the light beam.

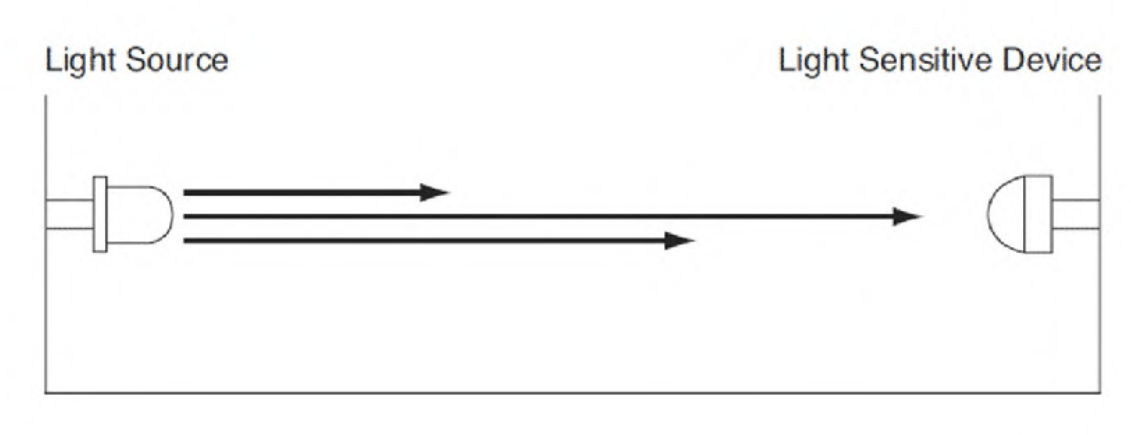
Smoke gets into the detector chamber and **scatters the light beam** (the light energy is deflected, or scattered), or **redirects it to hit the target**. When the target receives this reflected light, the detector circuitry generates an alarm.



(Click to enlarge image)

PHOTOELECTRIC BEAM-TYPE SMOKE DETECTORS

Photoelectric Beam-Type Smoke Detectors



(Click to enlarge image)

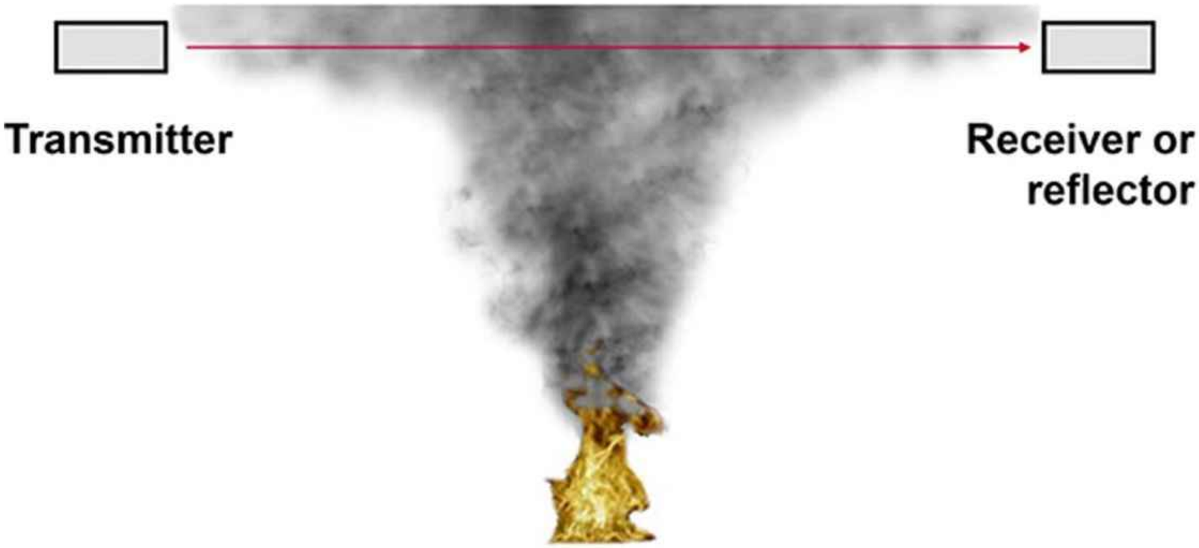
Photoelectric beam-type smoke detectors use the **light obscuration concept.**

Particles of combustion obscure a beam of light which is directed from a source to a target. The target then **senses the reduction in light** from the light source.

This light reduction reaches the design level of the detector, generating a signal which the control panel interprets as smoke in the protected area.

Light obscuration detectors are primarily intended for **large open areas** such as atriums, large entrances, large hallways, or other building features where we need to cover a large distance, area, or volume.

A **beam detector uses 2 components for detection**. The transmitter is the electronic part of the detector, and sends a beam to a receiver or reflector across from the transmitter. When smoke obstructs the beam path to the listed obstruction percentage, the transmitter provides an alarm signal. What is being shown in this image is photoelectric technology.



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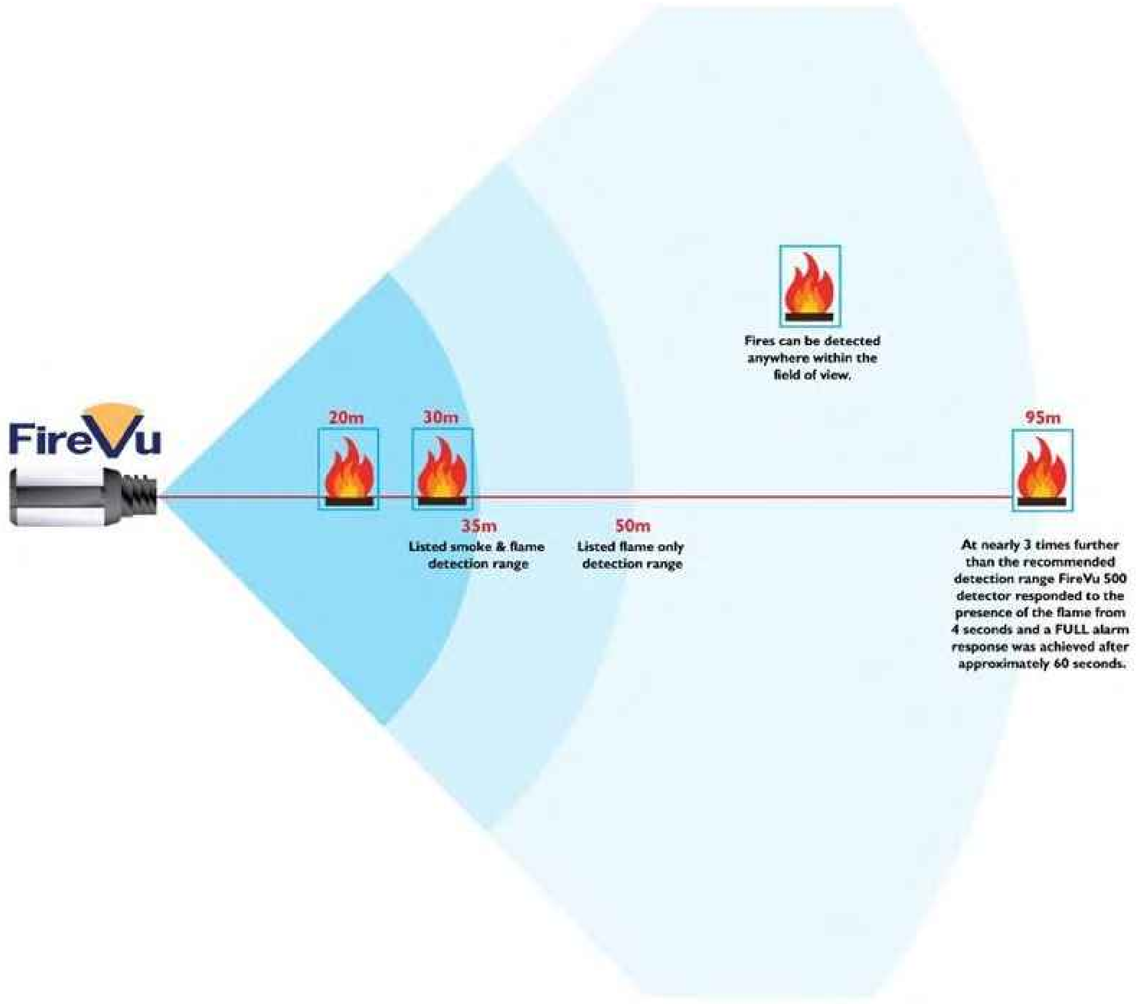


(Click to enlarge image)

There are video based smoke detection systems that are available and listed for these applications. This is accomplished by the installation of listed cameras that are focused on a view area, and when there is smoke present in this view area the system goes into alarm. The image (on the left) shows how video smoke/flame detection operates. These types of systems are recommended for large outdoor applications, like vehicle storage or airplane hangars.

AIR SAMPLING-TYPE SMOKE DETECTORS

Air Sampling-Type Smoke Detectors

An air sampling-type smoke detector has a **central detection unit** that draws air through a network of sampling pipes to detect smoke. They can detect smoke before it is visible to the human eye, and are normally used for challenging or special environmental applications such as data centers, cold storage areas, museums, or hospitals.

The use of laser and LED technology along with microcontrollers with advanced algorithms has advanced this technology, allowing for both early warning or elimination of nuisance alarms in places with rapidly changing environments.

(Click to enlarge image)

(Click to enlarge image)

CONTINUE

Let's do a quick check about what has been covered so far.

Match the following spot-type smoke detectors to their functions.

SUBMIT

Complete the knowledge check above before moving on.

Which Smoke Detector is Best?

Ionization —

Most common and the **most sensitive** because they sense both visible and invisible particles of combustion. Since ionization detectors are some of the most sensitive, you may want to choose another type detector to minimize **nuisance alarms** — for example, if a toaster always activates the fire alarm system.

Photoelectric light-scattering —

Does not work well with **dark smoke**.

Air sampling-type —

Very accurate, extremely sensitive, yet not prone to nuisance alarms as much as spot-type detectors . . . and **VERY expensive**.

Photoelectric beam-type –

Best for **high areas** such as atriums and shopping malls.

There is no single smoke detector that is best for all applications. It is important to select the best smoke detector for your specific application.

AMBIENT CONDITIONS

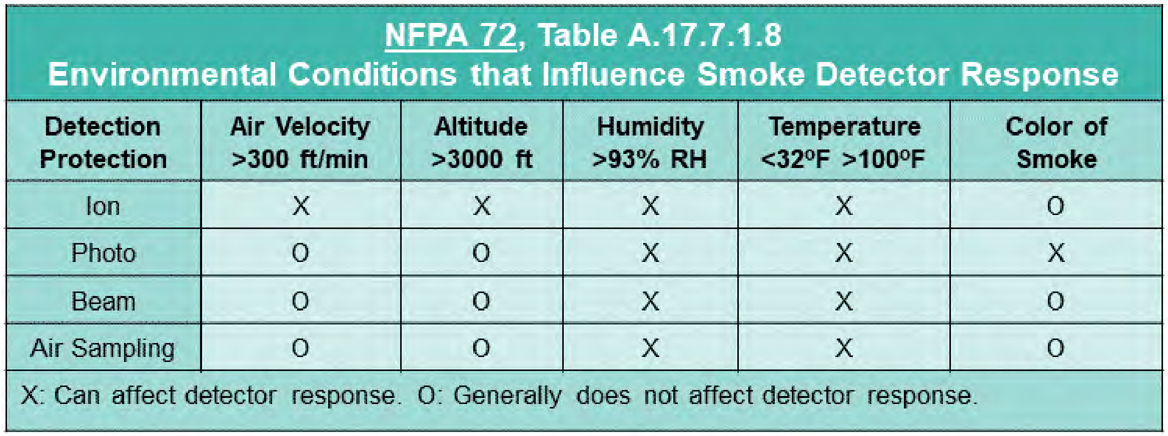
Ambient Conditions

NFPA 72 2016, Section 17.7.1.8

Smoke detectors **shall not be installed** if any of the following ambient conditions exist, unless specifically **designed** and **listed** for the expected conditions:

- Temperature below 32°F
- Temperature above 100°F
- Relative humidity above 93%
- Air velocity greater than 300 ft/min

***NFPA* 72 2016, Annex A** has a table that details how different detector technologies' response times are affected by environmental conditions.



NFPA 72, Table A.17.7.1.8
Environmental Conditions that Influence Smoke Detector Response

Detection Protection	Air Velocity >300 ft/min	Altitude >3000 ft	Humidity >93% RH	Temperature <32°F >100°F	Color of Smoke
Ion	X	X	X	X	O
Photo	O	O	X	X	X
Beam	O	O	X	X	O
Air Sampling	O	O	X	X	O

X: Can affect detector response. O: Generally does not affect detector response.

The table shows that **ionization detectors are most affected** by the environment, but **photoelectric spot-type detectors** are affected by the **color of the smoke**. Dark smoke will tend to absorb the light rather than reflect the light, making it harder to detect.

CONTINUE

NFPA 72 2016, Section 17.7.1.11

This section of the code is concerned with smoke detector chambers collecting dust and dirt during building construction.

If the smoke detectors are required to be operational during construction, they **must be cleaned or replaced** after construction is complete.

Another option is to **install approved covers** over the detectors until construction is complete.

> ⓘ If the detectors are not required to be operational during construction, the detectors shall not be installed until after all other trades have completed cleanup. If they are required for signal initiation during

construction, they are required to be *cleaned and verified* to be operating per their listed sensitivity, or replaced prior to final acceptance test of the system. **- *NFPA* 72 2016, Section 17.7.1.11**

CONTINUE TO NEXT LESSON: LOCATION AND SPACING

Lesson 3 of 4

Location and Spacing

How do you get a smoke detector to detect smoke if there is a draft blowing the smoke away from the detector?

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Properly locate smoke detectors in different construction configurations.

2 Define methods required for duct detector installation.

LOCATION AND SPACING OF SMOKE DETECTORS

Heating, Ventilating, and Air Conditioning Systems

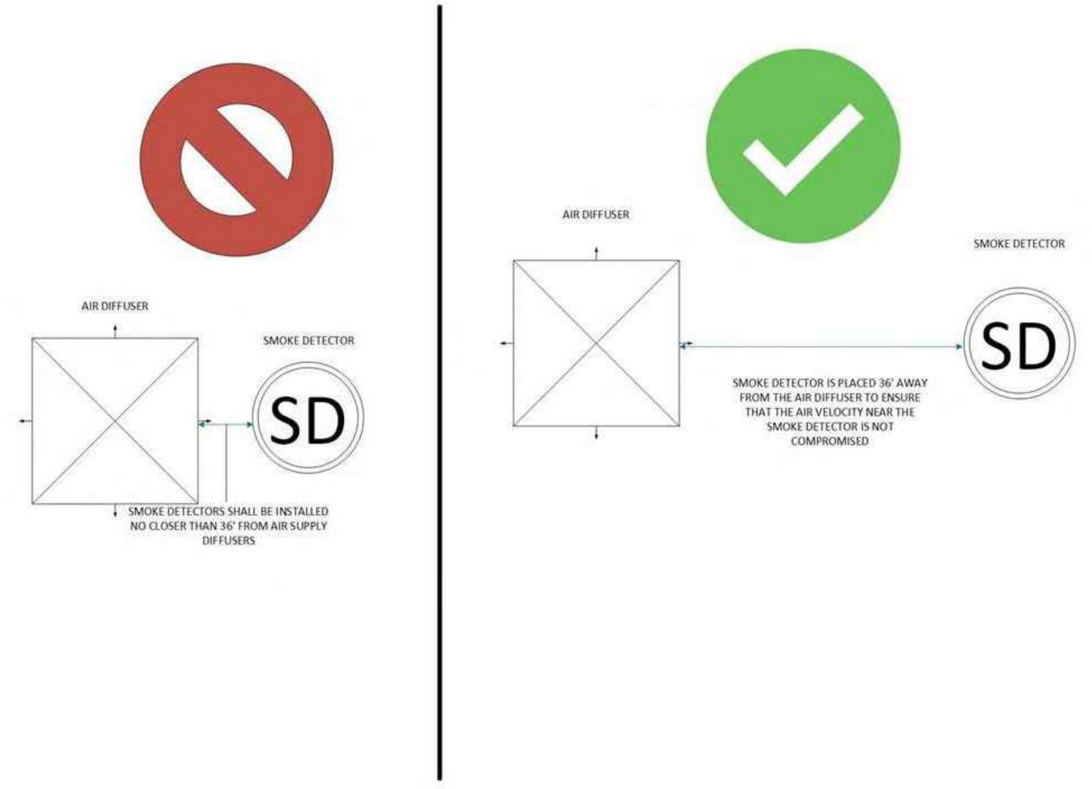
The use of smoke detectors can become quite interesting if our application happens to be spaces served by heating, ventilating, and air conditioning systems.

Smoke is going to travel in the direction of the air flow.

- We must be careful that the smoke which we are trying to detect will not be taken away or diluted to the point where it will not be effectively detected.
- Considerations must be given to potentially reducing the spacing of the detectors in these areas unless we can be assured that the flow and quantity of air is reasonable for our detector to handle.

- For example, a smoke detector **should** not **be located closer than three feet** to an air supply diffuser.

CONTINUE



(Click to enlarge image)

The image above illustrates incorrect placement of a smoke detector near an air diffuser. At this close distance to an air diffuser, the air velocity near this smoke detector could be greater than 300 ft/minute, thus affecting the operation of the detector negatively. When the detector is 3’ or more away from the diffuser as shown on the right, the air velocity is not adversely affected.   What if the spacing works out to have a detector less than 3’ from a diffuser? The prudent thing is to provide additional detectors to ensure proper coverage and operation of detectors.

CONTINUE

When spaces under floors and above ceilings are used as plenums or ducts for heating, ventilating, and air conditioning systems, the detectors are required to be listed for the air velocities anticipated.

These special smoke detectors are not suitable for use in normal applications.

(Click to enlarge image)

SPOT TYPE DETECTOR

Spot-Type Heat Detector and Spot-Type Smoke Detector Spacing

Section 17.7.3.2 is titled “Spot-Type Smoke Detectors.” The ionization and photoelectric light scattering detectors are examples of spot-type smoke detectors.

NFPA 72 2016, Section 17.7.3

Spot-Type Smoke Detectors

Location 1

High Ceiling

The Annex material of this section states that in high ceiling areas where spot-type detectors are not accessible for maintenance, projected beam or air sampling detectors shall be used.

Location 2

Ceiling

Spot-type detectors must be located on the ceiling or on the wall not more than 12 in. from the ceiling to the top of the detector.

Location 3

Raised Floor

Detectors must always be mounted in the orientation that they have been listed for, even if they are installed under a raised floor.

Location 4

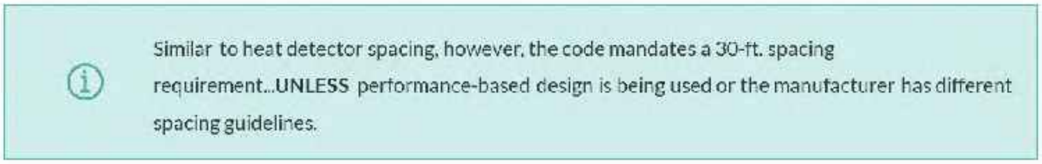
High Rack Storage

If smoke detectors are used in high rack storage, they should be mounted above each aisle and at intermediate levels in the racks per Section A.17.7.6.2.

CONTINUE

NFPA 72 2016, Section 17.7.3.2.3.1

When it comes to the spacing of spot-type smoke detectors, there's not much difference between spot-type heat detector and spot-type smoke detector spacing.

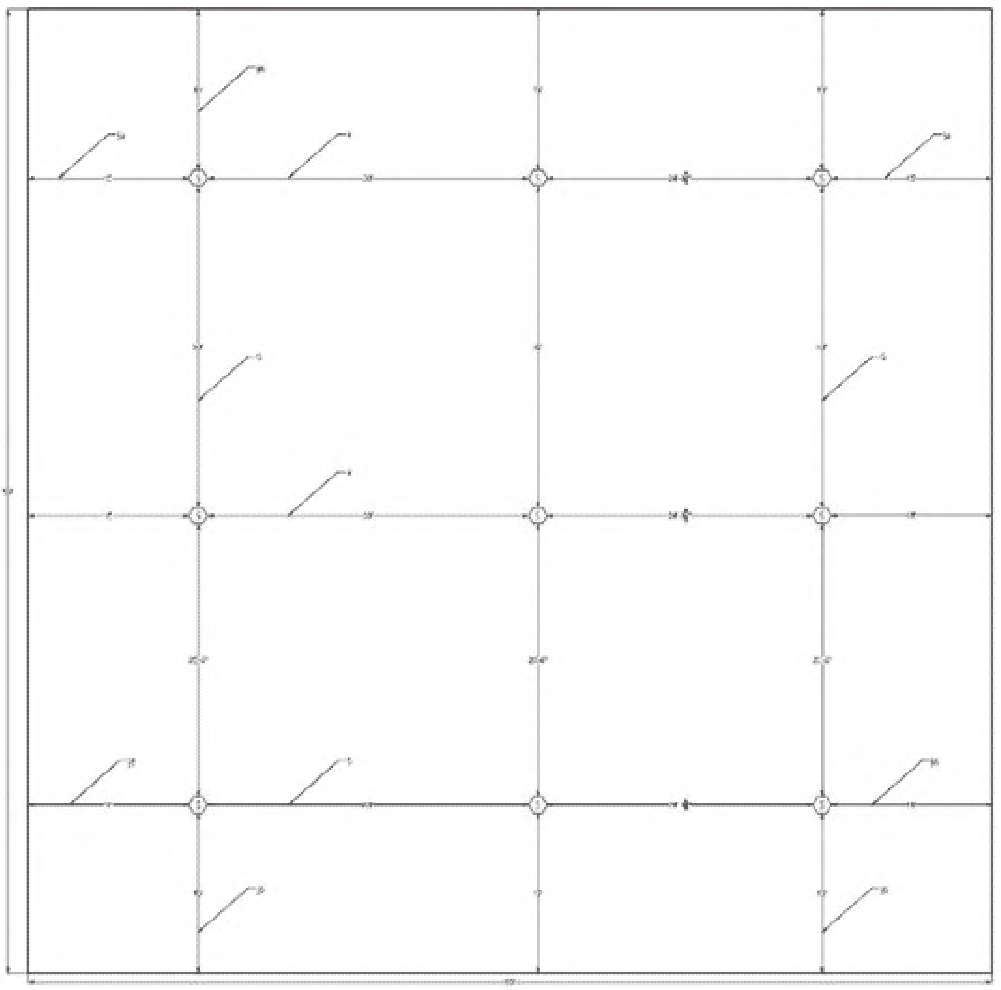


Similar to heat detector spacing, however, the code mandates a 30-ft. spacing requirement...**UNLESS** performance-based design is being used or the manufacturer has different spacing guidelines.

Here's what ***NFPA*** **72 2016** says about **spot-type smoke detector** spacing:

If performance-based design criteria is not available, **30-ft. spacing shall be used** for prescriptive designs. There are two optional methods for spacing of smoke detectors:

- **Section 17.7.3.2.3.1(1)** states that the distance between smoke detectors shall not exceed a **nominal spacing of 30 ft. (9.1 m)** and there shall be detectors within a distance of **one-half the nominal spacing**, measured at **right angles** from all walls or partitions extending upward to within the **top 15% of the ceiling height.**



(Click to enlarge image)

Smoke detector layout/spacing. On a smooth ceiling as shown above, smoke detectors are placed at 1/2S (half of nominal spacing) from the edge of the walls, and spaced at S between detectors within the room. Smoke Detectors do not have LISTED spacing. Smoke detectors are spaced based upon NOMINAL spacing. NOMINAL spacing for a smoke detector is 30′. Thus, at the wall edges the first row of detectors are spaced at 15′ from the edge of the wall (1/2S). each detector is spaced 30′ apart, with the exception of the detector found on the right of the first row. This one is spaced at approximately 25′, as this detector on the right is spaced 1/2S from the right wall in this room. The room is 90′ x 90′, based upon this layout with spacing, this room should have 9 smoke detectors for coverage.

CONTINUE

NFPA 72 2016, Section 17.7.3.2.3.1

Spacing of smoke detectors (continued):

Section **17.7.3.2.3.1(2)** states that all points on a smooth ceiling shall have a smoke detector within 0.7 times the listed spacing, or 21 ft.

This second option follows the rules for location of heat detectors and is sometimes useful for locating detectors in irregularly shaped areas.

If a **partition extends within 15% of the ceiling** height, it is **treated as a wall** as it relates to smoke detectors.

With a **10-ft. ceiling, an 8.5-ft. partition would be considered as a wall** for spacing of smoke detectors.

JOIST AND BEAM CONSTRUCTION

Joist and Beam Construction

NFPA 72 2016, Section 17.7.3.2.4

- Depending on the depth of the joists or beams, smoke tends to fill up the pockets formed by the beams before travelling to another area.
- Reduced spacing is required for these areas due to this reason.
- The rules for spacing of smoke detectors are the same for beams as they are for solid joist construction.

CONTINUE

For **level beamed ceilings** with the beam depth **less than 10%** of the height of the ceiling, **smooth ceiling spacing** can be used.

Spot-type smoke detectors may be located on the **bottom of the beams or joists**, or on the **ceiling**.

For a **beam or depth greater than 10%** of the ceiling height:

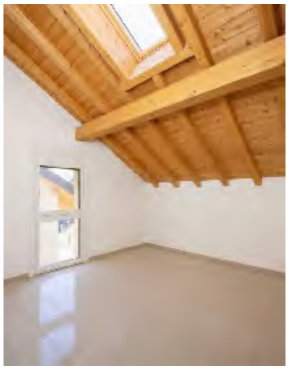
- If **beam spacing** is *equal to or greater than* **40% of ceiling height**, then detectors shall be located in each beam pocket.
- If **beam spacing** is *less than* **40% of ceiling height**, then smooth ceiling spacing in the direction parallel to the beams and at one-half smooth ceiling spacing in the direction perpendicular to the beams shall be used. Detectors can be located on the ceiling or on bottom of the beams.

There are **many different configurations** that can be created by beam construction:

Beams on a slope (parallel or

perpendicular to the slope)

Beam pockets on a slope (parallel or perpendicular to the slope)



Shed ceilings

Corridors

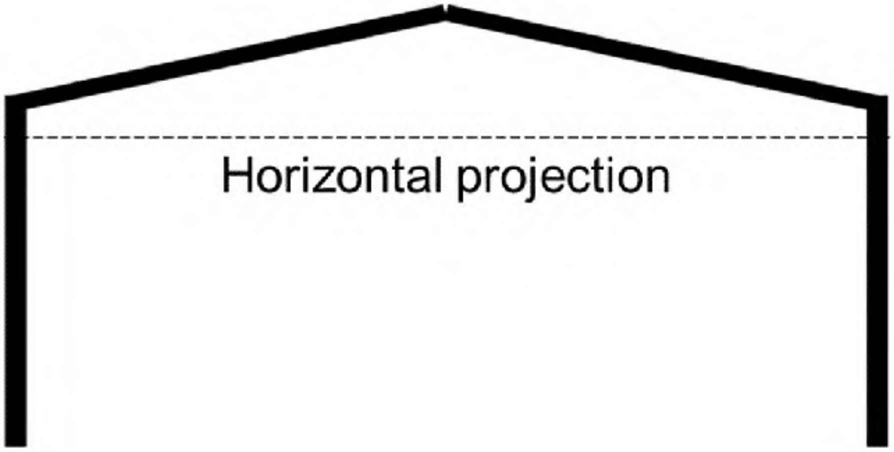
We will not discuss all of the different configurations in detail, but take care to find the appropriate sections starting with **Section 17.7.3.2.4** for your configuration.

NFPA 72 2016, SECTIONS 17.7.3.3 AND 17.7.7.3.4

NFPA 72 2016, Sections 17.7.3.3 and 17.7.7.3.4

For peaked and shed-type ceilings, the first row of detectors shall be located within 36 in. of the high point of the ceiling.

The number and spacing of additional detectors are based upon the horizontal projection of the ceiling.

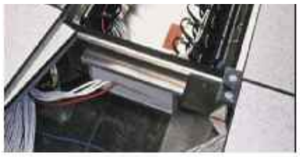


NFPA 72 2016, SECTION 17.7.3.5

NFPA 72 2016, Section 17.7.3.5

Areas above suspended ceilings and under raised floors must be treated as separate areas for detector coverage, if required.

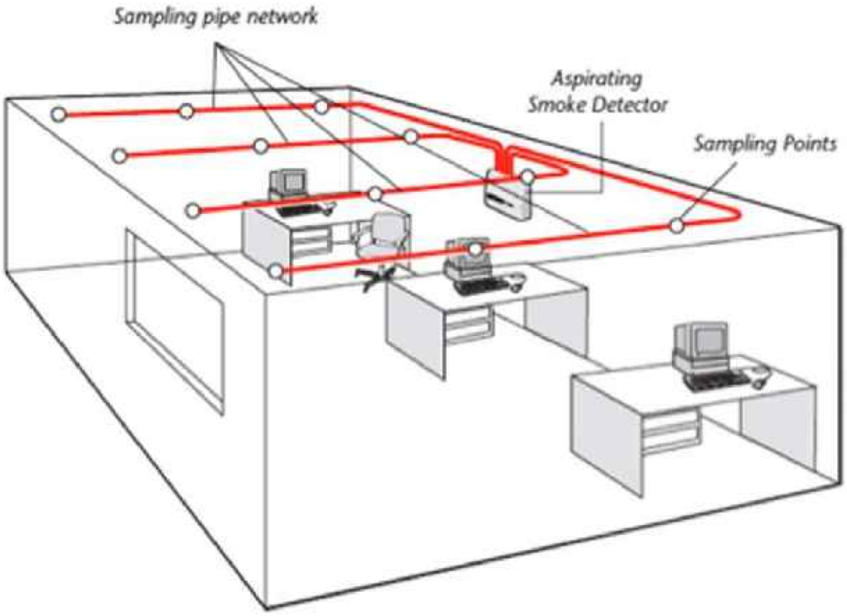
Detectors installed beneath raised floors or above suspended ceilings, or both, including raised floors and suspended ceilings used for environmental air, shall not be used in lieu of providing detection within the room.



AIR SAMPLING-TYPE SMOKE DETECTORS

Air Sampling-Type Smoke Detectors

NFPA 72 2016, Section 17.7.3.6



Each air sampling port shall be treated as a spot-type smoke detector for the purpose of location and spacing of the ports.

The maximum transport time from the furthest sampling port to the control unit **cannot exceed 120 seconds.**

Most manufacturers have software programs to design the piping distribution system to ensure proper operation.

The sampling pipe network design details shall include calculations showing the flow characteristics of the pipe network and each sample port.

They must generate a trouble signal if the air flow rate is out of range.

CONTINUE

NFPA 72 2016, Section 17.7.3.6 continued

The system piping must be identified with a sign “SMOKE DETECTOR SAMPLING TUBE — DO NOT DISTURB” at:

- Changes in direction or branches in piping

- At each side of a penetration of a wall, floor, or other barrier
- At piping intervals that provide visibility at least every 20 ft.

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CONTINUE

Let's do a quick check about what has been covered so far.

If a partition extends within ___ of the ceiling height, it is treated as a wall as it relates to smoke detectors.

○ 10%

○ 15%

○ 20%

○ 25%

SUBMIT

When spaces under floors and above ceilings are used as plenums or ducts for heating, ventilating, and air conditioning systems, the detectors are required to be listed for the _____ anticipated.

○ air velocities

○ air sampling

SUBMIT

If beam spacing is *equal to or greater than* ____ of ceiling height, then detectors shall be located in each beam pocket.

○ 20%

○ 30%

○ 40%

○ 50%

SUBMIT

The maximum transport time from the furthest sampling port to the control unit cannot exceed _____ seconds.

○ 30

○ 60

○ 90

○ 120

SUBMIT

Complete the knowledge check above before moving on.

Projected Beam-Type Smoke Detectors

NFPA 72, Section 17.7.3.7

Projected beam-type detectors will normally be located with their projected beams parallel to the ceiling and in accordance with the manufacturer's instructions.

Per Annex A, for smooth ceilings, a spacing of 60 ft. can be used as a guide.

Projected beam-type smoke detectors are often a good solution to environments where spot-type detectors cannot be used because of dirt, dust, heat, or humidity.

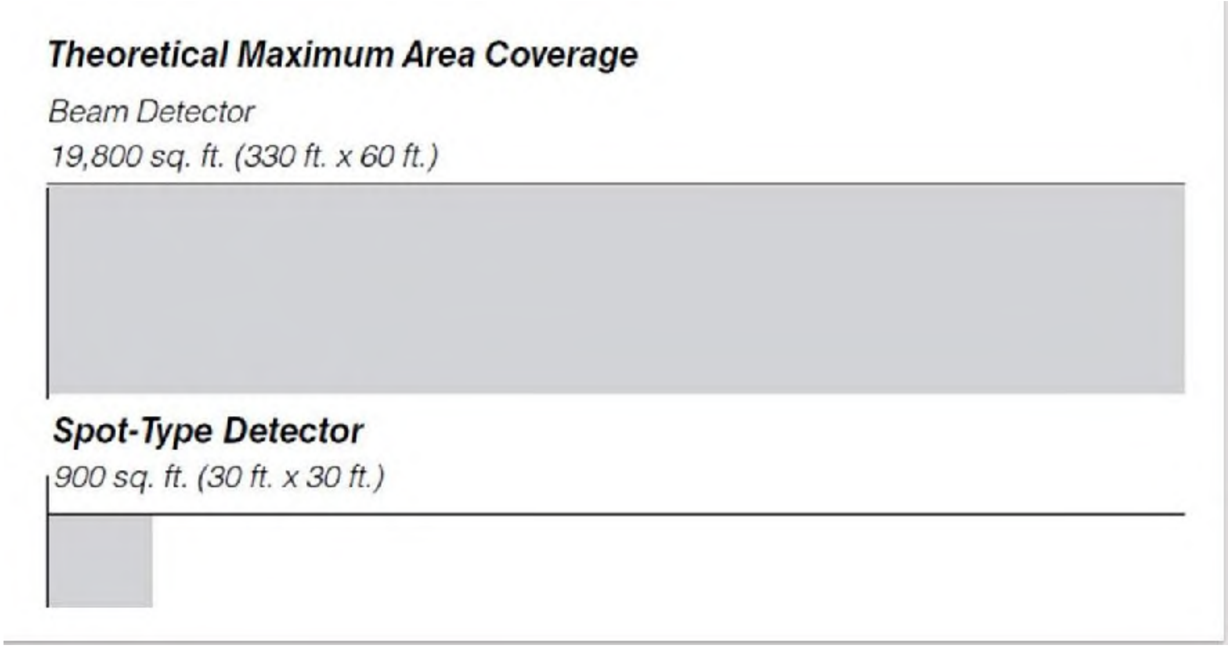
They are not as sensitive to these environmental factors unless those factors are extreme.

They are not recommended for outdoor applications where exposed to rain, snow, sleet, or fog.

CONTINUE

Projected beam-type smoke detectors are also good for high ceiling areas where it would be difficult to test and service spot-type detectors.

They typically have a range of 330 ft, giving them a theoretical maximum coverage of 19,800 ft^2.



A projected beam detector shall be considered as a row of spot-type detectors for level and sloping ceiling locations.

Mounting beam detectors per the manufacturer’s instructions is critical since building structures move with changes in temperature and other factors.

They must be designed such that a small angular movement of the light source or receiver does not inhibit operation or generate a false alarm.

They should also generate a trouble signal if abruptly blocked by a object rather than generating an alarm signal.

SMOKE DETECTORS FOR CONTROL OF SMOKE SPREAD

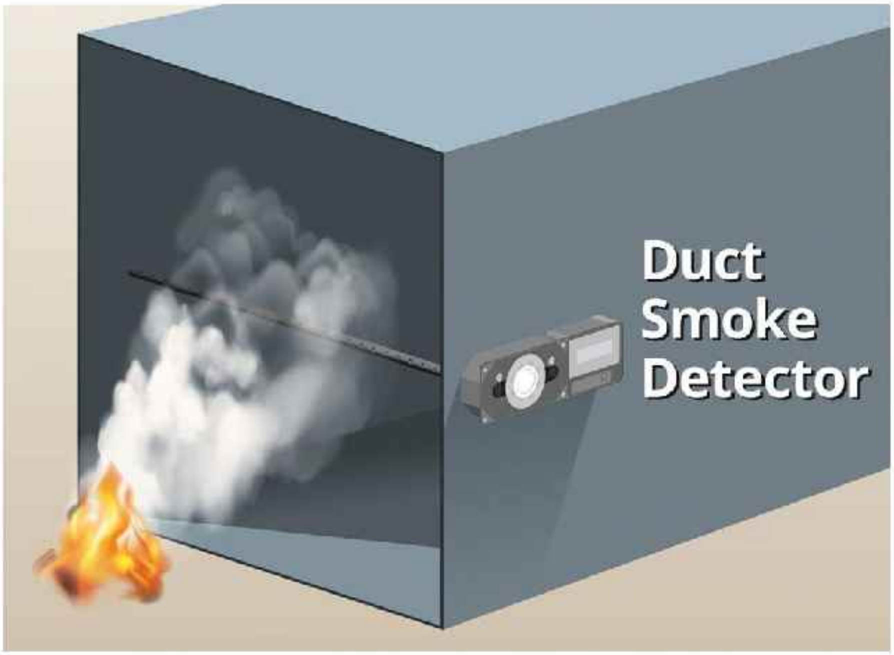
Duct Detectors

NFPA 72 2016, Section 17.7.5

The primary purpose of duct smoke detection is to prevent injury, panic, and property damage by **reducing the spread of smoke**. It also protects the HVAC system from fire and smoke damage.

Smoke detectors installed and used to prevent smoke spread by initiating control of fans, dampers, doors, and other equipment are to classified as follows:

- Area detectors installed in the related smoke compartment
- Detectors installed in air duct systems
- Video image smoke detection installed in related smoke compartments



duct detector (slide 39, location & spacing)

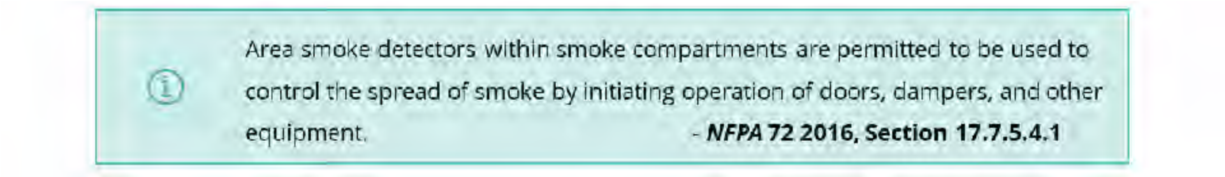
Duct detectors **are not a substitute** for area smoke detection, early warning, or replacing the building fire alarm system.

> Area smoke detectors within smoke compartments are permitted to be used to control the spread of smoke by initiating operation of doors, dampers, and other equipment. - *NFPA* 72 2016, Section 17.7.5.4.1

NFPA 72 2016, SECTION 17.7.5.5.2

Section 17.7.5.5.2 states four methods for installation of duct detectors:

1. Rigid mounting within the duct
2. Rigid mounting to the wall of the duct with the sensing element protruding into the duct
3. Installation outside the duct with rigidly mounted sampling tubes protruding into the duct
4. Installation through the duct with projected light beam



ⓘ Area smoke detectors within smoke compartments are permitted to be used to control the spread of smoke by initiating operation of doors, dampers, and other equipment. - ***NFPA* 72 2016, Section 17.7.5.4.1**

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NFPA 72 2016, SECTION 17.7.5.5.3 AND 17.7.5.6

NFPA 72 2016, Section 17.7.5.5.3

Duct smoke detectors must be accessible for cleaning and maintenance.

The locations for all duct detectors must be clearly and permanently identified.

ⓘ The technology normally used for duct detectors is photoelectric to reduce false alarms.

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NFPA 72 2016, SECTION 17.7.5.6

Door Release Service

NFPA 72 2016, Section 17.7.5.6

Smoke detectors are permitted to accomplish door release service, if part of an open area protection system covering the room, corridor, or enclosed space on each side of the smoke door.

If smoke door release is to be accomplished directly from the smoke detectors, then the detectors are required to be listed for releasing service.

Smoke detectors are required to be photoelectric, ionization or other approved types.

Refer to NFPA 72 2016, Section 17.7.5.6 for diagrams of the items below

If doors are intended to close in response to smoke flowing in either direction, then the following applies: (Click each tab below to learn more)

17.7.5.6.5.1(A), part A or B –

If the depth of the wall section above the door is 24 in. or less, one ceiling-mounted smoke detector is required on one side of the doorway only, or two wall-mounted detectors are required, one on each side of the doorway. See Figure **17.7.5.6.5.1(A), part A or B.**

17.7.5.6.1(A), part D –

If the depth of the wall section above the door is greater than 24 in. on one side only, one ceiling-mounted smoke detector is required on the higher side of the doorway only, or one wall-mounted detector is required on both sides of the doorway. See Figure **17.7.5.6.1(A), part D**.

17.7.5.6.1(A), part F –

If the depth of the wall section above the door is greater than 24 in. on both sides, two ceiling-mounted or wall-mounted detectors are required, one on each side of the doorway. See Figure **17.7.5.6.1(A), part F.**

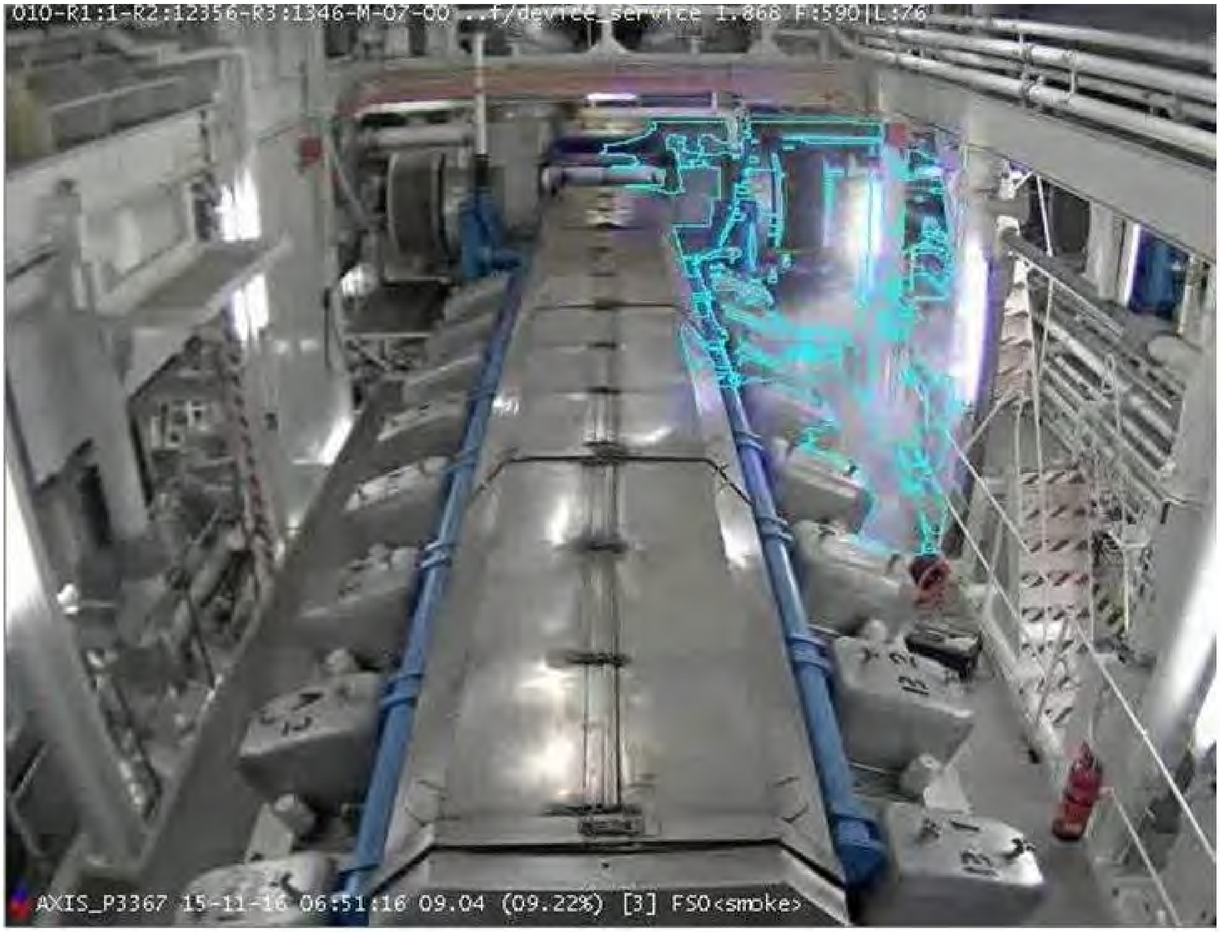
17.5.6.5.1(A), parts A, C, and E –

> If a detector is specifically listed for door frame mounting, or if a listed combination or integral detector-door closer assembly is used, only one detector is required, if installed per the manufacturer's instructions. See Figure **17.5.6.5.1(A), parts A, C, and E.**

VIDEO IMAGE SMOKE DETECTION

Video Image Smoke Detection Systems

Video image smoke detection systems are used in challenging structures or large places that need or want fire protection, where conventional detection devices will not work well for the application. These systems operate by continually capturing and digitally processing an image of the area to be protected, looking for changes that have the mathematical signature for smoke or fire characteristics.



They are based on security surveillance systems digital hardware with computer software to analyze the image.

NFPA 72 2016 states the system components and software must be listed for the purpose of smoke detection.

The images can also be transmitted to other systems, such as a security system, as long as it does not affect the ability of the system to detect the fire condition.

The systems must have passwords or other security protection to prevent unauthorized changes.

They have a fast reaction time, and typical system capabilities include detection of:

- Presence of flames within the field of view of the camera
- Reflected fire light when flames are obstructed
- Presence of pluming smoke clouds
- Presence of ambient smoke

CONTINUE

Let's do a quick check about what has been covered so far.

Smoke detectors installed and used to prevent smoke spread by initiating control of fans, dampers, doors, and other equipment are classified as follows: (Select all that apply)

- ☐ Area detectors installed in the related smoke compartment
- ☐ Detectors installed in air duct systems
- ☐ Video image smoke detection installed in related smoke compartments

SUBMIT

Based on diagrams in *NFPA* 72 2016, Section 17.7.5.6, if doors are intended to close in response to smoke flowing in either direction. If a detector is specifically listed for door frame mounting, or if a listed combination or integral detector-door closer assembly is used, how many detectors are required, if installed per the manufacturer's instructions.

○ one

○ two

○ four

SUBMIT

Video Image Smoke Detection has a fast reaction time, and typical system capabilities include detection of: (Select all that apply)

☐ Presence of flames within the field of view of the camera

☐ Reflected fire light when flames are obstructed

☐ Presence of pluming smoke clouds

☐ Presence of ambient smoke

SUBMIT

🔒 Complete the knowledge check above before moving on.

Lesson 4 of 4

Other Types of Detectors

Carbon monoxide detectors are just as important at saving lives as smoke and heat detectors. The location for installation of carbon monoxide detectors is critical to their effectiveness.

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Explain the unique features of sprinkler waterflow alarms and their impact on a fire alarm system.

2 Identify types and purpose of alarm-initiating supervisory devices.

3 Describe the functionality of different types of manually-actuated alarm-initiating devices.

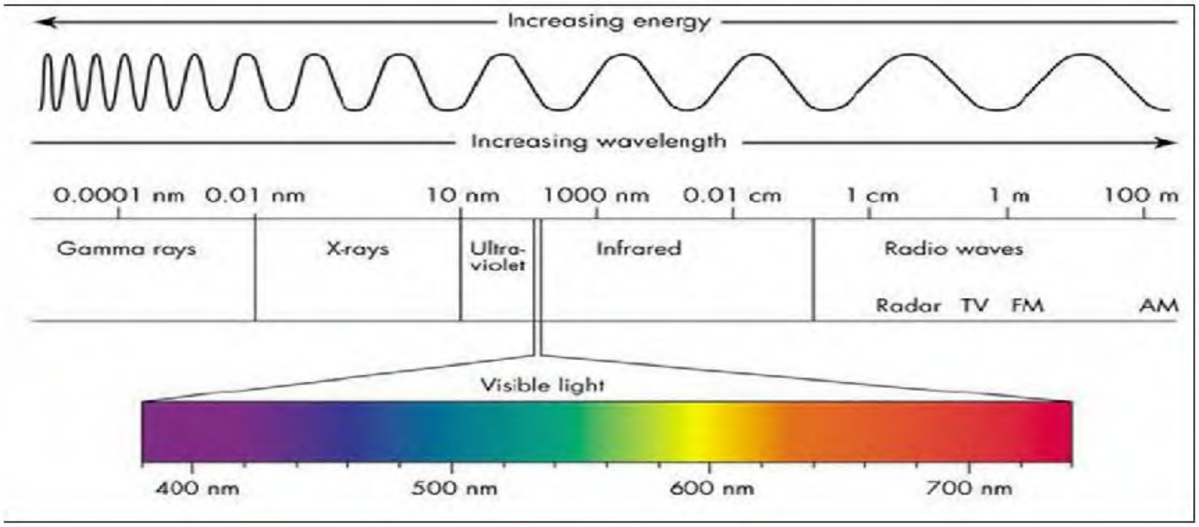
RADIANT ENERGY DETECTORS

Radiant Energy Detectors

When any material burns, it emits light in different frequency wavelengths. A small amount of the light is visible to humans, while the other light coming from the burning material will be in the **infrared and ultraviolet spectrums.**

A flaming fire will generate light in the infrared spectrum of light and **an ember or smoldering fire will generate light in the ultraviolet spectrum.** Radiant energy detectors look for light in these spectrums for instant detection of a flame or spark/ember.

They are normally used with **explosion suppression or prevention systems** such as hazardous material storage, oil rigs, airport facilities, and fuel loading racks.



(Click to enlarge image)

(Click to enlarge image)

Radiant energy detectors are normally designed to filter out visible light and **look for different or multiple frequencies** to minimize false alarms from unusual sources, such as welding or lightning. They are **fast acting** and can detect a fire in seconds rather than waiting for smoke or heat to be detected.

They are a line-of-sight device with a lens and **need to be able to see the fire**. If their field of view is obstructed by an object or the lens is dirty, they will not detect the fire.

CONTINUE

Flame Detectors

Advantages and Disadvantages of Flame Detectors

ADVANTAGES	DISADVANTAGES

Flame detectors are the **fastest of any of our detectors**. In terms of detection or response time, there is nothing that comes close to flame detectors.

ADVANTAGES | DISADVANTAGES

Flame detectors are line-of-sight devices, which have the capability of “seeing” a fire. **Significant maintenance procedures are required** to keep those eyes clean. Flame detectors are also very high in cost.

Flame detectors are famous for **false alarms.** Detectors look at a part of the light spectrum, from natural or human activities; such as, welding, lightning, and even sunlight. This radiates various wavelengths of light within the viewing spectrum of the detector.

Many of these disadvantages can be solved or minimized by **proper design and application techniques.**

The designer must be **selective** and **aware of the hazard** in order to determine the type of flame detector for a specific application. This has to be based on good engineering judgment in terms of the operating characteristics and the anticipated burning characteristics of the hazard.

The disadvantages are significant, but don't matter if time is a factor. For example, when installing an explosion suppression system using manual actuation, thermostats, or photoelectric smoke detection, your hazard is going to be all over the lot. **In this case, flame and pressure detectors are your ONLY choices.**

CONTINUE

Combination, multi-criteria, and multi-sensor detectors

NFPA 72 2016, Section 17.9

While combination, multi-criteria, and multi-sensor detectors all use multiple sensors, they also have differences. *NFPA* 72 2016, Section 17.9 states the requirements for all three types of detectors.

COMBINATION DETECTORS

Combination detectors

System Sensor 5151 thermal detector with fixed and rate of rise detection (Click to enlarge image)

Typical examples of combination detectors include a heat detector with a smoke detector or a combination rate-of-rise and fixed-temperature heat detector. This device has listings for each sensing method employed.

Combination detectors do not utilize a mathematical evaluation principle of signal processing more than a simple “or” function.

These type of detectors were the first to use multiple sensors without the advantage of having the mathematical evaluation of each sensor, but are still commonly used.

MULTI-CRITERIA DETECTORS

Multi-Criteria Detectors

An example of a multi-criteria detector is the System Sensor 2251-COPTIR Advanced Multi-Criteria Fire Detector with four unique sensing elements:

1. Photoelectric chamber **senses airborne particulate** for smoke detection.
2. Electrochemical cell technology **monitors carbon monoxide** (CO) produced by smoldering fires.
3. Infrared (IR) sensing **measures ambient light levels and flame signatures**.
4. Thermal detection **monitors temperature**.

System Sensor 2251-COPTIR (Click to enlarge image)

A multi-criteria detector **contains multiple sensors that separately respond to heat, smoke, or gases**. It can also be a detector that has **more than one sensor to detect the same condition** such as a heat detector with a fixed temperature sensor and a rate-of-rise sensor.

The sensor output is mathematically evaluated to determine when an alarm signal is warranted. The detector is capable of generating only one alarm signal and has a single listing that establishes the primary function of the detector.

Multi-Sensor Detectors

Multi-Sensor Detector (Click to enlarge image)

This type of detector contains **multiple sensors that separately respond to heat, smoke, or gases**. However, this device is capable of generating **multiple alarm signals independently or in combination**. The sensor output signals are mathematically evaluated to determine when an alarm signal is warranted.

This device has listings for each sensing method employed.

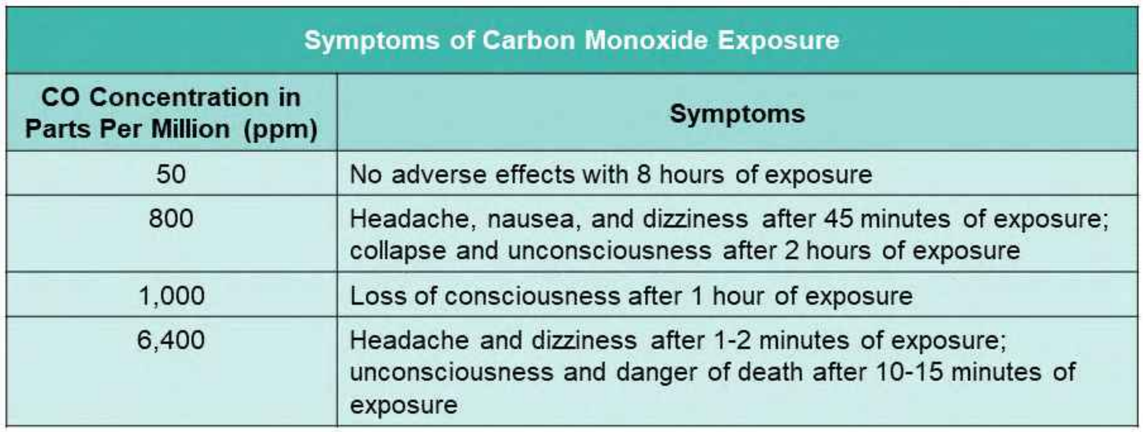
Typical examples of multi-sensor detectors are a **combination of a heat detector with a smoke detector**, or a **combination rate-of-rise and fixed-temperature heat detector** that evaluates both signals using an algorithm to generate an output such as pre-alarm or alarm.

CARBON MONOXIDE DETECTORS

Carbon monoxide detectors

Section 17.10 was added to *NFPA* 72 2016 in the 2010 edition and covers gas detection. **Carbon monoxide (CO) is a gas produced by incomplete combustion of fossil fuels including natural gas.**

CO poses a hazard because it is **tasteless, odorless, and it interferes with oxygen in the blood supply**, possibly causing injury, incapacitation, and even death.



Symptoms of Carbon Monoxide Exposure

CO Concentration in Parts Per Million (ppm)	Symptoms
50	No adverse effects with 8 hours of exposure
800	Headache, nausea, and dizziness after 45 minutes of exposure; collapse and unconsciousness after 2 hours of exposure
1,000	Loss of consciousness after 1 hour of exposure
6,400	Headache and dizziness after 1-2 minutes of exposure; unconsciousness and danger of death after 10-15 minutes of exposure

CONTINUE

The most common sources for CO exposure are:

- Heating systems
- Power tools
- Charcoal grills or other charcoal sources
- Gas ranges or ovens
- Camp stoves or lanterns
- Other or multiple appliances
- Emergency electrical generators

CONTINUE

Gas detectors are used as life safety devices, but **are not commonly connected to the fire protection system**.

NFPA 72 2016 does not require carbon monoxide detectors. **The requirements come from building codes, life safety codes, and *NFPA 720:*** *The Standard for the Installation of CO Detection and Warning Equipmen*t, 2012 edition. This standard defines requirements for both commercial and residential installations of CO detectors.

Gas Detection Systems are typically seen in commercial kitchens. They consist of two components.

The component on the **left** is a local sounder and “sniffer” for fuel sources.

The component on the **right** is generally hooked up upstream from the gas shutoff valve to detect any leaking. This component has a solenoid connection (black area) to a relay, that when a leak is detected or under general alarm, can drop this solenoid to stop gas flow to the gas-powered device like a cooking range.

(Click to enlarge image)

CONTINUE

System Sensor COSMO-2W Carbon Monoxide Detector (Click to enlarge image)

There are three technologies for detecting CO. The most common is an **electrochemical sensor with a platinum electrode and acid combination** to promote a reaction between CO and the oxygen in the air, which then produces an electric current. When CO is present in the air over time, **if the current increases beyond specific thresholds, the alarm is sounded.** This is a similar concept to the way ionization smoke detectors operate.

CO detectors have a specific limited life. Some are rated for a life of six years after manufacture. When these detectors are connected to a fire alarm system, they must generate a **trouble signal** at the end of the specified life.

CONTINUE

Let's do a quick check about what has been covered so far.

While combination, multi-criteria, and multi-sensor detectors all use multiple sensors, they also have differences. Match their unique capabilities below.

Combination Detector	does not have the advantage of having the mathematical evaluation of each sensor.
Multi-Criteria Detector	has more than one sensor to

	detect the same condition.
Multi-Sensor Detector	is capable of generating multiple alarm signals independently or in combination.

SUBMIT

Complete the knowledge check above before moving on.

Sprinkler waterflow alarms

The **waterflow alarm** from a sprinkler system **indicates that there is water flowing in the sprinkler system**. It is the only signal from a sprinkler system that actually **generates a fire alarm** just as a heat or smoke detector. The other signals from a sprinkler system generate a supervisory signal as we will discuss later.

Sprinkler waterflow alarm (Click to enlarge image)

Waterflow alarms can have a major impact on the requirements of the fire alarm system. The International Building Code **eliminates the requirement for manual pull stations** in many cases if there is a waterflow alarm from a sprinklered building.

It must react **within 90 seconds** to a flow equal to or greater than that from the smallest orifice sprinkler in the sprinkler system.

> Movement of water due to waste, surges, or variable pressure shall not initiate an alarm signal.
>
> — *NFPA 72* 2016, Section 17.12.3

MANUALLY ACTUATED ALARM-INITIATING DEVICES

Manually Actuated Alarm-Initiating Devices

There are several different types of manually actuated alarm-initiating devices (pull stations):

1. **A coded or non-coded signal:** type of signal which is sent from the signaling device.

   A coded manual fire alarm box sends a distinct or special signal from the box, and is required to repeat its fire signal a minimum of 3 times. **A non-coded box** does not have that capability.

2. **A pre-signal box:** a signal that is specifically designed for a given location and only notifies specified areas, such as a guard's tower or a central station of a problem condition.

These signals must be applied and used carefully because **further manual action is necessary** to generate a general evacuation signal.

3. **A general alarm box:** a signal which causes an overall evacuation signal to be sent immediately.

4. **Breakglass:** this type of device requires that a glass window or rod be broken prior to a signal being generated. The broken indicator must be replaced when the system is put back in service.

5. **Non-breakglass:** This type of device is self-explanatory. The initiating device does not utilize the broken glass indicator.

6. **Single-action:** with a single action station, there is only one activity which is needed to initiate the signal.

7. **Dual-action:** A double-action box requires two steps, such as push in, then pull down.

While you may come across a coded or pre-signal manual device (pull station) in the field, they are rare since most manufacturers no longer produce them.

PULL STATIONS

Pull stations shall only be used for alarm- initiating purposes.

Manual fire alarm boxes must be **RED** in color unless they are installed in an environment that prevents them from being plastic or painted. Pull stations may be permitted to be used for other than fire alarm purposes, if the devices are differentiated from manual fire alarm pull stations by colors other than red and labeling.

Pull stations must be mounted on a surface of **contrasting color**.

(Click to enlarge image)

(Click to enlarge image)

Combination pull stations and guard's tour signaling stations **shall** be permitted.

Pull stations must be **securely mounted** to their surfaces.

The operable part of the pull station (handle, lever, push button, etc.) shall be **no less than 42 in.** and **no more than 48 in. above floor level**.

Pull stations must be **accessible** and **unobstructed** at all times.

CONTINUE

Pull stations shall be located **within 5 ft. of each exit opening** at each exit on **each floor**.

Pull stations must be installed **on each side of grouped openings over 40 ft. in width** and **within 5 ft. of each side** of the opening.

Additional pull stations must be installed so that the travel distance between any two pull stations on the same floor is **not more than 200 ft.**

Clear protective covers are permitted for manual fire alarm boxes to help prevent false alarms. (The cover must be listed for use with fire alarm systems and the pull station it is used with).

(Click to enlarge image)

Some protective covers have a tamper switch that activates an audible device inside the box when the cover is removed. The Ohio Fire Code Section 907.4.2.5 states the audible cover alarm is only permitted if approved by the Fire Official.

Supervisory Alarm-Initiating Devices

NFPA 72 2016, Section 17.16

A **supervisory signal** indicates the need for action in connection with the supervision of guard tours, the fire suppression systems or equipment, or the maintenance features of related systems. Its primary function is to tell us if there is a need for action regarding the equipment or function which the supervisory circuit is monitoring.

***NFPA* 72 2016, Section 17.16** lists a number of different kinds of alarm and supervisory signals which are included with many fire alarm systems. *NFPA* 72 2016 **does not define what supervisory signals must be used** for a fire alarm system, but **it describes the requirements** for these supervisory signals if they are required.

Other NFPA codes such as *NFPA 13* for sprinkler systems, along with state, local, and AHJ requirements **dictate which supervisory signals are required on a given system.**

CONTINUE

Let's do a quick check about what has been covered so far.

Additional pull stations must be installed so that the travel distance between any two pull stations on the same floor is not more than ____ ft**.**

○ 50

○ 100

○ 150

○ 200

SUBMIT

Complete the knowledge check above before moving on.

Water Control Valves

NFPA 72 2016, Section 17.16.1

(Click to enlarge image)

The main sprinkler control valve **must be turned in the open position** in order for the supervisory signals to operate effectively.

When supervised, *NFPA* 72 2016 requires that there be a **distinctive signal for valves that are not in the proper position**. For example, there will be a signal if a hand wheel valve has been turned more than two turns or if a lever-operated valve has been moved approximately one-fifth of the distance from its normally open position.

A distinctive signal will also be generated when the valve is returned to its normal position.

PRESSURE SUPERVISION FOR PRESSURE TANKS

Pressure Supervision for Pressure Tanks

NFPA 72 2016, Section 17.16.2.2.1

Some automatic sprinkler systems use pressure tanks to maintain or supplement their water supply requirements. The tanks must maintain a specified design pressure to assure that the sprinkler system will operate properly. This pressure is necessary to make sure that the appropriate number of gallons per minute will be supplied to each of the operating sprinkler heads.

(Click to enlarge image)

For this supervisory function, *NFPA* 72 2016 allows a plus or minus 10 psi allowance from the design pressure. If this allowance is exceeded, a signal must be generated.

Example: If the required pressure is 40 psi and the pressure actually exceeds 50 psi or drops below 30 psi, a supervisory signal must be sent to the central station or area where the signals are received and processed.

PRESSURE SUPERVISION FOR DRY PIPE SPRINKLER SYSTEMS

Pressure Supervision for Dry Pipe Sprinkler Systems

NFPA 72 2016, Section 17.16.2.2.2

(Click to enlarge image)

Similar to the pressure tank supervisory signals, **a pressure supervisory signal-initiating device** for a dry pipe sprinkler system is required to indicate both high- and low-pressure conditions.

For this supervisory function, *NFPA* 72 2016 allows a **plus or minus 10 psi allowance** from the design pressure. If this allowance is exceeded, a signal must be generated.

CONTINUE

Water Level Supervision

Supervising and monitoring the water supply levels are important to make certain that there is a reliable water supply for our automatic sprinkler system.

A **supervisory signal** must result if the level **varies 3 inches in either the high or low direction.**

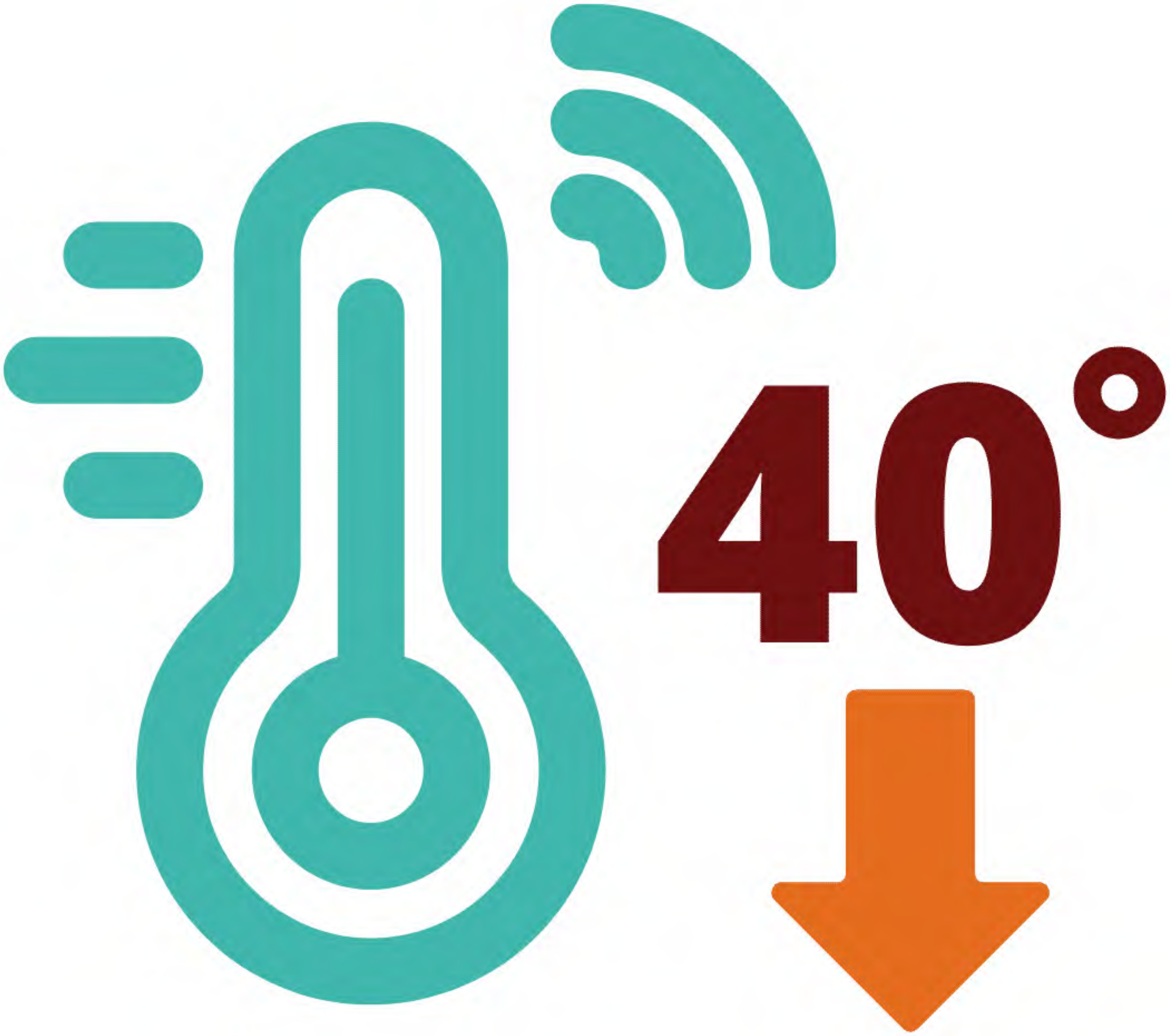
The "high water" requirement recognizes that a certain amount of air volume is required in a pressure tank to discharge properly. If the pressure tank was completely full of water and pressurized to 150 psi, opening the tank valve would only yield a very brief "spurt" of water. Minimal flow would be maintained.

On the other hand, in a water tower (gravity tank) there has to be a supervisory signal sent if the water level sinks below 12 in. of the design level.

(Click to enlarge image)

CONTINUE

Water Temperature Supervision



A supervisory signal must be generated if the **water temperature *falls* to 40°F**.

Water freezes at approximately 32°F, but various minerals and other contaminants can vary that number. Given that, a **40°F response temperature is required by *NFPA* 72 2016**.

PUMP SUPERVISION

Pump Supervision

If a sprinkler system requires a water pump/fire pump, the status of that pump has to be monitored by supervising its power supply.

If the power supply to the pump is interrupted for any reason, a **supervisory signal** is required.

A **pump running signal** can be **supervisory** or an **alarm signal**. **All other fire pump signals shall be supervisory** per *NFPA* 72 2016, Section 23.8.5.9.2.

A fire pump can have several components that shall be supervised by the FACP. In the example below, to the left of the pump there is a control valve for this riser that is being supervised in addition to the flow switches.

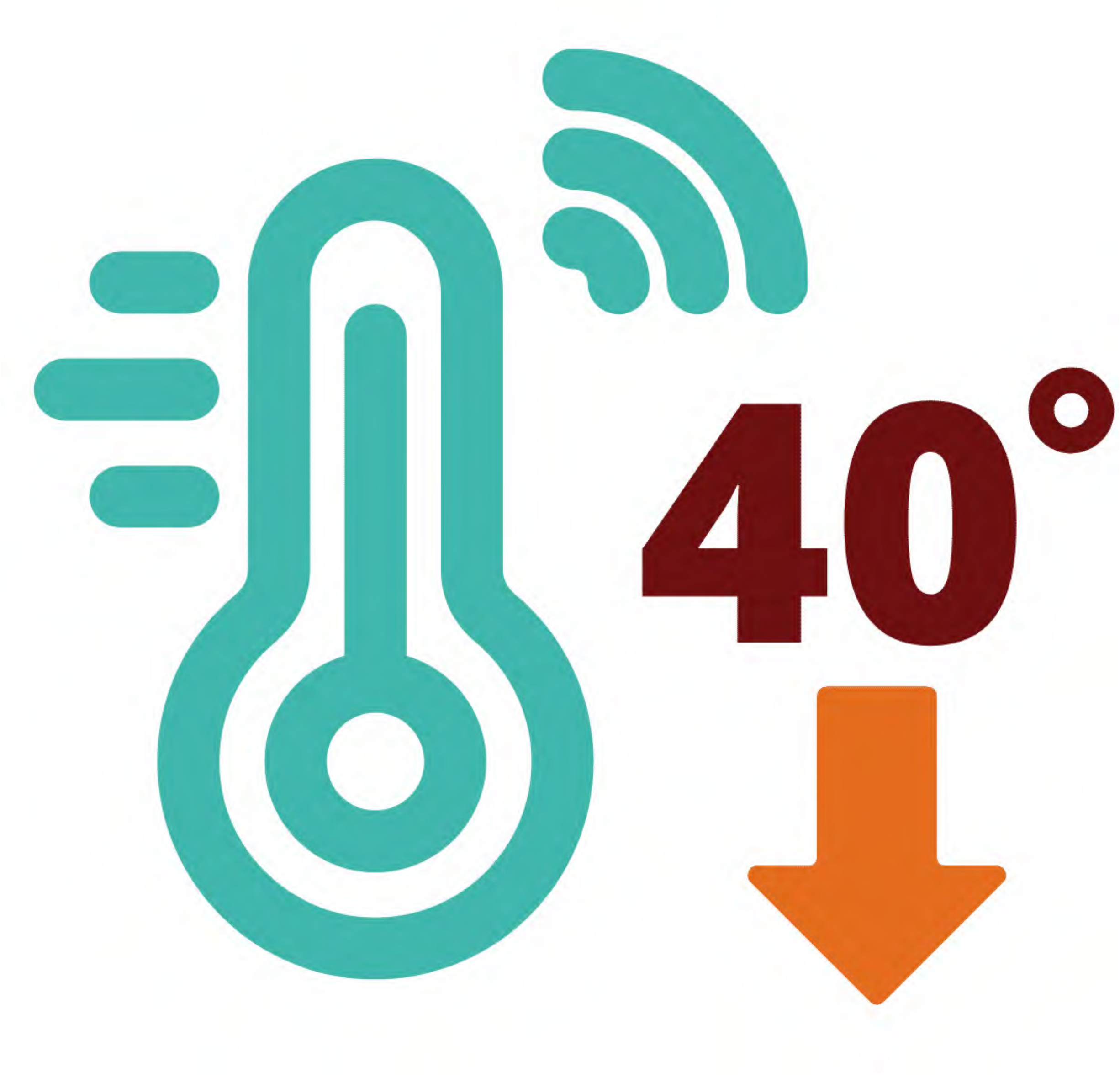
To the right of the pump is the main from the pump that provides the pumped water to the system. The 2 shut-off valves in between the main control are supervised to ensure that water is charged into the system. When the shutoffs are closed, this should cause a supervisory signal at the panel. The device to the right of the shutoffs is a backflow prevention device that shall be tested annually to ensure that there is no cross contamination from the pump water supply to the domestic water supply of the building, as the pump water supply is not generally a potable water supply.

(Click to enlarge image)

In addition to these points relating to water that are supervised, electrically, phase reversal is supervised (pumps are powered 3-phase, 408V), as well as pump fault, and loss of power. If a Jockey pump is provided, similar points shall also be supervised. A jockey pump is sometimes used to provide additional water pressure to a pump.

CONTINUE

Room temperature supervision



Some systems monitor room temperature required by the Authority Having Jurisdiction. If the temperature is too low, the sprinkler system will not function properly.

A supervisory signal must be generated if the **room temperature gets *down* to 40°F** and its **restoration to *above* 40°F**.

CONTINUE

With all supervisory functions, NFPA 72 2016 requires two distinct signals:

1. **For abnormal conditions**
2. **For the return to normal conditions**

CONTINUE

Let's do a quick check about what has been covered so far.

Supervising and monitoring the water supply levels are important to make certain that there is a reliable water supply for our automatic sprinkler system.

A ________ must result if the level varies 3 inches in either the high or low direction.

Type your answer here

SUBMIT

A pump running signal can be supervisory or an alarm signal. All other fire pump signals shall be _____ per *NFPA* 72 2016, Section 23.8.5.9.2.

Type your answer here

SUBMIT

Complete the knowledge check above before moving on.

After completing this module, you should now have a better understanding of the different types of detection and supervisory devices for fire alarm systems.

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.

Ohio Fire Alarm and Detection Equipment-Location and Spacing

Welcome to the Location and Spacing module of the Ohio Fire Alarm and Detection Systems Course.

By the end of this module, you will be able to do the following:

- Calculate proper spacing of heat detectors based on room size.
- Apply heat detector location and spacing rules for complex ceiling construction scenarios (beams, joists, slopes, and combinations).
- Properly protect smoke detectors when installed during construction.
- Apply smoke detector location and spacing rules for different types of detectors and various ceiling construction schemes.
- Identify location and spacing considerations for flame detectors and spark/ember detectors.
- Apply location and spacing rules for manual fire alarms.

Key References for this module:

- *NFPA* 72 - National Fire Alarm and Signaling Code, Chapter 17, 2016

- Ohio Fire Code (https://codes.iccsafe.org/content/OHFCJAN2019E/ohio-administrative-code-1301-7-7-09-fire-protection-systems)

When you are ready to begin, click on the button above to start the course.

Heat Detector Location and Spacing

Smoke Detector Location and Spacing

Radiant Energy-Sensing Detector Location and Spacing

Lesson 1 of 3

Heat Detector Location and Spacing

Is one detector enough for a whole house? Can one smoke detector and one heat detector per floor of a building meet the requirements? Location and spacing of fire alarm detection devices is critical for safety in the event of a fire. This module will explain the proper locations and spacing for fire alarm detection devices.

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Identify General Requirements for initiating devices
2. Calculate proper spacing of heat detectors based on room size.

3 Apply heat detector location and spacing rules for complex ceiling construction scenarios (beams, joists, slopes, and combinations).

CONTINUE

Due to the fact that fire detectors respond to various fire signatures such as **heat, smoke, and radiant energy**, it is necessary for them to be located where they are most likely to encounter these stimuli.

It is also necessary for there to be **enough detectors** in a given hazard location to assure that the **heat, smoke, and/or radiant energy** are **detected in the quickest practical time**.

Careful consideration should be given to detector *spacing*.

GENERAL REQUIREMENTS FOR INITIATING DEVICES

General Requirements for Initiating Devices

NFPA 72 2016, Section 17.4

First, we will review the general requirements for detectors of all kinds based on ***NFPA* 72 2016, Section 17.4**

- Devices shall be supported independently of their attachment to conductors.

- Devices shall be installed in such a manner that provides accessibility for periodic maintenance.

- Duplicate leads, terminals, or connectors that provide for the connection of installation wiring shall be provided to monitor the integrity of the signaling and power wiring.

Refer to ***NFPA* 72 2016, Figure A.17.4.6(a)**, Correct (and Incorrect) Wiring Methods, Page 210

- When a protective guard is used to prevent mechanical damage to a device it must be listed for the application.

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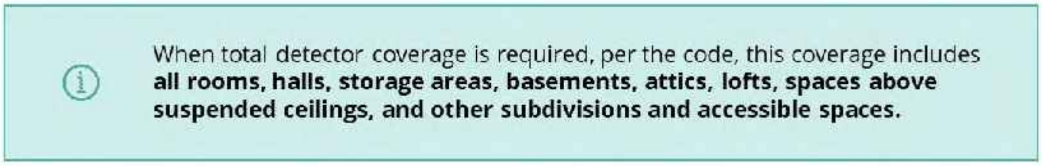
Requirements for Smoke and Heat Detectors

NFPA 72 2016, Section 17.5

Total coverage is defined in ***NFPA* 72 2016, Section 17.5.3.1**. Total (complete) coverage is only required if specified by the local Authority

Having Jurisdiction (AHJ) or codes.



When total detector coverage is required, per the code, this coverage includes **all rooms, halls, storage areas, basements, attics, lofts, spaces above suspended ceilings, and other subdivisions and accessible spaces.**

There are exceptions in the total coverage requirements listed in the code.

- If a detector is to be recess mounted, it must be tested and listed for recessed mounting.
- If a partition extends within 15% of the ceiling height, the spaces separated by the partitions shall be considered separate rooms.

CONTINUE

Let's do a quick check about what has been covered so far.

When total detector coverage is required, per the code, this coverage includes all of the following: (Select all that apply)

☐ Rooms

☐ Halls

☐ Storage areas

☐ Basements

☐ Attics

☐ Lofts

☐ Spaces above suspended ceilings

SUBMIT

Complete the knowledge check above before moving on.

Spacing

NFPA 72 2016, Section 17.6.3.1.1

The type of ceiling construction can definitely impact the flow of the convection currents carrying the heat across the ceiling.

With **smooth ceilings**, we have **two options** with regard to spacing our detectors. These two rules will apply:

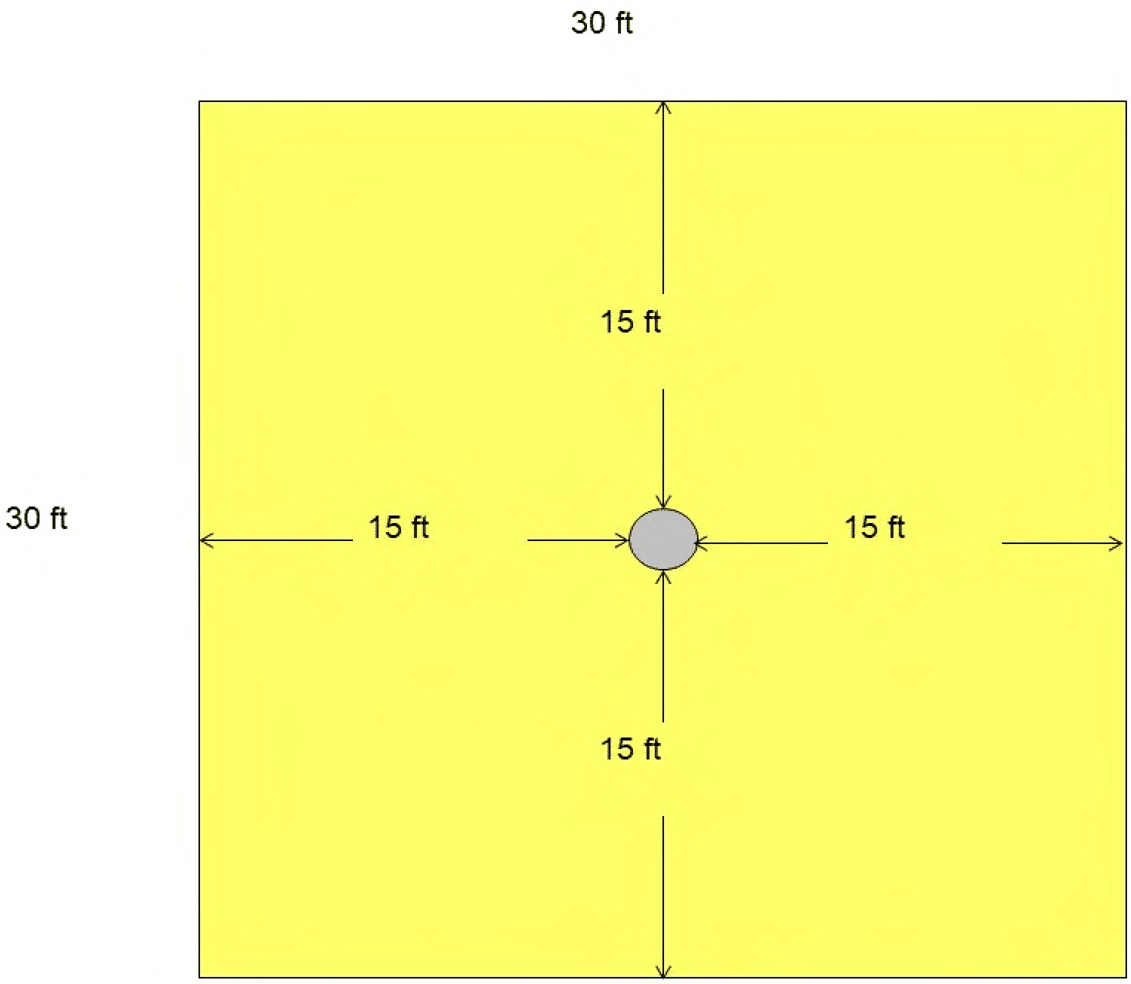
1. **The distance between detectors shall not exceed their listed spacing**. This option also requires that there shall be detectors within a distance of one-half the listed spacing, measured at a right angle, from all walls or partitions extending to within the top 15% of the ceiling.

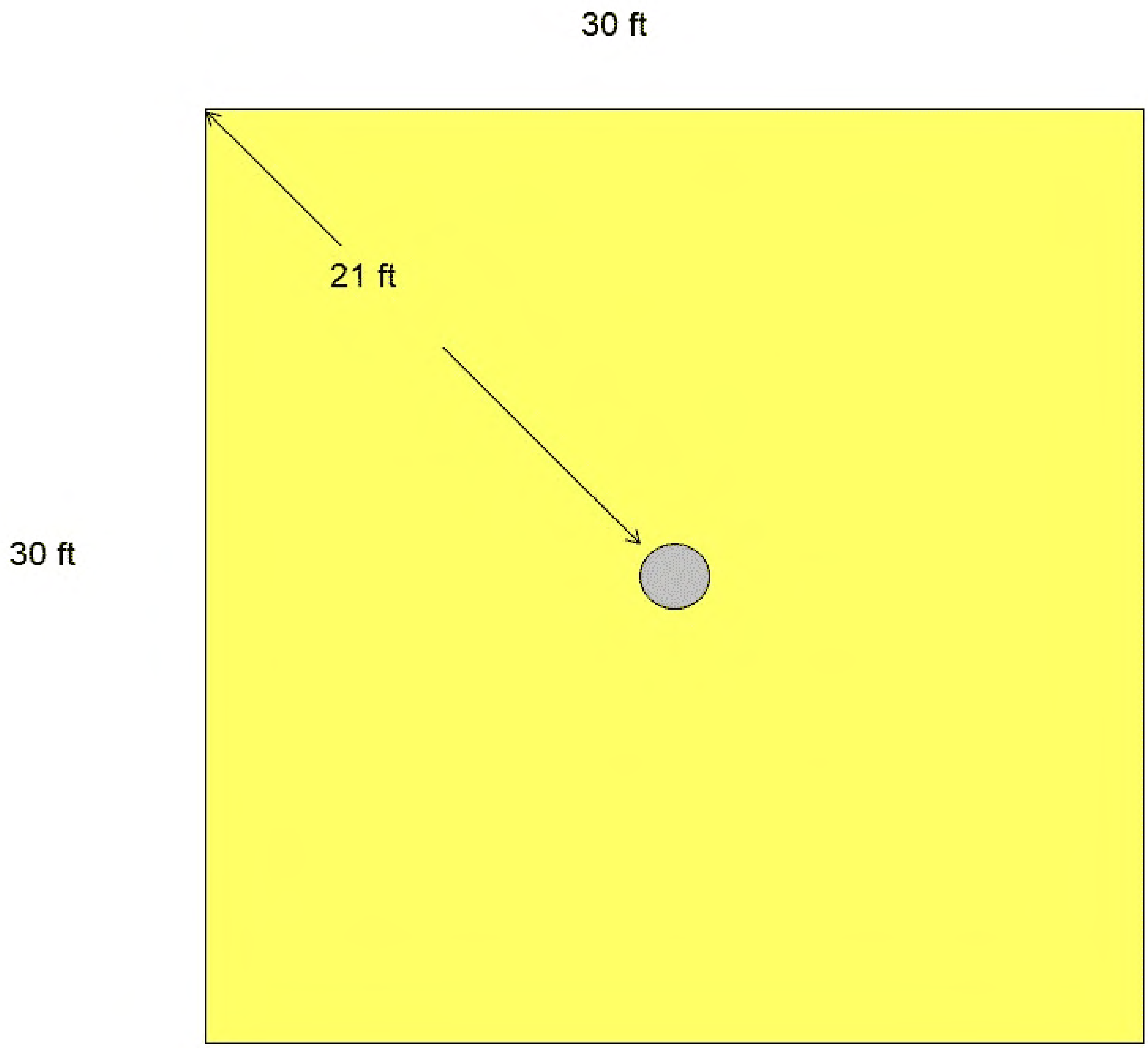
2. All points on the ceiling shall have a detector within a distance equal to or less than 0.7 times the listed spacing (0.7S)

30 x 30-FOOT ROOM

This diagram shows that for a 30 x 30-ft. room (900 foot^2):

- Heat detector is listed at 30-ft. spacing.
- If the detector is located at half the listed spacing from the walls, the detector will end up in the center of a room (15 ft. from each wall).


30 ft
30 ft
15 ft
15 ft
15 ft
15 ft



This diagram shows the same space and detector as the previous example.

If the detector is located at a 45° angle from any of the corners, the detector will end up in the center of a room. This also happens to be 15 ft. from each wall. Within this space, all points on the ceiling will be within 21 ft. of the detector.

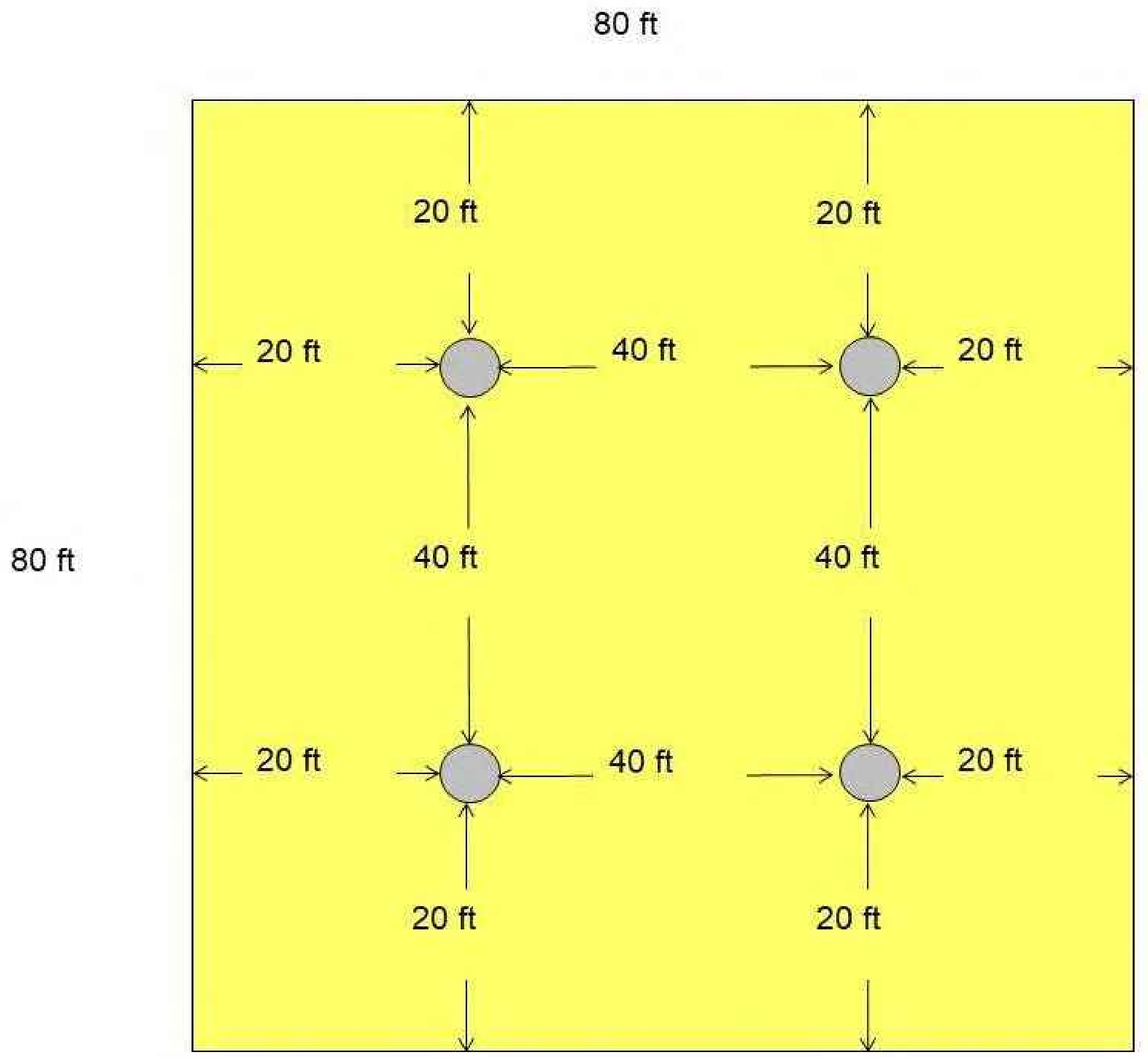
0.7 x 30 ft. = 21 ft. (that is a radius).

80 x 80 FOOT ROOM

Detector spacing is 40 ft.

The top left detector is located at half its spacing from top and left walls (20 ft). The same process is followed for the remaining 3 corners.

The distance between the top 2 detectors and bottom 2 detectors is 40 ft.


80 ft
80 ft
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40 ft
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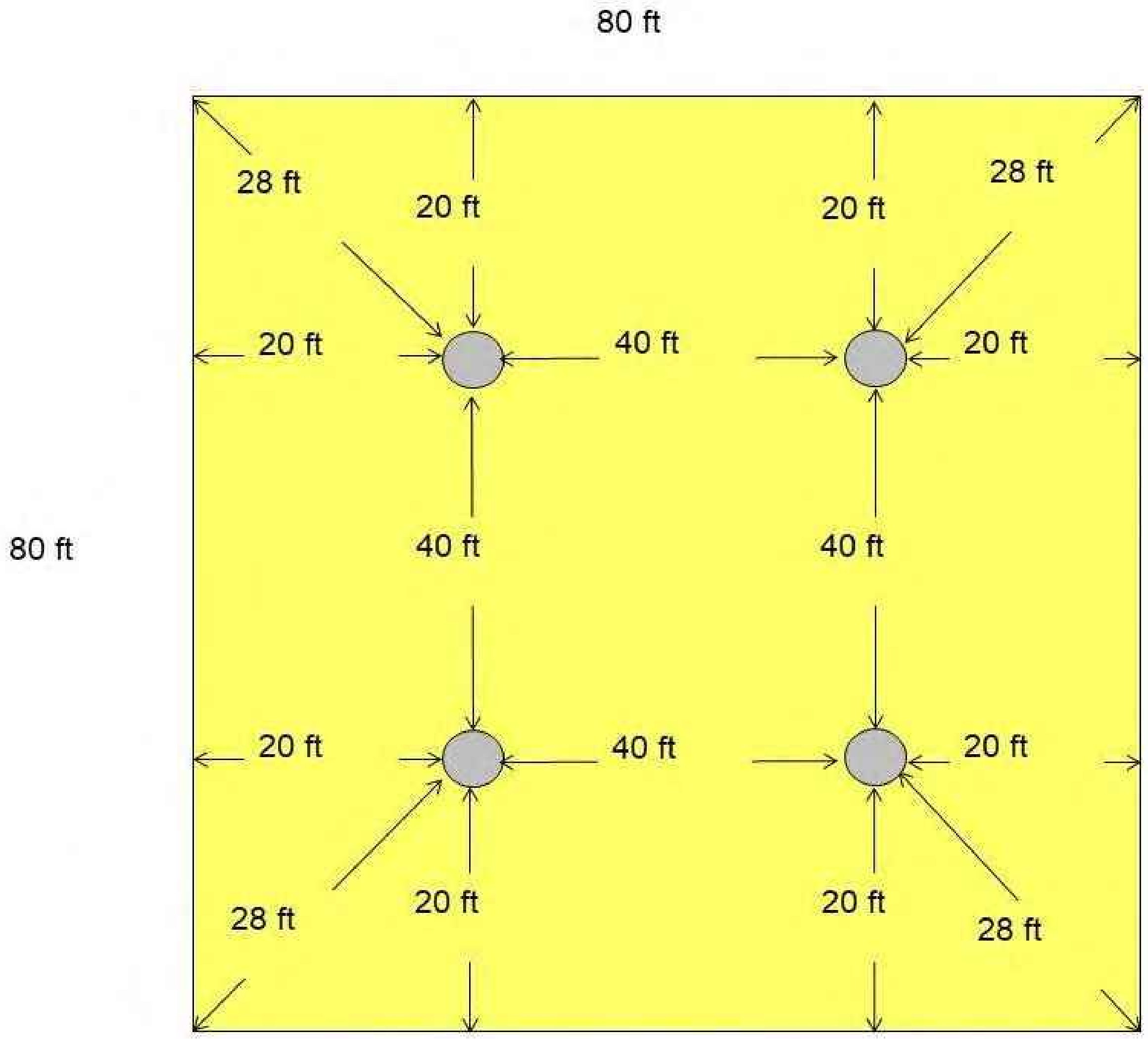
20 ft



Same room and detectors using the 0.7 spacing rule.

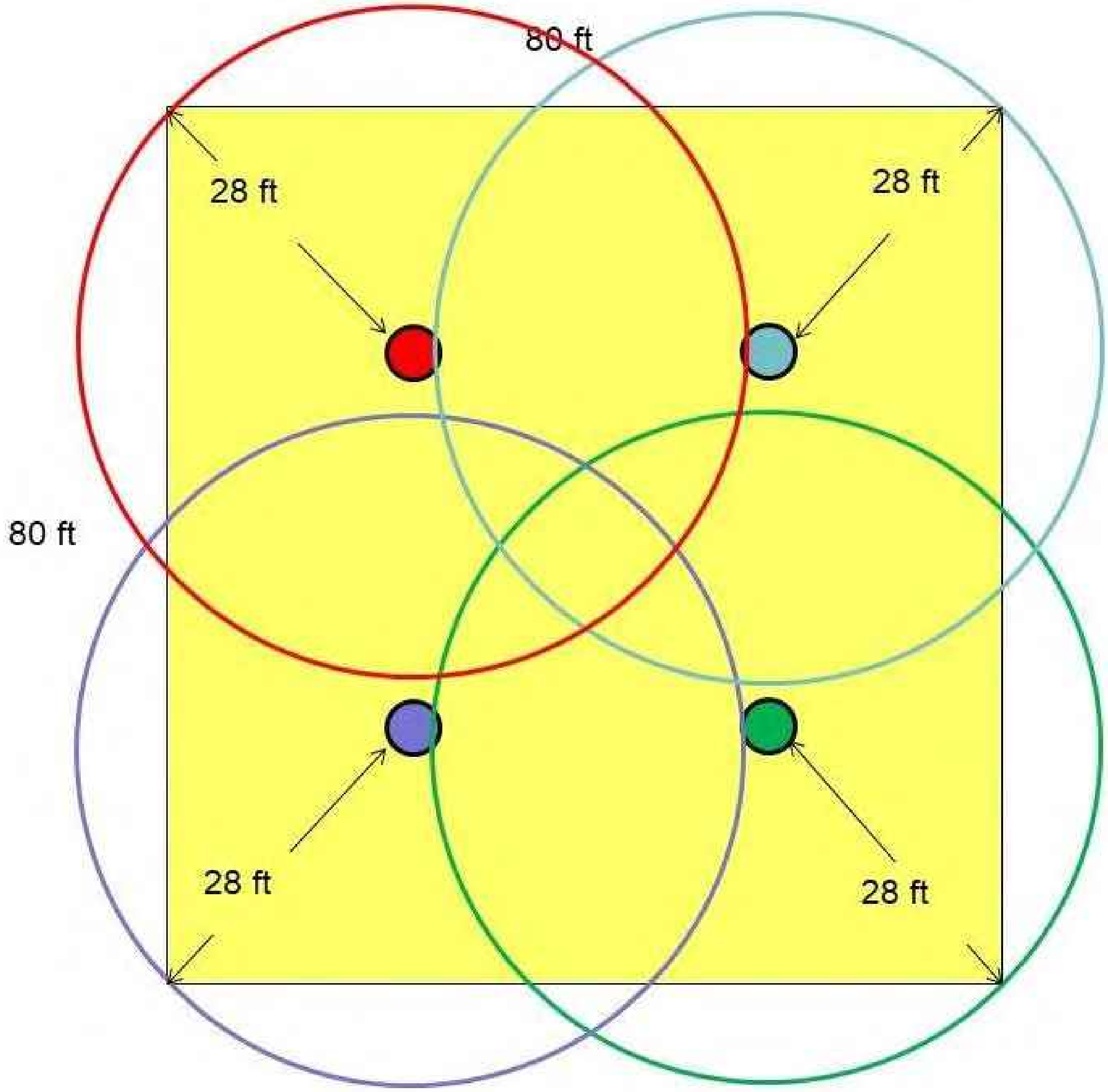
The first detector is located 28 ft. diagonally (45°) from the nearest corner.

The same process is followed for the remaining 3 corners.

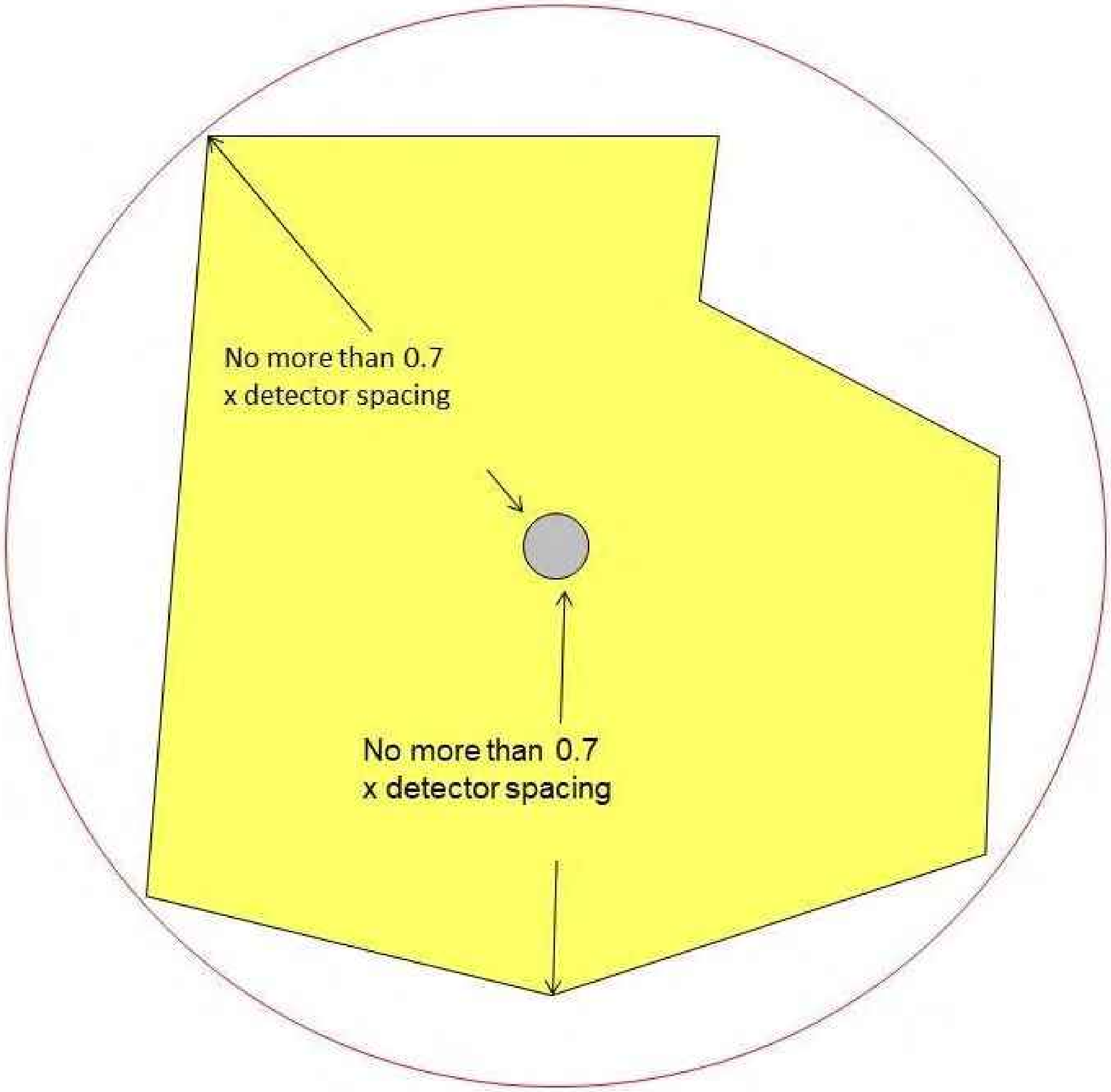
We end up with the same dimensions as using Rule 1.

Same room using the 0.7 spacing rule (Rule 2)

Each circle represents a 28-ft. radius to see where each detector's area of coverage is located.



IRREGULAR SHAPED SPACE



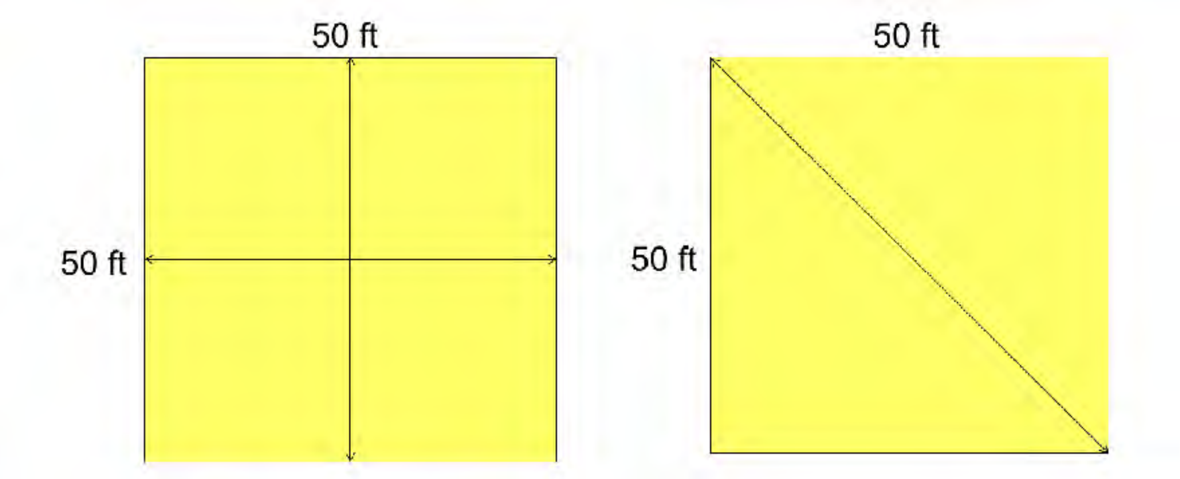
The 0.7 spacing rule is very useful for irregularly shaped spaces such as the example (on the left).

Per ***NFPA* 72 2016**, no space on the ceiling may be more than 0.7 x the detector's spacing (0.7S) away from the nearest detector.

CONTINUE

Let's do a quick check about what has been covered so far.

The 0.7 spacing rule says that all points on the ceiling shall have a detector within a distance equal to 0.7 times the listed spacing. Based on this rule, if the detector is listed at 30 ft. spacing, how many detectors are required for a 2500 (ft^2) room?



○ One

○ Two

○ Four

SUBMIT

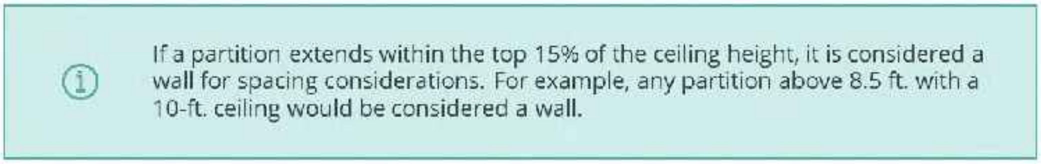
Complete the knowledge check above before moving on.

Location

NFPA 72 2016, Section 17.6.3.1.3

Spot-type detectors shall be located on the ceiling not less than 4 in. from the side wall or on the side walls *between* 4 in. and 12 in. from the ceiling.

Line-type heat detectors shall be located on the ceiling or on the sidewalls not more than 20 in. from the ceiling.



If a partition extends within the top 15% of the ceiling height, it is considered a wall for spacing considerations. For example, any partition above 8.5 ft. with a 10-ft. ceiling would be considered a wall.

SOLID JOIST CONSTRUCTION

Solid Joist Construction

NFPA 72 2016, Section 17.6.3.2

The location and spacing rules for heat detectors become more complex when you have ceilings with beams, joists, slopes, and combinations of those constructions.

Joists are solid projections, whether structural or not, **extending downward from the ceiling** that are **more than 4 in. in depth and are spaced on centers of 36 in. or less**. The 2 in. by 10 in. rafter installed on 16 in. centers supporting a roof deck is typical of solid joist construction.

If a joist is less than 4 in. in depth, it is considered a smooth ceiling for detector spacing purposes.

The spacing of heat detectors, when measured at right angles to a solid joist, shall not exceed 50% of the smooth ceiling spacing (derating is a factor if the ceiling height is above 10 ft).

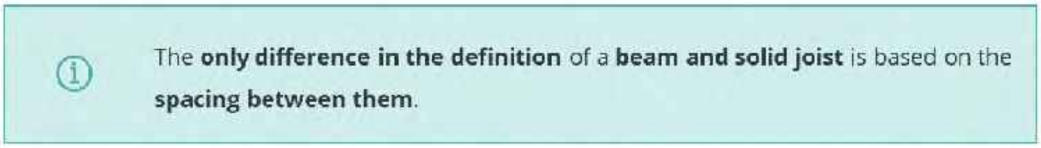
Heat detectors shall be mounted on the bottom of joists.

BEAM CONSTRUCTION

Beam Construction

NFPA 72 2016, Section 17.6.3.3

Beams are solid projections, whether structural or not, **extending downward from the ceiling** that are **more than 4 in. in depth and are spaced on centers of more than 36 in**.



The **only difference in the definition** of a **beam and solid joist** is based on the **spacing between them**.

Heat detector spacing on beams can get complicated.

If beams are 4 in. or less in depth, the ceiling is considered a smooth ceiling for spacing purposes.

CONTINUE

If beams are more than 4 in. in depth, detector spacing at right angles to the beams are reduced to 2/3 spacing (66%).

If beams are more than 18 in. in depth and more than 8 ft. on center, place detectors in beam pockets.

If the beams are less than 12 in. in depth and less than 8 ft. on center, detectors may be placed on the bottom of the beams.

CONTINUE

NFPA 72 2016, Section 17.6.3.3 (continued)

The ratio of beam depth to ceiling height and beam spacing to ceiling height can help to determine if the heat detectors should be located in the beam pockets or on the bottom of the beams. The following information comes from ***NFPA* 72 2016, Annex A, Section A.17.6.3.3**:

- If the depth ÷ height is greater than 0.10 AND the spacing ÷ height is greater than 0.40, then the detectors ***SHOULD*** be located in each beam pocket.

- If the depth ÷ height is less than 0.10 OR the spacing ÷ height is less than 0.40, then the detectors ***SHOULD*** be located on the bottom of the beams.

CONTINUE

Let's do a quick check about what has been covered so far.

______ are solid projections, whether structural or not, extending downward from the ceiling that are more than 4 in. in depth and are spaced on centers of 36 in. or less.

○ Joists

○ Beams

SUBMIT

If beams are ______ or less in depth, the ceiling is considered a smooth ceiling for spacing purposes.

○ 2 in.

○ 4 in.

○ 8 in.

SUBMIT

If the beams are less than 12 in. in depth and less than 8 ft. on center, where should the detectors be placed?

○ in beam pockets

○ on the bottom of the beams

SUBMIT

Complete the knowledge check above before moving on.

Sloping Ceilings (Peaked and Shed)

NFPA 72 2016, Section 17.6.3.4

The first factor to determine is the angle of the slope of the ceiling.

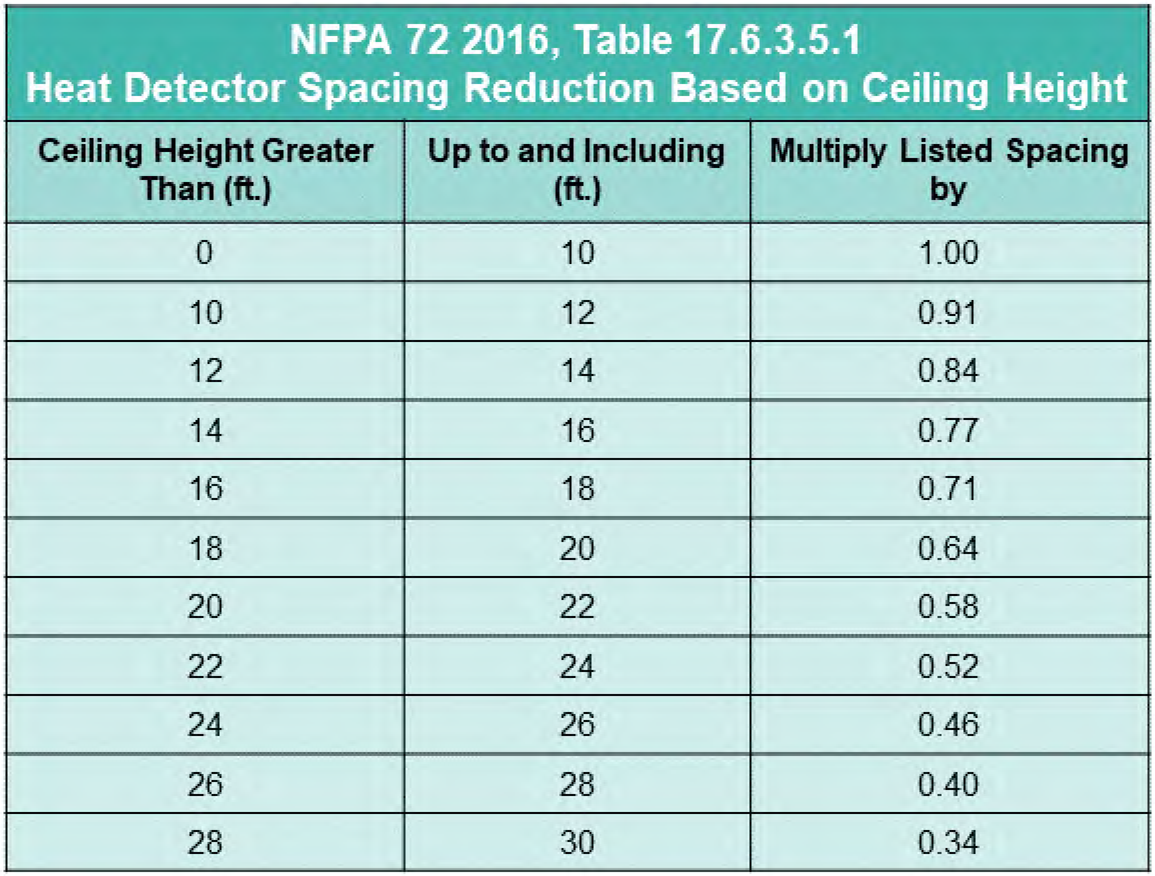
Since heat detector spacing is dependent on the height of the ceiling, we need to determine the height to use for spacing reduction on the sloped ceiling.

If the slope of the ceiling is less than 30 degrees, the height of the peak should be used for spacing determination.

If the slope of the ceiling is equal to or more than 30 degrees, all detectors, other than those located in the peak, shall be spaced using the average slope height or the height of the peak (designer’s choice unless local codes determine otherwise).

The first row of detectors shall be located at or within 36 in. from the peak of the ceiling.

The spacing for the remainder of the slope will be determined by using the ceiling height and referring to Table 17.6.3.5.1 (below).



NFPA 72 2016, Table 17.6.3.5.1 Heat Detector Spacing Reduction Based on Ceiling Height		
Ceiling Height Greater Than (ft.)	Up to and Including (ft.)	Multiply Listed Spacing by
0	10	1.00
10	12	0.91
12	14	0.84
14	16	0.77
16	18	0.71
18	20	0.64
20	22	0.58
22	24	0.52
24	26	0.46
26	28	0.40
28	30	0.34

NFPA 72 2016, SECTION 17.6.3.5

NFPA 72 2016, Section 17.6.3.5

Ceilings 10 to 30 ft. high require reduced spacing for heat detectors. *NFPA* 72 2016, Table 17.6.3.5.1 specifies a reduction factor.

Assuming our heat detector has a listed spacing of 30 feet, calculate for S.

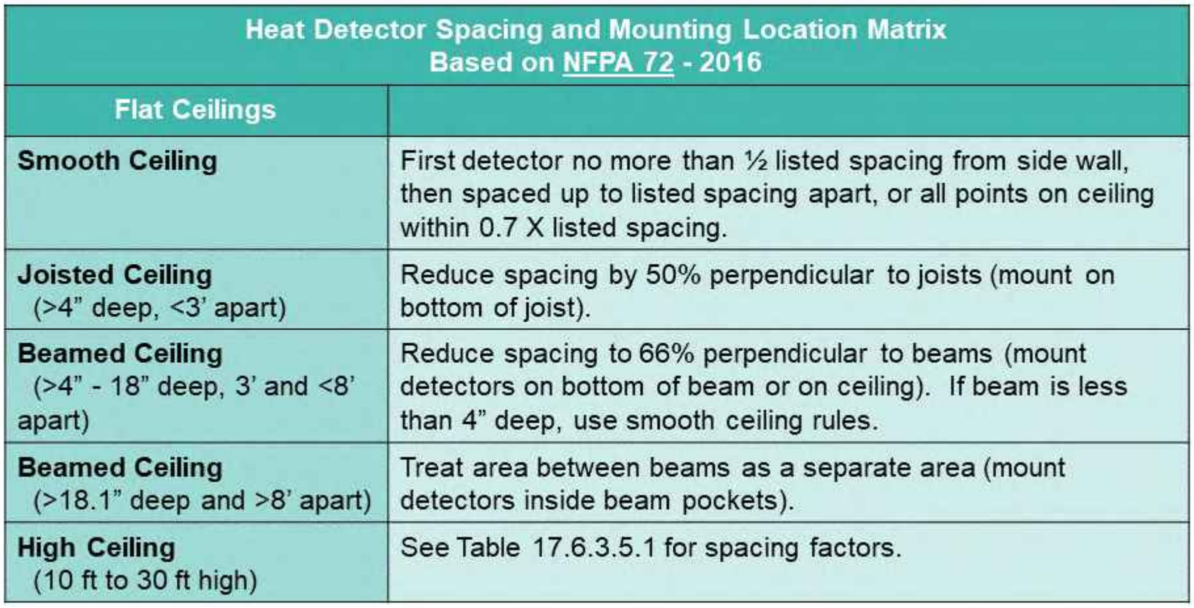
Example 1: 16 ft. ceiling, S = listed spacing x 0.71 (21.3 ft.)

Example 2: 18 ft, 1-in. ceiling, S = listed spacing x 0.64 (19.2 ft.)

ⓘ Section **17.6.3.5.2** states the **minimum spacing of heat detectors** shall not be required to be less than 0.4 times the ceiling height.

SPOT TYPE HEAT DETECTOR SPACING FOR FLAT CEILINGS

Below is a chart that defines spot type heat detector spacing for the various types of **flat ceiling** configurations.

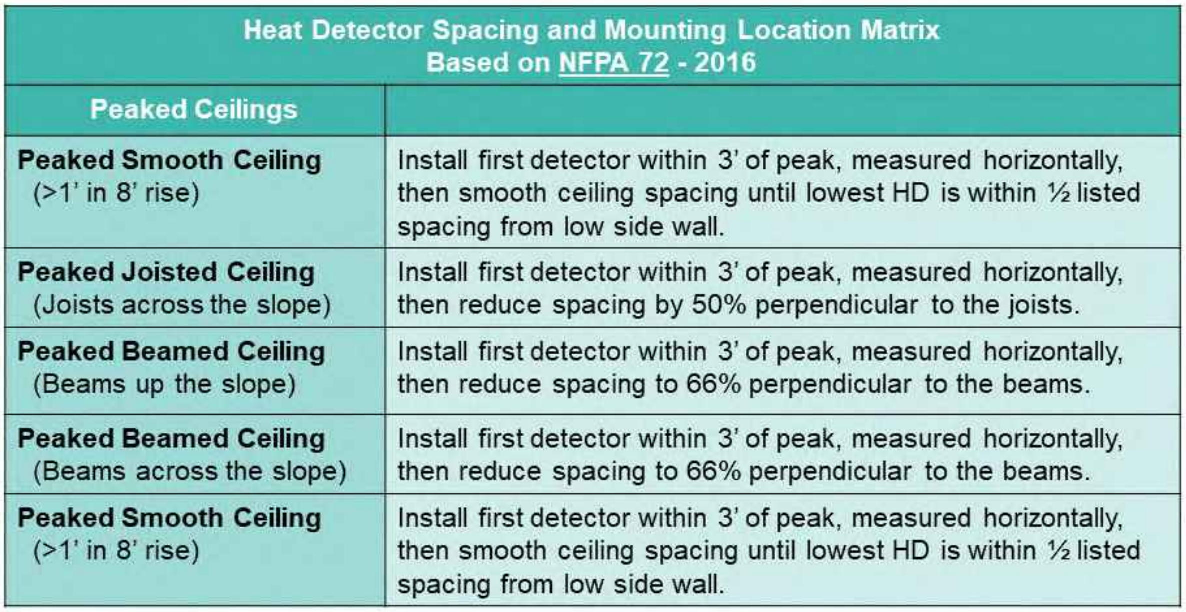


Heat Detector Spacing and Mounting Location Matrix
Based on NFPA 72 - 2016

Flat Ceilings	
Smooth Ceiling	First detector no more than ½ listed spacing from side wall, then spaced up to listed spacing apart, or all points on ceiling within 0.7 X listed spacing.
Joisted Ceiling (>4" deep, <3' apart)	Reduce spacing by 50% perpendicular to joists (mount on bottom of joist).
Beamed Ceiling (>4" - 18" deep, 3' and <8' apart)	Reduce spacing to 66% perpendicular to beams (mount detectors on bottom of beam or on ceiling). If beam is less than 4" deep, use smooth ceiling rules.
Beamed Ceiling (>18.1" deep and >8' apart)	Treat area between beams as a separate area (mount detectors inside beam pockets).
High Ceiling (10 ft to 30 ft high)	See Table 17.6.3.5.1 for spacing factors.

SPOT TYPE HEAT DETECTOR SPACING FOR PEAKED CEILINGS

Below is a chart that defines spot type heat detector spacing for the various types of **peaked ceiling** configurations.



Heat Detector Spacing and Mounting Location Matrix Based on NFPA 72 - 2016	
Peaked Ceilings	
Peaked Smooth Ceiling (>1' in 8' rise)	Install first detector within 3' of peak, measured horizontally, then smooth ceiling spacing until lowest HD is within ½ listed spacing from low side wall.
Peaked Joisted Ceiling (Joists across the slope)	Install first detector within 3' of peak, measured horizontally, then reduce spacing by 50% perpendicular to the joists.
Peaked Beamed Ceiling (Beams up the slope)	Install first detector within 3' of peak, measured horizontally, then reduce spacing to 66% perpendicular to the beams.
Peaked Beamed Ceiling (Beams across the slope)	Install first detector within 3' of peak, measured horizontally, then reduce spacing to 66% perpendicular to the beams.
Peaked Smooth Ceiling (>1' in 8' rise)	Install first detector within 3' of peak, measured horizontally, then smooth ceiling spacing until lowest HD is within ½ listed spacing from low side wall.

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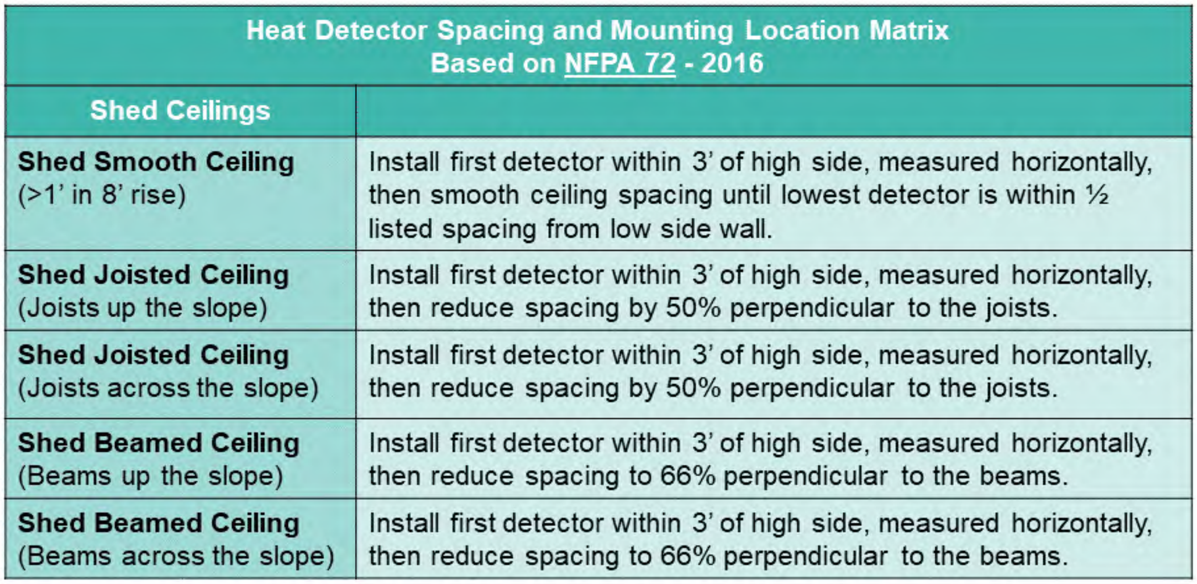
SPOT TYPE HEAT DETECTOR SPACING FOR SHED CEILINGS

Below is a chart that defines spot type heat detector spacing for the various types of **shed ceiling** configurations.



Heat Detector Spacing and Mounting Location Matrix Based on NFPA 72 - 2016	
Shed Ceilings	
Shed Smooth Ceiling (>1’ in 8’ rise)	Install first detector within 3’ of high side, measured horizontally, then smooth ceiling spacing until lowest detector is within ½ listed spacing from low side wall.
Shed Joisted Ceiling (Joists up the slope)	Install first detector within 3’ of high side, measured horizontally, then reduce spacing by 50% perpendicular to the joists.
Shed Joisted Ceiling (Joists across the slope)	Install first detector within 3’ of high side, measured horizontally, then reduce spacing by 50% perpendicular to the joists.
Shed Beamed Ceiling (Beams up the slope)	Install first detector within 3’ of high side, measured horizontally, then reduce spacing to 66% perpendicular to the beams.
Shed Beamed Ceiling (Beams across the slope)	Install first detector within 3’ of high side, measured horizontally, then reduce spacing to 66% perpendicular to the beams.

CONTINUE

Let's do a quick check about what has been covered so far with the location of spot type heat detectors on various ceilings.

Sort the cards into the correct categories based on the information for heat detector spacing and mounting for peaked ceilings, keeping in mind that in all situations, the first detector shall be installed within 3 ft. of the peak measured horizontally.

Peaked Smooth Ceiling

Spacing until lowest HD is within 1/2 listed spacing from low side wall

Peaked Joisted Ceiling

Reduce spacing by 50%, perpendicular to the joists

Peaked Beam Ceiling

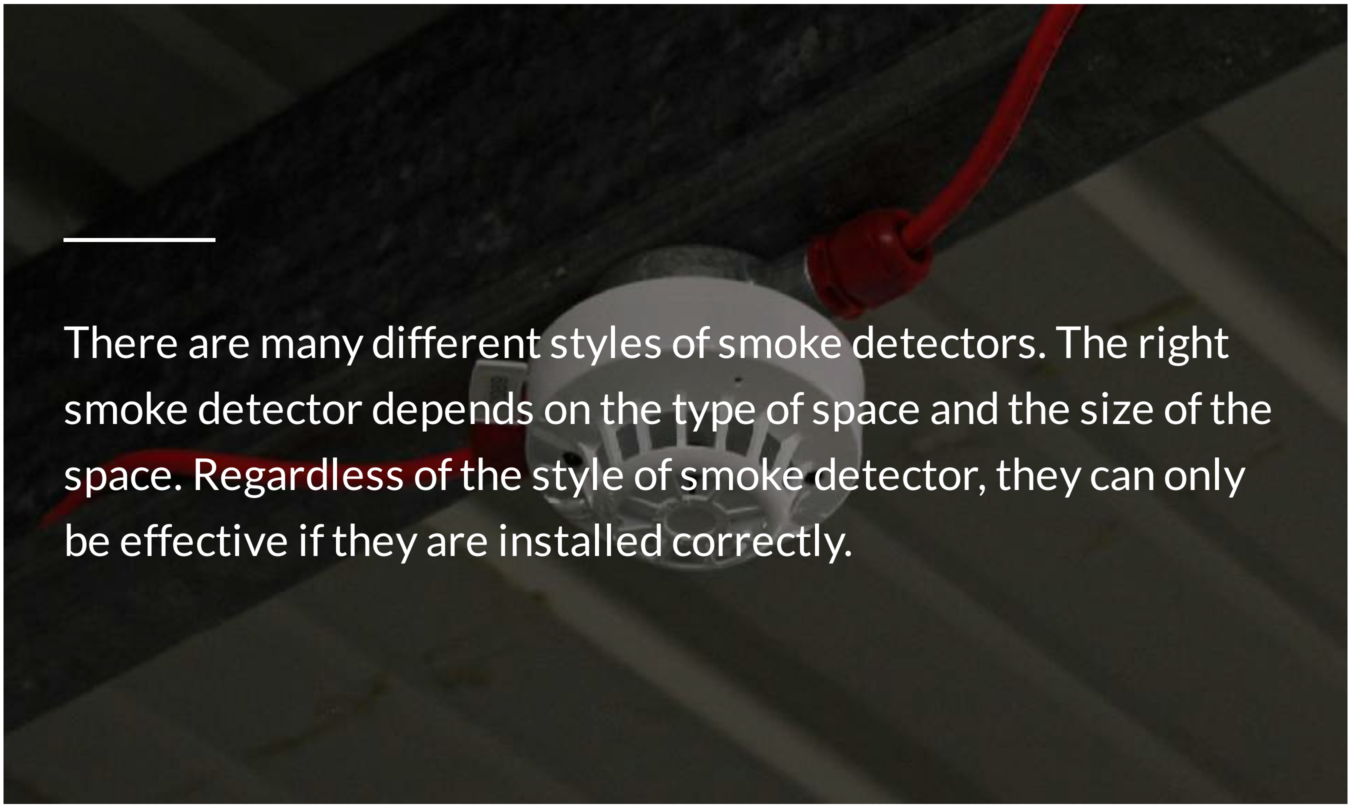
Reduce spacing to 66%

perpendicular to the beams

🔒 Complete the knowledge check above before moving on.

Lesson 2 of 3

Smoke Detector Location and Spacing



There are many different styles of smoke detectors. The right smoke detector depends on the type of space and the size of the space. Regardless of the style of smoke detector, they can only be effective if they are installed correctly.

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Properly protect smoke detectors when installed during construction.

2. Apply smoke detector location and spacing rules for different types of detectors and various ceiling construction schemes.

AMBIENT CONDITIONS

Smoke-Sensing Fire Detectors

***NFPA* 72 2016, Section 17.7**

> ⓘ Where smoke detectors are being installed to control the spread of smoke, they shall be installed in accordance with the requirements of **Section 17.7.5.**

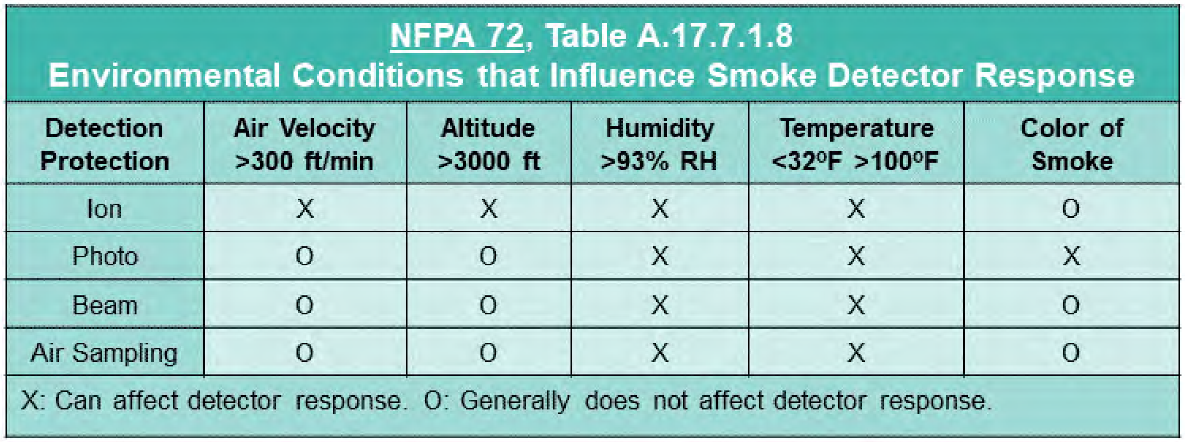
The selection and placement of smoke detectors shall take into account both the performance characteristics of the detector and the areas into which the detectors are to be installed to prevent nuisance and unintentional alarms or improper operation after installation.

Smoke detectors **shall not be installed** if any of the following ambient conditions exist, unless specifically **designed** and **listed** for the expected conditions:

- Temperature below 32^{o}F

- Temperature above 100^{O}F
- Relative humidity above 93%
- Air velocity greater than 300 ft/min (1.5m/sec)

***NFPA* 72 2016, Annex A** has a table that details how different detector technologies' response times are affected by environmental conditions.



NFPA 72, Table A.17.7.1.8
Environmental Conditions that Influence Smoke Detector Response

Detection Protection	Air Velocity >300 ft/min	Altitude >3000 ft	Humidity >93% RH	Temperature <32°F >100°F	Color of Smoke
Ion	X	X	X	X	O
Photo	O	O	X	X	X
Beam	O	O	X	X	O
Air Sampling	O	O	X	X	O

X: Can affect detector response. O: Generally does not affect detector response.

The table shows that **ionization detectors are most affected** by the environment, but **photoelectric spot-type detectors** are affected by the **color of the smoke**. Dark smoke will tend to absorb the light rather than reflect the light, making it harder to detect.

PROTECTION DURING CONSTRUCTION

ⓘ ***NFPA* 72 2016, Section 17.7.1.11,** This section of the code is concerned with smoke detector chambers collecting dust and dirt during building construction.

Protection During Construction

If smoke detectors are installed and used to detect fires during construction, the smoke detectors shall be cleaned and verified to be operating in accordance with the listed sensitivity, or they shall be replaced prior to the final acceptance of the system.

If smoke detectors are installed but not operational during construction, they shall be protected from construction debris, dust, dirt, and damage in accordance with the manufacturer’s recommendations and verified to be operating in accordance with the listed sensitivity, or they shall be replaced prior to the final acceptance of the system.

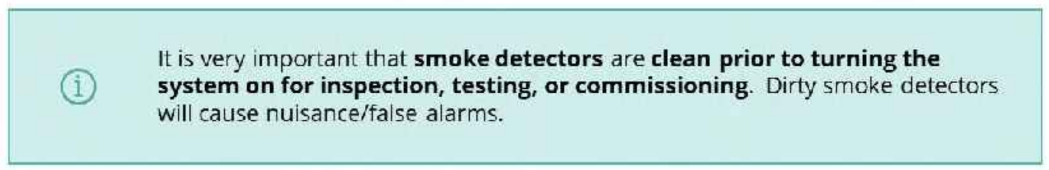
CONTINUE

If the smoke detectors are required to be operational during construction, they **must be cleaned or replaced** after construction is complete.

Another option is to **install approved covers** over the detectors until construction is complete.

Where smoke detection is not required during construction, the detectors shall not be installed until after all other construction trades have completed cleanup.

ⓘ If the detectors are not required to be operational during construction, the detectors shall not be installed until after all other trades have completed cleanup. If they are required for signal initiation during construction, they are required to be *cleaned and verified* to be operating per their listed sensitivity, or replaced prior to final acceptance test of the system. **- *NFPA* 72 2016, Section 17.7.1.11**



It is very important that **smoke detectors** are **clean prior to turning the system on for inspection, testing, or commissioning**. Dirty smoke detectors will cause nuisance/false alarms.

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CONTINUE

Let's do a quick check about what has been covered so far.

Smoke detectors **shall not be installed** if any of the following ambient conditions exist, unless specifically **designed** and **listed** for the expected conditions: (Select all that apply)

☐ Temperature below 0^{o}F

☐ Temperature above 100^{o}F

☐ Relative humidity above 93%

☐ Air velocity greater than 300 ft/min (1.5m/sec)

SUBMIT

If the smoke detectors are required to be operational during construction, the following must be adhered to: (Select all that apply)

☐ They must be cleaned or replaced after construction is complete.

☐ They must have approved covers installed over the detectors until construction is complete.

☐ They must be tested weekly until construction is complete.

☐ They must be cleaned and verified to be operating in accordance with the listed sensitivity.

SUBMIT

Complete the knowledge check above before moving on.

Location and Spacing

NFPA 72 2016, Section 17.7.3

Section 17.7.3.2 is titled Spot-Type Smoke Detectors. The ionization and photoelectric light scattering detectors are spot-type smoke detectors. This section also covers the different types of ceilings you may encounter and how smoke detectors are to be spaced or located.

Section A.17.7.3.2 states that in high ceiling areas where spot-type detectors are not accessible for maintenance, projected beam or air sampling detectors should be considered where access can be provided.

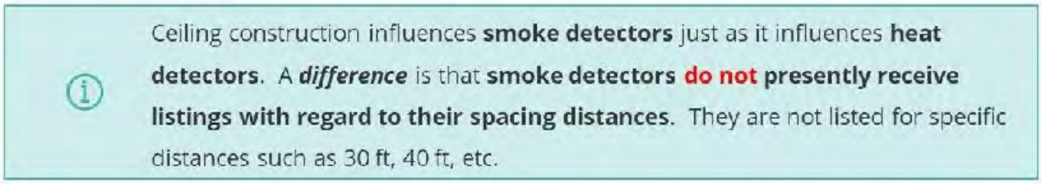
Spot-type smoke detectors must be located on the ceiling or on the wall not more than 12 in. from the ceiling to the top of the detector. Smoke detectors must always be mounted in the orientation that they have been listed for, even if they are installed under a raised floor.

If smoke detectors are used in high rack storage, they should be mounted above each aisle and at intermediate levels in the racks, per **Section A.17.7.6.2.**

SPOT-TYPE SMOKE DETECTORS

Spot-Type Smoke Detectors

NFPA 72 2016, Section 17.7.3.2



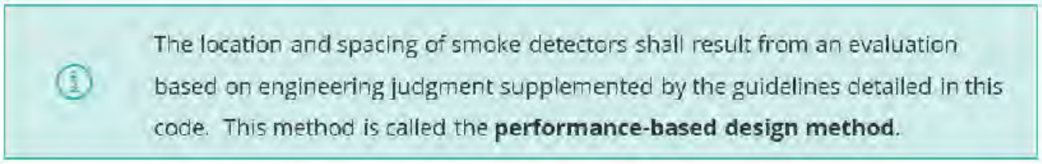
Ceiling construction influences **smoke detectors** just as it influences **heat detectors**. A ***difference*** is that **smoke detectors do not presently receive listings with regard to their spacing distances**. They are not listed for specific distances such as 30 ft, 40 ft, etc.

For **smooth ceiling construction**, the code allows for **30-ft. spacing** to be used as a guide (manufacturer's instructions shall always be followed). Considerations involving spacing may include factors such as **ceiling height** and **special response requirements**.

As with the heat detectors, the **code dictates that any point on the ceiling must be within a distance of 0.7 times the selected spacing**, whatever that may be.

With **projected beam detectors**, the manufacturer's installation instructions must be followed. For **smooth ceilings, a spacing of 60 ft.** can be used as a guide.

CONTINUE



The location and spacing of smoke detectors shall result from an evaluation based on engineering judgment supplemented by the guidelines detailed in this code. This method is called the **performance-based design method**.

The prescriptive requirements of the code apply to ordinary indoor locations.

The spacing requirements and method of layout for spot-type smoke detectors are similar to the spacing we covered for spot-type heat detectors. The difference is that **spacing for spot-type smoke detectors are not required to be reduced for ceiling heights over 10 ft.**

- **Or at least, there is no table in *NFPA* 72 2016 that covers this.**
- **Always consult the manufacturer’s published instructions.**

JOIST AND BEAM CONSTRUCTION

The rules for spacing of smoke detectors are the same for beams as they are for solid joist construction. With solid joist construction, **joists which are 10% of ceiling height or less in depth are permitted to be considered equivalent to a smooth ceiling**.

- Spot-type detectors can be mounted on the bottom of these joists or the ceiling.

Beams and joists that are more than 10% of the ceiling height have different location and spacing rules determined by the spacing of the beams or joists and whether the ceiling is sloped or peaked.

We will not discuss all of the different configurations for joists and beams as we did with heat detectors. The different scenarios could be a week-long class in and of itself.

Make sure to read the code very carefully for spot-type smoke detector spacing in these applications beginning on page 101. The location and spacing requirements deal with ratios of joist or beam depth to ceiling height. Those ratios determine if we mount the smoke detectors on the ceiling or on the bottom of the joist or beam.

PEAKED CEILINGS

Peaked Ceilings

NFPA 72 2016, Section 17.7.3.3

Spot-type smoke detectors installed on sloping peaked-type ceilings (peaked ceilings) will have the first detector **spaced** and **located within 3 ft. of the peak** and measured **horizontally**.

The number and spacing of additional detectors, if any, shall be based upon the **horizontal projection of the ceiling** (same requirement as spot-type heat detectors).

SHED CEILINGS

Shed Ceilings

NFPA 72 2016, Section 17.7.3.4

Spot-type smoke detectors installed on sloping shed-type ceilings (shed ceilings) will have the first detector **spaced** and l**ocated within 3 ft. of the high side of the ceiling**, measured **horizontally**.

The number and spacing of additional detectors, if any, shall be based on the **horizontal projection of the ceiling**.

CONTINUE

Let's do a quick check about what has been covered so far.

The difference in location and spacing between heat detectors and smoke detectors is that __________ do not presently receive listings with regard to their spacing distances.

○ heat detectors

○ smoke detectors

SUBMIT

Match the following location and spacing requirements:

Spot-type smoke detectors installed on peaked ceilings will have the first detector	spaced and located within 3 ft. of the peak and measured horizontally.
Spot-type smoke detectors installed on shed ceilings will have the first detector	spaced and located within 3 ft. of the high side of the ceiling, measured horizontally.

Spot-type smoke detectors on a smooth ceiling or on the wall must be located	not more than 12 in. from the ceiling to the top of the detector.

SUBMIT

Complete the knowledge check above before moving on.

Raised Floors and Suspended Ceilings

NFPA 72 2016, Section 17.7.3.5

The **spaces under raised floors** or **above suspended ceilings** shall be **treated as separate areas or rooms** for the purpose of smoke detection.

The **detectors installed under raised floors or above suspended ceilings**, including raised floors or spaces above suspended ceilings used for environmental air, **shall not be used in lieu of smoke detection within the room**.

ⓘ Spacing for smoke detectors used under raised floors or in spaces used for environmental air shall be in accordance with the requirements of **Sections 17.7.3.5.1 and 17.7.3.5.2.**

AIR SAMPLING-TYPE SMOKE DETECTORS

Air Sampling-Type Smoke Detectors

NFPA 72 2016, Section 17.7.3.6

Each air sampling port shall be treated as a spot-type smoke detector for the purpose of location and spacing of the ports.

The maximum transport time from the furthest sampling port to the control unit cannot exceed 120 seconds.

The **Sampling pipe network design** details shall include calculations showing the flow characteristics of the pipe network and each sample port.

The system piping must be identified with a sign "SMOKE DETECTOR SAMPLING TUBE — DO NOT DISTURB" at:

1. Changes in direction or branches in piping
2. At each side of a penetration of a wall, floor, or other barrier
3. At piping intervals that provide visibility at least every 20 ft.

PROJECTED BEAM-TYPE SMOKE DETECTORS

Projected Beam-Type Smoke Detectors

NFPA 72 2016, Section 17.7.3.7

A projected beam detector shall be considered as a row of spot-type detectors for level and sloping ceiling locations.

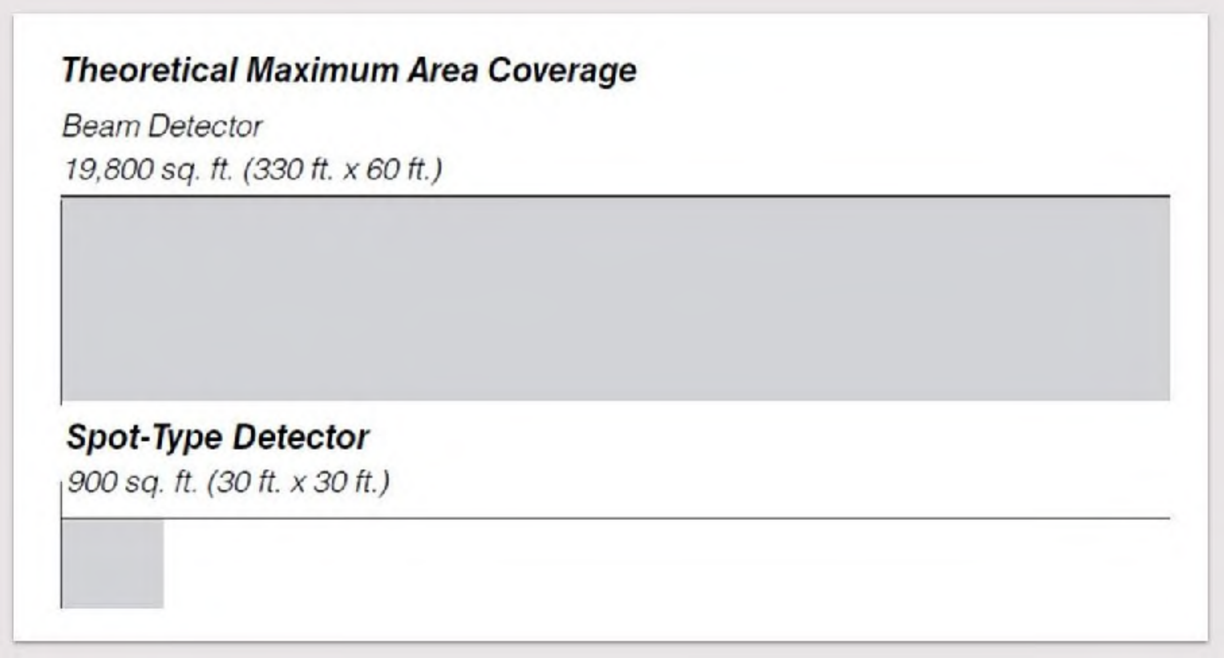
Projected beam detectors are often a good solution to environments where spot-type detectors cannot be used because of dirt, dust, heat, or humidity. They are not as sensitive to these factors unless they are extreme. They are not recommended for outdoor applications where exposed to rain, snow, sleet, or fog.

Mounting beam detectors per the manufacturer’s instructions is critical since building structures move with changes in temperature and other factors. Projected beam-type detectors and mirrors shall be mounted on stable surfaces to prevent false or erratic operation due to movement.

Projected beam-type smoke detectors will normally be located with their projected beams parallel to the ceiling and in accordance with the manufacturer's instructions.

ⓘ **Per Annex A**, for **smooth ceilings**, a **spacing of 60 ft.** can be used as a **guide**.

Projected beam detectors are also good for high ceiling areas where it would be difficult to test and service spot-type detectors. They typically have a range of 330 ft., giving them a theoretical maximum coverage of 19,800 ft^2.



CONTINUE

Let's do a quick check about what has been covered so far.

According to *NFPA* 72, Section 17.7.3.6 the maximum transport time from the furthest air sampling port to the control unit cannot exceed __________.

○ 30 seconds

○ 60 seconds

○ 120 seconds

SUBMIT

The air sampling system piping must be identified with a sign “SMOKE DETECTOR SAMPLING TUBE — DO NOT DISTURB” at: (Select all that apply)

☐ At piping intervals that provide visibility at least every 20 ft.

☐ Changes in ceiling height of more than 12 in.

☐ At each side of a penetration of a wall, floor, or other barrier

☐ Changes in direction or branches in piping

SUBMIT

Complete the knowledge check above before moving on.

Heating, Ventilating, and Air-Conditioning (HVAC)

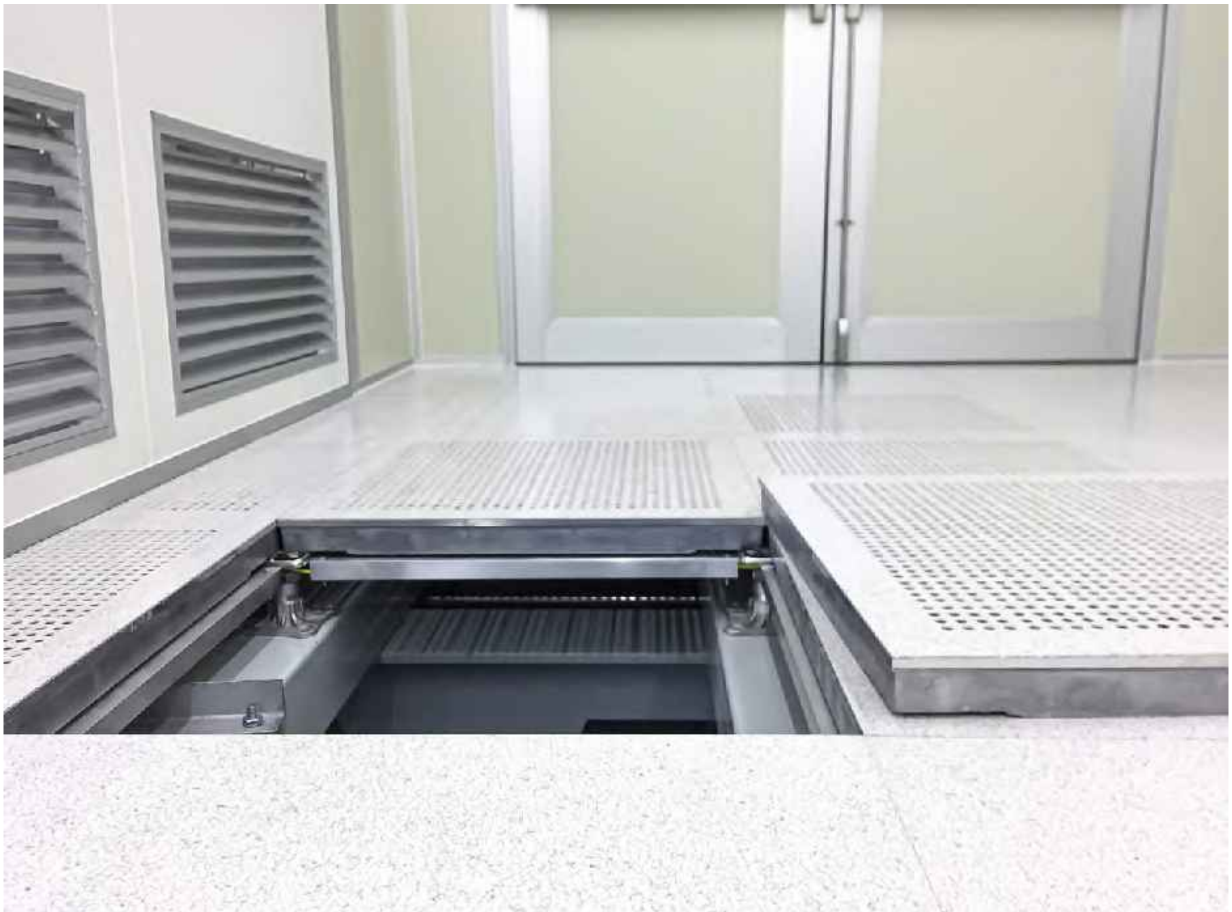
NFPA 72 2016, Section 17.7.4

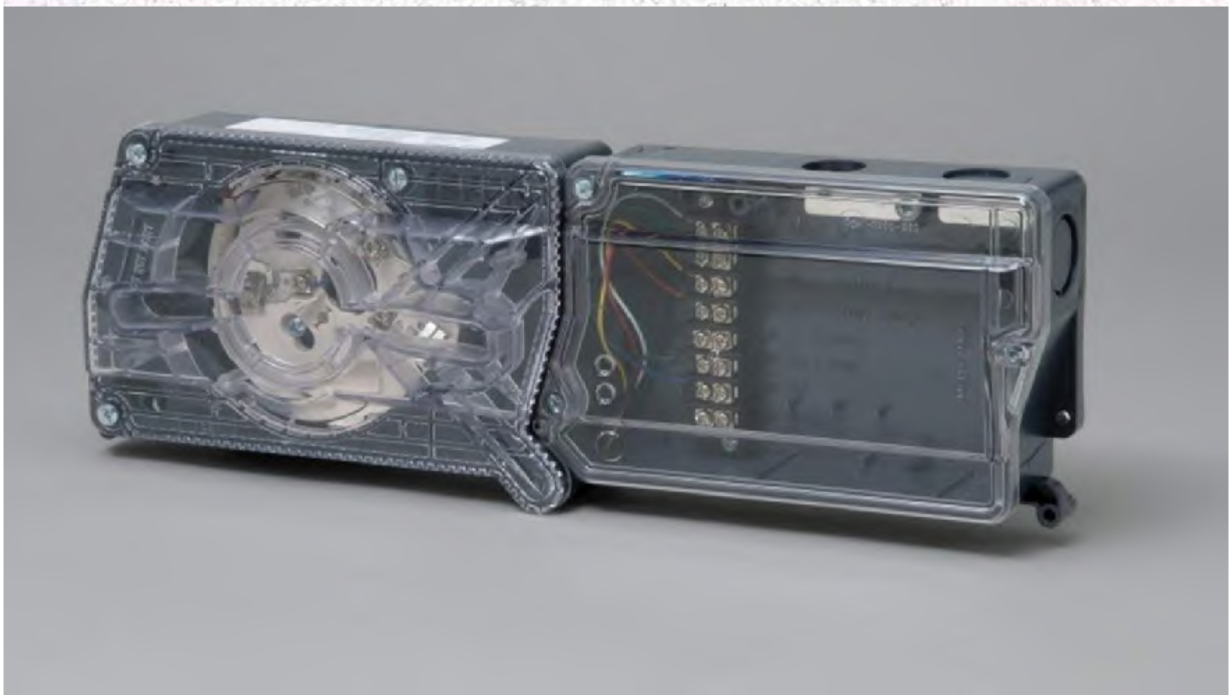
Smoke travels in the direction of the air flow. **We must be careful that the smoke which we are trying to detect will not be taken away or diluted to the point where it will not be effectively detected**.

Considerations must be given to potentially reduce the spacing of the detectors in these areas unless we can be assured that the flow and quantity of air is reasonable for our detector to handle. For example, **a smoke detector should not be located closer than 3 ft. to an air supply diffuser**.

CONTINUE

When spaces under floors and above ceilings are used as plenums or ducts for heating, ventilating, and air conditioning systems, the **detectors are required to be listed for the air velocities anticipated**. These special smoke detectors are not suitable (listed) for use in normal applications.





Duct detector requirements are specified by ***NFPA*** **90A -** Standard for the Installation of Air-Conditioning and Ventilating Systems, building codes, and other local standards and codes.

The primary purpose of duct smoke detection is to reduce the spread of smoke. **Duct detectors are not a substitute for area smoke detection.**

ⓘ Smoke detectors for air duct use are required to be **installed on the supply side** of air-handling equipment per ***NFPA* 90A.**

LOCATION AND INSTALLATION OF DETECTORS IN AIR DUCT

Location and Installation of Detectors in Air Duct Systems

NFPA 72 2016, Section 17.7.5.5

Air duct detectors must be installed to obtain a good sample of the airstream. This installation can be any of the following four methods:

1. Rigid mounting within the duct
2. Rigid mounting to the wall of the duct with the sensing element protruding into the duct
3. Installation outside the duct with rigidly mounted sampling tubes protruding into the duct
4. Installation through the duct with projected light beam

Detectors shall be mounted in accordance with the manufacturer’s published instructions and shall be accessible for cleaning by providing access doors or control units.

All penetrations of a return air duct in the vicinity of detectors installed on or in an air duct shall be sealed to prevent entrance of outside air which may dilute or redirect the smoke.

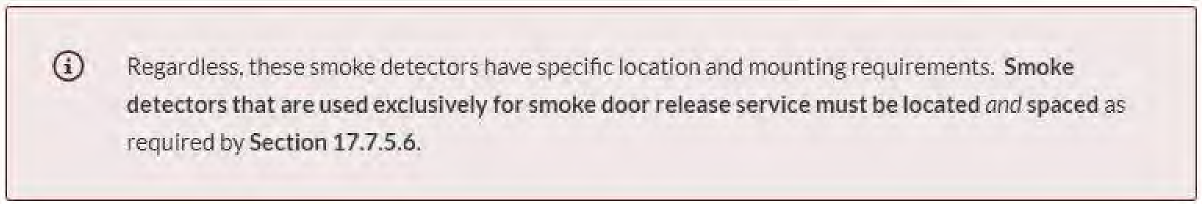
SMOKE DETECTORS FOR DOOR RELEASE SERVICE

Smoke Detectors for Door Release Service

NFPA 72 2016, Section 17.7.5.6

If **smoke door release is accomplished directly from the smoke detectors**, the **detectors *must* be listed for releasing service**.

NFPA 72 2016, Section 17.7.5.6



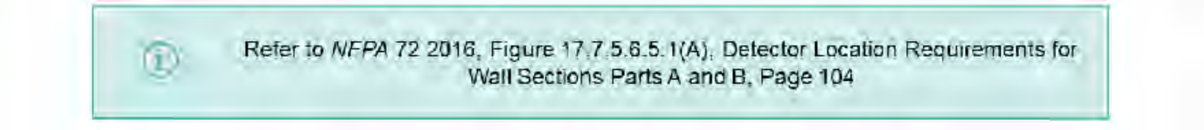
Regardless, these smoke detectors have specific location and mounting requirements. **Smoke detectors that are used exclusively for smoke door release service must be located** *and* **spaced** as required by **Section 17.7.5.6.**

There are some spot-type smoke detectors used to release smoke doors. These detectors are typically four-wire smoke detectors which may or may not be connected into the fire alarm system. That will depend upon local codes and regulations.

If doors are to be closed in response to smoke flowing in either direction, the requirements of Sections 17.7.5.6.5.1(A) through 17.7.5.6.5.1(D) shall apply.

Requirement 1

Section A Parts A & B

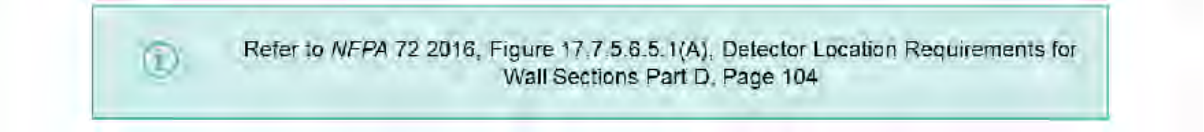


Refer to *NFPA* 72 2016, Figure 17.7.5.6.5.1(A), Detector Location Requirements for Wall Sections Parts A and B, Page 104

(A) If the depth of wall section above the door is 24 in. (610 mm) or less, one ceiling-mounted smoke detector shall be required on one side of the doorway only, or two wall-mounted detectors shall be required, one on each side of the doorway. Figure 17.7.5.6.5.1(A), part A or B, shall apply.

Requirement 2

Section B Part D



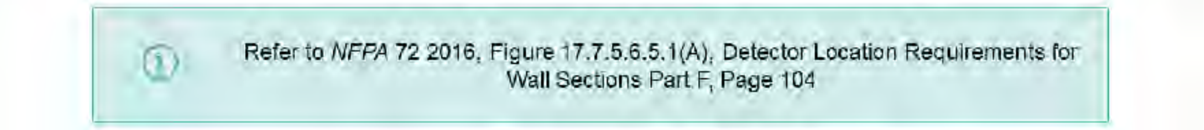
Refer to *NFPA* 72 2016, Figure 17.7.5.6.5.1(A), Detector Location Requirements for Wall Sections Part D, Page 104

(B) If the depth of wall section above the door is greater than 24 in. (610 mm) on one side only, one ceiling-mounted smoke detector shall be required on the higher side of the doorway only, or one wall-mounted detector shall be required on both sides of the doorway.

Figure 17.7.5.6.5.1(A), part D, shall apply.

Requirement 3

Section C Part F

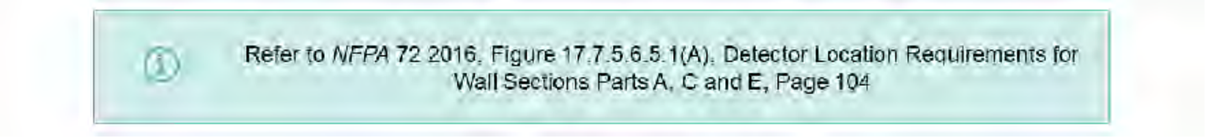


① Refer to *NFPA* 72 2016, Figure 17.7.5.6.5.1(A), Detector Location Requirements for Wall Sections Part F, Page 104

(C) If the depth of wall section above the door is greater than 24 in. (610 mm) on both sides, two ceiling-mounted or wall-mounted detectors shall be required, one on each side of the doorway. Figure 17.7.5.6.5.1(A), part F, shall apply.

Requirement 4

Section D Parts A, C, & E



Refer to *NFPA* 72 2016, Figure 17.7.5.6.5.1(A), Detector Location Requirements for Wall Sections Parts A, C and **E**, Page 104

(D) If a detector is specifically listed for door frame mounting, or if a listed combination or integral detector-door closer assembly is used, only one detector is required if installed in the manner recommended by the manufacturer’s published instructions.

Figure 17.7.5.6.5.1(A), parts A, C, and E, shall apply.

Additional Requirements

There are **additional requirements in Section 17.7.5.6** covering the smoke detectors for door release service.

Study and understand Figures:

- 17.7.5.6.5.1(A) – Detector Location Requirements for Wall Sections
- 17.7.5.6.5.3(A) – Detector Location Requirements for Single and Double Doors
- 17.7.5.6.5.3(B) – Detector(s) Location + 24 in. (0.6 m) Requirements for Group Doorways
- 17.7.5.6.5.3(C) – Detector(s) Location + 24 in. (0.6 m) Requirements for Group Doorways over 20 ft (6.1 m) in Width

All figures are located on pages 104 and 105 of *NFPA* 72 2016.

SPECIAL CONSIDERATIONS

Special Considerations

NFPA 72 2016, Section 17.7.6

Combination and multi-sensor smoke detectors with a fixed-temperature heat detector element as part of the unit shall be selected per the guidelines for maximum ceiling temperature expected (see **Table 17.6.2.1**).

Holes in the back of a detector shall be covered by a gasket, sealant, or equivalent means, and the detector shall be mounted so that airflow from inside or around the housing does not prevent the entry of smoke during a fire or test condition.

HIGH AIR MOVEMENT AREAS

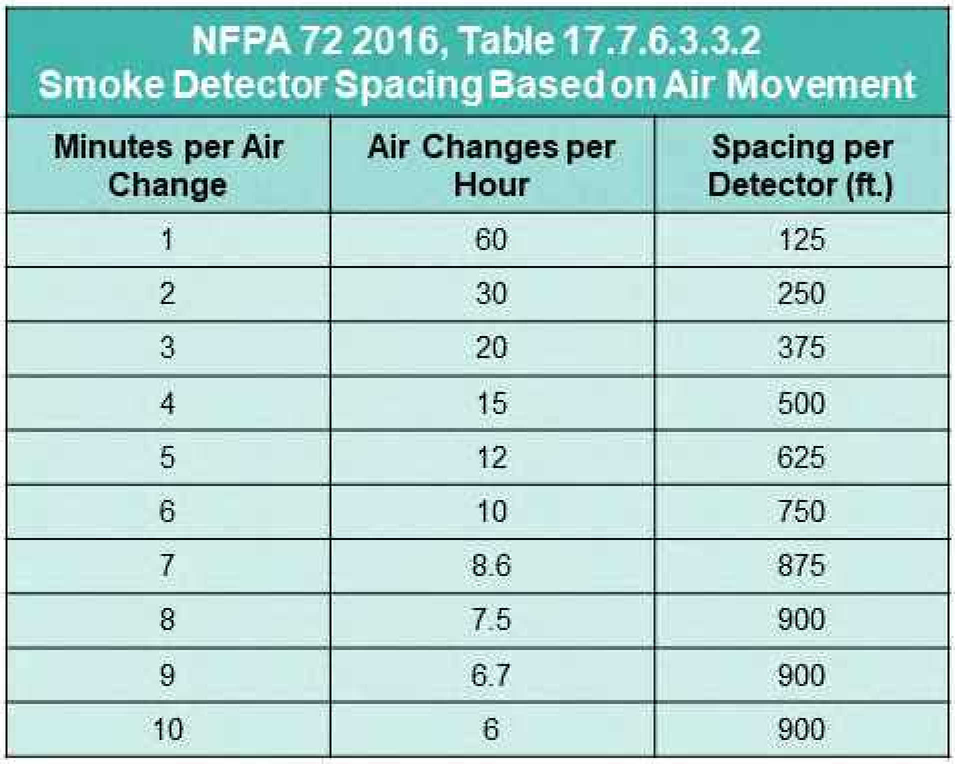
High Air Movement Areas

NFPA 72 2016, Section 17.7.6.3

This section covers spacing and location of smoke detectors used for high air movement areas.

This section does not cover smoke detectors used for control of smoke spread. Those detectors are covered in **Section 17.7.5**.

Smoke detectors shall not be located directly in the airstream of supply registers. This would dilute the smoke or move the smoke away from the detector’s sensing chamber. In high air movement areas, spot-type smoke detectors will be spaced in accordance with **Table 17.7.6.3.3.2** (do not use table for under floor or above ceiling spaces).



NFPA 72 2016, Table 17.7.6.3.3.2
Smoke Detector Spacing Based on Air Movement

Minutes per Air Change	Air Changes per Hour	Spacing per Detector (ft.)
1	60	125
2	30	250
3	20	375
4	15	500
5	12	625
6	10	750
7	8.6	875
8	7.5	900
9	6.7	900
10	6	900

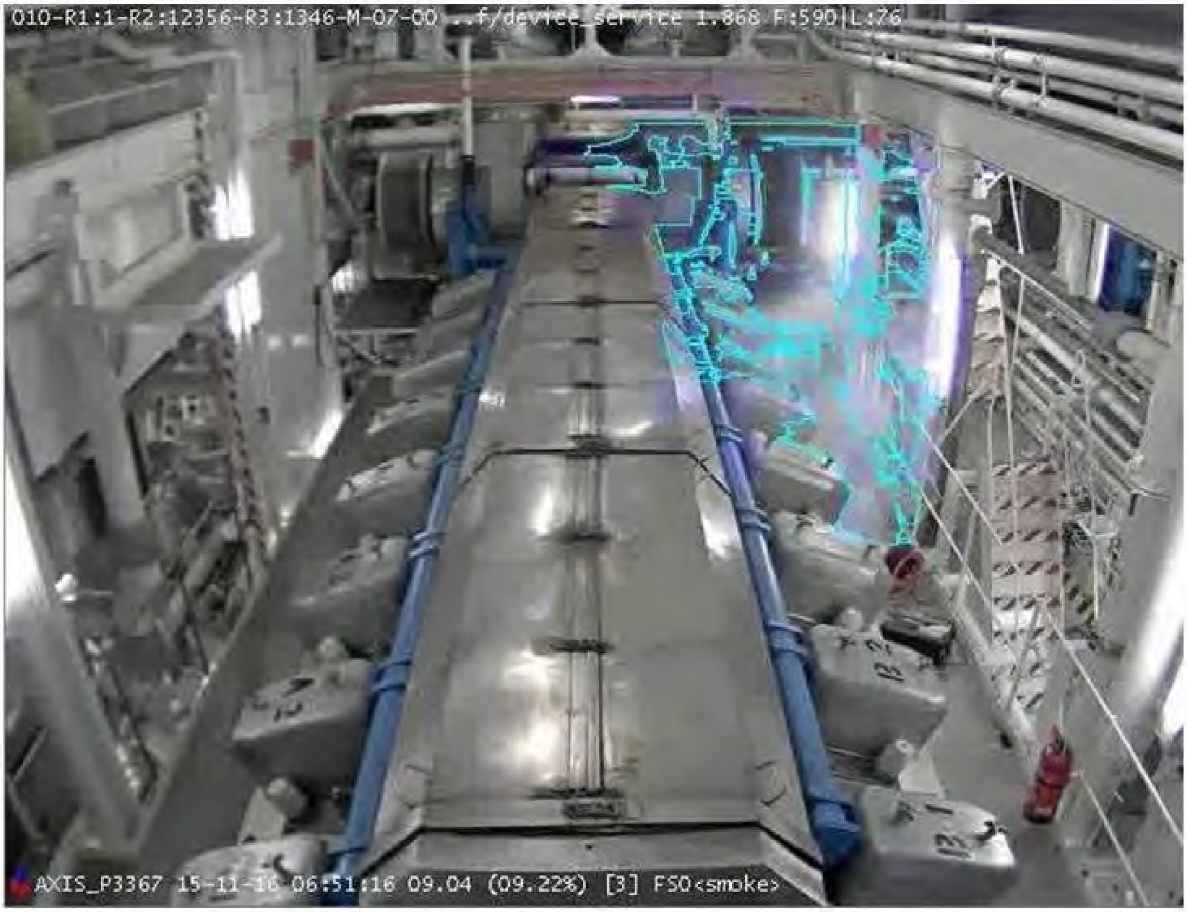
Air-sampling and projected beam-type smoke detectors used in high air movement areas must be installed as per the manufacturer’s published instructions.

If an HVAC mechanical room is used as an air plenum for return air, the spacing of smoke detectors (in those areas) is not required to be reduced based upon the number of air changes.

VIDEO IMAGE SMOKE DETECTION

Video Image Smoke Detection

NFPA 72 2016, Section 17.7.7



The location and spacing of video image smoke detection must comply with **Section 17.11.5**, which means:

- The location and spacing of this system shall be based upon the operating principals and an engineering survey of the conditions anticipated.
- Follow the recommendations of the manufacturer's published instructions for detector use and locations.
- Detectors shall not be spaced beyond their listed or approved maximums.

CONTINUE

Let's do a quick check about what has been covered so far.

Air duct detectors must be installed to obtain a good sample of the airstream.

This installation can be any of the following methods: (Select all that apply)

☐ Rigid mounting within the duct

☐ Rigid mounting to the wall of the duct with the sensing element protruding into the duct

☐ Installation outside the duct with rigidly mounted sampling tubes protruding into the duct

☐ Installation through the duct with a heat detector

SUBMIT

If smoke door release is accomplished directly from the smoke detectors, the detectors *must* be listed for ______.

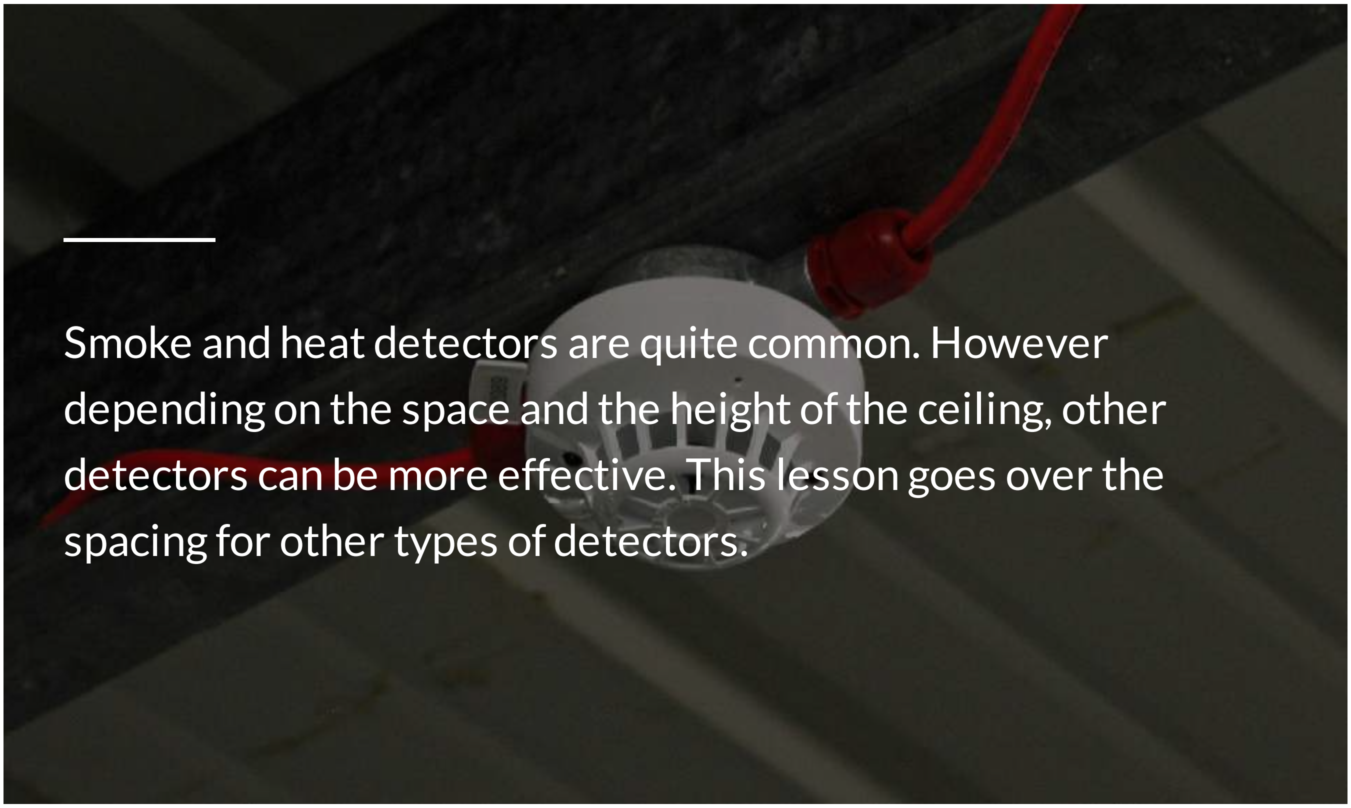
Type your answer here

SUBMIT

Complete the knowledge check above before moving on.

Lesson 3 of 3

Radiant Energy-Sensing Detector Location and Spacing



Smoke and heat detectors are quite common. However depending on the space and the height of the ceiling, other detectors can be more effective. This lesson goes over the spacing for other types of detectors.

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Identify location and spacing considerations for flame detectors and spark/ember detectors.

RADIANT ENERGY-SENSING DETECTORS

Location and Spacing

NFPA 72 2016, Section 17.8

The type and quantity of radiant energy-sensing fire detectors shall be determined on the basis of the performance characteristics of the detector and an analysis of the hazard, which includes the burning characteristics of the fuel, the fire growth rate, the environment, the ambient conditions, and the capabilities of the extinguishing media and equipment.

Basically, an engineer will be the person to figure this out.

The selection of the radiant energy-sensing detectors shall be based on the following:

1. Matching of the spectral response of the detector to the spectral emissions of the fire or fires to be detected
2. Minimizing the possibility of spurious nuisance alarms from non-fire sources inherent to the hazard area

Radiant energy-sensing fire detectors shall be employed **consistent with the listing or approval and the inverse square law**, which defines the fire size versus distance curve for the detector.

Detector quantity shall be based on the detectors being positioned so that **no point requiring detection in the hazard area is obstructed or outside the field of view of at least one detector**.

SPACING CONSIDERATIONS FOR FLAME DETECTORS

Spacing Considerations for Flame Detectors

NFPA 72 2016, Section 17.8.3.2.1

The location and spacing of detectors shall be the result of an engineering evaluation that includes the following:

1. Size of the fire that is to be detected
2. Fuel involved
3. Sensitivity of the Detector
4. Field of view of the detector
5. Distance between the fire and the detector
6. Radiant energy absorption of the atmosphere
7. Presence of extraneous sources of radiant emissions
8. Purpose of the detection system
9. Response time required

CONTINUE

In applications where the **fire to be detected could occur in an area not on the optical axis of the detector**, the distance to the **area covered** by the detector **shall be *reduced* or additional detectors shall be *added* to compensate for the angular displacement of the fire**.

In applications in which the fire to be detected is of a fuel that differs from the test fuel used in the process of listing or approval, the distance between the detector and the fire shall be adjusted consistent with the fuel specificity of the detector as established by the manufacturer.

Because **flame detectors are line-of-sight devices**, their ability to respond to the required area of fire in the zone that is to be protected **shall not be compromised (obstructed) by the presence of intervening structural members or other opaque objects or materials**.

SPACING CONSIDERATIONS FOR SPARK/EMBER DETECTORS

Spacing Considerations for Spark/Ember Detectors

NFPA 72 2016, Section 17.8.3.3.1

The location and spacing of detectors shall be the result of an engineering evaluation that includes the following:

1. Size of the spark or ember that is to be detected
2. Fuel involved
3. Sensitivity of the detector
4. Field of view of the detector
5. Distance between the fire and the detector
6. Radiant energy absorption of the atmosphere
7. Presence of extraneous sources of radiant emissions
8. Purpose of the detection system
9. Response time required

CONTINUE

ⓘ Spark detectors shall be positioned so that all points within the cross section of the conveyance duct, conveyor, or chute where the detectors are located are within the field of view (as **defined in Section 3.3.98**) of at least one detector.

The **location and spacing of the detectors shall be adjusted using the inverse square law**, modified for the **atmospheric absorption and the absorption of nonburning fuel suspended in the air** in accordance with the manufacturer’s published instructions.

In applications where the **sparks to be detected could occur in an area not on the optical axis** of the detector, the **distance shall be *reduced* or detectors shall be *added* to compensate for the angular displacement of the fire** in accordance with the manufacturer’s published instructions.

MANUAL FIRE ALARM BOXES

Requirements for Manual Fire Alarm Boxes

NFPA 72 2016, Section 17.14

Manually actuated alarm-initiating devices for initiating signals other than for fire alarms shall be permitted if the devices are differentiated from manual fire alarm boxes by a color other than red and labeling.

Manual fire alarm boxes shall be **located not more than 5 ft. from each exit on each floor**. Grouped **openings over 40 ft**. in width **require a manual box within 5 ft. from both sides of the grouped opening**.

Additional manual boxes are **required every 200 horizontal feet of travel distance on each floor**.

The **height** of manual fire alarm boxes **shall be a minimum of 42 in. and a maximum of 48 in**. from the **floor to the operating lever**.

CONTINUE

Let's do a quick check about what has been covered so far.

Radiant energy-sensing fire detectors shall be employed consistent with the listing or approval and the _______ law, which defines the fire size versus distance curve for the detector.

Type your answer here

SUBMIT

Based on *NFPA* 72 2016, Section 17.8.3.2, Spacing Considerations for Flame Detectors, the location and spacing of detectors shall be the result of an engineering evaluation that includes the following: (Select all that apply)

☐ Number of floors in the dwelling

☐ Distance between the fire and the detector

☐ Radiant energy absorption of the atmosphere

☐ Presence of extraneous sources of radiant emissions

SUBMIT

The height of manual fire alarm boxes shall be a minimum of ____ in. and a maximum of ____ in. from the floor to the operating lever.

○ 30 / 36

○ 36 / 42

○ 42 / 48

○ 48 / 54

SUBMIT

Complete the knowledge check above before moving on.

The location and spacing of other detectors such as video flame detection, combination, multi-criteria, and multi-sensor detectors, and gas detectors are not specifically covered in their applicable sections.

Location and spacing of these detectors are accomplished using engineering judgement and/or the manufacturer's published installation instructions.

- For instance, System Sensor® installation instructions requires one of its multi-criteria sensors be spaced 20 or 30 ft. apart depending on which listing agency is being used, or if it has a heat detector as part of the unit.
- Make sure to always follow the manufacturer's published instructions.

Other types of initiating devices such as sprinkler waterflow alarm-initiating devices and supervisory-signal initiating devices also do not have location and spacing requirements spelled out such as heat and smoke detectors.

These initiating devices are placed where they are needed in accordance with applicable codes, laws, or regulations.

SUMMARY

There are many requirements to locating and spacing detectors.

Take some time to review the information and familiarize yourself with the information.

This module should help you to understand these location and spacing requirements.

CONTINUE

After completing this module, you should now have a better understanding of the different requirements for the location and spacing of devices for fire alarm systems.

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.

Ohio Fire Alarm and Detection Equipment-Notification Appliances

FIRE TECH
PRODUCTIONS

Welcome to the Notification Appliances module of the Ohio Fire Alarm and Detection Systems Course.

By the end of this module, you will be able to do the following:

- Identify General Requirements for Chapter 18 in *NFPA* 72 2016
- Differentiate between public- and private-mode audible appliance requirements
- Identify sound level requirements for sleeping areas
- Apply location rules for audible notification appliances
- Recognize visual characteristics of visible signaling appliances
- Properly locate wall-mounted and ceiling-mounted appliances at effective intensity levels
- Determine if synchronization is needed in areas with multiple visible signaling devices

Key Reference for this module:

- *NFPA* 72 – National Fire Alarm and Signaling Code, Chapter 18, 2016

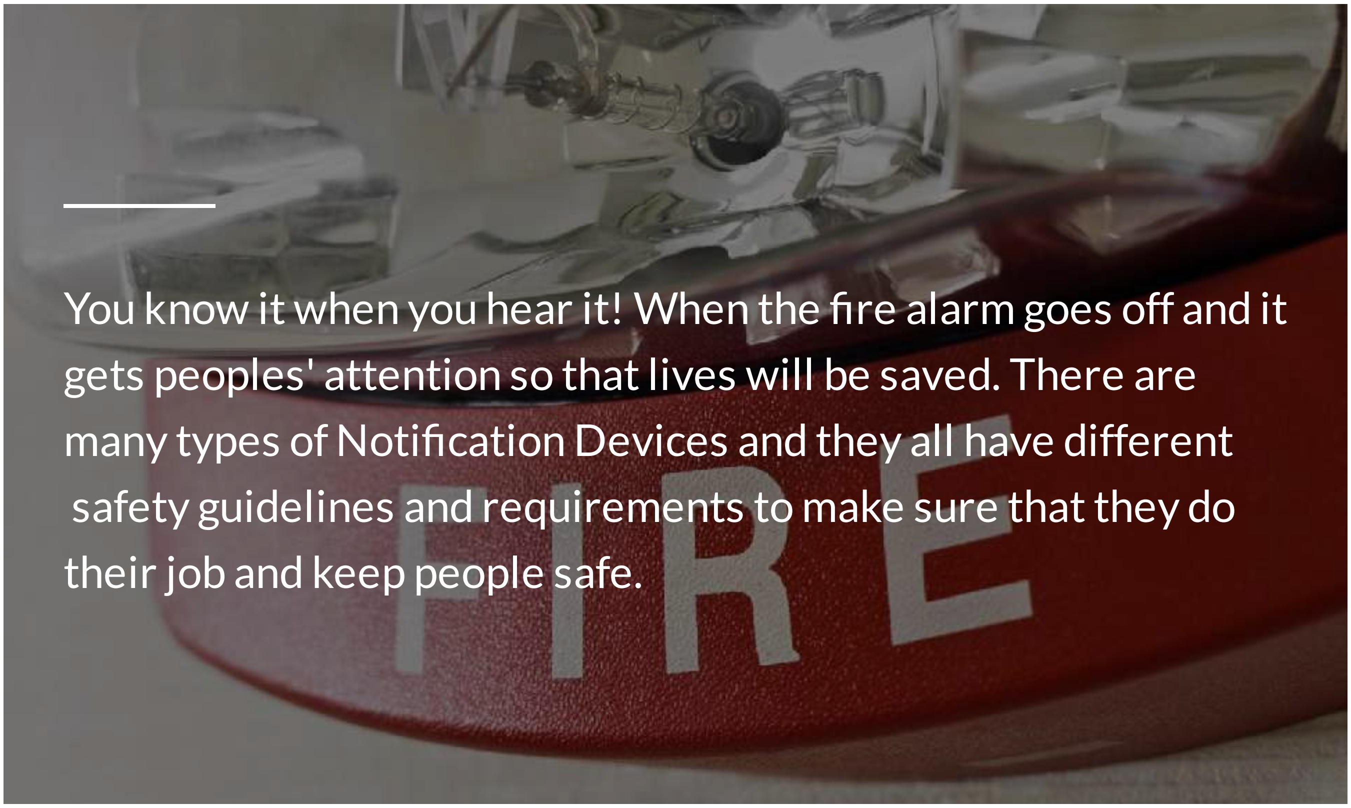
When you are ready to begin, click on the button above to start the course.

Chapter 18 Scope and Audible Appliances

Visible and other Notification Appliances

Lesson 1 of 2

Chapter 18 Scope and Audible Appliances



You know it when you hear it! When the fire alarm goes off and it gets peoples' attention so that lives will be saved. There are many types of Notification Devices and they all have different safety guidelines and requirements to make sure that they do their job and keep people safe.

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Identify General Requirements for Chapter 18 in *NFPA* 72 2016
2. Differentiate between public- and private-mode audible appliance requirements.

3. Identify sound level requirements for sleeping areas.
4. Apply location rules for audible notification appliances.

LET'S GET STARTED

NFPA 72 2016, Chapter 18 Scope

***NFPA* 72 2016 does not have any requirements** to provide **notification to occupants or staff**.

The **requirements for notification are dictated by local codes**, the Authorities Having Jurisdiction (AHJ) and **NFPA 101, Life Safety Code**.

If notification is required, ***NFPA* 72 2016** defines the requirements and methods to accomplish that task.

***NFPA* 72 2016** establishes the **minimum requirements for performance, location, and mounting of notification appliances associated with fire alarm systems.** These devices tell the occupants of the protected property to either evacuate or relocate as the result of a fire condition.

As the code dictates, all of these appliances must be listed for their intended use.

The intent of the **code requirements** focuses on the ability of the appliance to deliver a message. The content of the message is not part of the responsibility of the code.

Coded and Non-Coded Signals

As they are addressed by the code, **notification signals** are classified in the following manner:

A **coded signal** can be either *audible* or *visual*. It conveys discrete bits of information such as a given number of flashes from a light or a given number of tones from a horn that tell what floor and section of the building the alarm was generated from.

A **non-coded** signal conveys only one discrete bit of information.

- A **non-coded perceptually constant signal** is one where the notification appliance, either *visible* or *audible*, is operated continuously.
- A **non-coded perceptually repetitious signal**, however, is where the appliance is interrupted at a continuous uniform

rate.

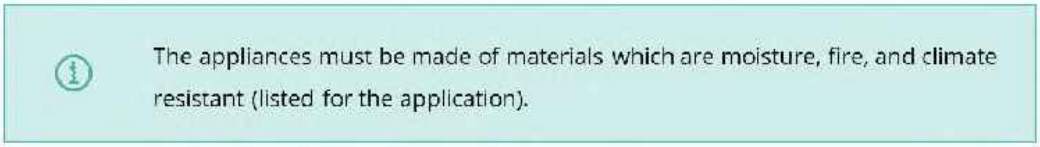
- A **non-coded single event signal** is a single flash of light or a single stroke of a bell. This is not a valid fire alarm signal.

GENERAL REQUIREMENTS

NFPA 72 2016, Section 18.3

Notification appliances are required to have nameplates on them which provide information on the following:

- Their electrical requirements
- Audible or visual performance as listed
- Information or references regarding their parameters



The appliances must be made of materials which are moisture, fire, and climate resistant (listed for the application).

Notification appliances used for **signaling** ***other than fire*** are **not allowed to have the word** "**FIRE**", **or any fire symbol**, in any form (i.e., stamped, imprinted, etc.) on the appliance visible to the public.

Notification appliances with **multiple visible elements** are allowed to have **fire markings only on those visible elements that are used for fire signaling.**

Their construction must be damage and tamper resistant and, where subject to conditions where mechanical damage is probable, they must be suitably protected.

CONTINUE

Notification appliances must be **mounted independent of their circuit conductors**.

Notification appliances must be **listed for use with fire alarm systems** as well as the **environment and location where they are installed**.

ⓘ Notification appliances are not required in exit stair enclosures, exit passageways, and elevator cars. -*NFPA* 72 2016, Section 23.8.6.2

If any type of guard, cover, or lens is used with notification appliances, **the guard, cover, or lens must be listed for use with the appliance**.

CONTINUE

Let's do a quick check about what has been covered so far.

Notification appliances are required to have nameplates on them which provide information on the following: (Select all that apply)

- ☐ Their electrical requirements
- ☐ Audible or visual performance as listed
- ☐ Name of manufacturer
- ☐ Information or references regarding their parameters

SUBMIT

🔒 Complete the knowledge check above before moving on.

General Requirements for Audible Appliances

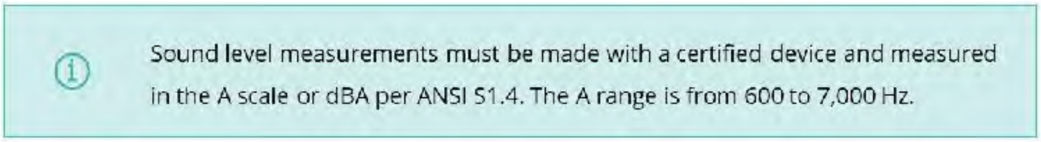
NFPA 72 2016, Section 18.4.1

An **average ambient sound level *greater than 105 dBA* shall require the use of visible notification appliances**.

The **total sound level produced** by combining the ambient sound pressure level with all audible notification appliances operating **shall not exceed 110 dBA at the minimum hearing distance**.

Sound from **normal or permanent sources having a duration greater than 60 seconds shall be included when measuring maximum ambient sound level**.

Sound from temporary or abnormal sources shall not be required to be included when measuring maximum ambient sound level.



Sound level measurements must be made with a certified device and measured in the A scale or dBA per ANSI S1.4. The A range is from 600 to 7,000 Hz.

PUBLIC MODE AUDIBLE REQUIREMENTS

Public Mode Audible Requirements

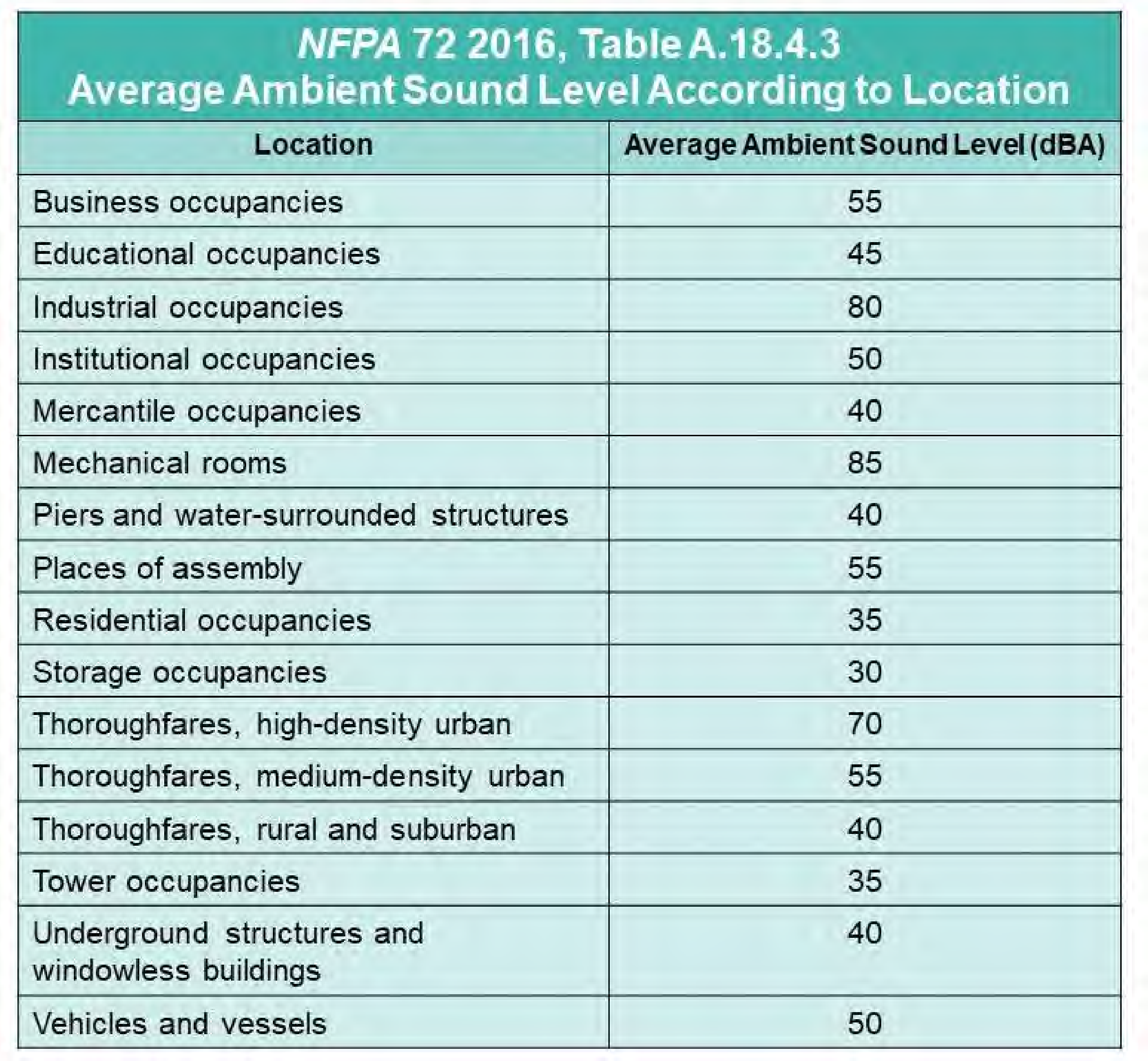
NFPA 72 2016, Section 18.4.3

Public mode audible signals shall have a **sound level of at least 15 dB above the average ambient sound level** or **5 dB above the maximum ambient sound level**, whichever is **greater**.

That level must be **maintained for at least 60 seconds** measured at 5 ft. above the floor.

High sound levels not believed to be typical of the area do not need to be considered in the measurement of maximum sound levels (for example, a vacuum cleaner in an office)

CONTINUE



NFPA 72 2016, Table A.18.4.3
Average Ambient Sound Level According to Location

Location	Average Ambient Sound Level (dBA)
Business occupancies	55
Educational occupancies	45
Industrial occupancies	80
Institutional occupancies	50
Mercantile occupancies	40
Mechanical rooms	85
Piers and water-surrounded structures	40
Places of assembly	55
Residential occupancies	35
Storage occupancies	30
Thoroughfares, high-density urban	70
Thoroughfares, medium-density urban	55
Thoroughfares, rural and suburban	40
Tower occupancies	35
Underground structures and windowless buildings	40
Vehicles and vessels	50

(Click image to enlarge)

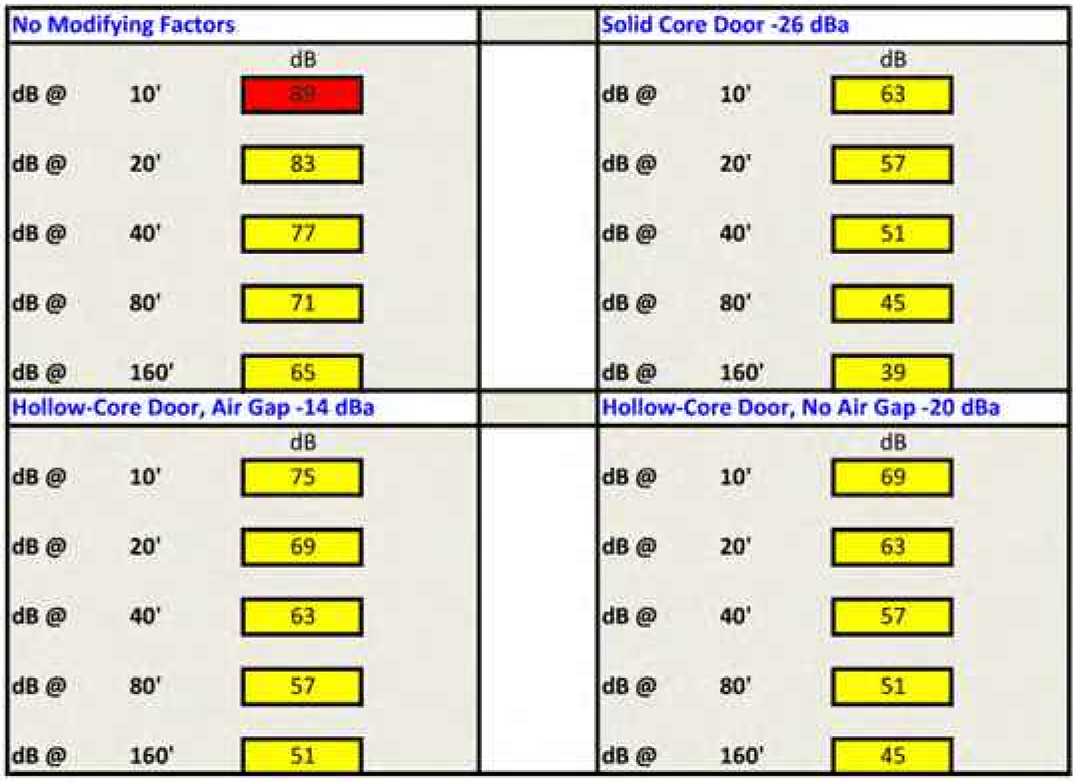
This table provides the average ambient sound of various locations in a building. **The decibel level listed for the device plus the ambient sound of the**

specific location cannot exceed 110db, ***otherwise*** **a visual notification appliance shall be installed.**

CONTINUE

Other considerations to calculate for is how far a person can be away from the device, as the decibel level drops the distance away from the device, in addition to any door construction from adjacent rooms, (see image below).

Use the tables below to help work through the following example.

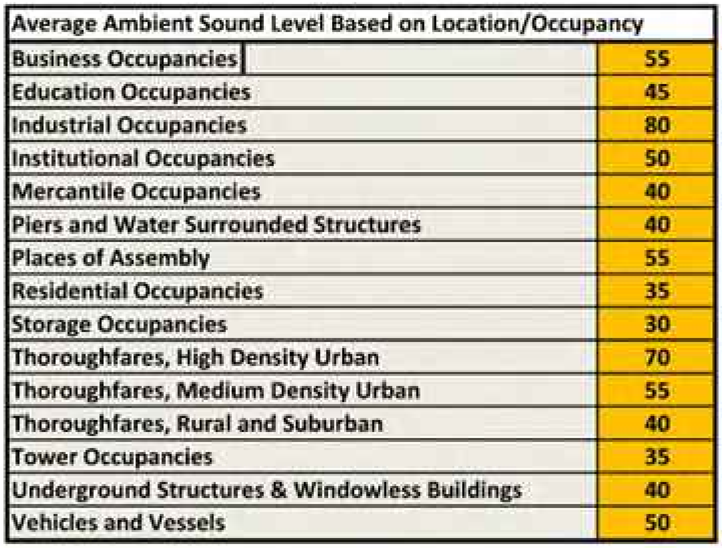


No Modifying Factors		dB
dB @	10'	89
dB @	20'	83
dB @	40'	77
dB @	80'	71
dB @	160'	65

Solid Core Door -26 dBa		dB
dB @	10'	63
dB @	20'	57
dB @	40'	51
dB @	80'	45
dB @	160'	39

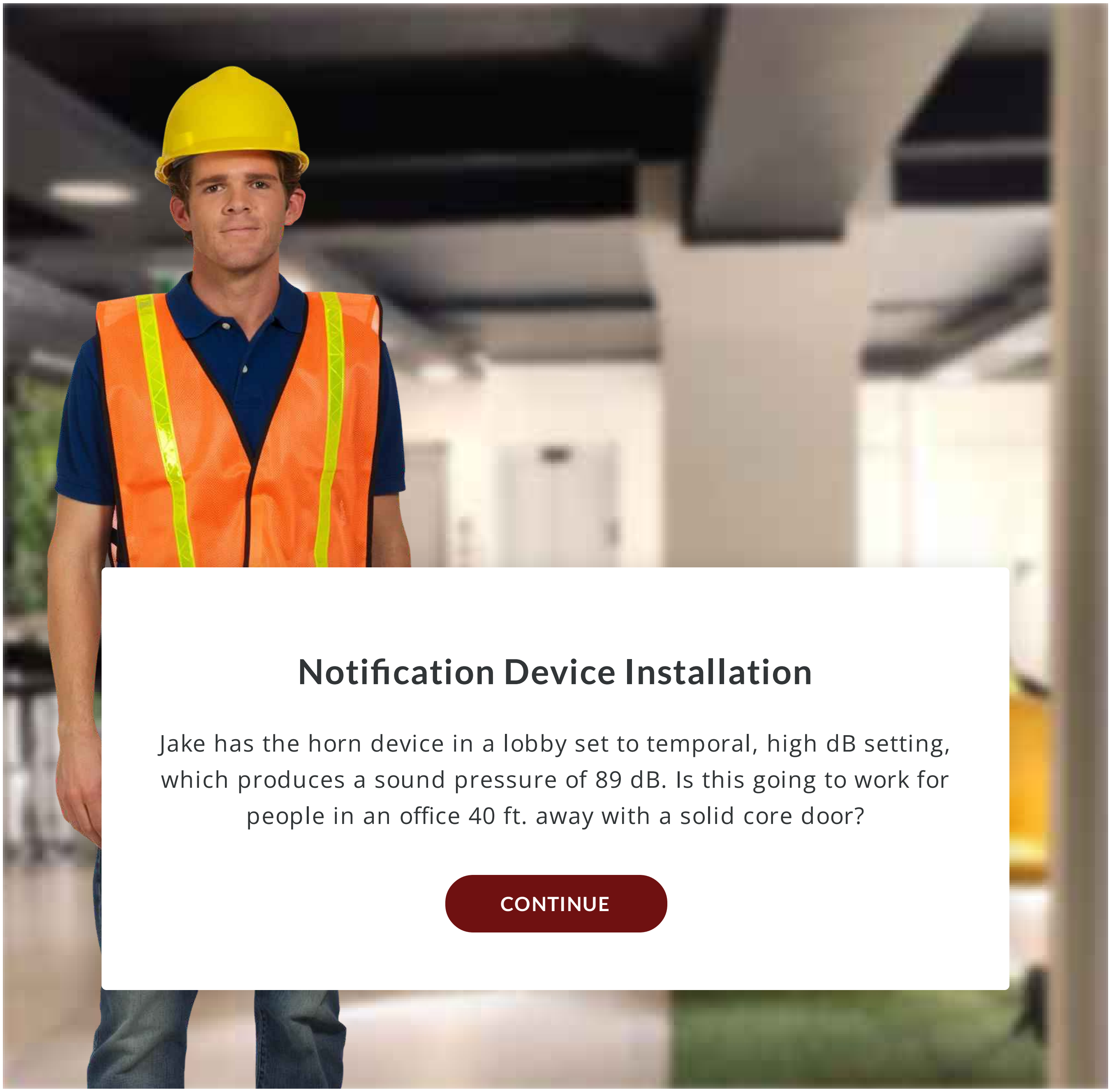
Hollow-Core Door, Air Gap -14 dBa		dB
dB @	10'	75
dB @	20'	69
dB @	40'	63
dB @	80'	57
dB @	160'	51

Hollow-Core Door, No Air Gap -20 dBa		dB
dB @	10'	69
dB @	20'	63
dB @	40'	57
dB @	80'	51
dB @	160'	45



Average Ambient Sound Level Based on Location/Occupancy	
Business Occupancies	55
Education Occupancies	45
Industrial Occupancies	80
Institutional Occupancies	50
Mercantile Occupancies	40
Piers and Water Surrounded Structures	40
Places of Assembly	55
Residential Occupancies	35
Storage Occupancies	30
Thoroughfares, High Density Urban	70
Thoroughfares, Medium Density Urban	55
Thoroughfares, Rural and Suburban	40
Tower Occupancies	35
Underground Structures & Windowless Buildings	40
Vehicles and Vessels	50

For the example below, we are installing System Sensor, L-Series Horn Strobe, Part # P2RL. You will need to **refer to the chart above** and **Table A.18.4.3** to determine if this notification device is going to work in this situation.



Notification Device Installation

Jake has the horn device in a lobby set to temporal, high dB setting, which produces a sound pressure of 89 dB. Is this going to work for people in an office 40 ft. away with a solid core door?

Scene 1 Slide 1

Continue → Next Slide

Look at the upper right quadrant for a solid core door on the chart, knowing it's 40 ft. from the horn to the office, & use Table A.18.4.3 to determine business occupancy sound level. Will it work?

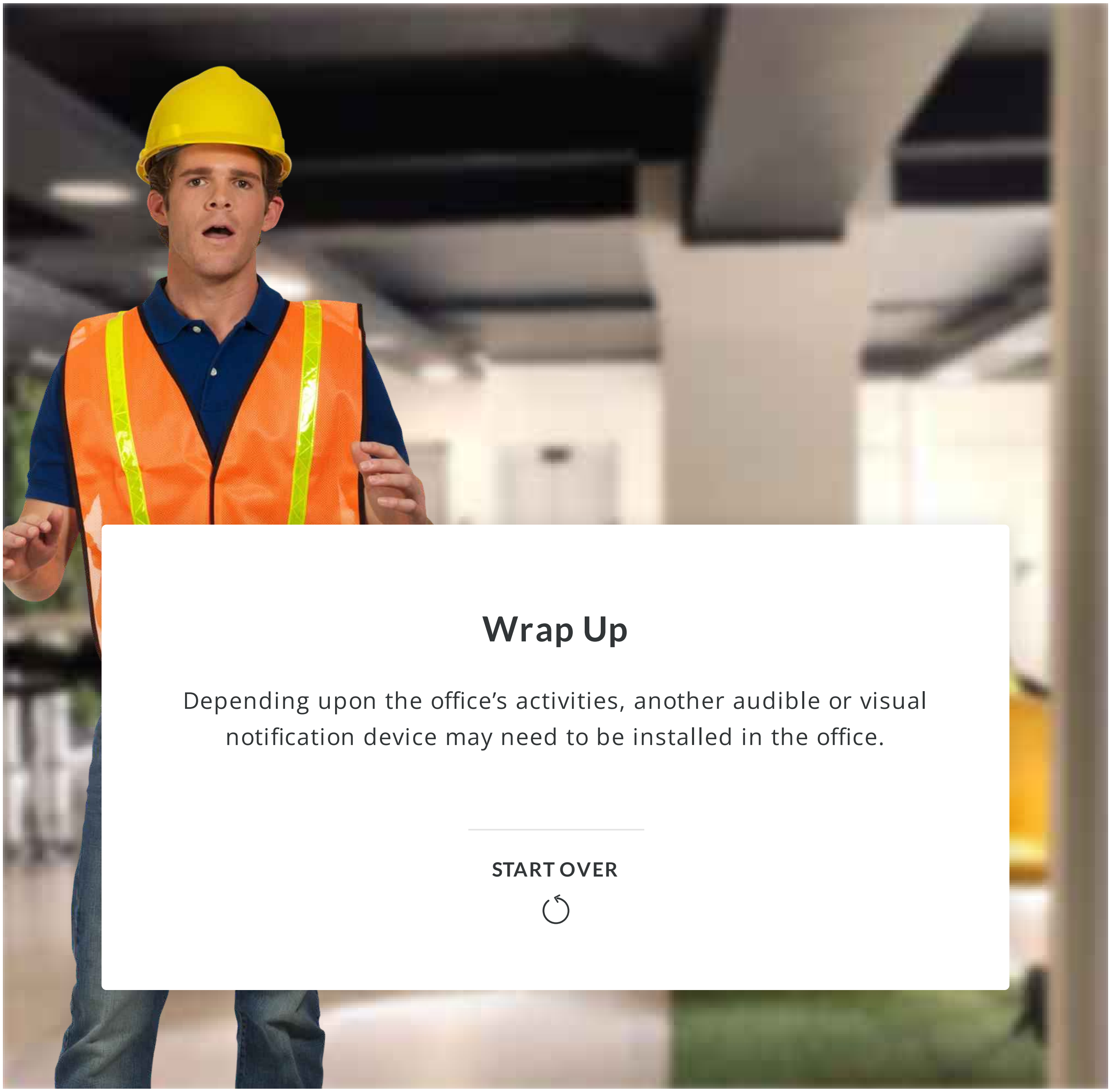
1 No, it is not adequate.

2 Yes, it is adequate.

Scene 1 Slide 2

0 → Next Slide

1 → Next Slide



Wrap Up

Depending upon the office's activities, another audible or visual notification device may need to be installed in the office.

START OVER ↻

Scene 1 Slide 3

Continue → End of Scenario

Complete the scenario above before moving on.

Exceptions to the public mode requirements:

☐ The requirements for audible signaling shall be permitted to be reduced or eliminated when visible signaling is provided and approved by the AHJ.

☐ Audible alarm notification appliances installed in elevator cars shall be permitted to use the audibility criteria for private mode appliances.

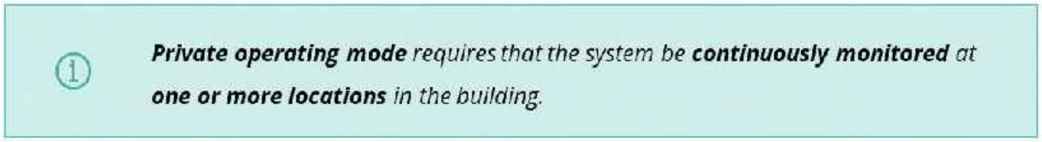
☐ Audible alarm notification appliances installed in restrooms shall be permitted to use the audibility criteria for private mode.

☐ A signaling system arranged to stop or reduce ambient noise shall comply with Sections 18.4.3.5.1 through 18.4.3.5.3. An example of this would be the fire alarm system initiating a signal to shunt trip a circuit breaker to the sound system in a night club.

CONTINUE

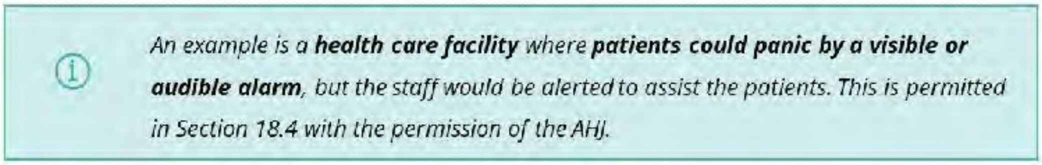
In **private mode**, the sound level needs to be a minimum of 10 dB above the average ambient sound level, or 5 dB above the maximum sound level. The 110 dBA maximum at minimum hearing distance also applies.

Audible or visible signaling will alert only those persons directly concerned with the implementation and direction of emergency action initiation and procedure in the area protected by the fire alarm system.



Private operating mode *requires that the system be* ***continuously monitored*** *at* ***one or more locations*** *in the building.*

There are situations where it might not be desirable to have audible or visible notification appliances except in supervised stations.


*An example is a **health care facility** where **patients could panic by a visible or audible alarm**, but the staff would be alerted to assist the patients. This is permitted in Section 18.4 with the permission of the AHJ.*

CONTINUE

Let's do a quick check about what has been covered so far.

Based on *NFPA* 72 2016, Section 18.4.3, public mode audible signals shall have a sound level of at least 15 dB above the average ambient sound level or 5 dB above the maximum ambient sound level, whichever is greater. That level must be maintained for at least 60 seconds measured at _____ ft. above the floor.

○ 5

○ 6

○ 7

SUBMIT

Complete the knowledge check above before moving on.

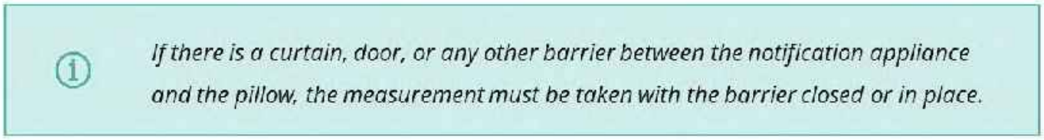
Sleeping Area Requirements

NFPA 72 2016, Section 18.4.5

Sleeping areas are treated separately in the code in regards to notification appliances based on studies on how long it takes to awaken a sleeping person at different sound levels and the amount of time for someone to be alert to respond to the alarm.

The sound level must be measured at the pillow level in the area required to be served.

Audible appliances for sleeping areas shall have a sound level of at least **15 dB above the average ambient sound level or 5 dB above the maximum sound level having a duration of at least 60 seconds or a sound level of at least 75 dBA**, whichever is greater.

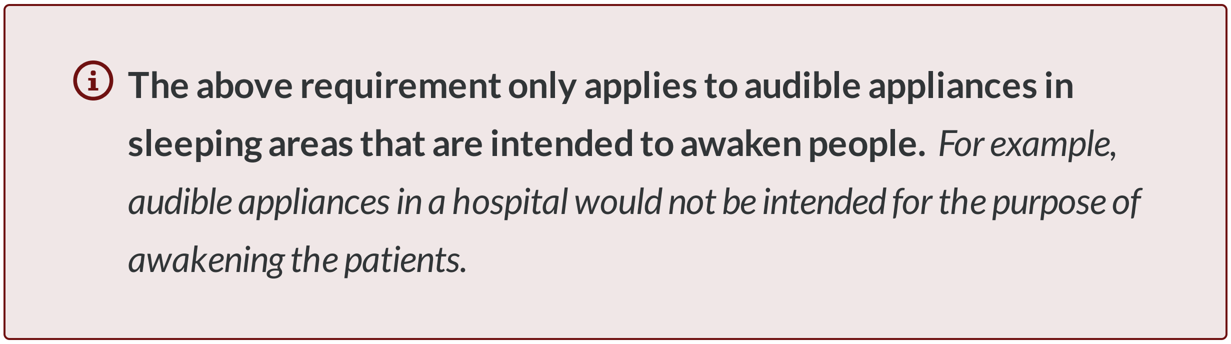


If there is a curtain, door, or any other barrier between the notification appliance and the pillow, the measurement must be taken with the barrier closed or in place.

Audible appliances provided for the sleeping areas shall produce a low frequency alarm signal that complies with the following:

1. The alarm signal shall be a square wave or provide equivalent awakening ability.
2. The wave shall have a fundamental frequency of 520 Hz ± 10%.
3. The notification equipment shall be listed for producing a low frequency waveform.

Research has shown that a low frequency 520 Hz square wave signal can awaken and alert people with hearing loss, as well as alcohol-impaired adults.



The above requirement only applies to audible appliances in sleeping areas that are intended to awaken people. *For example, audible appliances in a hospital would not be intended for the purpose of awakening the patients.*

Location of Audible Appliances in a Building or Structure

NFPA 72 2016, Section 18.4.8

Wall-mounted audible alarm appliances shall be located at **least 90 in. above the floor** if ceiling height permits, and at **least 6 in. below the ceiling**.

Ceiling-mounted and recessed appliances are permitted.

If the device is a combination audible and visible alarm, the location rules for visible appliances shall be used. If the device is part of a detector/alarm unit, the location rules for the detector shall be used.

ⓘ Even though the code has specific mounting heights, **Section 18.4.8.5 states other mounting heights shall be permitted**, provided that the **sound pressure level requirements of Section 18.4.3 for public mode**, **Section 18.4.4 for private mode**, or **Section 18.4.5 for sleeping areas**, based on the application, **are met**.

CONTINUE

Voice Intelligibility

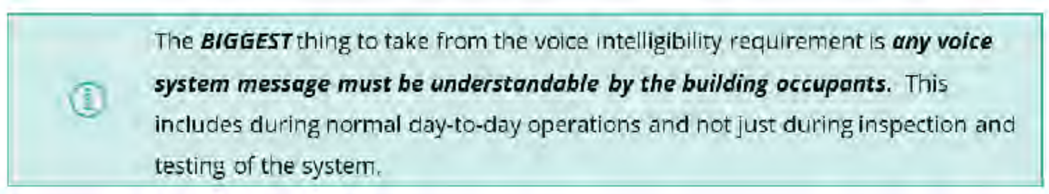
NFPA 72 2016, Section 18.4.10

Within the acoustically distinguishable spaces (ADS) where voice intelligibility is required, voice communications systems shall reproduce prerecorded, synthesized, or live (e.g., microphone, telephone handset, and radio) messages with voice intelligibility.

ADSs shall be determined by the system designer during the planning and design of all emergency communications systems (ECS).

Each ADS shall be identified as requiring or not requiring voice intelligibility.

Where required by the AHJ, ADS assignments must be submitted for review and approval.



The ***BIGGEST*** thing to take from the voice intelligibility requirement is ***any voice system message must be understandable by the building occupants.*** This includes during normal day-to-day operations and not just during inspection and testing of the system.

CONTINUE

Let's do a quick check about what has been covered so far.

According to *NFPA* 72 2016, Section 18.4.5, for sleeping levels, the sound level must be measured at the _____ level in the area required to be served.

Type your answer here

SUBMIT

According to *NFPA* 72 2016, Section 18.4.5, research has shown that a low frequency 520 Hz square wave signal can awaken and alert people with hearing loss, as well as alcohol-impaired adults.

○ True

○ False

SUBMIT

According to *NFPA* 72 2016, Section 18.4.8, wall-mounted audible alarm appliances shall be located at least _____ in. above the floor if ceiling height permits, and at least 6 in. below the ceiling.

○ 70

○ 80

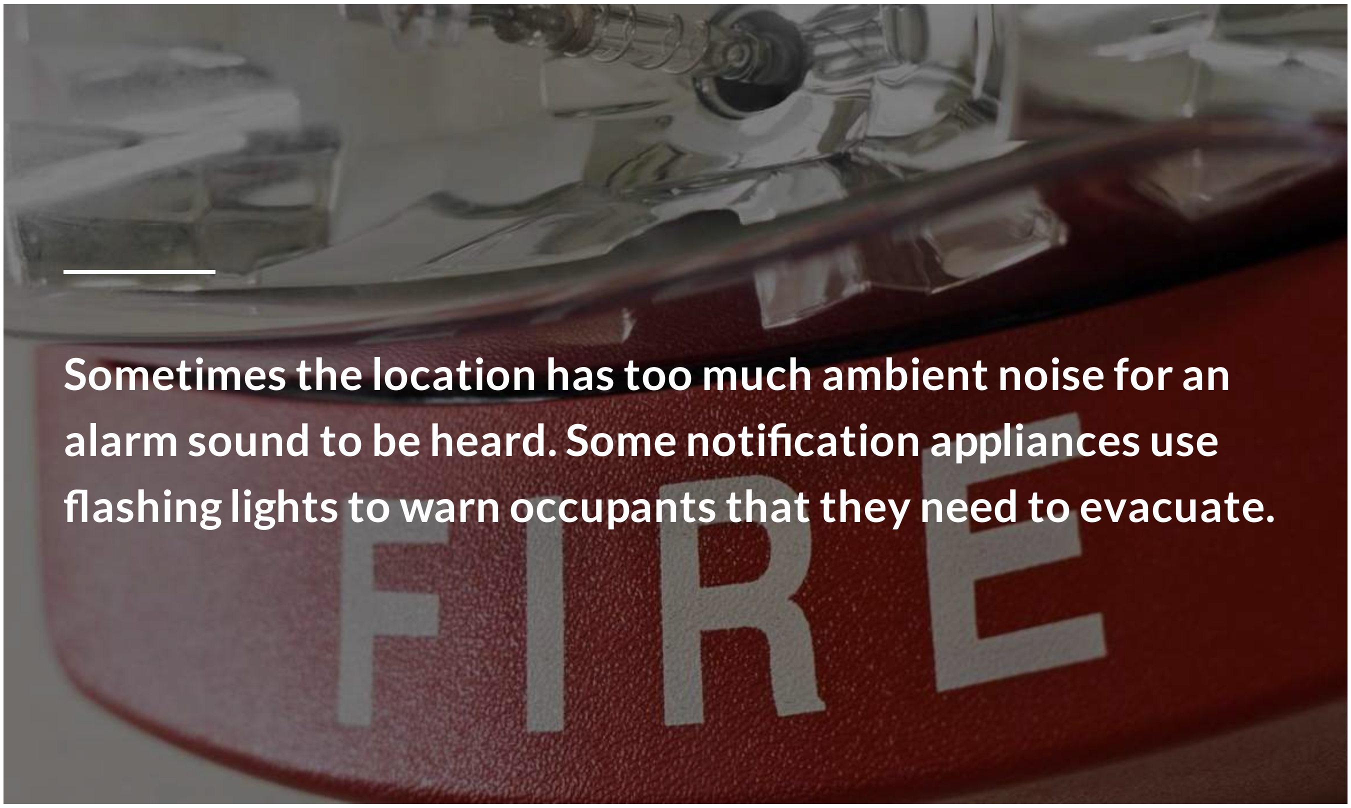
○ 90

SUBMIT

Complete the knowledge check above before moving on.

Lesson 2 of 2

Visible and other Notification Appliances



Sometimes the location has too much ambient noise for an alarm sound to be heard. Some notification appliances use flashing lights to warn occupants that they need to evacuate.

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Recognize visual characteristics of visible signaling appliances

2. Properly locate wall-mounted and ceiling-mounted appliances at effective intensity levels

3. Determine if synchronization is needed in areas with multiple visible signaling devices

CODED AND NON-CODED SIGNALS

Coded and Non-Coded Signals

As they are addressed by the code, **notification signals** are classified in the following manner:

A **coded signal** can be either *audible* or *visual*. It conveys discrete bits of information such as a given number of flashes from a light or a given number of tones from a horn that tell what floor and section of the building the alarm was generated from.

A **non-coded** signal conveys only one discrete bit of information.

- A **non-coded perceptually constant signal** is one where the notification appliance, either *visible* or *audible*, is operated continuously.

- A **non-coded perceptually repetitious signal**, however, is where the appliance is interrupted at a continuous uniform rate.
- A **non-coded single event signal** is a single flash of light or a single stroke of a bell. This is not a valid fire alarm signal.

VISIBLE CHARACTERISTICS-PUBLIC MODE

Visible Characteristics – Public Mode

NFPA 72 2016, Section 18.5

Just as was the case with audible appliances, the requirement to provide visible notification comes from ***NFPA 101*** or other state, local, or AHJ requirements.

ⓘ The only requirement for visible appliances in ***NFPA 72*** is in the case where audible notification is required and the ambient sound level is too high to use audible appliances. If this is the case, then visible appliances must be used.

These requirements are normally only for occupiable areas. You would not want to put visible appliances in closets. However, you might have a file room the size of a large closet where you may want to provide notification.

Our main discussion will focus on the visible characteristics required of visible signaling appliances in the public mode.

LIGHT, COLOR AND PULSE CHARACTERISTICS

NFPA 72 2016, Section 18.5.3

The flash rate of the device **cannot exceed two flashes per second** nor can it be **less than one flash per second**.

The code defines a flash or pulse duration as the time interval between initial and final points of 10% of maximum signal.

The **maximum pulse duration is limited to 20 milliseconds** (0.02 seconds) with a maximum duty cycle of 40%.

The **light source can be clear or nominal white**, and must not exceed an effective intensity of more than 1,000 candela (cd).

CONTINUE

Let's do a quick check about what has been covered so far.

A **non-coded** signal conveys only one discrete bit of information. Match the following non-coded signals to their action.

Non-coded perceptually constant signal	is where the notification appliance, either visible or audible, is operated continuously.
	is where the appliance is

Non-coded perceptually repetitious signal	interrupted at a continuous uniform rate.
Non-coded single event signal	is a single flash of light or a single stroke of a bell. Not a valid fire alarm signal.

SUBMIT

Complete the knowledge check above before moving on.

Appliance Location

NFPA 72 2016, Section 18.5.5

Wall-mounted appliances must have the entire lens located between 80 in. and 96 in. above the finished floor.

If the ceiling height is too low to mount the units a minimum of 80 in., the appliances shall be mounted 6 in. below the ceiling.

ⓘ ***NFPA 72 2016*** states the room size covered by a strobe of a given value shall be reduced by twice the difference between the minimum mounting height of 80 in. and the actual lower mounting height.

The minimum mounting height is 80 in. If the appliances were mounted at 70 in., the room size coverage requirements would be reduced by 2 x 10 in., or 20 in.

For a 15 cd appliance that would normally cover a 20 ft. x 20 ft. area, the appliance will now only cover an 18-ft, 4-in. x 18-ft, 4-in. area.

Visible appliances listed for mounting parallel to the floor shall be permitted to be located on the ceiling, or suspended below the ceiling.

Two tables establish the requirements for wall-mounted and ceiling-mounted appliances respectively.

1

1. Table 18.5.5.4.1(a) (wall-mounted appliances):

- Lists room sizes and then tells us that we can choose one appliance for one wall or a single appliance on each wall.
- We are also given the intensity requirements for these potential mounting configurations.

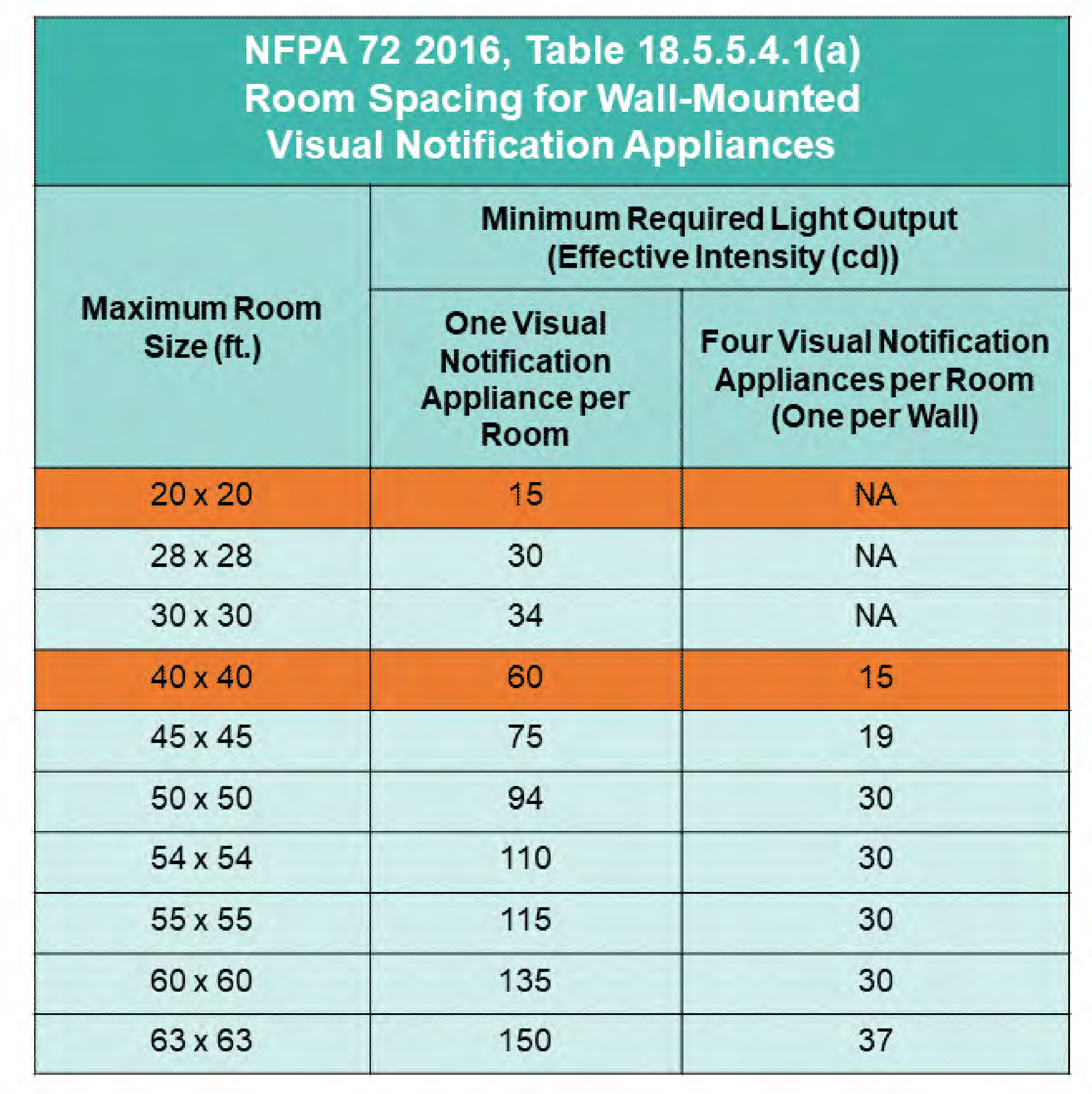
You can use the table to determine what size strobe is needed for a given area. A 20 ft x 20 ft area requires a single 15 cd strobe.

A 15 cd wall-mounted strobe "covers" a distance of 20 ft. in front of it and 10 ft. to either side of its centerline, for a total 20 ft. x 20 ft. area.

A 40 ft. x 40 ft. area requires a single 60 cd strobe.

40 ft. in front of it and 20 ft. to either side of its centerline.

Keep in mind that if a room is large enough, four strobes may be placed in the room. Each strobe will be offset to ensure maximum coverage.



NFPA 72 2016, Table 18.5.5.4.1(a)
Room Spacing for Wall-Mounted
Visual Notification Appliances

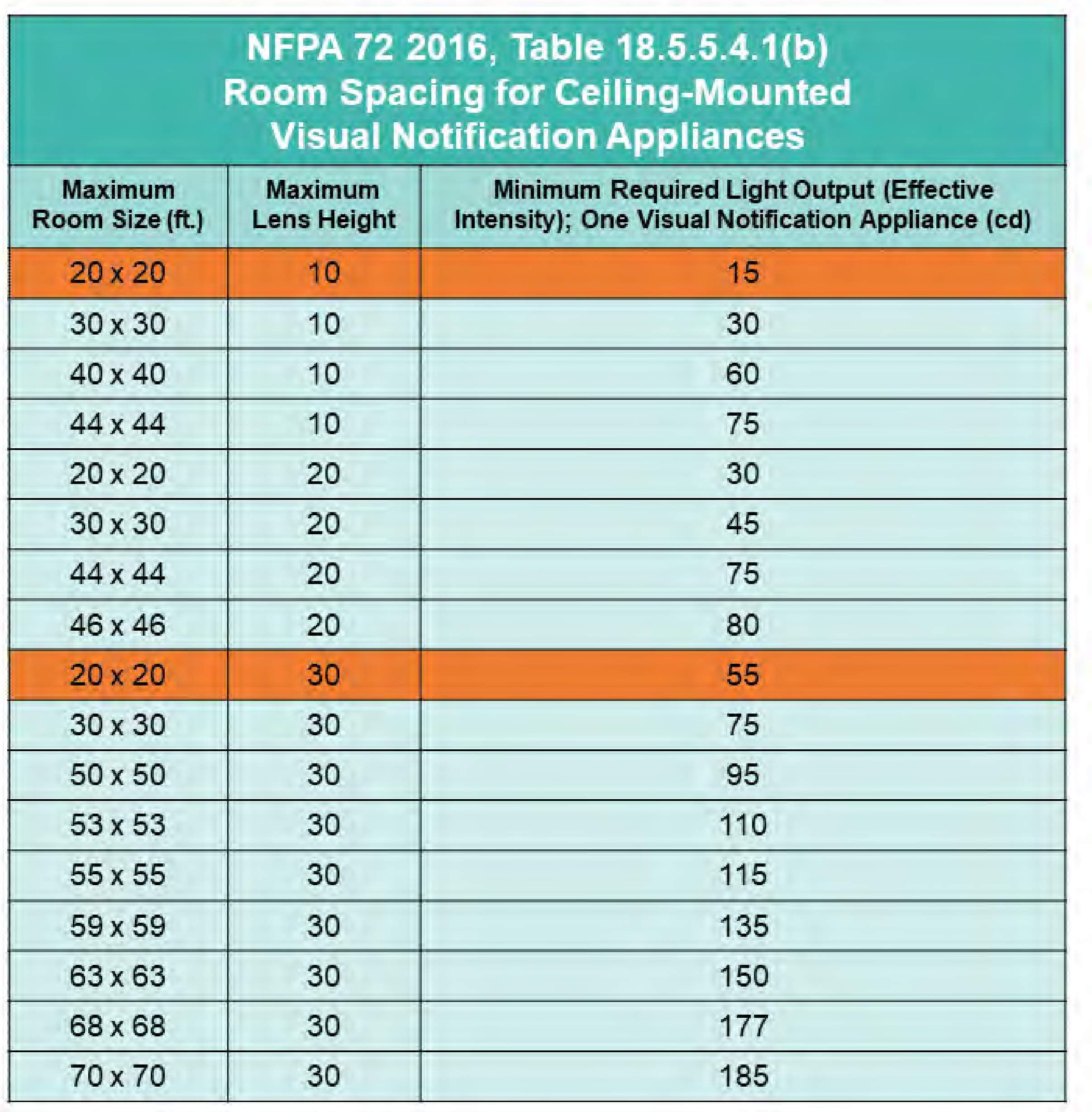
Maximum Room Size (ft.)	Minimum Required Light Output (Effective Intensity (cd))	
	One Visual Notification Appliance per Room	Four Visual Notification Appliances per Room (One per Wall)
20 x 20	15	NA
28 x 28	30	NA
30 x 30	34	NA
40 x 40	60	15
45 x 45	75	19
50 x 50	94	30
54 x 54	110	30
55 x 55	115	30
60 x 60	135	30
63 x 63	150	37

2

2. Table 18.5.5.4.1(b) (ceiling-mounted appliances):

- Brings ceiling height into the equation.
- Maximum ceiling height is 30 ft. If a ceiling-mounted appliance must be installed in a space with a ceiling height greater than 30 ft,

the appliance must be installed so that it is no more than 30 ft. from the floor.



NFPA 72 2016, Table 18.5.5.4.1(b)
Room Spacing for Ceiling-Mounted Visual Notification Appliances

Maximum Room Size (ft.)	Maximum Lens Height	Minimum Required Light Output (Effective Intensity); One Visual Notification Appliance (cd)
20 x 20	10	15
30 x 30	10	30
40 x 40	10	60
44 x 44	10	75
20 x 20	20	30
30 x 30	20	45
44 x 44	20	75
46 x 46	20	80
20 x 20	30	55
30 x 30	30	75
50 x 50	30	95
53 x 53	30	110
55 x 55	30	115
59 x 59	30	135
63 x 63	30	150
68 x 68	30	177
70 x 70	30	185

You can use the table to determine what size strobe is needed for a given area with a ceiling height of 10, 20, or 30 ft.

A 20 ft. x 20 ft. area with a 10 ft. ceiling requires a single 15 cd strobe.

A 15 cd ceiling-mounted strobe “covers” a distance from the ceiling to the floor of 10 ft. and “covers” a distance of 10 ft. in all directions.

A 20 ft. x 20 ft. area with a 30 ft. ceiling requires a single 55 cd strobe.

30 ft. from the ceiling to the floor, but only 10 ft. in all directions.

SPACING IN ROOMS

Spacing in Rooms

NFPA 72 2016, Section 18.5.5.4

Two or more visible signaling devices must be synchronized if they are in the **same field of view**.

Synchronization is not required if it is a household application per Section 29.3.9, or if the indoor visible appliances are viewed from an outdoor location.

Supplementary visible signaling devices are also discussed in Section 18.7.

- These are intended to supplement or enhance an audible or visible appliance.
- Since these are supplemental to the primary system, they are permitted to be mounted lower than 80 in. above the floor.

SPACING IN CORRIDORS

Spacing in Corridors up to 20 ft. in width

NFPA 72 2016, Section 18.5.5.5

The **intensity of the appliances used in corridors** must be **at least 15 cd.**

The **appliances cannot be located more than 15 ft. from the end of the corridor**, and the **separation distance of appliances** is limited to **100 ft**.

If there is an **interruption to the concentrated viewing path**, such as a **fire door, elevation change**, etc., the **area shall be treated as a separate corridor**.

If more than two visible appliances are in any field of view in the corridor, the appliances must be synchronized.

ⓘ **Wall-mounted visible appliances can be mounted on either end of the wall** or **the side wall of the corridor**, as long as the **spacing requirements of Section 18.5.5.5.5** are met.

CONTINUE

Let's do a quick check about what has been covered so far.

Based on Table 18.5.5.4.1(a) (room spacing for wall-mounted visible appliances), which of the following requirements must be met for the minimum light output (effective intensity (cd)) for a 60 ft. x 60 ft. area? (Select all that apply)

☐ one light per room (115 cd)

☐ one light per room (135 cd)

☐ four lights per room (one per wall - 30 ft.)

☐ four lights per room (one per wall - 37 ft.)

SUBMIT

Based on Table 18.5.5.4.1(b) (room spacing for ceiling-mounted visible appliances), which of the following requirements must be met for the minimum light output (effective intensity (cd)) and maximum lens height for a 50 ft. x 50 ft. area? (Select all that apply)

☐ maximum lens height (20 ft.)

☐ maximum lens height (30 ft.)

☐ minimum light output (95 cd)

☐ minimum light output (110 cd)

SUBMIT

Complete the knowledge check above before moving on.

Sleeping Areas

NFPA **72 2016, Section 18.5.5.7**

Section 18.5.5.7 and Table 18.5.5.7.2 establish minimum intensity requirements for sleeping rooms.

Per Table 18.5.5.7.2, if the distance from the ceiling to the top of the appliance lens is equal to or greater than 24 in, the effective intensity must be at least 110 cd.

If the distance from the ceiling to the top of the appliance lens is less than 24 in, the effective intensity must be at least 177 cd.

The appliance can be no further than 16 ft. from the pillow.

Several diagrams in the Annex A material related to this section give us some examples of locating visible notification appliances (page 235 - 237).

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TEXTUAL AND TACTILE APPLIANCES

Textual Audible Appliances

NFPA 72 2016, Section 18.8

Speaker appliances shall comply with **Section 18.4 (Audible Characteristics)**.

Speaker appliances must meet the same sound pressure level requirements (in dBA) for **private operating mode** **and** **public operating mode** as **audible appliances**.

This is for speakers that may generate signals similar to a bell, horn, chime, or a tone.   There are different (intelligibility) requirements when the speaker broadcasts a live or synthesized voice message.

A **textual signal** is one which contains a series of information pieces. These can be either audible or visual. For example, voice communication would be considered to be an audible textual signal. A CRT display or sign would be a visual textual device.

NFPA 72 2016, Section 18.9

Textual visible appliances are permitted if used in addition to audible or visible appliances, or both.

The information produced by textual visible appliances must legible.

Unless otherwise permitted by the AHJ, textual visible appliances used in the private mode must be located in rooms only accessible to personnel directly concerned with implementation and direction of emergency action initiation.

Textual visible appliances used in the public operating mode must be located to ensure readability.

TACTILE APPLIANCES

Tactile Appliances

NFPA 72 2016, Section 18.10

Tactile appliances are permitted if used in addition to audible or visible appliances, or both.

Tactile appliances must meet the requirements of ANSI/UL 1971, Standard for Signaling Devices for the Hearing Impaired, or equivalent.

CONTINUE

Let's do a quick check about what has been covered so far.

Based on *NFPA* 72 2016, Section 18.5.5.7, for sleeping areas, the visual appliance can be no further than ___ ft. from the pillow.

○ 8

○ 12

○ 16

SUBMIT

🔒 Complete the knowledge check above before moving on.

Familiarize yourself with requirements for audible appliance sound levels.

The audibility requirements for private and public mode areas have slightly different requirements.

Sleeping areas have their own audibility requirements to include the requirement for the 520 Hz low frequency square wave appliances.

Remember where and why private mode requirements may be needed.

In sleeping areas, don’t forget limitations on how far a visible appliance can be placed from the pillow (16 ft. max).

Ensure you understand visible appliance synchronization requirements.

In addition to audible and visible appliances, there are other appliances such as visible textual or tactile.

CONTINUE

After completing this module, you should now have a better understanding of the different audible and visible appliances for fire alarm systems.

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.

Ohio Fire Alarm and Detection Equipment-Household Fire Alarm Systems

Welcome to the Household Fire Alarm Systems module of the Ohio Fire Alarm and Detection Systems Course.

By the end of this module, you will be able to do the following:

- Identify basic requirements for Chapter 29 in *NFPA* 72 2016
- Recognize detection requirements for smoke alarms
- Describe required occupant notification
- Apply the Ohio Building Code, Section 915 to carbon monoxide alarms
- Compare various types of equipment performance
- Recognize operational characteristics of combination systems
- Identify proper installation of fire alarm systems
- Identify requirements for detector location and spacing
- Identify requirements for audible alarms
- Recognize markings and instructions for various components of fire warning systems

Key Reference for this module:

- *NFPA* 72 – The National Fire Alarm and Signaling Code, Chapter 29, 2016

When you are ready to begin, click on the button above to start the course.

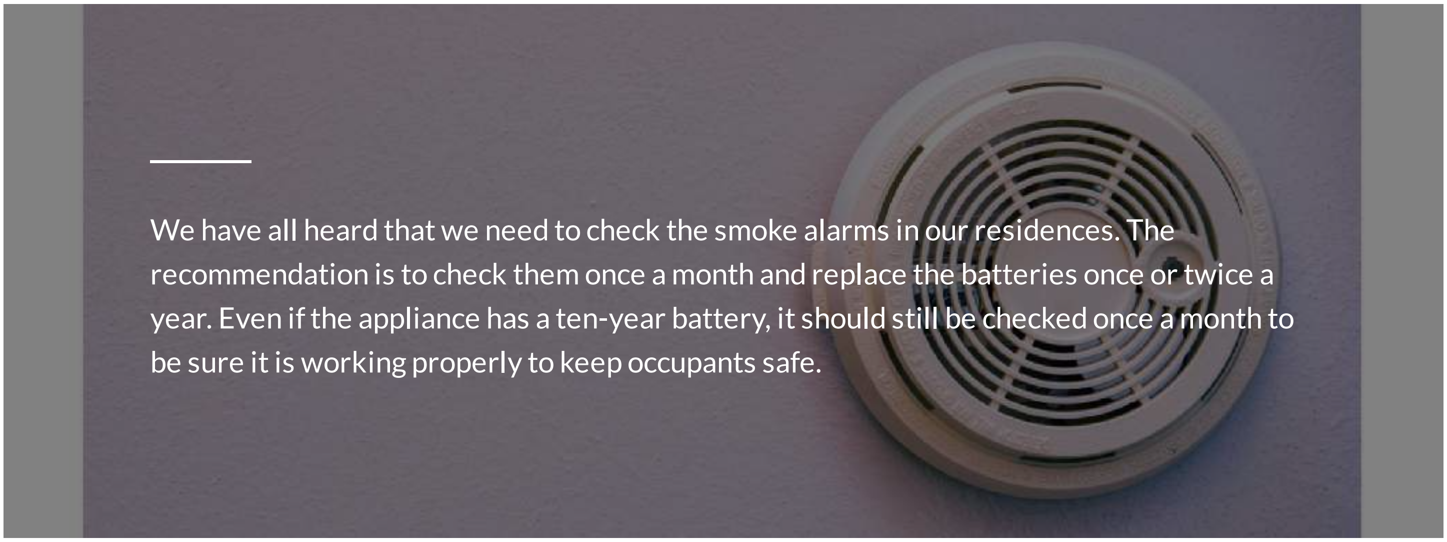
Basic Requirements and Smoke Alarms

Power Supplies and Equipment Performance

Installation and Location & Spacing

Lesson 1 of 3

Basic Requirements and Smoke Alarms



We have all heard that we need to check the smoke alarms in our residences. The recommendation is to check them once a month and replace the batteries once or twice a year. Even if the appliance has a ten-year battery, it should still be checked once a month to be sure it is working properly to keep occupants safe.

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Identify basic requirements for Chapter 29 in *NFPA* 72 2016
2. Recognize detection requirements for smoke alarms
3. Describe required occupant notification

LET'S GET STARTED

NFPA **72 2016** defines a **Household Fire Alarm System** as a system of devices that uses a **fire alarm control unit** **to produce an** **alarm signal** in the household for the purpose of **notifying the occupants** of the presence of a fire so that **they will evacuate** the premises.

NFPA 72 2016, Chapter 29 covers the requirements for:

1. One- and two-family dwelling units
2. Sleeping rooms of lodging and rooming houses
3. Individual dwelling units of apartment buildings
4. Guest rooms, sleeping rooms, and living areas within guest suites of hotels and dormitories
5. Day-care homes
6. Residential board and care facilities
7. Other locations where applicable laws, codes, or standards specify a requirement for the installation of smoke alarms

CONTINUE

A **multiple-station alarm device** is **an interconnection of two or more single-station alarm devices which, when one alarms, will alarm all integral or separate alarm devices**.

- If one of your alarms goes off, its connection to the others will give you a chorus of alarms. But, the multiple-station concept does create a situation where a single alarm will alert many people to the presence of smoke, heat, or whatever happens to be the response mode of that particular detector.

A **single-station alarm device** is simply a **unit containing the detection, control, and alarm units**. Power can be either internal or wired at the point of attachment. This could be the type of detector which we can buy at the hardware store. It's the typical smoke detector installed in many older homes.

Remember:

- **Smoke ALARMS** are **single- or multiple-station alarm devices *not normally connected* to a fire alarm system**, that are capable of detecting a fire condition and alerting the occupants**.**
- **Smoke DETECTORS** are **connected to a fire alarm system and *send a signal* to the fire alarm control unit**. The fire alarm control unit then activates the notification appliances to alert the occupants**.**

BASIC REQUIREMENTS

NFPA 72 2016, Section 29.3

Any and all devices and equipment to be installed in conformity with Chapter 29 shall be approved or listed for the purposes for which they are intended.

Fire-warning equipment shall be installed in accordance with the listing and manufacturer's published instructions.

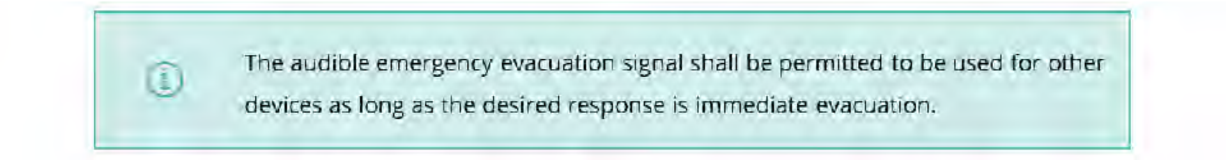
The installation of smoke alarms or fire alarm systems, or combinations of these, shall comply with the requirements of this chapter and shall satisfy the minimum requirements for number and location of smoke alarms or smoke detectors by one of the following:

1. The required minimum number and location of smoke detection devices shall be satisfied (independently) through the installation of smoke alarms. The installation of additional smoke alarms shall be permitted.
2. The required minimum number and location of smoke detection devices shall be satisfied (independently) through the installation of system smoke detectors.

Additional smoke alarms or detectors are permitted to be installed.

Fire-warning equipment to be installed in residential occupancies shall produce the audible emergency evacuation signal described in ANSI S3.41, American National Standard Emergency Evacuation Signal, whenever the intended response is to evacuate the building.

Exception: Where mechanically powered single-station heat alarms are used as supplementary devices, unless required by applicable laws, codes, or standards, such devices shall not be required to produce the emergency evacuation signal described in ANSI S3.41.



The audible emergency evacuation signal shall be permitted to be used for other devices as long as the desired response is immediate evacuation.

CONTINUE

Let's do a quick check about what has been covered so far.

Match the words to their definitions.

☰ Smoke Alarm	single- or multiple-station alarm device not normally connected to a fire alarm system
☰ Smoke Detector	connected to a fire alarm system and sends a signal to the fire alarm control unit

SUBMIT

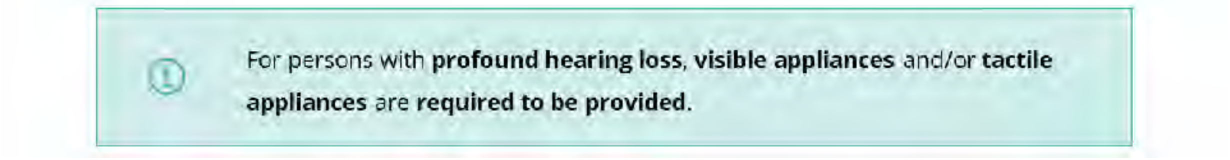
🔒 Complete the knowledge check above before moving on.

ⓘ **Audible fire alarm signals shall meet the performance requirements of Sections 18.4.3, 18.4.5.1, 18.4.5.2, and 29.3.8.**

Individuals with Hearing Loss

Visible appliances shall meet the requirements of Section 18.5. If the occupants of the residence have hearing deficits, it is the responsibility of the party with the hearing loss to inform the installer of the hearing deficit.

Where required by governing laws, codes, or standards, **low frequency 520 Hz (+/- 10%) square wave audible appliances** are to be provided for those persons with **mild to severe hearing loss**.



For persons with **profound hearing loss, visible appliances** and/or **tactile appliances** are **required to be provided.**

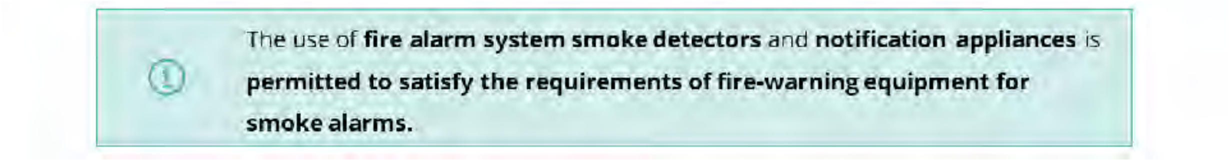
SMOKE ALARMS

Required Detection

***NFPA* 72 2016, Section 29.5.1**

This section defines the detection requirements for smoke alarms in these applications:

1. In all sleeping rooms and guest rooms
2. Outside of each separate dwelling unit sleeping area, within 21 ft of any door to a sleeping room, with the distance measured along a path of travel
3. On every level of a dwelling unit, including basements
4. On every level of a residential board and care occupancy (small facility), including basements and excluding crawl spaces and unfinished attics
5. In the living area(s) of a guest suite
6. In the living area(s) of a residential board and care occupancy (small facility)



The use of **fire alarm system smoke detectors** and **notification appliances** is **permitted to satisfy the requirements of fire-warning equipment for smoke alarms.**

CONTINUE

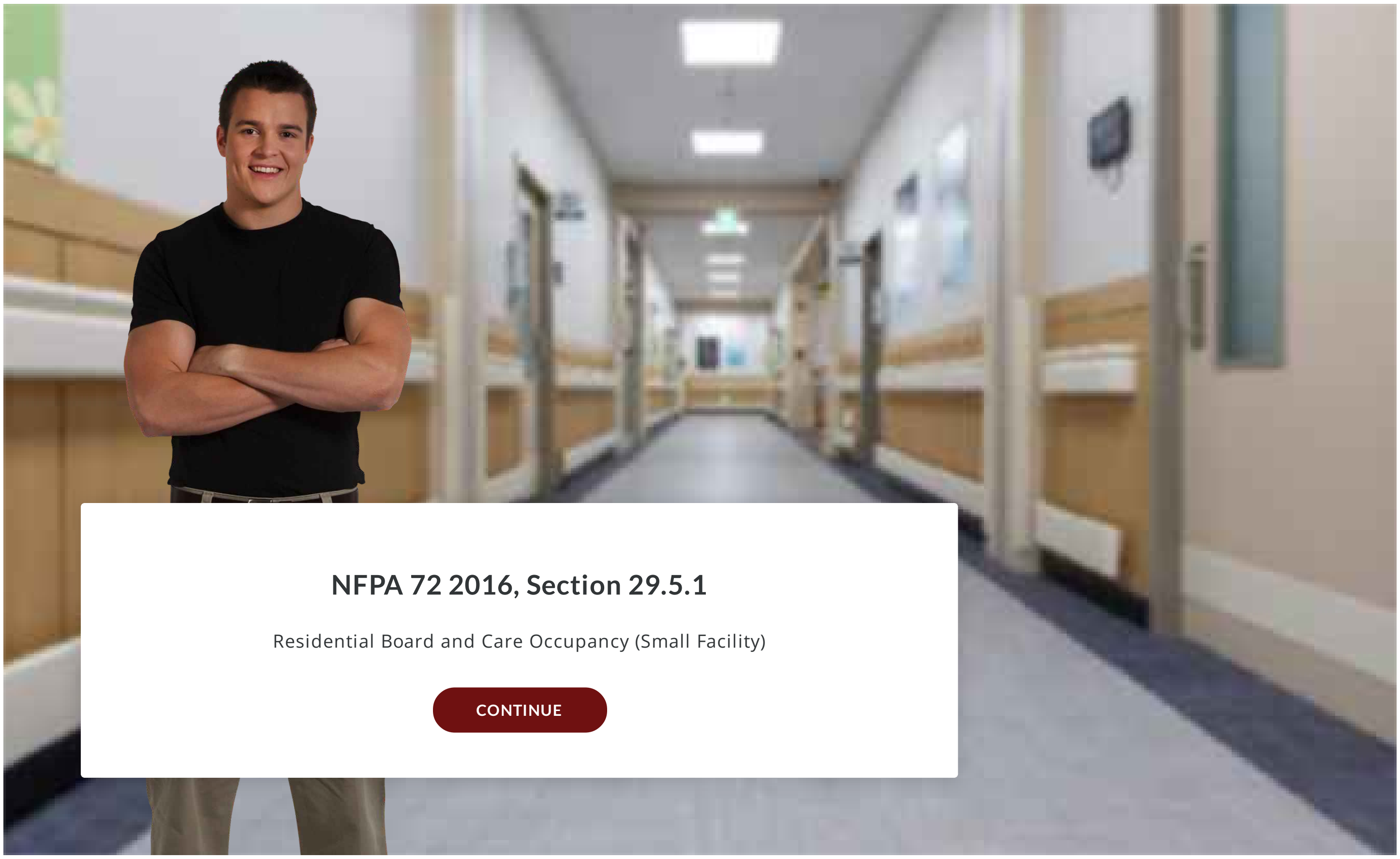
If the area outside the sleeping rooms is separated from the adjacent living areas by a door, a smoke alarm shall be installed in the area between the door and the sleeping rooms, and additional alarms shall be installed on the living area side of the door.

If the interior floor area for a given level of a dwelling unit, excluding garage areas, is greater than 1,000 ft^2, smoke alarms shall be installed per the following:

- All points on the ceiling shall have a smoke alarm within a 30 ft travel distance or shall have an equivalent of one smoke alarm per 500 ft^2 of floor area. One smoke alarm per 500 ft^2 is calculated by dividing the total interior square footage of floor area per level by 500 ft^2.
- Where dwelling units include great rooms or vaulted/cathedral ceilings extending over multiple floors, smoke alarms located on the upper floor that are intended to protect the great room(s) are permitted to be considered as part of the lower floor(s) protection scheme used to meet the requirements of the statement above.

CONTINUE

Try the following scenario to see how you would do in this situation.

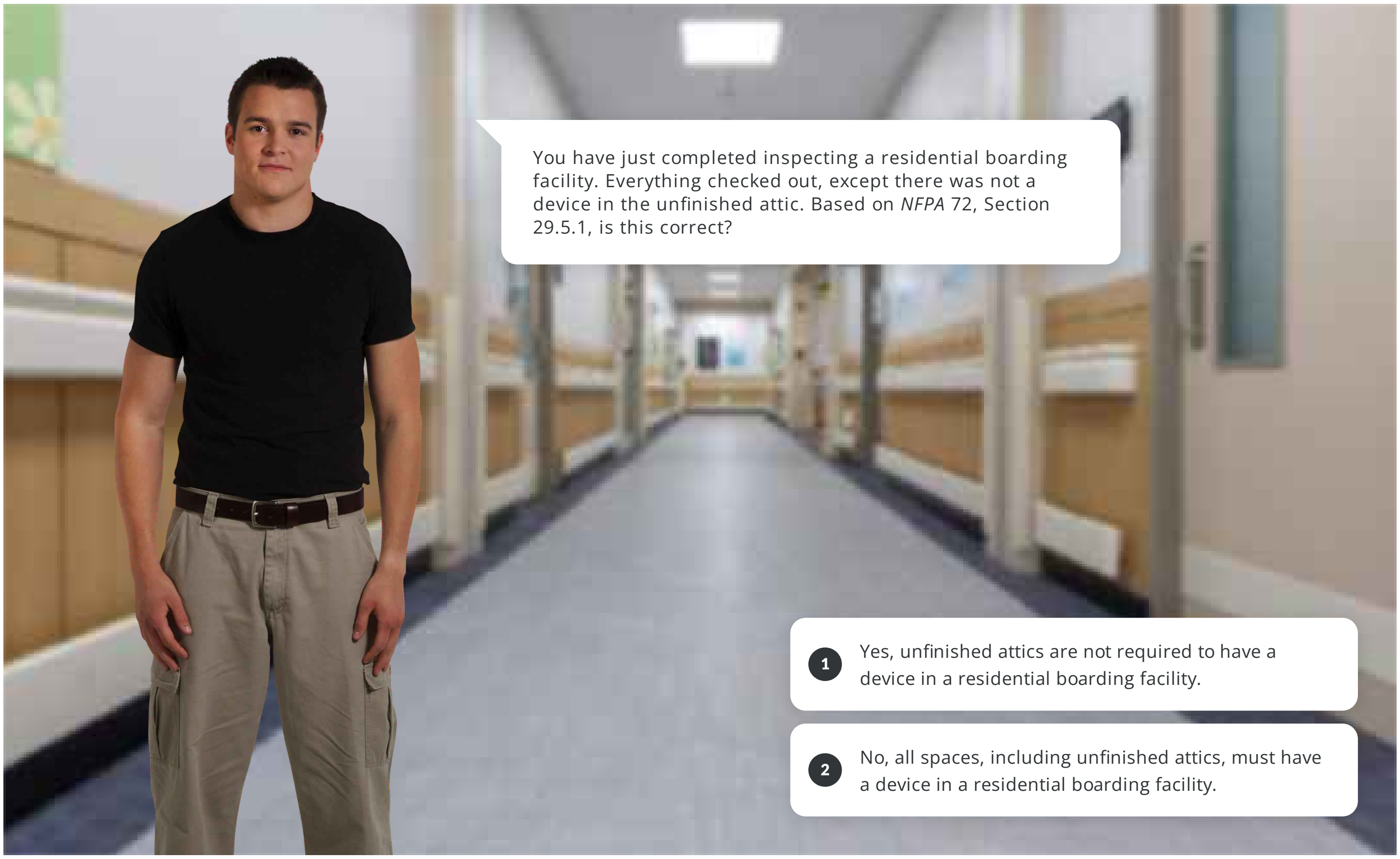


NFPA 72 2016, Section 29.5.1

Residential Board and Care Occupancy (Small Facility)

Scene 1 Slide 1

Continue → Next Slide



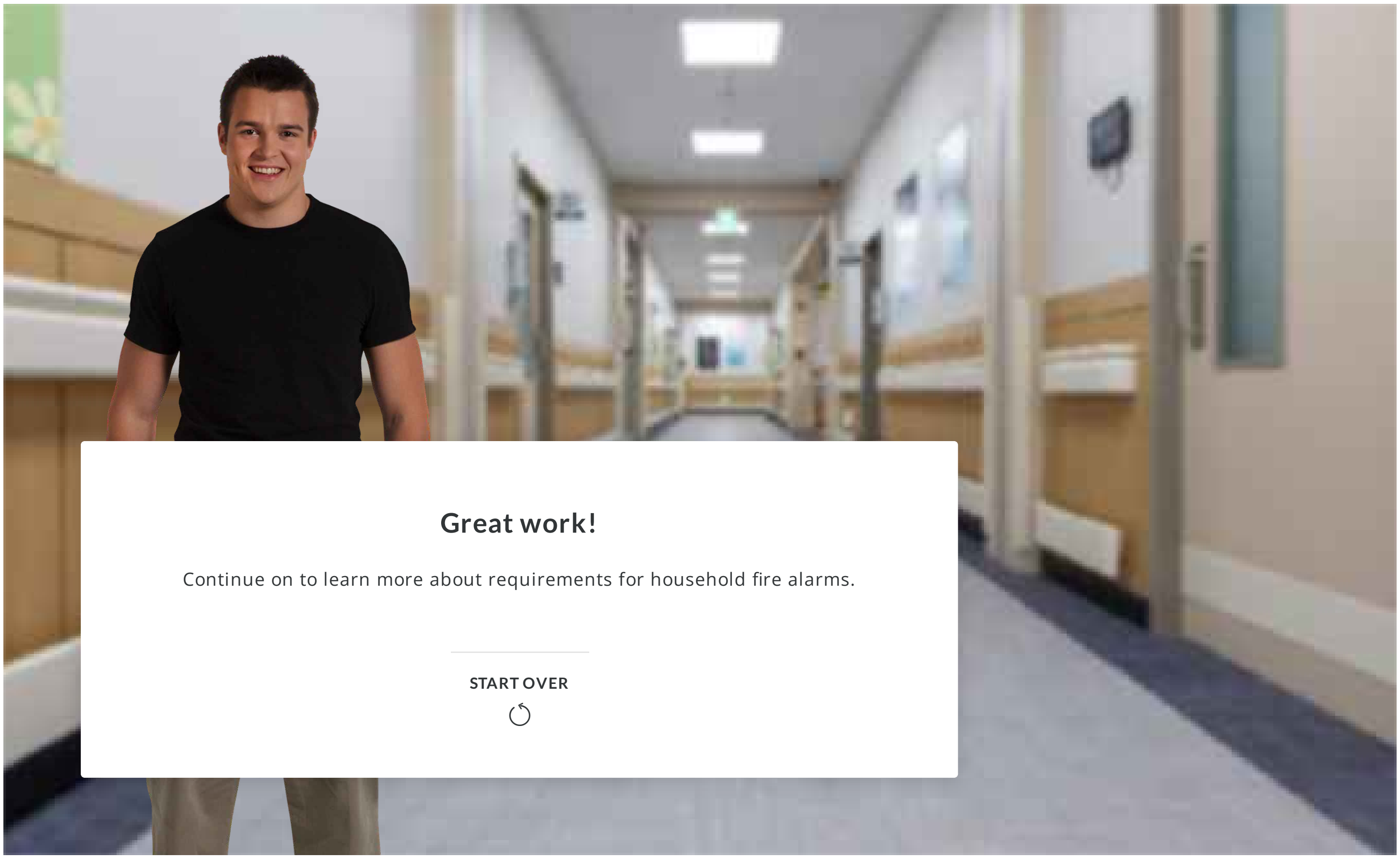
You have just completed inspecting a residential boarding facility. Everything checked out, except there was not a device in the unfinished attic. Based on *NFPA* 72, Section 29.5.1, is this correct?

1. Yes, unfinished attics are not required to have a device in a residential boarding facility.
2. No, all spaces, including unfinished attics, must have a device in a residential boarding facility.

Scene 1 Slide 2

0 → Next Slide

1 → Next Slide



Great work!

Continue on to learn more about requirements for household fire alarms.

Scene 1 Slide 3

Continue → End of Scenario

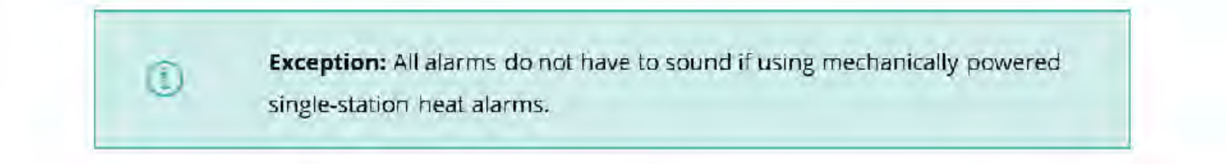
Complete the scenario above before moving on.

Required Occupant Notification

NFPA 72 2016, Section 29.5.2

Fire-warning equipment used to provide required or optional detection shall produce audible fire alarm signals.

Unless exempted by applicable laws, codes, or standards, smoke or heat alarms in a dwelling unit must be installed so that if one smoke or heat alarm sounds, all smoke or heat alarms within a dwelling unit, suite of rooms, or similar area, sound to notify the occupants.



Exception: All alarms do not have to sound if using mechanically powered single-station heat alarms.

Unless otherwise permitted by the authority having jurisdiction (AHJ), audible fire alarm signals shall sound only in an individual dwelling unit, suite of rooms, or similar area and shall not be arranged to operate fire-warning equipment or fire alarm systems outside these locations. Remote annunciation shall be permitted.

CONTINUE TO NEXT LESSON: POWER SUPPLIES & EQUIPMENT PERFORMANCE

Lesson 2 of 3

Power Supplies and Equipment Performance

Did you know that heat detectors or heat alarms are sensitive to ambient temperatures?

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Apply the Ohio Building Code, Section 915 to carbon monoxide alarms
2. Compare various types of equipment performance
3. Recognize operational characteristics of combination systems

CONTINUE

Carbon Monoxide Alarms

Ohio Building Code, Section 915

Section 915.1 Carbon monoxide alarms: Section 915.1.1-915.6 of the Ohio Building Code states that for new construction, an approved carbon monoxide detector shall be installed in the immediate vicinity of the sleeping units, classrooms, and dwelling units that contain fuel-burning appliances, a fuel-burning fireplace, a fuel-burning forced air furnace, or attached private garages are required to have carbon monoxide detectors.

*Note: There are exceptions for the above-mentioned locations that have either fuel-burning, forced air furnaces, or attached private garages.

Section 915.2 Where required: Where work requiring a permit occurs in existing dwellings that have attached garages or in existing dwellings within which fuel-fired appliances exist, carbon monoxide alarms shall be provided **in accordance with Section 915.1.**

ⓘ **There is an Ohio Building Code and an Ohio Residential Building Code. The Ohio Residential Building Code was updated in 2013 and requires Carbon Monoxide Alarms.**

POWER SUPPLIES

NFPA 72 2016, Section 29.6.1

Smoke and Heat Alarms Power Supplies

The power supply requirements for smoke and heat alarms are as follows...

Requirement 1

A commercial light and power source along with a secondary power source that is capable of operating the device for at least **7 days in the normal condition**, followed by **4 minutes of alarm**. Note the 4-minute requirement vs. the normal 5-minute requirement for system power supplies.

Requirement 2

If a commercial light and power source is not normally available, a noncommercial AC power source along with a secondary power source capable of supplying the device for at least **7 days in normal condition** and **4 minutes in alarm**.

Requirement 3

A nonrechargeable, nonreplaceable battery capable of operating the device for **10 years in normal condition**, followed by **4 minutes in alarm**, followed by **7 days in a** *trouble condition*.

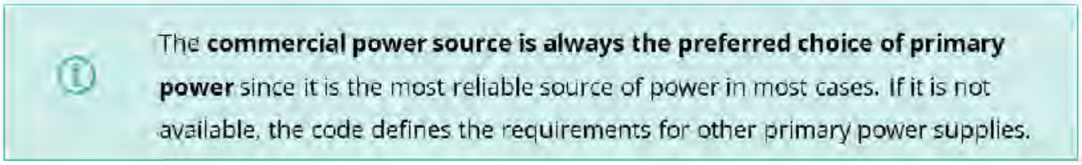
Requirement 4

If a battery primary power supply is specifically permitted, a battery meeting the requirements of **Section 29.6.6 (nonrechargeable primary battery)** or the requirements of **Section 29.6.7 (rechargeable primary battery)** is permitted.

Requirement 5

A suitable spring-wound mechanism for the nonelectrical portion of a listed single-station alarm with a visible indication to show that sufficient operating power is not available.

Summary


The **commercial power source is always the preferred choice of primary power** since it is the most reliable source of power in most cases. If it is not available, the code defines the requirements for other primary power supplies.

CONTINUE

Let's do a quick check about what has been covered so far.

When was the Ohio Residential Building Code updated to require Carbon Monoxide Alarms for new construction?

○ 2011

○ 2013

○ 2015

○ 2017

SUBMIT

According to Ohio Building Code Section 915.1, an approved carbon monoxide alarm shall be installed in which of the following places? (Choose all that apply)

☐ Outside each separate sleeping area of the dwelling

☐ In dwellings with detached garages

☐ In the immediate vicinity of the bedrooms of the dwelling

☐ In dwellings with fuel fired appliances

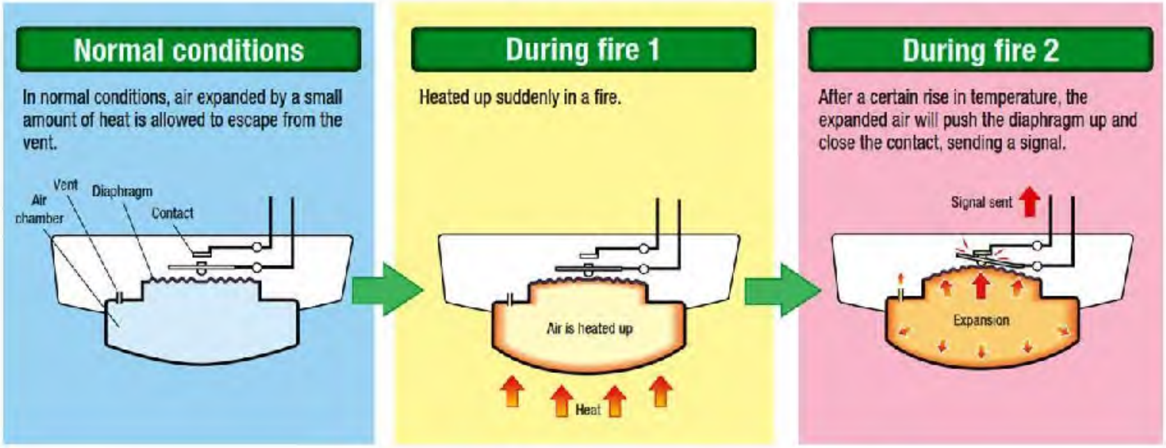
SUBMIT

Complete the knowledge check above before moving on.

Equipment Performance

NFPA 72 2016, Section 29.7

Any failure of any nonreliable or short-life component that renders the detector inoperable shall result in a trouble signal or otherwise be apparent to the occupant of the living unit without the need for test.



Rate of Rise Detector (Click to enlarge image)

Heat detectors and heat alarms, including heat detectors or alarms combined with smoke detectors or smoke alarms may be fixed-temperature or rate-of-rise and shall be **listed for no less than 50 ft. spacing**.

Fixed temperature heat detectors or heat alarms must have a **temperature rating at least 25°F above the normal ambient temperature** and shall **not be rated less than 50°F higher than the maximum expected ambient temperature** in the area where it is installed.

All single-station alarm devices and multiple-station alarm devices must have a convenient means of testing its operability by the occupant, owner, or other responsible party.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

As per the power supply requirements for smoke and heat alarms, a non-rechargeable, non-replaceable battery capable of operating the device for 10 years in normal condition, followed by 4 minutes in alarm, followed by 7 days in a(n) _____ condition.

○ Alarm

○ Supervisory

○ Trouble

SUBMIT

Complete the knowledge check above before moving on.

System Control Equipment

NFPA 72 2016, Section 29.7.5

If a fire alarm system is used for household fire-warning equipment, the control equipment shall be automatically restoring upon restoration of electrical power.

The system control equipment must be of a type that "locks in" (latch) on an alarm condition. Smoke detection circuits are not required to lock in.

If a reset switch is provided, it must be a self-restoring (momentary operation) type.

A means for silencing the trouble notification appliance(s) is permitted only if the following conditions are met:

1. The means is key-operated or located within a locked enclosure, or arranged to provide protection against unauthorized use.
2. The means transfers the trouble indication to an identified lamp or other acceptable visible indicator, such as an LED, and the visible indication stays lit until the trouble condition has been corrected.

A means for turning off activated alarm notification appliances is permitted only if the following conditions are met:

1. The means is key-operated or located within a locked cabinet, or arranged to provide protection against unauthorized use.
2. The means includes the provision of a visible alarm silence indication.

Household fire alarm system smoke detectors, initiating devices, and notification appliances shall be monitored for integrity so that the occurrence of a single open or single ground fault in the interconnection, which prevents normal operation of the interconnected devices, is indicated by a distinctive trouble signal.

*This is the **same requirement** as a **protected premises fire alarm system**...because basically it **is** a protected premises system.*

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Smoke detection circuits are not required to lock in.

○ True

○ False

SUBMIT

Complete the knowledge check above before moving on.

Combination System

NFPA 72 2016, Section 29.7.6

Combination systems are **permitted as long as the fire alarm signals take precedence over non-fire alarm signals**, even if the other signals activated first.

Fire alarm signals must be distinctive from non-fire alarm signals so occupants can distinguish from other signals that may require them to respond differently.

Faults in other systems or components cannot affect the operation of the fire alarm portion of the system.

Installations that include the connection of single-station alarm device or multiple-station alarm device with other input or output devices shall be permitted. An open, ground fault, or short circuit of the wiring connecting input or output devices to the single- or multiple-station alarms shall not prevent operation of each individual alarm.

WIRELESS DEVICES

Wireless Devices

NFPA 72 2016, Section 29.7.7

Household fire alarm systems utilizing low-power wireless transmission of signals within the protected dwelling unit shall comply with the requirements of **Section 23.16**.

To ensure adequate transmission and reception capability, nonsupervised, low-power wireless alarms shall be capable of reliably communicating at a distance of 100 ft. indoors.

****There's much more to this requirement that involves formulas. Check NFPA 72 2016, page 170 and 171****

Fire alarm signals have priority over all other signals.

The maximum allowable response delay from activation of an initiating device to receipt and alarm/display by the receiver or control unit is 20 seconds.

Wireless interconnected smoke alarms, in the receive mode, shall remain in alarm as long as the originating unit (transmitter) remains in alarm.

A **single fault** that disables a transceiver **shall not prevent** other transceivers in the system from operating.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

To ensure adequate transmission and reception capability, nonsupervised, low-power wireless alarms shall be capable of reliably communicating at a distance of ____ indoors.

○ 50 ft.

○ 100 ft.

○ 150 ft.

SUBMIT

Wireless interconnected smoke alarms shall remain in alarm in the ____ mode as long as the originating unit (transmitter) remains in alarm.

Type your answer here

SUBMIT

🔒 Complete the knowledge check above before moving on.

Lesson 3 of 3

Installation and Location & Spacing

Smoke alarms and heat alarms are point of use devices. They need to be installed in the correct location in order to do their job. If they are tucked away because they do not fit the aesthetic feel of a room, it defeats their purpose.

Goals of this Lesson

By the end of this lesson, you will be able to do the following:

1. Identify proper installation of fire alarm systems
2. Identify requirements for detector location and spacing
3. Identify requirements for audible alarms
4. Recognize markings and instructions for various components of fire warning systems

INSTALLATION

Installation

NFPA **72 2016, Section 29.8**

The installation of household fire alarm systems has to be done in a manner where they are immune to vibration or jarring.

The detectors and components must be mounted independently of their wiring, and they have to be restored promptly after any alarm or test.

The supplier or installing contractor shall provide the owner or other responsible parties with the following:

1. An instruction booklet illustrating typical installation layouts
2. Instruction charts describing the operation, method, and frequency of testing and maintenance of fire-warning equipment
3. Printed information for establishing an emergency evacuation plan
4. Printed information to inform owners of repair or replacement services and how to find replacements for parts within 2 weeks
5. Information noting both of the following:

    a. Unless manufacturers recommend otherwise, smoke alarms shall be replaced when they fail to respond to tests

    b. Smoke alarms installed in one- and two-family dwellings shall not remain in service longer than 10 years from the date of manufacture

INTERCONNECTION OF DETECTORS OR MULTIPLE STATION ALARMS

Interconnection of Detectors or Multiple Station Alarms

NFPA 72 2016, Section 29.8.2

The interconnection of smoke or heat alarms must comply with the following:

1. Smoke or heat alarms may not be interconnected in numbers that exceed the manufacturer’s published instructions.
2. If the interconnecting means is not supervised, no more than 18 initiating devices may be interconnected (of which 12 can be smoke alarms).
3. If the interconnecting means is supervised, no more than 64 initiating devices may be interconnected (of which 42 can be smoke alarms).

4. Smoke or heat alarms shall not be interconnected with alarms from other manufacturers unless listed as being compatible with the specific model.

5. When alarms of different types are interconnected, all interconnected alarms shall produce the appropriate audible response for the phenomena being detected, or remain silent.

A single fault on the interconnecting means between multiple-station alarm devices shall not prevent single-station alarm device operation of any of the interconnected alarms.

Remote notification appliance circuits of multiple-station alarms shall be capable of being tested for integrity by activation of the test feature on any interconnected alarm.

Activation of the test feature shall result in the operation of all interconnected notification appliances.

DETECTOR LOCATION AND SPACING

Smoke Alarms and Smoke Detectors

***NFPA* 72 2016, Section 29.8.3**

Smoke alarms or smoke detectors mounted on a **peaked ceiling shall be located within 36 in. horizontally of the peak, but not closer than 4 in. vertically to the peak**.

Smoke alarms or smoke detectors mounted on a **sloped ceiling having a rise greater than 1 ft. in 8 ft. horizontally shall be located within 36 in. of the high side of the ceiling**, but **not closer than 4 in. from the adjoining wall** surface.

Wall mounted smoke alarms or detectors shall be **mounted no more than 12 in. from the ceiling.**

Smoke alarms and smoke detectors **shall not be located in unfinished attics or garages where temperatures may be below 40°F or over 100°F** unless they are rated for the environment.

- If the outside wall could be considerably warmer or cooler than the room temperature, the smoke detection devices shall be mounted on an inside wall.
- Smoke alarms or detectors **shall not be mounted within 10 ft. radial** from a stationary or fixed **cooking appliance**. There are **exceptions to this requirement in Section 29.8.3.4**.

CONTINUE

Let's do a quick check about what has been covered so far.

According to *NFPA* 72, Section 29.8.2, if the interconnecting means is not supervised, no more than _____initiating devices may be interconnected (of which ____ can be smoke alarms).

○ 18 (12)

○ 20 (14)

○ 22 (16)

○ 24 (18)

SUBMIT

According to *NFPA* 72, Section 29.8.2, If the interconnecting means is supervised, no more than ____ initiating devices may be interconnected (of which ____ can be smoke alarms).

○ 60 (40)

○ 62 (41)

○ 64 (42)

○ 66 (43)

SUBMIT

Smoke alarms and smoke detectors shall not be located in unfinished attics or garages where temperatures may be below ____°F or over 100°F unless they are rated for the environment.

○ 32°F

○ 36°F

○ 40°F

SUBMIT

Complete the knowledge check above before moving on.

Heat Detectors and Alarms

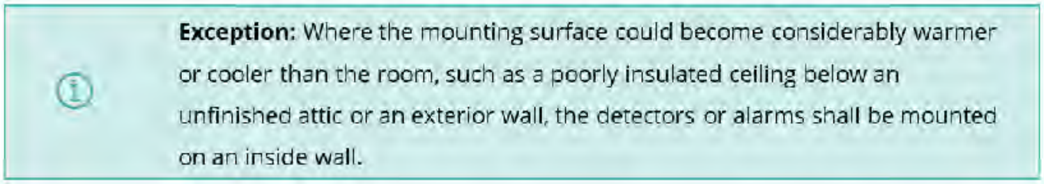
NFPA 72 2016, Section 29.8.4

On smooth ceilings, heat detectors and heat alarms shall be installed within the strict limitations of their listed spacing.

For **sloped ceilings** having a **rise greater than 1 ft. in 8 ft. horizontally**, the detector or alarm **shall be located within 36 in. of the peak.** The spacing of additional detectors or alarms, if any, shall be based on a horizontal distance measurement, not on a measurement along the slope of the ceiling.

CONTINUE

Heat detectors or alarms shall be mounted on the ceiling at least 4 in. from a wall or on a wall with the top of the detector or alarm not less than 4 in., nor more than 12 in. below the ceiling.



Exception: Where the mounting surface could become considerably warmer or cooler than the room, such as a poorly insulated ceiling below an unfinished attic or an exterior wall, the detectors or alarms shall be mounted on an inside wall.

In rooms with **open joists or beams, all ceiling-mounted detectors or alarms shall be located on the bottom of such joists or beams**.

Detectors or alarms installed on an **open-joisted ceiling shall have their smooth ceiling spacing reduced** where this spacing is measured at right angles to solid joists; **in the case of heat detectors or heat alarms, this spacing shall not exceed one-half of the listed spacing**.

Additional Considerations

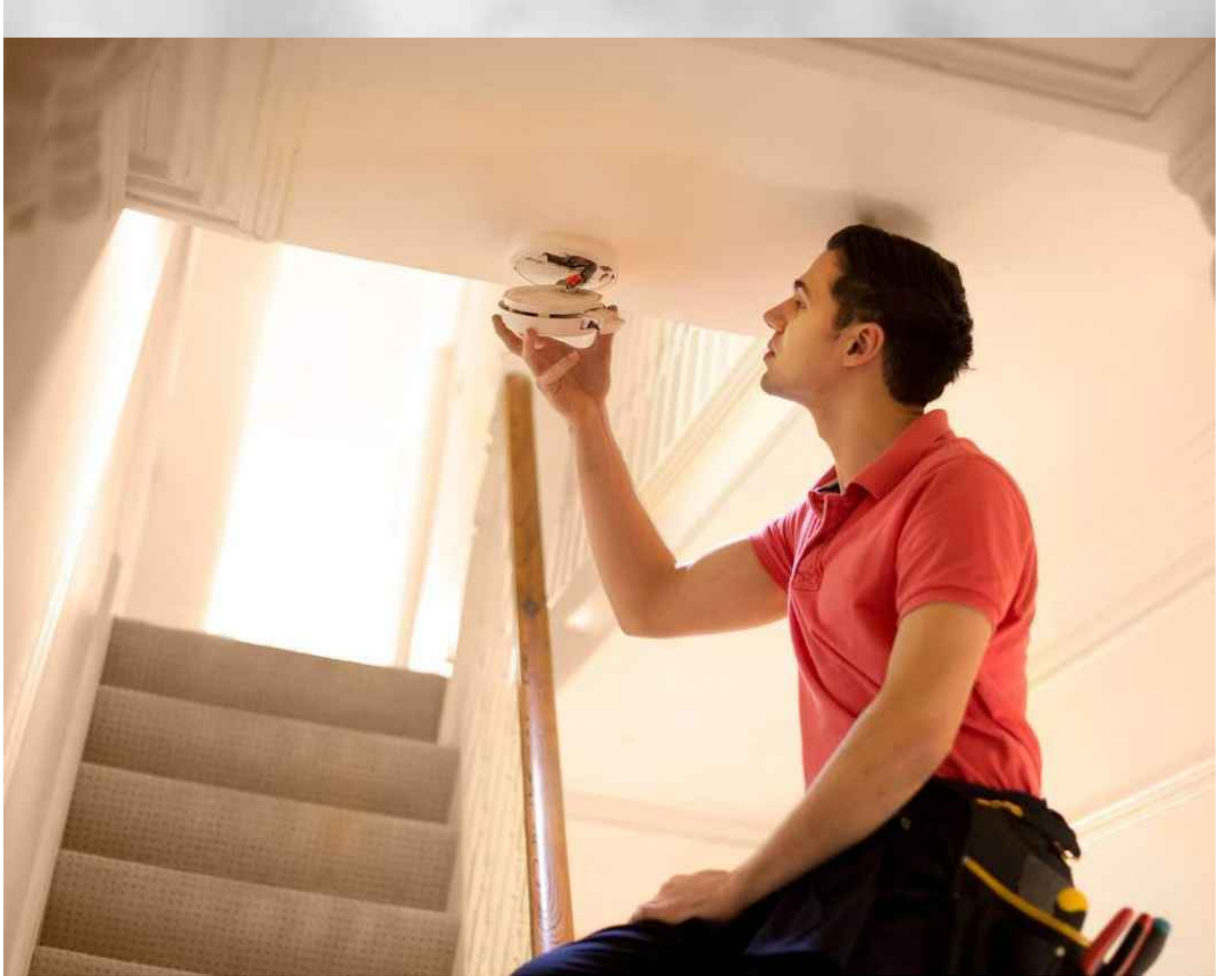
Per Section 29.3.6, fire-warning audible alarms must meet the requirements of Sections 18.4.3 and 18.4.5. They must **be at least 15 dBA above the average ambient sound level**, or 5 dBA above the maximum sound level.

In the **sleeping areas**, the **sound level must be a minimum of 75 dbA** measured at the **pillow level**. The code specifies requirements for notification appliances in sleeping and guest rooms for people with hearing loss in **Section 29.3.8.**

As previously stated, for **mild to severe hearing loss**, the audible appliance must also **produce a low frequency alarm signal with a fundamental frequency of 520 Hz +/- 10%**.

If the **hearing loss is profound**, **visible appliances must be provided**. In the applications that apply to Chapter 29, synchronization of visible appliances in the same field of view is not required.

When we have devices such as smoke alarms and heat alarms, we must realize that they respond only to smoke or heat in their immediate location. **They are point-of-use devices**. If we tuck the alarms away somewhere because we don't like their appearance or their color, we are defeating the purpose of the alarm itself.



A **basement alarm must be close to the connecting stairway.** As the smoke rises, it will approach the stairway and go up to where there are sleeping occupants of the building. **We want to detect the smoke when it gets close to these connecting stairways going up.**

This requirement also holds for other non-sleeping floors. If we have a downstairs living area only, we must mount our alarms close to any stairway leading up to the sleeping areas.

This helps to catch the smoke at the very earliest possible time.

Smoke alarms protecting a sleeping area must be installed close to, but *outside* of, bedrooms.

An alarm installed inside of a bedroom would be a little late in terms of alarming the occupants of other bedrooms, especially if the doors were closed. **Smoke alarms should alert occupants prior to smoke getting inside the bedroom.**

To **avoid dead air space**, it is **required** that **heat alarms be mounted at least 4 in. from a wall**, ***or* on a wall between 4 and 12 in. from the ceiling.**

Do not place smoke or heat alarms in kitchens, garages, or other areas where the temperature can exceed 100°F or fall below 32°F.

Heat alarms must be installed within their listed spacing. There are many mounting conditions. **Review the requirements in Chapter 17**.

Heat alarms must be installed at or near the ceiling, and at or within 3 ft. of the peak of a sloped ceiling.

WIRING AND MAINTENANCE

Wiring and Maintenance

System wiring must comply with *NFPA* 70, National Electrical Code, and with Article 760, which contains the *NFPA* 70 wiring requirements for protective signaling systems (fire alarms).

Maintenance and testing must be done in accordance with the **manufacturer's instructions and Chapter 14.**

This is a very common requirement throughout most of the NFPA standards.

Single-station alarm device and multiple-station alarm devices must have this done monthly.

MARKINGS AND INSTRUCTIONS

Markings and Instructions

Our last reference involves the required markings and instructions. This is a list of the required markings and instructions which must appear on the various components and systems comprising these fire warning systems for dwelling units.

Extra Notes:

- Read the *NFPA* 72 2016 Annex material, if for no other reason than your own safety.
- Review what you have in your own home.
- Review what you have in your own shop.

- Make certain that you, your family, and your fellow employees are in a situation where you're as well protected and as safe as you can possibly be.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

In the sleeping areas, the sound level must be a minimum of _____ measured at the pillow level.

○ 75 dbA

○ 85 dbA

○ 95 dbA

SUBMIT

Smoke alarms protecting a sleeping area must be installed inside of bedrooms.

○ True

○ False

SUBMIT

Heat alarms must be installed within their listed spacing. There are many mounting conditions. Review the requirements in Chapter ____.

Type your answer here

SUBMIT

🔒 Complete the knowledge check above before moving on.

- This completes the Household Fire Alarm Systems module.
- There are many more requirements than we have the time to review in this module.
- Take time to familiarize yourself with the requirements since some of the requirements are unique to household fire-warning systems and components.

***Remember that Chapter 29 does occasionally refer you to other chapters of the code**.

CONTINUE

After completing this module, you should now have a better understanding of the different types of household fire alarm systems.

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.

Ohio Fire Alarm and Detection Equipment- Inspection, Testing and Maintenance

FIRE TECH
PRODUCTIONS

Welcome to the Inspection, Testing and Maintenance module of the Ohio Fire Alarm and Detection Systems Course.

By the end of this module, you will be able to do the following:

- Know who and when to notify when system impairments are found
- Determine qualification criteria for service personnel
- Notify the correct parties prior to and upon completion of testing a fire alarm system
- Differentiate between inspection and testing requirements for fire alarm systems and their components
- Identify differences in functional test requirements when software changes occur
- Recognize replacement timeframes for single and multiple station fire alarms
- Identify all inspection, testing, and maintenance information required to be recorded, filed, and distributed

- Distinguish ITM record retention requirements for different types of fire alarm system components

Key Reference for this module:

- *NFPA* 72 – The National Fire Alarm and Signaling Code, Chapter 14, 2016

When you are ready to begin, click on the button above to start the course.

Lesson 1 of 3

General Information

Who is responsible for inspection, testing, maintenance, or modifications to the system?

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Know who and when to notify when system impairments are found

2 Determine qualification criteria for service personnel

3 Notify the correct parties prior to and upon completion of testing a fire alarm system

LET'S GET STARTED

Performance Verification

NFPA 72 2016, Section 14.2.2.1

To ensure **operational integrity of the system**, an **inspection, testing, and maintenance program is mandatory**.

Inspection, testing, and maintenance programs shall satisfy the requirements of the code and conform to the manufacturer’s published instructions, while confirming correct system operation.

IMPAIRMENTS

Impairments

NFPA 72 2016, Section 14.2.2.2

The requirements of **Section 10.20** shall apply when a system has impairments.

System defects must be corrected. **If a system defect cannot be corrected at the end of the inspection or test**, the **owner or owner's designated representative must be notified within 24 hours**.

If equipment is **part of a recall**, the system owner or their representative **must be notified in writing**.

Responsibilities

NFPA 72 2016, Section 14.2.3

The property owner, building owner, or system owner is responsible for inspection, testing, maintenance, or modifications to the system.

Where the **property owner is not the occupant**, the property owner is **permitted to delegate the authority and responsibility for inspecting, testing, and maintaining the fire protection systems** to the occupant, management firm, or managing individual **through specific provisions in the lease, written use agreement, or management contract.**

Inspection, testing, or maintenance shall be permitted to be done by the building or system owner, or a person or organization other than the building or system owner if conducted under a written contract.

Where the **building or system owner has delegated any responsibilities for inspection, testing, or maintenance**, a copy of the **written delegation** required by **Section 14.2.3.3** shall be **provided to the Authority Having Jurisdiction** (AHJ) upon request.

Testing and maintenance of central station service systems shall be performed under the contractual arrangements specified in **Section 26.3.3.**

SERVICE PERSONNEL QUALIFICATIONS AND EXPERIENCE

Service Personnel Qualifications and Experience

NFPA 72 2016, Section 14.2.3.6

ⓘ **Service personnel must be qualified and experienced in accordance with the requirements of Section 10.5.3.**

Section 10.5.3.3 states service personnel are **qualified** when their knowledge and experience is **acceptable to the AHJ** or **meet one or more of the requirements of Section 10.5.3.4 below:**

1. Personnel who are factory trained and certified for the specific type and brand of system being serviced
2. Personnel who are certified by a nationally recognized certification organization acceptable to the AHJ
3. Personnel, either individually or through their affiliation with an organization that is registered, licensed, or certified by a state or local authority to perform service on systems addressed within the scope of this Code
4. Personnel who are employed and qualified by an organization listed by a nationally recognized testing laboratory for the servicing of systems within the scope of this Code

CONTINUE

Authority Having Jurisdiction (AHJ)

NFPA 72 2016, Section A.3.2.2

The phrase "Authority Having Jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the AHJ may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority.

- There may be multiple AHJs for a given project or property. Any AHJ has the authority to require more stringent standards or rules. *NFPA* 72 2016 is considered the minimum requirement and the AHJ cannot agree to something less stringent than *NFPA* 72 2016, unless it is stated in the code.

- When the various AHJs have different requirements, the most stringent of the requirements shall be followed.

For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the Authority Having Jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the Authority Having Jurisdiction. At government installations, the commanding officer or departmental official may be the Authority Having Jurisdiction. Any given physical property may have multiple Authorities Having Jurisdiction, which may be concerned with life safety, property protection, mission continuity, heritage preservation, and environmental protection. Some Authorities Having Jurisdiction may impose additional requirements beyond those of the Code. If there are conflicting requirements for the installation of a specific fire alarm system, the installer must follow the most stringent requirements.

Watch the video below to learn more about the AHJ (Authority Having Jurisdiction)

Video run time 3:21

CONTINUE

Let's do a quick check about what has been covered so far.

If a system defect cannot be corrected at the end of the inspection or test, how soon must the owner or owner’s designated representative must be notified?

○ Within 1 week

○ Within 2 days

○ Within 24 hours

SUBMIT

Where the property owner is not the occupant, who can the property owner permit to delegate the authority and responsibility for inspecting, testing, and maintaining the fire protection systems through specific provisions in the lease, written use agreement, or management contract. (Select all that apply)

☐ management firm

☐ managing individual

☐ AHJ

☐ occupant

SUBMIT

Section 10.5.3.3 states service personnel are qualified when their knowledge and experience is acceptable to the AHJ or meet one or more of the requirements of Section 10.5.3.4 below: (Select all that apply)

☐ Personnel who are employed by an organization for the servicing of systems

☐ Personnel who are employed and qualified by an organization listed by a nationally recognized testing laboratory for the servicing of systems within the scope of this Code

☐ Personnel who are certified by a nationally recognized certification organization acceptable to the AHJ

☐ Personnel who are factory trained for the specific type and brand of system being serviced

SUBMIT

Complete the knowledge check above before moving on.

Notification

NFPA 72 2016, Section 14.2.4

Before proceeding with any testing, all persons and facilities receiving alarm, supervisory, or trouble signals and all building occupants must be notified of the testing to prevent unnecessary occupant or emergency services response.

At the conclusion of testing, those previously notified (and others, as necessary) shall be notified that testing has been completed.

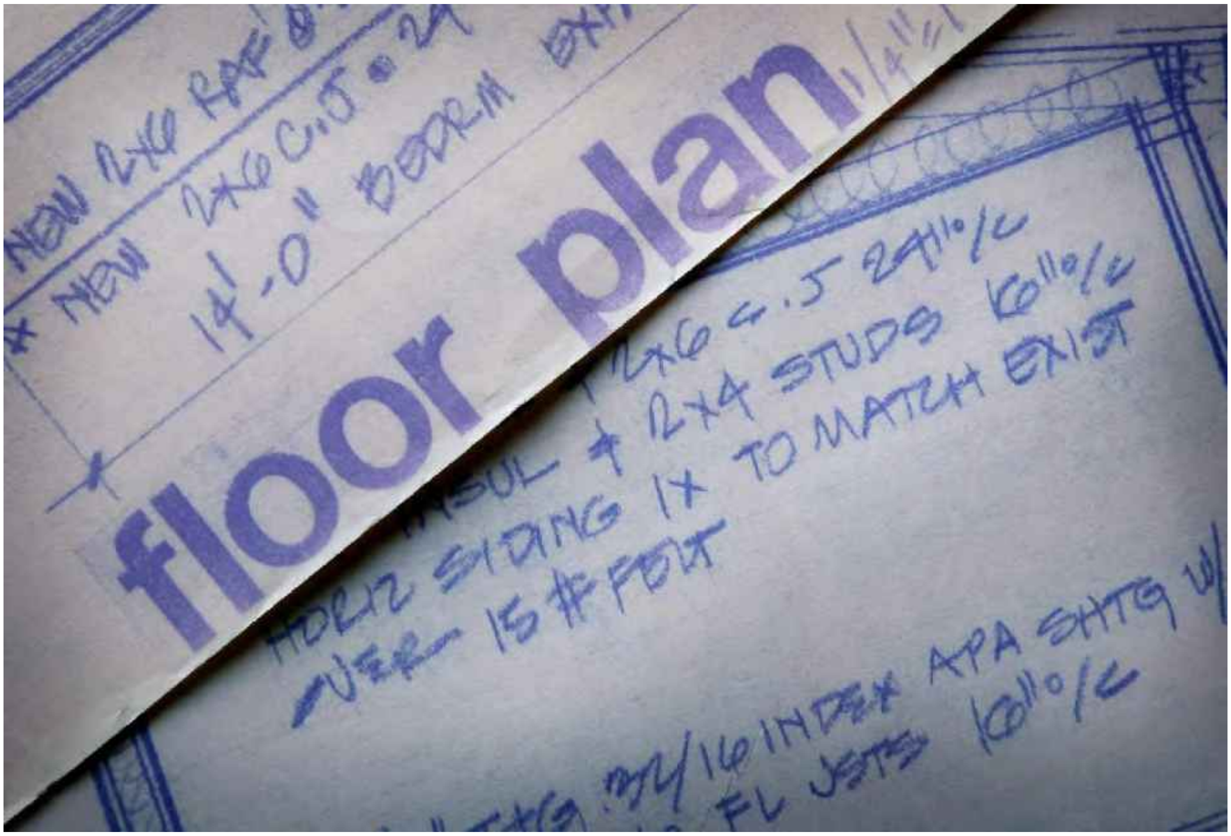
The owner or the owner's designated representative and service personnel shall coordinate all system testing to prevent interruption of critical building systems or equipment.

SYSTEM DOCUMENTATION

System Documentation

NFPA 72 2016, Section 14.2.5

Prior to any maintenance or testing, the owner or designated representative must provide the system record of completion and information required by **Chapter 7** regarding the system to include specifications, wiring diagrams, and floor plans.



RELEASING SYSTEMS

Releasing Systems

NFPA 72 2016, Section 14.2.6

Testing personnel shall be qualified and experienced in the specific arrangement and operation of a suppression system(s) and a releasing function(s), and shall be cognizant of the hazards associated with inadvertent system discharge.

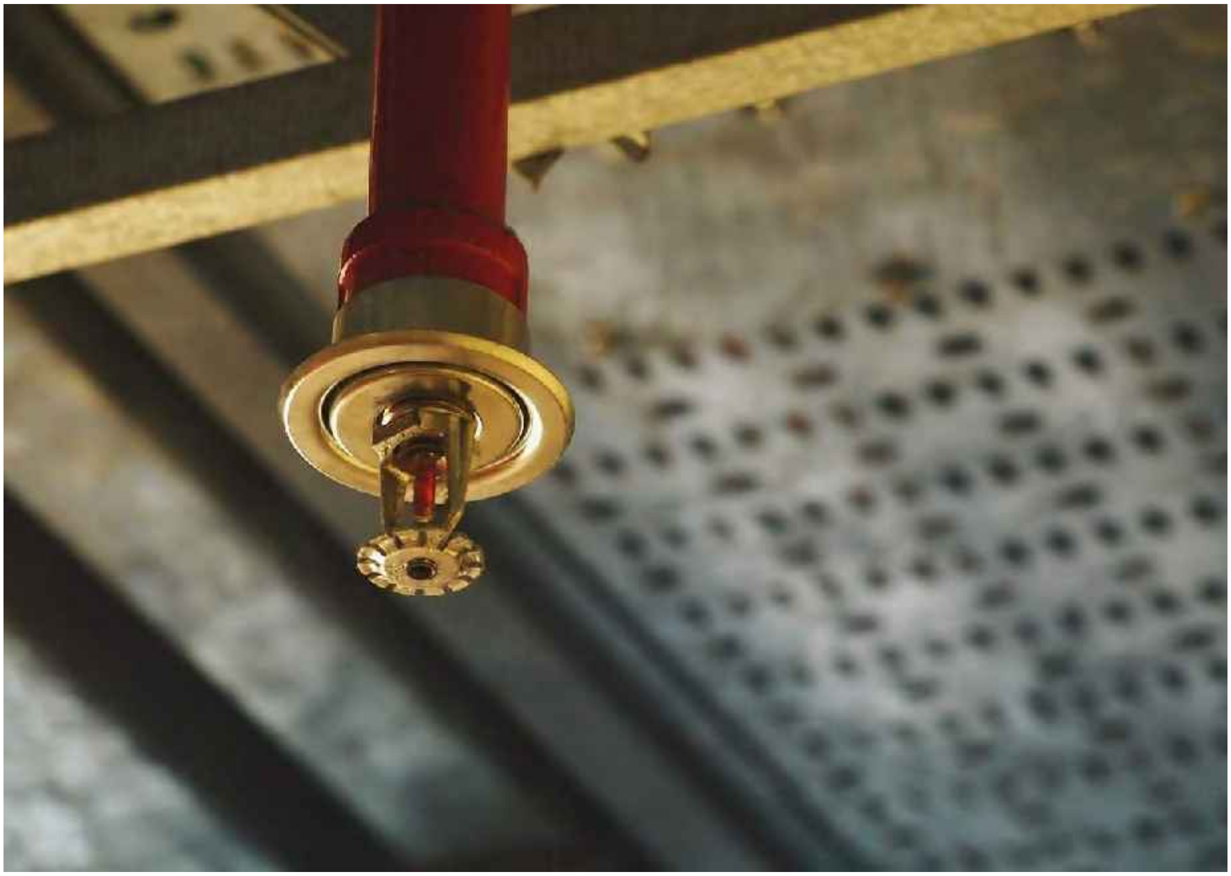
Occupant notification shall be required whenever a fire alarm system configured for releasing service is being serviced or tested.

ⓘ **Discharge testing** of suppression systems **shall not be required by the code.**

Suppression systems shall be secured from inadvertent actuation, including disconnection of releasing solenoids or electric actuators, closing of valves, other actions, or combinations thereof, for the specific system, for the duration of the fire alarm system testing.

Testing shall include verification that the releasing circuits and components energized or actuated by the fire alarm system are electrically monitored for integrity and operate as intended on alarm.

Suppression systems and releasing components shall be returned to their functional operating condition upon completion of system testing.



INTERFACE EQUIPMENT AND EMERGENCY CONTROL FUNCTIONS

Interface Equipment and Emergency Control Functions

NFPA 72 2016, Section 14.2.7

Testing personnel shall be qualified and experienced in the arrangement and operation of interface equipment and emergency control functions.

If unfamiliar with the operation of the emergency control function, such as ***elevator recall****, it is always best to coordinate testing with the responsible agent for the controlled function so that you are onsite at the same time.*

ⓘ Testing of the interface and emergency control function shall be accomplished in accordance with **Table 14.4.3.2**.

CONTINUE

Let's do a quick check about what has been covered so far.

Prior to any maintenance or testing, the owner or designated representative must provide the system record of completion and information regarding the system to include specifications, wiring diagrams, and floor plans. Where are these requirements found?

○ Chapter 5

○ Chapter 6

○ Chapter 7

SUBMIT

_______ systems shall be secured from inadvertent actuation, including disconnection of releasing solenoids or electric actuators, closing of valves, other actions, or combinations thereof, for the specific system, for the duration of the fire alarm system testing.

Type your answer here

SUBMIT

Complete the knowledge check above before moving on.

Automated Testing

NFPA 72 2016, Section 14.2.8

Automated testing arrangements that provide equivalent means of testing devices to those **specified in Table 14.4.3.2** at a frequency at least equivalent to those specified in **Table 14.4.3.2** shall be **permitted to be used to comply with the requirements of this chapter**.

Failure of a device on an **automated test** shall result in an **audible *and* visual trouble signal**.

TEST PLAN

Test Plan

NFPA 72 2016, Section 14.2.10

A test plan must be written to clearly establish the scope of the fire alarm system testing.

The test plan and the results shall be documented with the system testing records.

There are no templates or examples of the test plan in NFPA 72 2016.

CONTINUE

Let's do a quick check about what has been covered so far.

Failure of a device on an automated test shall result in an audible and visual __________ signal.

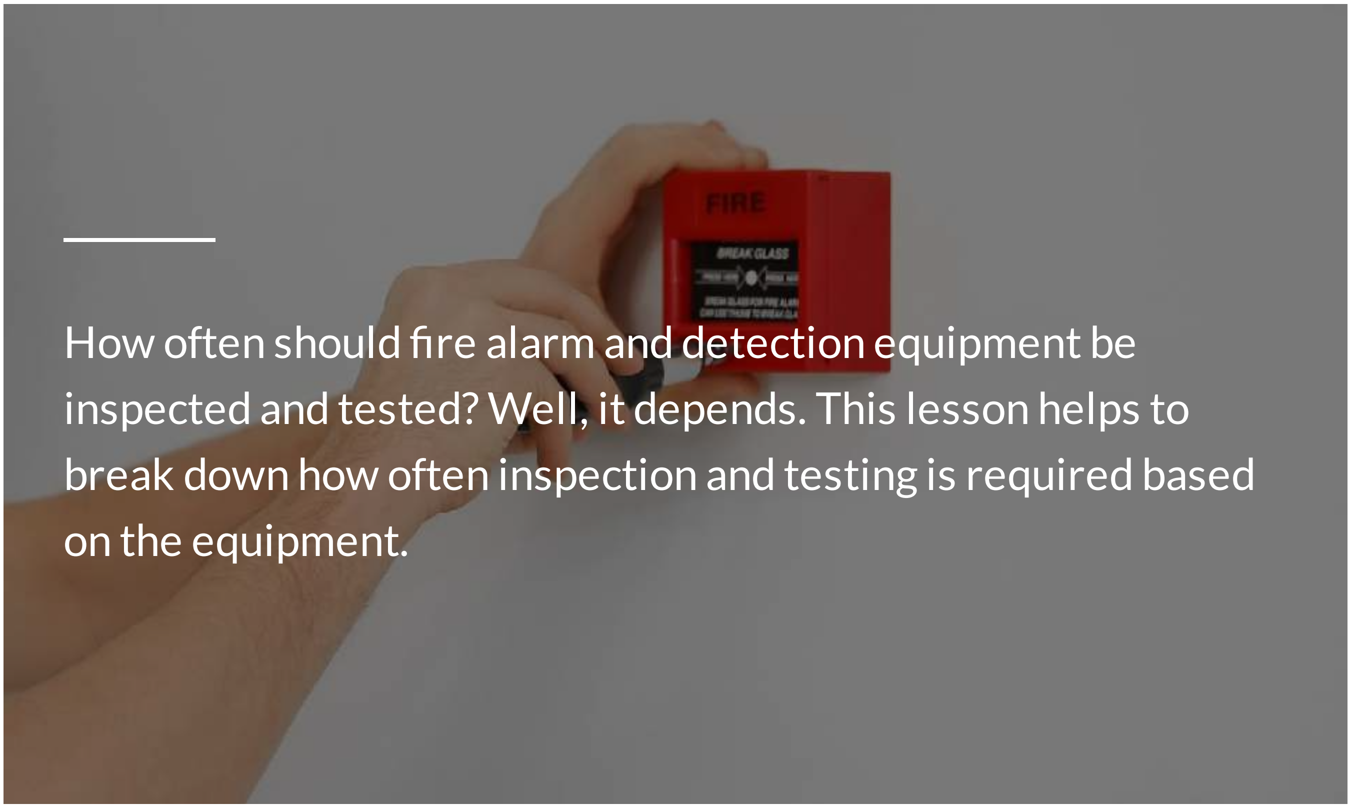
Type your answer here

SUBMIT

Complete the knowledge check above before moving on.

Lesson 2 of 3

Inspection Frequency and Testing Frequency



How often should fire alarm and detection equipment be inspected and tested? Well, it depends. This lesson helps to break down how often inspection and testing is required based on the equipment.

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Differentiate between inspection and testing requirements for fire alarm systems and their components

2. Identify differences in functional test requirements when software changes occur

3. Recognize replacement timeframes for single and multiple station fire alarms

INSPECTION FREQUENCY

Inspection

NFPA 72 2016, Section 14.3

Table 14.3.1 specifies the minimum frequencies required for visual inspections on various components and subsystems of the fire alarm system. The authority having jurisdiction (AHJ) can define testing intervals more frequent than the table if they deem necessary.

The table shows each component of the system has an inspection interval ranging from one week to annually.

Some items just require inspection on the initial installation. The initial inspection applies to all equipment.

Visual inspections must be conducted to verify nothing has changed that will affect system or equipment performance.

CONTINUE

ⓘ Devices that cannot be inspected per the frequencies of **Table 14.3.1**, due to safety concerns, can be inspected at **scheduled shutdown periods if approved by the AHJ**, but the **extended period cannot exceed 18 months**.

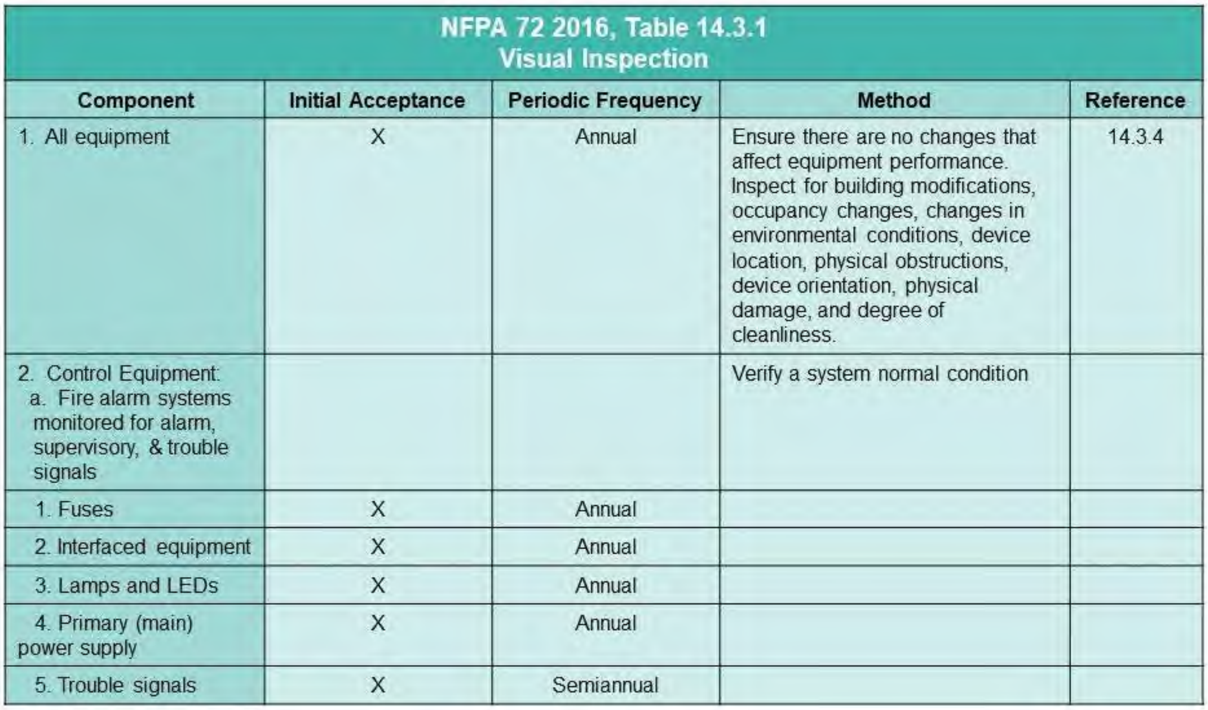
Table 14.3.1 is the visual inspection frequency table. Take some time to review the entire table.

The visual inspection frequencies are marked with an "X" and include:

- Initial/Reacceptance
- Monthly
- Quarterly
- Semiannually
- Annually

Occasionally you will find a "weekly" requirement for a piece of equipment.

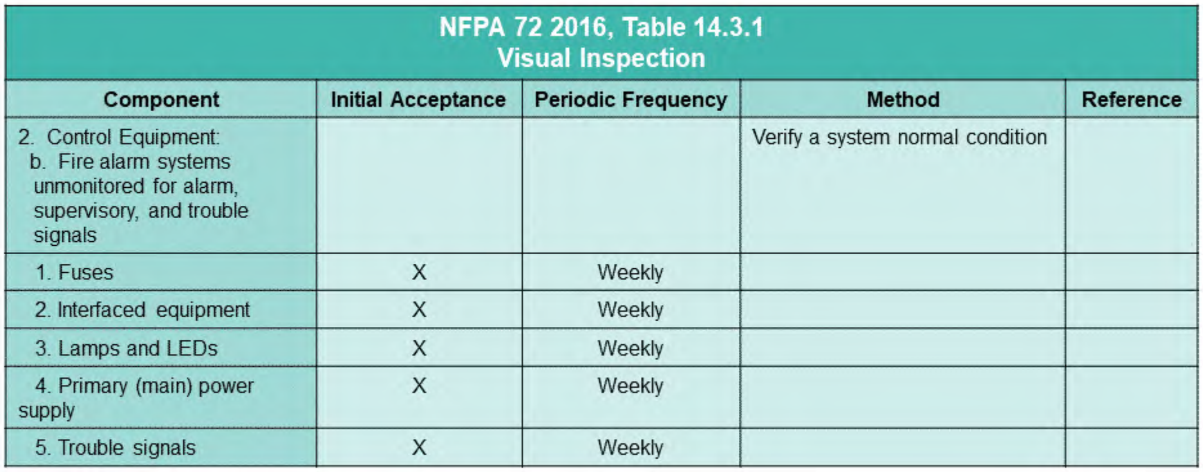
Portions of Table 14.3.1 are shown below.



NFPA 72 2016, Table 14.3.1
Visual Inspection

Component	Initial Acceptance	Periodic Frequency	Method	Reference
1. All equipment	X	Annual	Ensure there are no changes that affect equipment performance. Inspect for building modifications, occupancy changes, changes in environmental conditions, device location, physical obstructions, device orientation, physical damage, and degree of cleanliness.	14.3.4
2. Control Equipment: a. Fire alarm systems monitored for alarm, supervisory, & trouble signals			Verify a system normal condition	
1. Fuses	X	Annual		
2. Interfaced equipment	X	Annual		
3. Lamps and LEDs	X	Annual		
4. Primary (main) power supply	X	Annual		
5. Trouble signals	X	Semiannual		

***NFPA* 72 2016, Page 80**



NFPA 72 2016, Table 14.3.1
Visual Inspection

Component	Initial Acceptance	Periodic Frequency	Method	Reference
2. Control Equipment: b. Fire alarm systems unmonitored for alarm, supervisory, and trouble signals			Verify a system normal condition	
1. Fuses	X	Weekly		
2. Interfaced equipment	X	Weekly		
3. Lamps and LEDs	X	Weekly		
4. Primary (main) power supply	X	Weekly		
5. Trouble signals	X	Weekly		

***NFPA* 72 2016, Page 80**

CONTINUE

Based on ***NFPA* 72 2016, Table 14.3.1-Visual Inspection**, sort the following cards into the correct periodic frequency categories.

Monitored

Control Equipment-a. 1. Fuses (annual)

Control Equipment-a. 2. Interfaced equipment (annual)

Control Equipment-a. 3. Lamps and LED's (annual)

Control Equipment-a. 4. Primary (main) power supplies (annual)

Unmonitored

Control Equipment-b. 1. Fuses (weekly)

Control Equipment-b. 2. Interfaced equipment (weekly)

Control Equipment-b. 3. Lamps and LED's (weekly)

Control Equipment-b. 4. Primary (main) power supplies (weekly)

Control Equipment-b. 5. Trouble signal (weekly)

Complete the card sort above before moving on.

Testing

NFPA 72 2016, Section 14.4

All **new systems** shall have an **initial acceptance test** and the **AHJ shall be notified prior to the initial acceptance test**.

When changes are made to the site specific software, all functions directly affected by the change shall be 100% tested. Additionally, 10% (max of 50) of the initiating devices not directly affected by the change shall be tested.

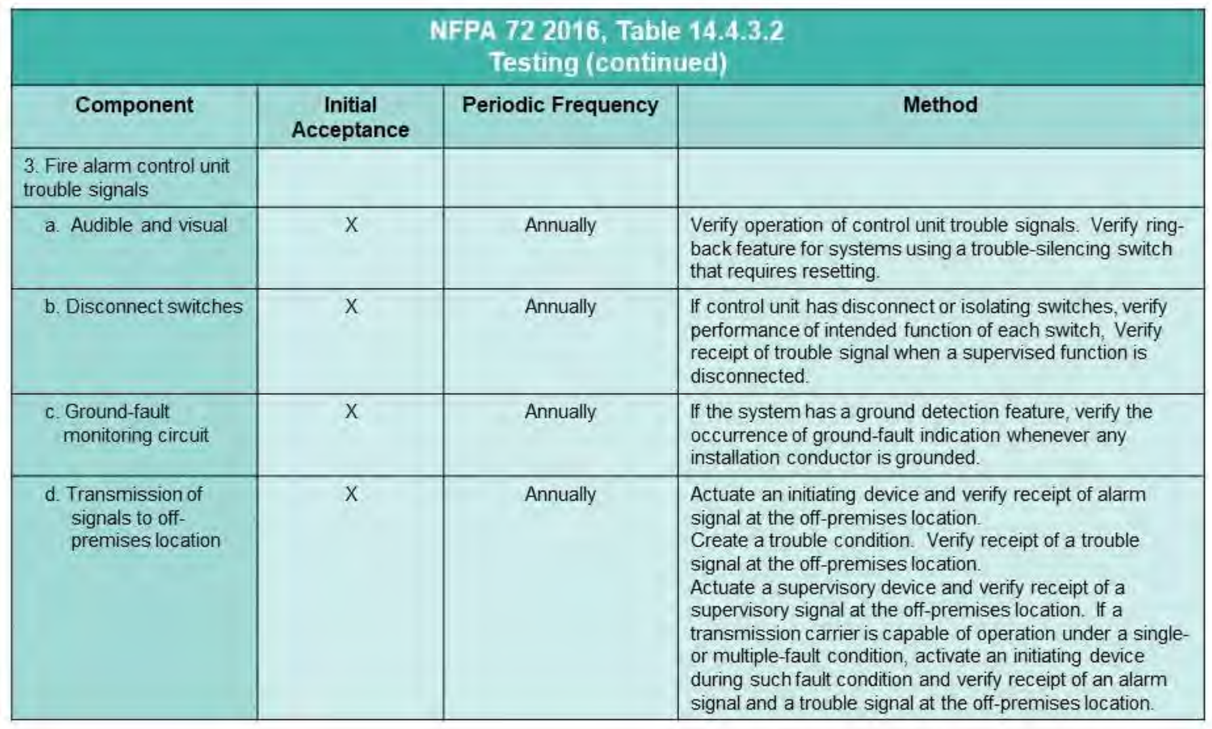
When changes or additions are made to the system, the changes must have reacceptance testing of all added devices, circuits, or control equipment per Table 14.4.3.2.

CONTINUE

Changes to all control units connected or controlled by the system executive software shall require a 10% functional test of the system. This includes a test of at least one device on each input and output circuit to verify critical system functions, such as notification appliances, control functions, and off-premises reporting.

A revised record of completion must be prepared to reflect all changes.

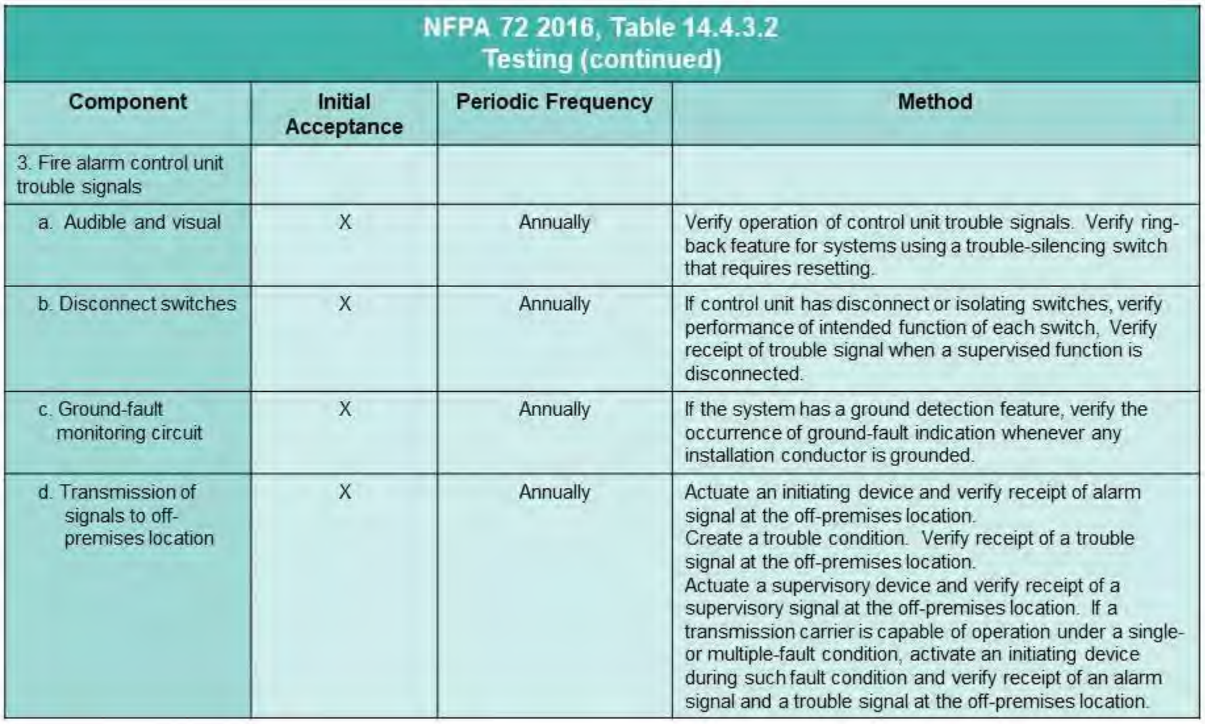
Table 14.4.3.2 provides information on how to test equipment and components. Portions of Table 14.4.3.2 are shown below



NFPA 72 2016, Table 14.4.3.2
Testing (continued)

Component	Initial Acceptance	Periodic Frequency	Method
3. Fire alarm control unit trouble signals			
a. Audible and visual	X	Annually	Verify operation of control unit trouble signals. Verify ring-back feature for systems using a trouble-silencing switch that requires resetting.
b. Disconnect switches	X	Annually	If control unit has disconnect or isolating switches, verify performance of intended function of each switch, Verify receipt of trouble signal when a supervised function is disconnected.
c. Ground-fault monitoring circuit	X	Annually	If the system has a ground detection feature, verify the occurrence of ground-fault indication whenever any installation conductor is grounded.
d. Transmission of signals to off-premises location	X	Annually	Actuate an initiating device and verify receipt of alarm signal at the off-premises location. Create a trouble condition. Verify receipt of a trouble signal at the off-premises location. Actuate a supervisory device and verify receipt of a supervisory signal at the off-premises location. If a transmission carrier is capable of operation under a single- or multiple-fault condition, activate an initiating device during such fault condition and verify receipt of an alarm signal and a trouble signal at the off-premises location.

***NFPA* 72 2016, Page 84**



NFPA 72 2016, Table 14.4.3.2
Testing (continued)

Component	Initial Acceptance	Periodic Frequency	Method
3. Fire alarm control unit trouble signals			
a. Audible and visual	X	Annually	Verify operation of control unit trouble signals. Verify ring-back feature for systems using a trouble-silencing switch that requires resetting.
b. Disconnect switches	X	Annually	If control unit has disconnect or isolating switches, verify performance of intended function of each switch. Verify receipt of trouble signal when a supervised function is disconnected.
c. Ground-fault monitoring circuit	X	Annually	If the system has a ground detection feature, verify the occurrence of ground-fault indication whenever any installation conductor is grounded.
d. Transmission of signals to off-premises location	X	Annually	Actuate an initiating device and verify receipt of alarm signal at the off-premises location. Create a trouble condition. Verify receipt of a trouble signal at the off-premises location. Actuate a supervisory device and verify receipt of a supervisory signal at the off-premises location. If a transmission carrier is capable of operation under a single- or multiple-fault condition, activate an initiating device during such fault condition and verify receipt of an alarm signal and a trouble signal at the off-premises location.

***NFPA* 72 2016, Page 84**

CONTINUE

Let's do a quick check about what has been covered so far.

All new systems shall have an initial acceptance test. Who should be notified prior to the initial acceptance test?

○ Property owner

○ Occupant

○ AHJ

SUBMIT

Changes to all control units connected or controlled by the system executive software shall require what percentage of a functional test of the system?

○ 10%

○ 20%

○ 30%

SUBMIT

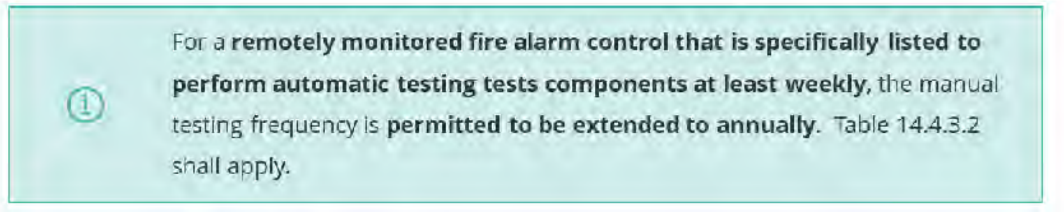
Complete the knowledge check above before moving on.

Testing Frequency

NFPA 72 2016, Section 14.4.4

In this section you will find the testing time interval requirements for various components and systems.

Devices that **cannot be tested per the frequencies of Table 14.4.3.2** due to safety concerns can be inspected at **scheduled shutdown periods if approved by the AHJ**, but the **extended period cannot exceed 18 months**.



For a **remotely monitored fire alarm control that is specifically listed to perform automatic testing tests components at least weekly**, the manual testing frequency is **permitted to be extended to annually**. Table 14.4.3.2 shall apply.

In other than one- and two-family dwelling units, smoke detector and smoke alarm sensitivity testing shall be accomplished as follows:

- Sensitivity testing shall be checked within 1 year after installation.

- Sensitivity testing shall be accomplished every other year thereafter.
- After the second sensitivity test, if the smoke detector or smoke alarm is still within its listed sensitivity range, the tests may be extended to 5 years.

If tests are extended to 5 years, records of nuisance alarms shall be maintained. The records are needed to see if trends exist. If there is a trend of nuisance alarms over a previous year, calibration (sensitivity) tests are required.

CONTINUE

Smoke detector sensitivity testing shall be performed by using any of the following methods:

1. Calibrated test method
2. Manufacturer’s calibrated sensitivity test instrument
3. Listed control equipment arranged for this purpose
4. Smoke detector/fire alarm control unit arrangement whereby the detector causes a signal at the fire alarm control unit where its sensitivity is outside its listed sensitivity range

5 Other calibrated sensitivity test methods approved by the AHJ

CONTINUE

Smoke detectors or smoke alarms **sensitivity shall not be tested or measured using any device that administers an unmeasured concentration of smoke or aerosol** into the smoke detector or smoke alarm.

Test frequencies for interfaced equipment shall be the same as specified by the NFPA standard for the supervised equipment.

Two or more restorable fixed-temperature heat detectors are required to be tested on each circuit annually. Different detectors are to be tested each year. All detectors shall be tested within a 5-year period.

Records must be kept identifying which detectors have been tested.

CONTINUE

Let's do a quick check about what has been covered so far.

In other than one- and two-family dwellings, smoke detector and smoke alarm sensitivity testing shall be accomplished as follows:

Sensitivity testing shall be checked	within 1 year after installation
Sensitivity testing shall be accomplished	every other year thereafter
It is still within its listed sensitivity range	tests may be extended to 5 years

SUBMIT

Smoke detector sensitivity testing shall be performed by using any of the following methods: (Select all that apply)

☐ Administer an unmeasured concentration of smoke or aerosol into the smoke detector or smoke alarm

☐ Listed control equipment arranged for this purpose

☐ Calibrated test method

☐ Manufacturer's calibrated sensitivity test instrument

SUBMIT

How many restorable fixed-temperature heat detectors are required to be tested on each circuit annually?

○ One or more

○ Two or more

○ Three or more

SUBMIT

Complete the knowledge check above before moving on.

Single and Multiple Station Fire Alarms

NFPA 72 2016, Section 14.4.5

The responsibility for inspection, testing, and maintenance of smoke alarms and connected appliances shall be in accordance with **Section 14.2.3**.

Smoke alarms and all interconnected appliances shall be inspected and tested in accordance with the manufacturer's published instructions monthly.

Smoke alarms shall be replaced when they fail to respond to operability tests.

Smoke alarms shall not remain in service longer than 10 years from the date-of-manufacture, *unless* otherwise provided by the manufacturer’s published instructions.

Combination smoke/carbon monoxide alarms shall be replaced when the end-of-life signal activates or 10 years from the date-of-manufacture, whichever comes first, unless otherwise provided by the manufacturer's published instructions.

HOUSEHOLD FIRE ALARM SYSTEMS

Household Fire Alarm Systems

NFPA 72 2016, Section 14.4.6

The installing contractor must provide testing information to the owner.

If the household system is monitored by an offsite monitoring company, the supervising station contractor must provide notice of inspection and testing information to the owner on an annual basis.

Maintenance of household fire alarm systems will be in accordance with the manufacturer's published instructions.

ⓘ **Household fire alarm systems shall be tested by a qualified technician (see Section 10.5.3.3) at least annually according to the methods of Table 14.4.3.2.**

CONTINUE

Let's do a quick check about what has been covered so far.

How often should smoke alarms and all interconnected appliances be inspected and tested in accordance with the manufacturer's published instructions?

○ Monthly

○ Every six months

○ Yearly

SUBMIT

Smoke alarms shall not remain in service longer than ______ from the date-of-manufacture, unless otherwise provided by the manufacturer’s published instructions.

○ 1 year

○ 5 years

○ 10 years

SUBMIT

If the household system is monitored by an offsite monitoring company, how often must the supervising station contractor provide notice of inspection and testing information to the owner?

○ Monthly

○ Every six months

○ Yearly

SUBMIT

Complete the knowledge check above before moving on.

In-Building Emergency Radio Communication Systems

NFPA 72 2016, Section 14.4.9

In-building emergency radio communication systems shall be inspected and operationally tested in accordance with the requirements of ***NFPA* 1221**.

VOICE INTELLIGIBILITY

Voice Intelligibility

NFPA 72 2016, Section 14.4.10

Voice communication using prerecorded messages and manual voice announcements shall be **verified as being intelligible** in accordance with the requirements of **Section 18.4.10**.

Intelligibility shall not be required to be determined through quantitative measurements. Quantitative measurements as described in **Annex D** shall be permitted, but are not required.

CONTINUE TO NEXT LESSON: MAINTENANCE AND RECORD KEEPING

Lesson 3 of 3

Maintenance and Record Keeping

How long should maintenance, inspection, and testing records be maintained?

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Identify all inspection, testing, and maintenance information required to be recorded, filed, and distributed

2 Distinguish ITM record retention requirements for different types of fire alarm system components

MAINTENANCE

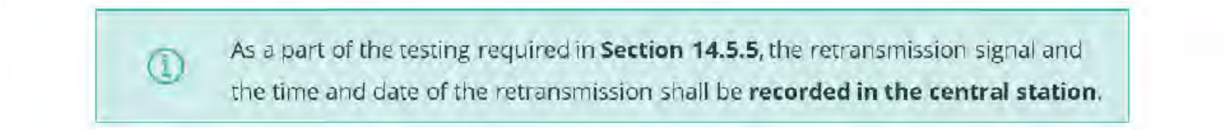
Maintenance

NFPA 72 2016, Section 14.5

The frequency of cleaning system equipment shall depend on the type of equipment and the local ambient conditions.

All apparatus requiring rewinding or resetting to maintain normal operation shall be rewound or reset as promptly as possible after each test and alarm.

ⓘ Unless otherwise permitted by **Section 14.5.6**, the retransmission means as defined in **Section 26.3** (for supervising stations) **shall be tested at intervals of not more than 12 hours**. When the retransmission means is the public-switched telephone network, testing shall be permitted at weekly intervals to confirm its operation to each communications center.



As a part of the testing required in **Section 14.5.5**, the retransmission signal and the time and date of the retransmission shall be **recorded in the central station.**

RECORDS

Records

NFPA 72 2016, Section 14.6

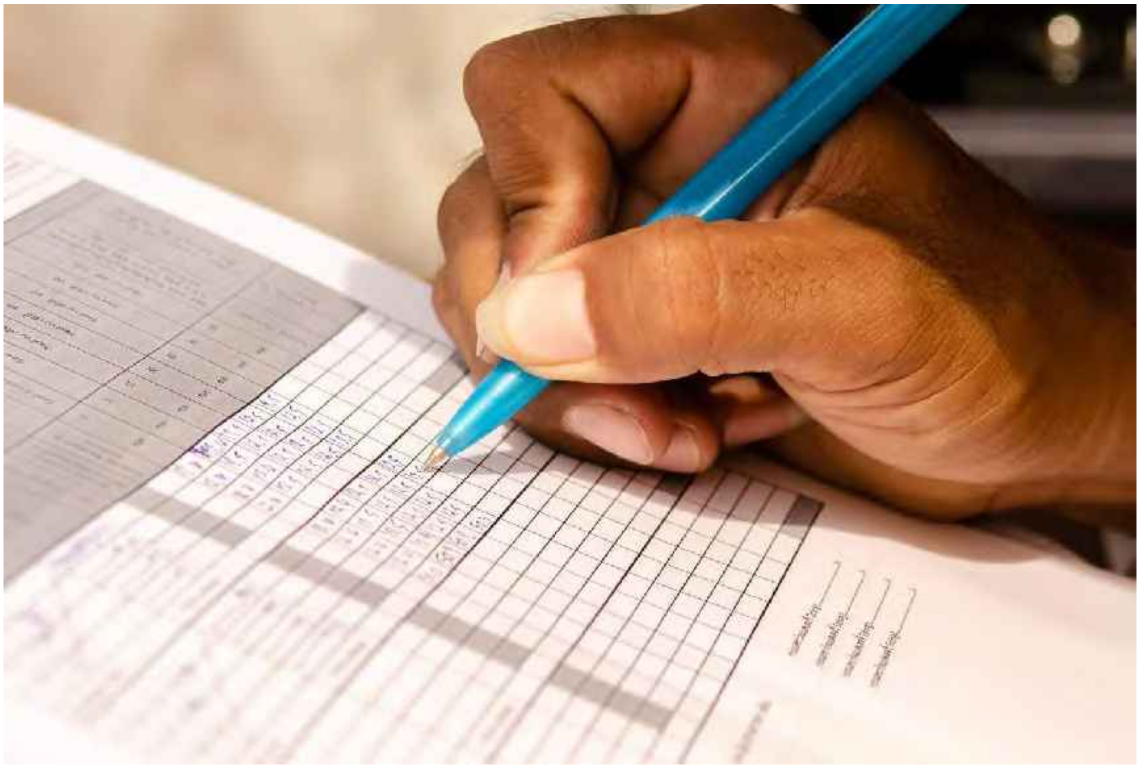
Section 7.8.2 provides sample "Inspection and Testing Forms." If you haven't already done so, **you should review this section**. It identifies all of the information which has to be permanently recorded, filed, and distributed to the appropriate persons.

NFPA 72 2016, Section 14.6

The following are record keeping requirements for ***NFPA* 72 2016, Section 14.6**

Requirement 1

The records must be permanent.



Requirement 2

The owner shall be required to keep all permanent records on paper or electronic media for the life of the system.

Requirement 3

Permanent records include as-built drawings, system operation and maintenance manuals, written sequence of operation, and inspection and testing documentation.

Requirement 4

A copy of site-specific software shall be kept in a non-erasable format, such as a CD-ROM.

Requirement 5

The owner is responsible for maintaining the records for the life of the system.

MAINTENANCE, INSPECTION, AND TESTING RECORDS

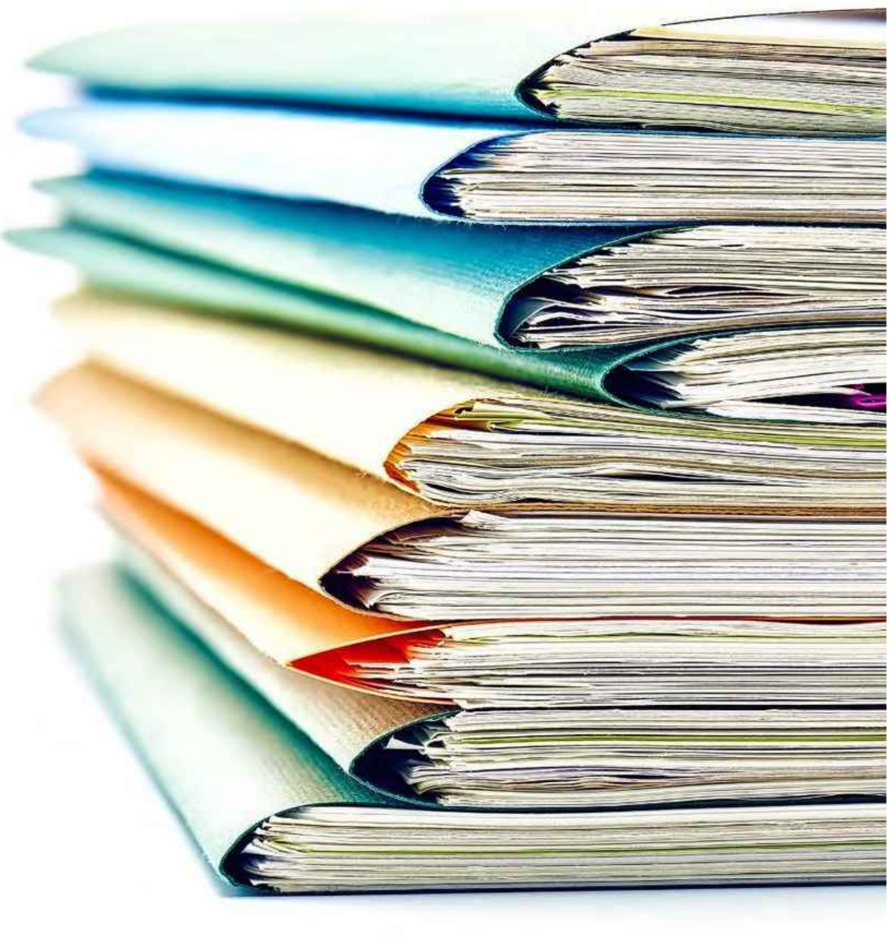
Inspection and Testing

NFPA 72 2016, Section 14.6.2

Maintenance, inspection, and testing records shall be **maintained for one year after the next test**.

Records for **testing of spot-type heat detectors** shall be **kept for five years and for one year thereafter**.

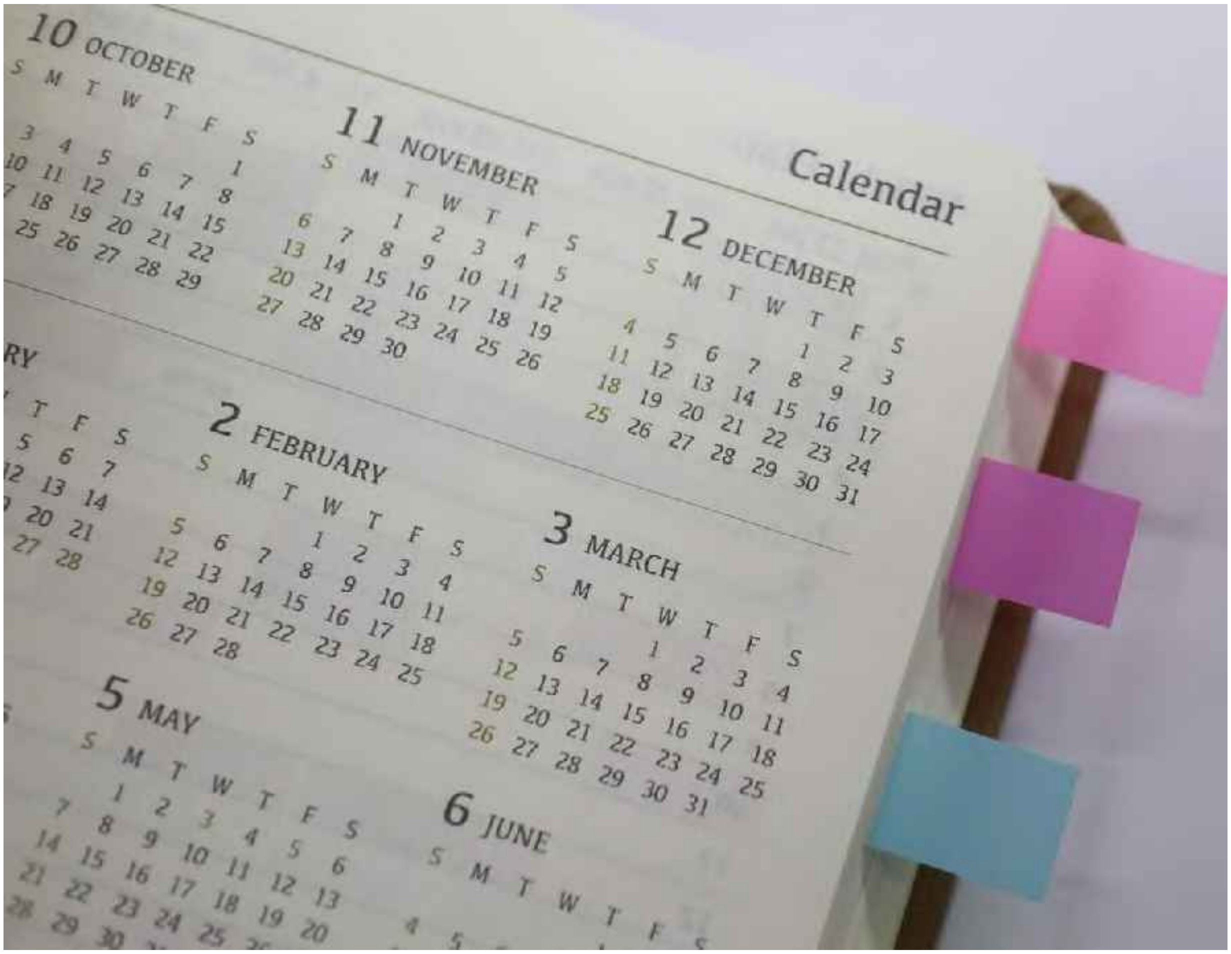
The records shall be on a medium that will survive the retention period. **Paper or electronic media shall be permitted**.



SUPERVISING STATION RECORDS

Supervising Station Records

NFPA 72 2016, Section 14.6.3



For supervising station alarm systems, records pertaining to signals received at the supervising station that result from maintenance, inspection, and testing shall be **maintained for not less than 12 months.**

Records must be stored on a medium that will survive the retention period.

CONTINUE

Let's do a quick check about what has been covered so far.

The frequency of cleaning system equipment shall depend on ___ (Select all that apply)

☐ the type of equipment

☐ the local ambient conditions

☐ the building owner

☐ the condition of the equipment

SUBMIT

Match the following testing frequency rules for *NFPA* 72 2016, Section 14.6.2**.**

Maintenance, inspection, and testing records shall be maintained for	one year after the next test
Records for testing of spot-type heat detectors shall be kept for	five years and for one year thereafter
Supervising station alarm systems & records pertaining to signals received are kept for	not less than 12 months.

SUBMIT

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Complete the knowledge check above before moving on.

Simulated Operation Note

NFPA 72 2016, Section 14.6.4

If the operation of a device, circuit, fire alarm control unit function, or special hazard system interface is simulated, it shall be noted on the inspection/test form that the operation was simulated.

DO NOT REMOVE BY ORDER OF THE
STATE FIRE MARSHAL (OFC 901.7)

– FIRE ALARM SYSTEM IS IMPAIRED –
DOESN'T MEET STATE STANDARDS

Harbor Security
678 Main Street
Milion, OH 44089
800-555-5535 LIC #55-22-1021

(Date) (Technician signature) (Technician Lic. No.)

List Impairment(s):

DO NOT REMOVE BY ORDER OF THE
STATE FIRE MARSHAL (OFC 901.7)

— FIRE ALARM SYSTEM IS —
OUT OF SERVICE

Harbor Security
678 Main Street
Milion, OH 44089
800-555-5535 LIC #55-22-1021

(Date) (Technician signature) (Technician Lic. No.)

List Conditions:

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OHIO FIRE CODE SECTION 901.6.2

Ohio Fire Code Section 901.6.2

DO NOT REMOVE BY ORDER OF THE
STATE FIRE MARSHAL (OFC 901.6.2)

FIRE ALARM SYSTEM
SERVICE RECORD

Harbor Security
678 Main Street
Milion, OH 44089
800-555-5155 LIC.#55-22-1021

(Date) (Technician signature) (Technician Lic. No.)

List Services/Repairs

DO NOT REMOVE BY ORDER OF THE
STATE FIRE MARSHAL (OFC 901.6.2)

FIRE ALARM SYSTEM
SERVICE RECORD

Harbor Security
678 Main Street
Milion, OH 44089
800-555-5155 LIC.#55-22-1021

(Date) (Technician signature) (Technician Lic. No.)

List Services/Repairs

Ohio Fire Code Section 901.6.2 requires all records for inspections tests, and maintenance to be retained.

Acceptance testing records are required to be maintained for the life of the system.

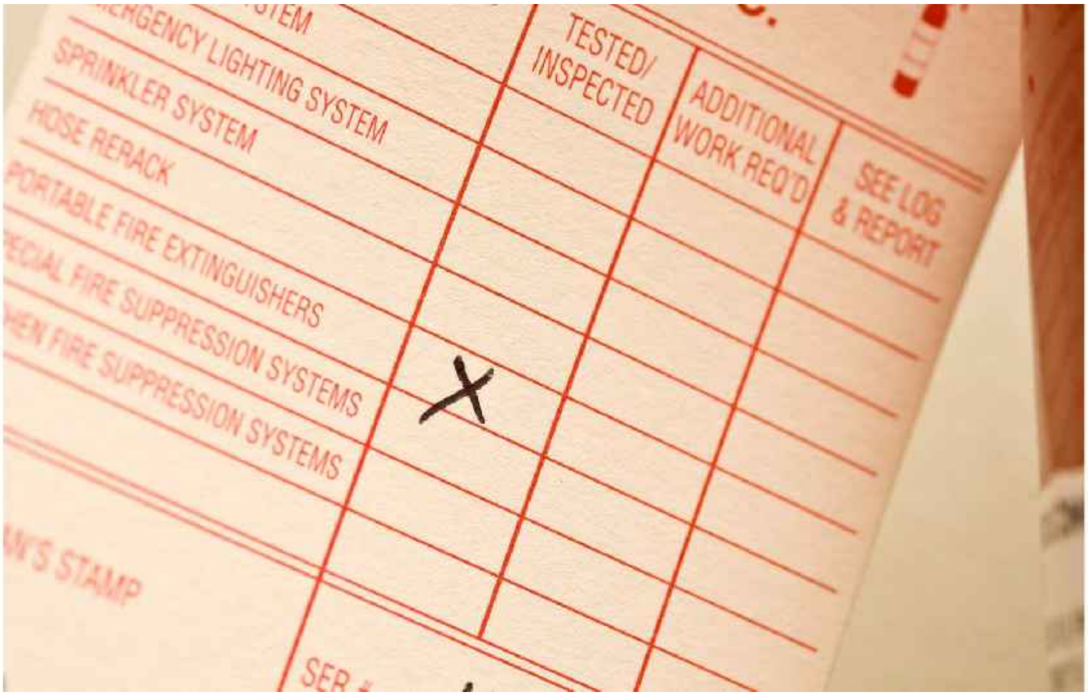
An inspection tag is to be placed on or near the fire alarm control panel or other location as determined by the fire code official. The tag must have the following information:

- The individual performing the work and the individual’s state fire marshal certification number
- Date of the test

- Results of the inspection and test
- Deficiencies or impairments noted “yes/no”

Ohio Fire Code requires a tag to indicate a system or portion of a system has been removed from service or is defective.

The fire official shall specify where the tag is to be placed.



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CONTINUE

Let's do a quick check about what has been covered so far.

An inspection tag is to be placed on or near the fire alarm control panel or other location as determined by the fire code official. The tag must have the following information:

☐ Address of the location

☐ Date of the test

☐ Results of the inspection and test

☐ Deficiencies or impairments noted “yes/no”

SUBMIT

Ohio fire Code Section 901.6.2 requires all acceptance testing records be kept for _____.

○ One year

○ A minimum of three years

○ Until the manufacturer's warranty ends

○ The life of the system

SUBMIT

Complete the knowledge check above before moving on.

This completes the Inspection, Testing, and Maintenance module.

NFPA 72 2016, Chapter 14 provides good information on how to inspect and test fire alarm systems, but ***don't forget to follow the manufacturer's published instructions***.

There are many more requirements than we have the time to review in this module. **Take time to familiarize yourself with Chapter 14**.

Inspecting, testing, and maintaining fire alarm systems is of the utmost importance.

By **ensuring these systems are always operational**, we **significantly reduce the chance someone may be injured or killed in a fire**.

Remember that Chapter 14 does occasionally refer you to other chapters of the code.

CONTINUE

After completing this module, you should now have a better understanding of the inspection frequency, testing, maintenance and record keeping of fire alarm systems.

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.

Ohio Fire Alarm and Detection Equipment- Emergency Control Functions and Interfaces

FIRE TECH
PRODUCTIONS

Welcome to the Emergency Control Functions and Interfaces module of the Ohio Fire Alarm and Detection Systems Course.

By the end of this module, you will be able to do the following:

- Identify different types of emergency control functions
- Determine distances permitted between components controlling the emergency control functions
- Define interconnection methods between a fire alarm system and the controlled system
- Identify smoke detector location and mounting requirements when used for elevator recall purposes
- Determine the purpose and functionality of elevator control circuits connected to smoke detectors
- Be aware of the limitations placed on heat detectors when used in elevator shut down applications

- Identify the *NFPA* 72 2016 requirements for emergency control functions for HVAC systems
- Identify the *NFPA* 72 2016 requirements for emergency control functions for door and shutter release systems

Key Reference for this module:

- *NFPA* 72 – The National Fire Alarm and Signaling Code, Chapter 21, 2016

When you are ready to begin, click on the button above to start the course.

☰ **General Information**

☰ **Elevator Recall for Firefighters' Service**

☰ **HVAC Systems and Door & Shutter Release**

Lesson 1 of 3

General Information

The performance of automatic emergency control functions must not interfere with power for lighting or for operating elevators.

Goals of this Module:

By the end of this lesson, you will be able to do the following:

1. Identify different types of emergency control functions

2. Determine distances permitted between components controlling the emergency control functions
3. Define interconnection methods between a fire alarm system and the controlled system

LET'S GET STARTED

Emergency control functions are intended to increase the level of life safety for occupants or to control the spread of the harmful effects of fire. These functions include, but are not limited to:

1. Elevator recall
2. The closing of smoke dampers and fire doors
3. The shutdown of air-handling equipment such as fans and heating, ventilation, and air conditioning systems

These functions can be performed by the protected premises fire alarm system control unit (panel), or the function can be controlled by dedicated system initiating devices, such as smoke detectors.

GENERAL INFORMATION

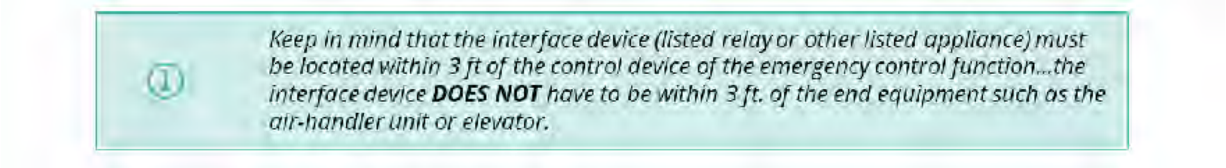
General

NFPA 72 2016, Section 21.2

Emergency control functions are permitted to be performed automatically.

The performance of automatic emergency control functions must not interfere with power for lighting or for operating elevators.

A listed relay or other listed appliance connected to the fire alarm system used to initiate control of the protected premises emergency control functions must be located within 3 ft. of the component controlling the emergency control function.

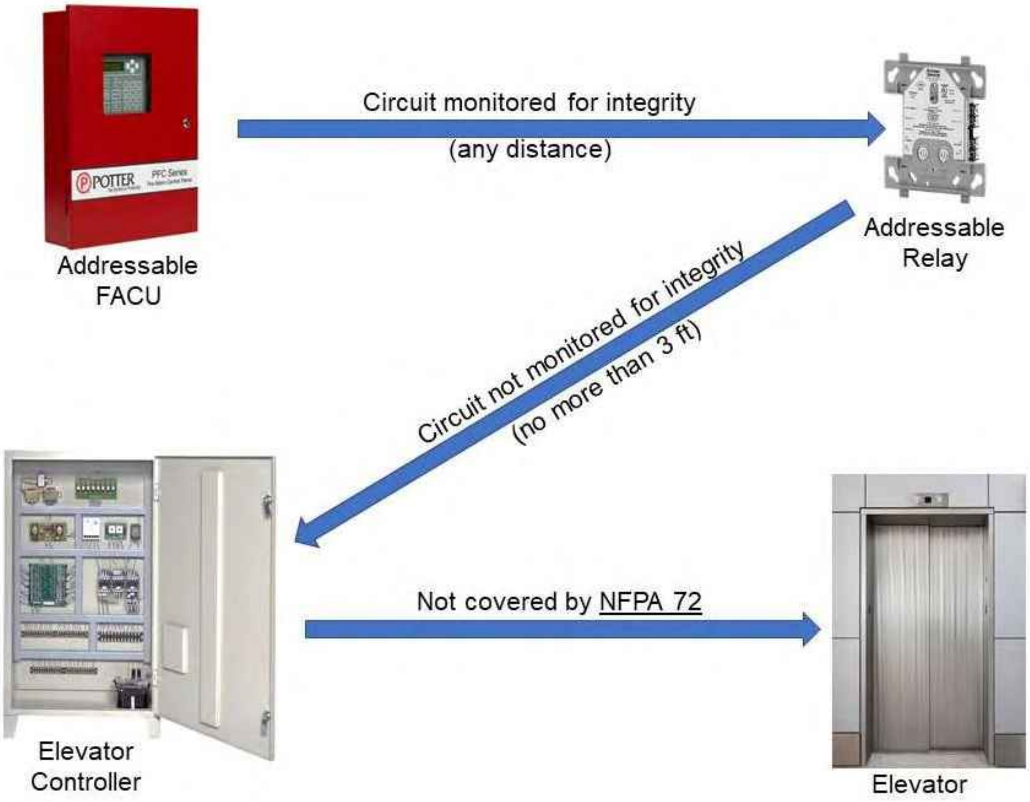


*Keep in mind that the interface device (listed relay or other listed appliance) must be located within 3 ft of the control device of the emergency control function...the interface device **DOES NOT** have to be within 3 ft. of the end equipment such as the air-handler unit or elevator.*

CONTINUE

The method(s) of interconnection between the fire alarm system and emergency control function interface device will be monitored for integrity in accordance with **Section 12.6**.

See graphic below.



The relay or other appliance must function within the voltage and current limitations of the fire alarm control unit.

The installation wiring between the fire alarm control unit and the emergency control function interface device shall be Class A, Class B, Class D, Class N, or Class X in accordance with Chapter 12.

Emergency control functions must not interfere with other operations of the fire alarm system.

ⓘ The method(s) of **interconnection between the fire alarm system and the controlled electrical and mechanical system** *must* **comply** with the applicable provisions of ***NFPA* 70 - National Electrical Code.**

The method(s) of interconnection between the fire alarm system and the controlled electrical and mechanical system shall be achieved by one of the following:

1. Electrical contacts listed for the connected load
2. Data communications over a signaling line circuit(s) dedicated to the fire alarm or shared with other premises operating systems
3. Other listed methods

If a fire alarm system is a component of a life safety network and it communicates data to other systems providing life safety functions, or it receives data from such systems, the following shall apply:

Rule 1

The path used for communicating data shall be monitored for integrity. This includes monitoring the physical communication media and the ability to maintain intelligible communications.

Rule 2

Data received from the network shall not affect the operation of the fire alarm system in any way other than to display the status of life safety network components.

Rule 3

> Where non-fire alarm systems are interconnected to the fire alarm system using a network or other digital communication technique, a signal (e.g., heartbeat, poll, ping, query) shall be generated between the fire alarm system and the non-fire alarm system. Failure of the fire alarm system to receive confirmation of the transmission shall cause a trouble signal to indicate within 200 seconds.

CONTINUE

Let's do a quick check over what we just covered.

The installation wiring between the fire alarm control unit and the emergency control function interface device shall be which of the following classes in accordance with Chapter 12? (Select all that apply)

☐ Class A

☐ Class B

☐ Class C

☐ Class D

☐ Class N

☐ Class X

SUBMIT

The relay or other _____ must function within the voltage and current limitations of the fire alarm control unit.

Type your answer here

SUBMIT

If a fire alarm system is a component of a life safety network and it communicates data to other systems providing life safety functions, or it receives data from such systems, the following rule shall apply: Data received from the network shall not affect the operation of the fire alarm system in any way other than to display the status of life safety network components. Which of the three rules is this?

○ Rule 1

○ Rule 2

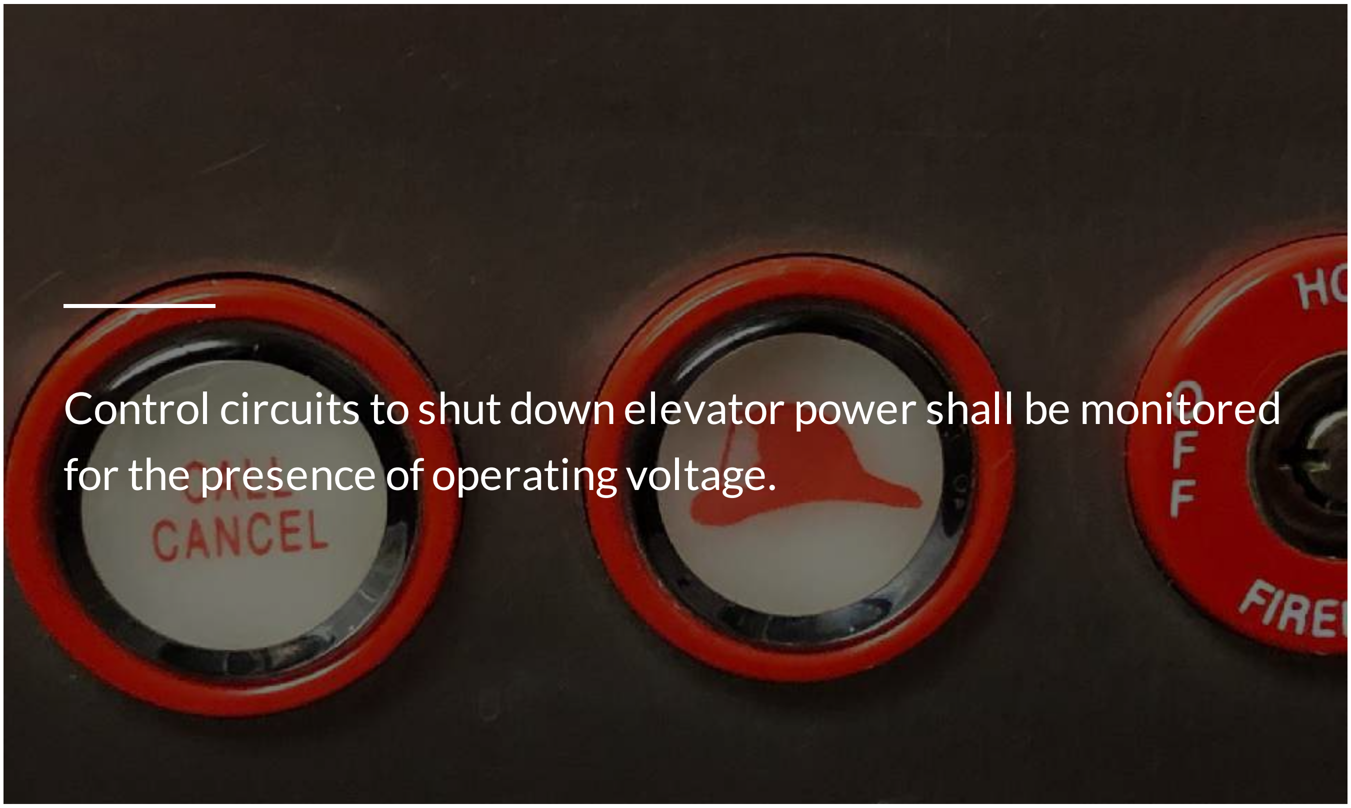
○ Rule 3

SUBMIT

Complete the knowledge check above before moving on.

Lesson 2 of 3

Elevator Recall for Firefighters' Service



Control circuits to shut down elevator power shall be monitored for the presence of operating voltage.

Goals for this Lesson:

By the end of this lesson, you will be able to do the following:

1. Identify smoke detector location and mounting requirements when used for elevator recall purposes

2. Determine the purpose and functionality of elevator control circuits connected to smoke detectors
3. Be aware of the limitations placed on heat detectors when used in elevator shut down applications

CONTINUE

The requirement to install alarm-initiating devices for elevator recall comes from ANSI/ASME A17.1a/CSA B44a, Safety Code for Elevators and Escalators.

Elevator recall is used to take the elevator to a designated level when specific fire detection sensors activate. This allows for safe exit by passengers and use of the elevator for fire fighters.

For fire alarm systems and/or emergency control function circuits that control elevators, there are specific requirements that must be adhered to for the safety of occupants and fire fighters.

ELEVATOR RECALL FOR FIREFIGHTERS' SERVICE

Elevator Recall for Firefighters' Service

NFPA 72 2016, Section 21.3

Initiating devices used to initiate fire fighter's service (elevator) recall must be connected to the building fire alarm system.

In facilities without a building fire alarm system, initiating devices used to initiate fire fighters' service recall shall be connected to a dedicated function fire alarm control unit that shall be designated as "elevator recall control and supervisory control unit," permanently identified on the dedicated function fire alarm control unit and on the record drawings.

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CONTINUE

Unless otherwise required by the Authority Having Jurisdiction (AHJ), only the elevator lobby, elevator hoistway, elevator machine room, elevator control room, and elevator control space smoke detectors, or other automatic fire detection as permitted by **Section 21.3.9**, shall be used to recall elevators for fire fighters' service.

> *A waterflow switch shall be permitted to initiate elevator Phase I Emergency Recall Operation upon activation of a sprinkler installed at the bottom of the elevator hoistway (the elevator pit), provided the waterflow switch and pit sprinkler are installed on a separately valved sprinkler line dedicated solely for protecting the elevator pit, and the waterflow switch is provided without time-delay capability.*

CONTINUE

These detectors must be able to perform the recall function when all other devices on the same initiating circuit have been manually or automatically placed in alarm. Detectors are typically four-wire devices to ensure power is always available during an alarm.

A lobby smoke detector must be located on the ceiling within 21 ft of the centerline of each elevator door within the elevator bank under control of the detector.

ⓘ **Exception:** For **lobby ceiling configurations exceeding 15 ft in height** or that are **other than flat and smooth**, detector **locations shall be determined in accordance with Chapter 17**.

CONTINUE

Smoke detectors cannot be installed in unsprinklered elevator hoistways *unless* **they are installed to activate elevator hoistway smoke control equipment or to initiate Phase I recall.**

If ambient conditions do not allow the use of smoke detectors, other automatic fire detectors may be used.

The detector, when actuated, must initiate an alarm condition on the building fire alarm system and must visibly annunciate the circuit or zone from which the alarm originated.

With the **permission of the AHJ**, the hoistway and machine room detectors **need only initiate a supervisory signal** *instead* of an **alarm signal**.

ⓘ Activation of the smoke detector(s) or other automatic fire detectors for the elevator hoistway, elevator machine room, elevator machinery space, elevator control space, or elevator control room as permitted by Section 21.3.9, shall cause separate and distinct visible annunciation at the building fire alarm control unit, or the fire alarm control unit described in Section 21.3.2.

ⓘ There must be separate outputs from the fire alarm systems to the elevator controller(s) to implement elevator Phase I Emergency Recall Operation in accordance with Section 2.27 of ANSI/ASME A17.1a/CSA B44, Safety Code for Elevators and Escalators.

CONTINUE

Let's do a quick check over what we just covered.

The detector, when actuated, must initiate an _____ condition on the building fire alarm system and must visibly annunciate the circuit or zone from which the alarm originated.

○ alarm

○ supervisory

SUBMIT

Complete the knowledge check above before moving on.

Designated Level Recall, Alternate Recall Level, Visual Warning

NFPA 72 2016, Sections 21.3.13.1, 21.3.13.2, 21.3.13.3

For each group of elevators, a minimum of three elevator control circuits must be provided to the elevator controller in the group's elevator machine room.

The smoke detectors must be connected to the control units in the following way: (Click on each tab to learn more)

SECTION 21.3.14.1 | SECTION 21.3.14.2 | SECTION 21.3.14.3

The fire detection device(s) located in the lobby of the designated level (and other areas) shall activate the first elevator control circuit sending the elevator(s) to the alternate recall level.

SECTION 21.3.14.1 | SECTION 21.3.14.2 | SECTION 21.3.14.3

The fire detection device(s) located on any other level (and the other areas) shall activate the second elevator control circuit sending the elevator(s) to the primary recall level.

SECTION 21.3.14.1

SECTION 21.3.14.2

SECTION 21.3.14.3

The third circuit is for each cab warning light. An additional circuit is required for each additional hoistway to indicate to the fire fighter the alarm signal is coming from that particular elevator machine room, elevator machinery space, elevator control space, or elevator control room, so that the elevator is not used for service.

We recommend you **review Sections 21.3.13.1, 21.3.13.2, and 21.3.13.3 repeatedly**, until you feel you are comfortable with those sections. **They can be difficult to understand.**

CONTINUE

The best way to explain it is that for **each group of elevators, a minimum of two control circuits are required** (*one* for the **designated level recall** and *one* for the **alternate level recall**) *PLUS* **one visual warning circuit for all elevator cabs**.

Example 1: There is one elevator for the building. There shall be one circuit for the designated level recall, one circuit for the alternate level recall, and one circuit for the visual warning indicator inside the elevator cab to signify the hoistway may be compromised by a fire condition (3 circuits).

2

Example 2: There are three separate elevators, hoistways, machine rooms, etc. for the building. For each elevator, there shall be one circuit for the designated level recall, one circuit for the alternate level recall, and one circuit for the visual warning indicator inside the elevator cabs to signify the elevator(s) hoistway(s) may be compromised by a fire condition (9 circuits).

ELEVATOR SHUTDOWN

Elevator Shutdown

NFPA 72 2016, Section 21.4

If heat detectors are used to shut down elevator power prior to sprinkler activation, the **heat detector must have a lower temperature rating and a higher sensitivity compared to the sprinkler.**

If heat detectors are used to shut down elevator power prior to sprinkler operation, they **shall be placed within 24 in. of each sprinkler head** and be installed in accordance with the requirements of Chapter 17.

Alternatively, engineering methods such as those specified in Annex B, shall be permitted to be used to select and place heat detectors to ensure response prior to any sprinkler head operation under a variety of fire growth rate scenarios.

CONTINUE

Let's do a quick check over what we just covered.

There is one elevator for the building. Select which of the circuits below would be used for this elevator. (Select all that apply)

- ☐ one circuit for the designated level recall
- ☐ one circuit for halting elevator cab service
- ☐ one circuit for the visual warning indicator
- ☐ one circuit for alternate level recall

SUBMIT

According to *NFPA* 72 2016, Sections 21.3.13.1, 21.3.13.2, 21.3.13.3, the smoke detectors must be connected to the control units in the following way:

SUBMIT

Complete the knowledge check above before moving on.

If **heat detectors** are used to **shut down elevator power** prior to sprinkler operation, they shall be **placed within 24 in. of each sprinkler head** and be installed in accordance with the requirements of **Chapter 17.**

If pressure or waterflow switches are used to shut down elevator power immediately upon, or prior to, the discharge of water from sprinklers, the use of devices with time-delay switches or time-delay capability is not permitted.

CONTINUE

Control circuits to shut down elevator power shall be monitored for the presence of operating voltage. Loss of voltage to the control circuit for the disconnecting means must cause a supervisory signal to be indicated at the building fire alarm control unit or at the control unit described in **Section 21.3.2.**

ⓘ The **initiating devices described in Sections 21.4.2 and 21.4.3** (for elevator power shut off and control circuits to shut down elevator power) must be **monitored for integrity** by the **fire alarm control unit**.

FIRE SERVICE ACCESS ELEVATORS

Fire Service Access Elevators

***NFPA* 72 2016, Section 21.5**

Where there are one or more elevators specifically designated and marked as fire service access elevators, the requirements of **Section 21.5.1 and 21.5.2** shall apply.

1. Status of elevator(s), including location within the hoistway, direction of travel, and whether the elevator(s) are occupied, shall be permitted to be displayed on a building fire alarm system annunciator located at the fire command center.

2. Temperature and presence of smoke in associated lobbies, machine rooms, control rooms, machinery spaces, or control spaces shall be continuously monitored and displayed on a building fire alarm system annunciator located at the fire command center.

ⓘ **The conditions shall be displayed on a standard emergency services interface complying with Section 18.11.**

OCCUPANT EVACUATION ELEVATORS

Occupant Evacuation Elevators

NFPA 72 2016, Section 21.6

Click each "**+**" below to learn more about **NFPA 72 2016, Section 21.6**

Sections 21.5 and 21.6 –

Where one or more elevators are specifically designated and marked for use by occupants for evacuation during fires, they shall comply with all of the provisions of **Sections 21.5 and 21.6.**

Sections 21.6.2.1 and 21.6.2.2 –

The outputs from the fire alarm system to the elevator controller(s) shall be provided to implement elevator occupant evacuation operation in accordance with Section 2.27 of ASME A17.1/CSA B44 (2013), Safety Code for Elevators and Escalators, as required in **Sections 21.6.2.1 and 21.6.2.2**.

Sections 21.6.2.1.1 through 21.6.2.1.4 –

Where an elevator or group of elevators is designated for use by occupants for evacuation, the provisions of **Sections 21.6.2.1.1 through 21.6.2.1.4** shall apply for partial evacuation.

- Sections 21.6.2.1.1 through 21.6.2.1.4 covers the requirements for initiation, floor identification, manual floor selection, and occupant notification.
- While we will not cover the requirements in this module, we recommend you study/review this information.

CONTINUE

Let's do a quick check over what we have covered so far.

If heat detectors are used to shut down elevator power prior to sprinkler operation, they shall be placed within ____ of each sprinkler head and be installed in accordance with the requirements of Chapter 17.

○ 12 in.

○ 24 in.

○ 12 ft.

○ 24 ft.

SUBMIT

Complete the knowledge check above before moving on.

Lesson 3 of 3

HVAC Systems and Door & Shutter Release

All detection devices used to cause the operation of HVAC systems smoke dampers, fire dampers, fan control, smoke doors, and fire doors must be monitored for integrity

Goals of this Lesson:

By the end of this lesson, you will be able to do the following:

1. Identify the *NFPA* 72 2016 requirements for emergency control functions for HVAC Systems

2 Identify the *NFPA* 72 2016 requirements for emergency control functions for Door and Shutter Release systems

HVAC SYSTEMS

Heating, Ventilating and Air-Conditioning (HVAC) Systems

NFPA 72 2016, Section 21.7

The provisions of **Section 21.7** apply to fire alarm systems with interfaces with HVAC systems.

If connected to the fire alarm system serving the protected premises, all detection devices used to cause the operation of HVAC systems smoke dampers, fire dampers, fan control, smoke doors, and fire doors must be monitored for integrity in accordance with **Section 12.6.**

Connections between fire alarm systems and the HVAC system, for the purpose of monitoring and control, shall operate and be monitored in accordance with the applicable NFPA standards.

CONTINUE

2 Identify the *NFPA* 72 2016 requirements for emergency control functions for Door and Shutter Release systems

HVAC SYSTEMS

Heating, Ventilating and Air-Conditioning (HVAC) Systems

NFPA 72 2016, Section 21.7

The provisions of **Section 21.7** apply to fire alarm systems with interfaces with HVAC systems.

If connected to the fire alarm system serving the protected premises, all detection devices used to cause the operation of HVAC systems smoke dampers, fire dampers, fan control, smoke doors, and fire doors must be monitored for integrity in accordance with **Section 12.6.**

Connections between fire alarm systems and the HVAC system, for the purpose of monitoring and control, shall operate and be monitored in accordance with the applicable NFPA standards.

CONTINUE

Smoke detectors mounted in the air ducts of HVAC systems shall initiate a supervisory signal.

Smoke detectors mounted in the air ducts of HVAC systems in a fire alarm system without a constantly attended location or supervising station shall be permitted to initiate an alarm signal.

Smoke detectors mounted in the air ducts of HVAC systems shall be permitted to initiate an alarm signal where required by other governing laws, codes, or standards.

If the fire alarm control unit actuates the HVAC system for the purpose of smoke control, the automatic alarm-initiating zones shall be coordinated with the smoke control zones they actuate.

CONTINUE

If carbon monoxide detection or a dedicated carbon monoxide system initiates a ventilation response, a smoke control response of the fire alarm system shall take precedence over the response of the carbon monoxide detectors during a fire alarm condition.

Where interconnected as a combination system, a fire fighter's smoke control station (FSCS) shall be provided so that firefighters may perform manual control over the automatic operation of the system's smoke control strategy.

Where interconnected as a combination system, the smoke control system programming shall be designed such that normal HVAC operation or changes do not prevent the intended performance of the smoke control strategy.

CONTINUE

Let's do a quick check over what we have covered so far.

Smoke detectors mounted in the air ducts of HVAC systems in a fire alarm system without a constantly attended location or supervising station shall be permitted to initiate what type of signal?

○ Supervisory

○ Alarm

SUBMIT

Complete the knowledge check above before moving on.

Door and Shutter Release

NFPA 72 2016, Section 21.8

The provisions of **Section 21.8** shall apply to the **methods of connection of door and shutter hold-open release devices** and to **integral door and shutter hold-open release, closer, and smoke detection devices**.

All detection devices used for door and shutter hold-open release service shall be monitored for integrity in accordance with **Section 12.6.**


Exception: Smoke detectors used only for door and shutter release and not for open area protection.

CONTINUE

All door and shutter hold-open release and integral door and shutter release and closure devices used for release service shall be monitored for integrity in accordance with **Section 12.6**.

Exception: Pathways installed as Class D circuits in accordance with Section 12.3.4.

Magnetic door and shutter holders that allow doors to close upon loss of operating power shall not be required to have a secondary power source.

ELECTRICALLY LOCKED DOORS

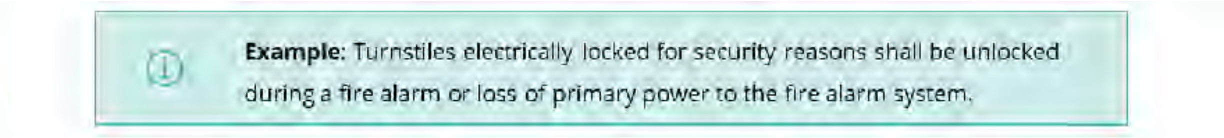
Electrically Locked Doors

NFPA 72 2016, Section 21.9

Electrically locked doors in a required means of egress shall unlock in the direction of egress where required by other laws, codes, and governing standards.

All means of egress doors are to be connected in accordance with Section 21.9.1 where secondary power supplies of fire alarm control units are used. They shall comply with Section 10.6.7.

Locks powered by independent power supplies dedicated to lock power and access control functions, and that unlock upon loss of power, are not required to comply with the statement above.

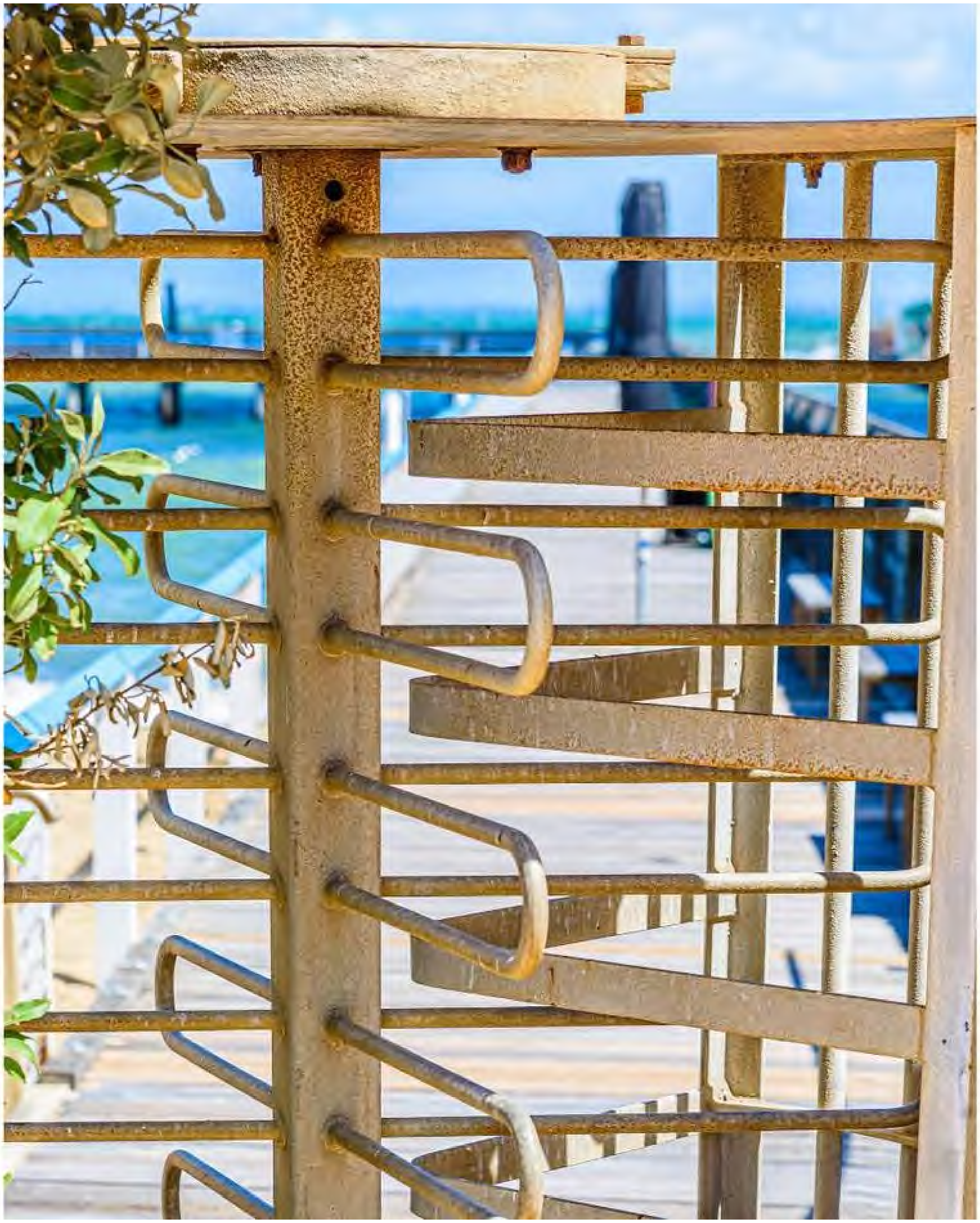


Example: Turnstiles electrically locked for security reasons shall be unlocked during a fire alarm or loss of primary power to the fire alarm system.

CONTINUE

Fire alarm control unit secondary power supplies cannot be used to maintain egress doors in the locked condition, unless the fire alarm control unit is arranged with circuitry and sufficient secondary power to ensure the egress doors will unlock within 10 minutes of loss of primary power.

If egress doors are unlocked by the fire alarm system, the unlocking function shall occur prior to, or concurrent with, activation of any public-mode notification appliances in the area(s) served by the normally locked egress doors.



All doors that are required to be unlocked by the fire alarm system must remain unlocked until the fire alarm condition is manually reset.

CONTINUE

Let's do a quick check over what we just covered.

Magnetic door and shutter holders that allow doors to close upon loss of operating power shall _____ to have a secondary power source.

○ be required

○ not be required

SUBMIT

If egress doors are unlocked by the fire alarm system, the unlocking function shall occur _______, activation of any public-mode notification appliances in the area(s) served by the normally locked egress doors. (Select all that apply)

☐ prior to

☐ concurrent with

☐ post alarm

SUBMIT

Complete the knowledge check above before moving on.

This completes the Emergency Control Functions and Interfaces module.

Chapter 21 is not a large chapter, but it does have information that may have to be reviewed quite a few times to ensure you become familiar with the requirements.

There will be times when Chapter 21 refers you to other chapters for monitoring of integrity requirements or annunciation requirements.

Remember, for elevator control there are specific requirements for the automatic fire detectors/circuits used for elevator recall:

- Designated level, alternate level, warning indicator
- Lobby smoke detectors
- Hoistway heat detectors when sprinklers are present

CONTINUE

After completing this module, you should now have a better understanding of the different types of emergency control functions related to elevator controls and door releases.

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.

Ohio Fire Alarm and Detection Equipment - Ohio Building Code & Ohio Fire Code

FIRE TECH
PRODUCTIONS

Welcome to the Ohio Building Code and Ohio Fire Code module of the Ohio Fire Alarm and Detection Systems Course.

When you are ready to get started, click on the "**Begin**" button.

This module will provide information on SOME of the Ohio Building Code and Ohio Fire Code requirements for fire alarm systems.

You can reference the Ohio Building Code at: https://codes.iccsafe.org/content/OHBCU2017/cover

You can reference the Ohio Fire Code at: http://codes.ohio.gov/oac/1301:7-7-09.

Key References for this module:

- Ohio Building Code - Fire Protection Systems
    - https://codes.iccsafe.org/content/OHBCU2017/chapter-9-fire-protection-systems

- Ohio Fire Code – Chapter 9, Fire Protection Systems (https://codes.iccsafe.org/content/OHFCJAN2019E/ohio-administrative-code-1301-7-7-09-fire-protection-systems)

Sections 508.1, 901, 902, 903.4.1 and 904.3.5

Sections 907, 914, and 1009.6.5.1

Lesson 1 of 2

Sections 508.1, 901, 902, 903.4.1 and 904.3.5

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Gain a working knowledge of the Ohio Building Code and the Ohio Fire Alarm Code requirements for fire alarm systems.

2. Determine inspection tag information and placement.
3. Follow proper procedures for preplanned impairment programs and verify correct system restoration processes.

LET'S GET STARTED!

Many of the requirements are the same or very similar to requirements from *NFPA* 72 2016, *The National Fire Alarm and Signaling Code*, 2016 edition.

In other instances, the Ohio Codes will refer you back to *NFPA* 72 2016 for either installation requirements, or inspection and testing requirements.

Ohio Building Code

Click the button on the right to reference the fire protection systems portion of the Ohio Building Code.

OHIO BUILDING CODE

Ohio Fire Code

Click the button on the right to reference the fire protection systems portion of the Ohio Fire Code.

OHIO FIRE CODE

1301:7-7-80

Click on the button to take a look at the table that lists all of the sections that deal with fire alarm systems in the Ohio Fire Code.

CLICK HERE

The information we are looking for is on the *NFPA* table under the "Standard Reference Number" column and titled "72-16."

Per the *NFPA* table, the sections of the building code covering fire alarm systems are:

- Section 508.1
- Table 901.6.1
- Section 903.4.1
- Section 904.3.5
- Section 907
- Section 1009.6.5.1

We will **not** cover every section listed above, but will provide information so that you get a feel for what the Ohio Building Code and Ohio Fire Code entail.

OHIO FIRE CODE SECTION 508.1

Section 508 Fire Command Center provides information with regard to fire command centers, if required.

Ohio Fire Code, Section 508.1

Where Required

Where required by other paragraphs of this code and in all buildings classified as high-rise buildings by the building code as listed in rule 1301:7-7-80 of the Administrative Code, a fire command center for fire department operations shall be provided.

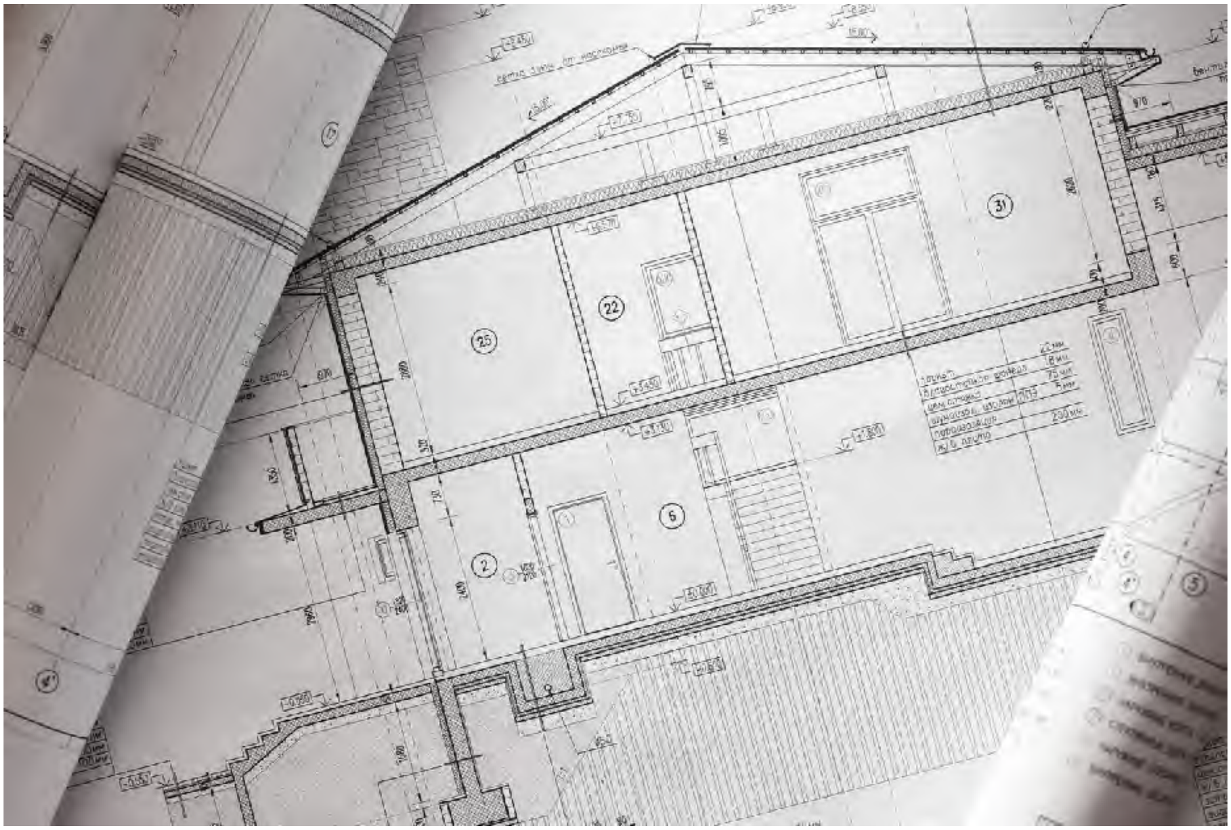
The location and access of the fire command center shall be approved by the fire code official, be separated from the remainder of the building with an approved fire barrier or horizontal assembly, and be at least 200 ft^2 in size. A layout of the fire command center and related features shall be submitted for approval prior to installation. Storage that is separate from fire command center operations is **not** permitted.

ⓘ ***NFPA* 72 2016 provides additional information for the Fire Command Center in Section A.3.3.104**

OHIO FIRE CODE SECTION 508.1.6

Ohio Fire Code, Section 508.1.6

Required Features



Some of the features the fire alarm installer may be interested in include:

- The emergency voice/alarm communication system unit
- Fire-detection and alarm system annunciator
- Schematic building plans indicating the typical floor plan and detailing among other features the fire protection systems

Section 901 General provides information with regard to all fire protection systems.

Ohio Building Code and Ohio Building Code 2017, Section 901.1

Scope

The provisions of this rule shall specify where fire protection systems are required and **shall apply to the design, installation, inspection, operation, testing and maintenance of all fire protection systems**. The requirements in this rule for fire protection systems in structures regulated by the building code as listed in **rule 1301:7-7-80** of the **Administrative Code** submitted for plan review in accordance with this paragraph are **subject to and do not supersede or otherwise conflict with the requirements of paragraph (D)(2)(a)(104.2.1) of rule 1301:7-7-01 of the Administrative Code**.

SECTION 901.4

Ohio Fire Code, Section 901.4

Installation

Fire protection systems shall be maintained in accordance with the original installation standards for that system. Required fire protection systems shall be extended, altered, or augmented as necessary to maintain and continue protection whenever the building is altered, remodeled, or added to. Alterations to fire protection systems shall be done in accordance with the building code as listed in rule 1301:7-7-80 of the Administrative Code and applicable standards.

Ohio Fire Code, Section 901.6

Inspection, Testing, and Maintenance

Fire detection, alarm, and extinguishing systems shall be maintained in an operative condition at all times, and shall be replaced or repaired where defective. Nonrequired fire protection systems and equipment shall be inspected, tested, and maintained, or removed. Any discontinuance or removal of nonrequired fire protection equipment shall be approved by the fire code official. Such approval shall be conditioned upon receipt of verification of building official determination that such fire protection equipment is nonrequired.

SECTION 901.6.1 - 901.6.2

Ohio Fire Code, Section 901.6.1

Standards

Fire protection systems shall be inspected, tested, and maintained in accordance with the referenced standards listed in Table 901.6.1 of this rule.

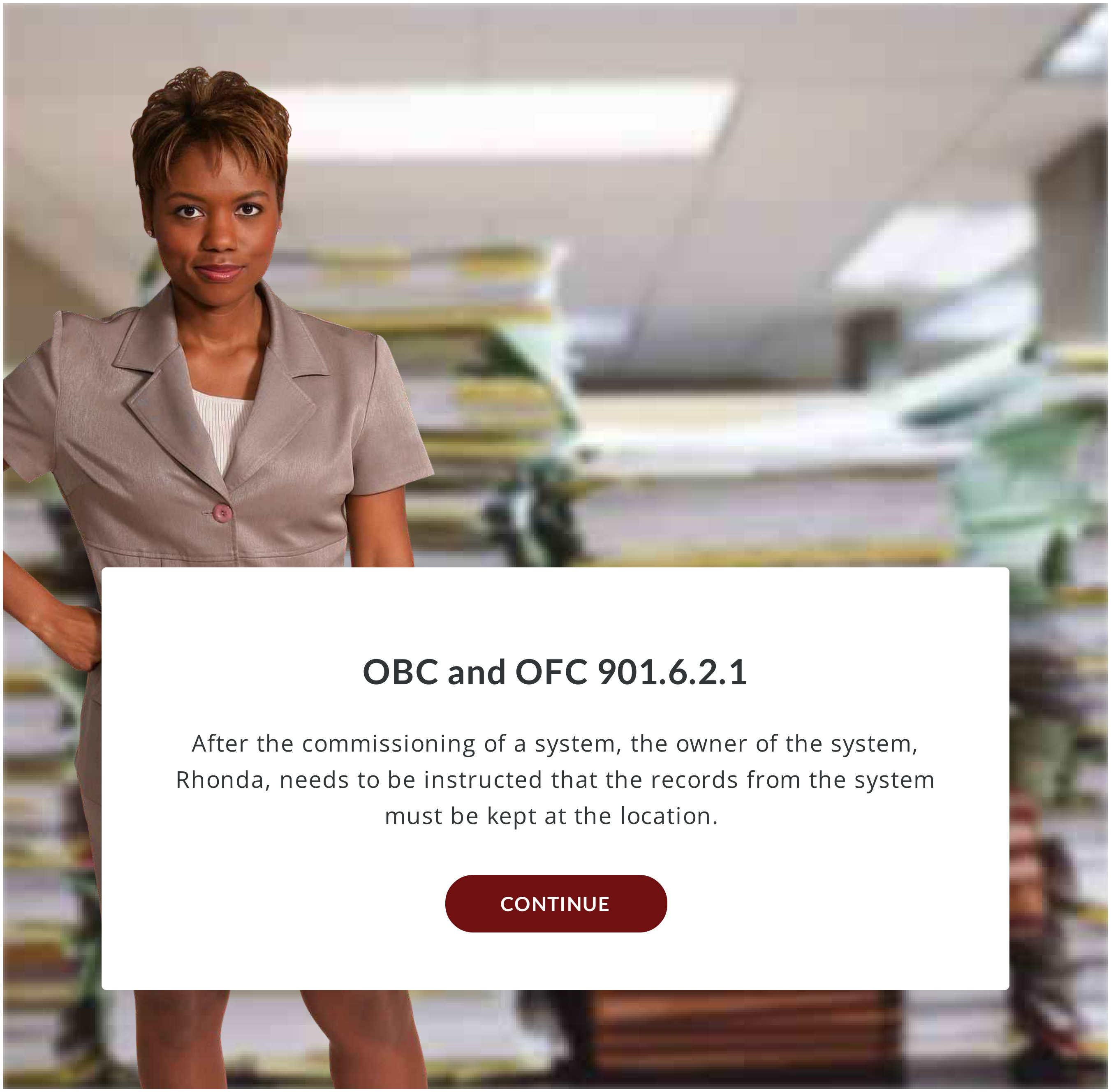
Ohio Fire Code, Section 901.6.2

Records

Records of all system inspections, tests, and maintenance required by the referenced standards shall be maintained. Find out more about the responsibility of the owner in the scenario below.

SECTION 901.6.2.1

Ohio Building Code 2017 and Ohio Fire Code 2017, Section 901.6.2.1



OBC and OFC 901.6.2.1

After the commissioning of a system, the owner of the system, Rhonda, needs to be instructed that the records from the system must be kept at the location.

Scene 1 Slide 1

Continue → Next Slide

How long must Rhonda keep the records from the system acceptance test, list of equipment by floor, make, model, and manufacturer information and instructions at the location?

1. A minimum of 1 year until the next inspection is performed
2. A minimum of 2 years or until the first smoke detector sensitivity test records are available
3. For the life of the system

Scene 1 Slide 2

0 → Next Slide

1 → Next Slide

2 → Next Slide

Records Information

Initial records shall include the name of the installation contractor, type of components installed, the manufacturer of the components, and the location and number of components installed per floor. Records shall also include the manufacturer's operation and maintenance instruction manuals, and be maintained on the premises. **Acceptance testing records (original documents) shall be retained for the life of the system**.

SECTION 901.6.3

Ohio Fire Code, Section 901.6.3

Annual Inspection Tag for Fire Protection Systems

An inspection tag shall be attached to each fire protection system near the main control valve, main panel, or other such appropriate and visible location as determined by the fire code official. The annual inspection tag shall contain the following information:

1. The individual performing the work and the state fire marshal installer certification number(s), when applicable
2. Date of test
3. Results of inspection and test
4. Deficiencies or impairments noted (yes or no)

LET'S REVIEW

Let's do a quick check about what has been covered so far.

According to Ohio Fire Code Section 508.1.6, some of the features the fire alarm installer may be interested in include: (Select all that appy)

☐ The budget for the project

☐ The emergency voice/alarm communication system unit

☐ Schematic building plans indicating the typical floor plan and detailing among other features the fire protection systems

☐ Fire-detection and alarm system annunciator

SUBMIT

According to Ohio Fire Code Section 901.6.3, an inspection tag shall be attached to each fire protection system near the main control valve, main panel, or other such appropriate and visible location as determined by the fire code official. The annual inspection tag shall contain the following information:

(Select all that apply)

☐ The individual performing the work and the state fire marshal installer certification number(s), when applicable

☐ Deficiencies or impairments noted (yes or no)

☐ Date to return for follow-up

☐ Results of inspection and test

☐ Date of test

SUBMIT

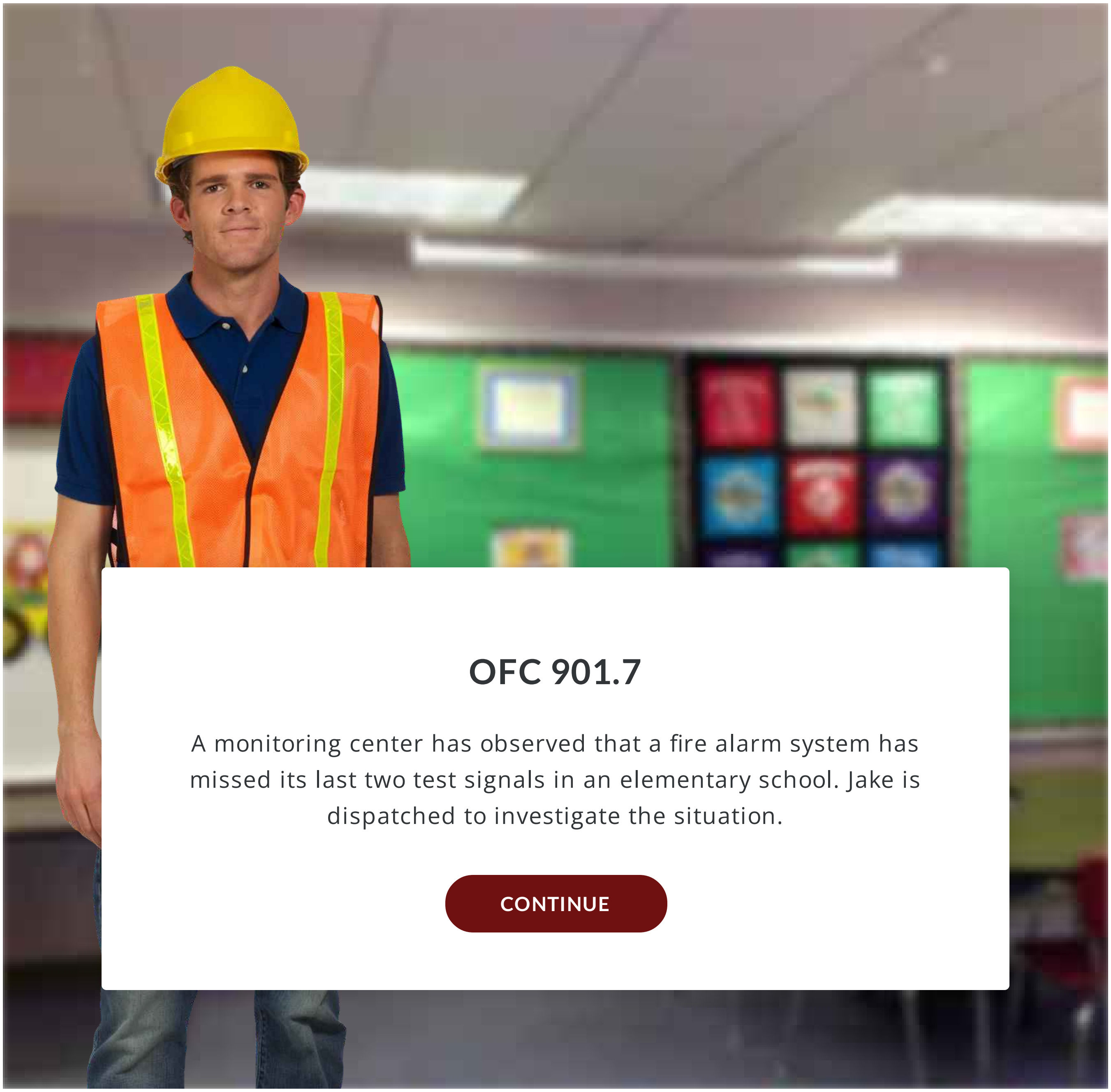
Complete the knowledge check above before moving on.

Ohio Fire Code, Section 901.7

Systems Out of Service

Where a required fire protection system is out of service, the fire department and the fire code official shall be notified immediately and, where required by the fire code official, the building shall either be evacuated or an approved fire watch shall be provided for all occupants left unprotected by the shutdown until the fire protection system has been returned to service.

Where utilized, fire watches shall be provided with at least one approved means for notification of the fire department, and their only duty shall be to perform constant patrols of the protected premises and keep watch for fires.



OFC 901.7

A monitoring center has observed that a fire alarm system has missed its last two test signals in an elementary school. Jake is dispatched to investigate the situation.

Scene 1 Slide 1

Continue → Next Slide

When he arrives, he finds that the power supply board on the main fire alarm controller is non-functional & will need to be replaced. The part is available in a warehouse that is out of town.

Scene 1 Slide 2

The part can be shipped next-day air and will be available tomorrow to be installed. What must Jake do to comply with Ohio Fire Code regulations?

1. Notify the school personnel that the part is on the way and he will have the system back in service within 24 hours.
2. Do everything in choice #1, but he must also tell school personnel that the fire official must be contacted immediately to request instructions.
3. Do everything in choice #1, but he must also tell the school personnel that a building evacuation will be required until the system can be repaired.

Scene 1 Slide 3

0 → Scene 1 Slide 1

1 → Next Slide

2 → Next Slide

Ohio Fire Code, Section 901.7.2

Tag Required

A tag shall be used to indicate that a system, or portion thereof, has been removed from service.

Ohio Fire Code, Section 901.7.3

Placement of Tag

The tag shall be posted at each fire department connection (FDC), system control valve, fire alarm control unit, fire alarm annunciator, and fire command center, indicating which system, or part thereof, has been removed from service.

The fire code official shall specify where the tag is to be placed.

Ohio Fire Code, Section 901.7.4

Preplanned Impairment Programs

Preplanned impairments shall be authorized by the impairment coordinator. Before authorization is given, a designated individual shall be responsible for verifying that all of the following procedures have been implemented:

☐ The extent and expected duration of the impairment have been determined.

☐ The areas or buildings involved have been inspected and the increased risks determined.

☐ Recommendations have been submitted to management or building owner/manager.

☐ The fire department has been notified.

☐ The insurance carrier, alarm company, building owner/manager, and other AHJs have been notified.

☐ The supervisors in the areas to be affected have been notified.

☐ A tag impairment system has been implemented.

☐ Necessary tools and materials have been assembled on the impairment site.

SECTION 901.7.5 - 901.7.6

Ohio Fire Code, Section 901.7.5

Emergency Preplanned Impairment

When unplanned impairments occur, appropriate emergency action shall be taken to minimize potential injury and damage. The impairment coordinator shall implement the steps outlined in Section 901.7.4 (Preplanned impairment programs).

Ohio Fire Code, Section 901.7.6

Restoring Systems to Service

OFC 901.7.6 (v)

The power supply board for the elementary school finally arrived and Jake just finished repairing the main fire alarm control panel's power supply.

Scene 1 Slide 1

Continue → Next Slide

After repairing the power supply of the main fire alarm control panel’s power supply which of the following is **NOT** a requirement.

1 For the record, the impairment tag needs to be kept in place but draw a red or black diagonal line across the tag to show the condition doesn't exist.

2 The impairment coordinator needs to verify that the insurance carrier for the building has been contacted to let them know the system is repaired.

3 School Personnel, the fire official, alarm company, & all other involved parties need to be notified that repairs are complete and the alarm is fixed.

Scene 1 Slide 2

0 → Next Slide
1 → Next Slide
2 → Next Slide

CONTINUE

When impaired equipment is restored to normal working order, the impairment coordinator shall verify that all of the following procedures have been implemented:

☐ Necessary inspections and tests have been conducted to verify that affected systems are operational.

☐ Supervisors have been advised that protection is restored.

☐ The fire department has been advised that protection is restored.

☐ The building owner/manager, insurance carrier, alarm company, and other involved parties have been advised that protection is restored.

☐ The impairment tag has been removed.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

According to Ohio Fire Code Section 901.7.3, A tag shall be posted at each fire department connection (FDC), system control valve, fire alarm control unit, fire alarm annunciator, and fire command center, indicating which system, or part thereof, has been removed from service. Who shall specify where the tag is to be placed?

○ The manufacturer

○ The owner of the building

○ The fire code official

○ The *Ohio Building Code,* 2017

SUBMIT

According to Ohio Fire Code Section 901.7.6, a tag shall be used to indicate that a system, or portion of a system, has been removed from service. When impaired equipment is restored to normal working order, the impairment coordinator shall verify that the following procedures have been implemented: (Select all that apply)

☐ The impairment tag has been removed.

☐ Supervisors have been advised that protection is restored.

☐ Allow employees who may have been impacted that they may return to work.

☐ The fire department has been advised that protection is restored.

SUBMIT

Complete the knowledge check above before moving on.

Ohio Fire Code, Section 901.8

Removal of or Tampering with Equipment

It shall be unlawful for any person to remove, tamper with, or otherwise disturb any fire hydrant, fire detection and alarm system, fire suppression system, or other fire appliance required by this code except for the purpose of extinguishing fire, training purposes, recharging, making necessary repairs, or when approved by the fire code official.

Ohio Fire Code, Section 901.8.1

Removal of or Tampering with Appurtenances

Locks, gates, doors, barricades, chains, enclosures, signs, tags, or seals that have been installed by or at the direction of the fire code official shall not be removed, unlocked, destroyed, tampered with, or otherwise vandalized in any manner.

SECTION 901.10

Ohio Fire Code, Section 901.10

Recall of Fire Protection Components

Any fire protection system component regulated by this code that is the subject of a voluntary or mandatory recall under federal law shall be replaced with approved, listed components in compliance with the referenced standards of this code. The fire code official shall be notified in writing by the building owner when the recalled component parts have been replaced.

ⓘ **There are other requirements in Section 901 that may apply to your particular situation. It is highly recommended that you look through Section 901 in its entirety to make sure you have all the information you may need.**

SECTION 902

Ohio Building Code 2017 and Ohio Fire Code 2017, Chapter 2

Definitions

We will not cover the definitions of Section 902.

Many are similar to the definitions you may find in *NFPA* 72 - *The National Fire Alarm and Signaling Code*.

Be aware that the definitions are there. We recommend familiarizing yourself with them.

SECTION 903.4.1

Ohio Building Code 2017 and Ohio Fire Code 2017, Section 903.4.1

Monitoring

Alarm, supervisory, and trouble signals shall be distinctly different and shall be automatically transmitted to an approved supervising station or, when approved by the building official with input from the fire official, shall sound an audible signal at a constantly attended location. At locations or in structures not regulated by the building code as listed in rule 1301:7-7-80 of the Administrative Code, the constantly attended location shall be approved by the fire code official prior to system installation.

Exceptions:

1. Underground key or hub valves in roadway boxes provided by the municipality or public utility are not required to be monitored.

2. Backflow prevention device test valves located in limited area sprinkler supply piping shall be locked in the open position. In occupancies required to be equipped with a fire alarm system, the back-flow preventer valves shall be electrically supervised by a tamper switch installed in accordance with *NFPA* 72 and separately annunciated.

SECTION 904.3.5

Ohio Building Code 2017 and Ohio Fire Code 2017, Section 904.3.5

Monitoring

Where a building fire alarm system is installed, automatic fire-extinguishing systems shall be monitored by the building fire alarm system in accordance with ***NFPA* 72.**

There are other requirements in Section 904 that may apply to your particular situation. **It is highly recommended that you look through Section 904 in its entirety to make sure you have all the information you may need.**

LET'S REVIEW

Let's do a quick check about what has been covered so far.

According to Ohio Fire Code Section 903.4.1, there are two exceptions to monitoring.

Is the following exception true or false?

Underground key or hub valves in roadway boxes provided by the municipality or public utility are required to be monitored.

○ True

○ False

SUBMIT

According to Ohio Fire Code Section 904.3.5, where a building fire alarm system is installed, automatic fire-extinguishing systems shall be monitored by the _____ in accordance with *NFPA* 72 as listed in rule 1301:7-7-80 of the Administrative Code.

○ building fire alarm system

○ authority having jurisdiction

○ supervising station

SUBMIT

Complete the knowledge check above before moving on.

Lesson 2 of 2

Sections 907, 914, and 1009.6.5.1

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Specify occupancies that require the installation of fire alarms, as well as exceptions to these requirements.

2. Determine correct placement of manual fire alarm boxes.

3. Identify acceptable sound pressure levels for audible alarm notification appliances.

4. Recognize where fire protection systems are required based on special use and occupancy details.

SECTION 907

Ohio Building Code 2017 and Ohio Fire Code 2017, Section 907

Section 907 is titled Fire Alarm and Detection Systems.

It covers the application, installation, performance, and maintenance of fire alarm systems and their components in new and existing buildings and structures.

The general information covered in this section is similar to the requirements in *NFPA* 72 and you should take the time to familiarize yourself with the requirements.

Some of the requirements include:

- Construction documents
- Shop drawings showing location of systems components, ceiling heights, equipment ratings, etc
- Listing of equipment used in fire alarm systems
- Where manual fire alarm systems or boxes (pull stations) shall be installed, in which occupancy group, and any exceptions to those rules

ⓘ **You should become familiar with the comprehensive list of requirements found in Section 907 of the Ohio Building Code and the Ohio Fire Code.**

SECTION 907.2

Ohio Building Code 2017 and Ohio Fire Code 2017, Section 907.2

Where Required - New Buildings and Structures

An approved fire alarm system installed in accordance with the provisions of this code and ***NFPA*** **72 shall be provided in new buildings and structures** and **provide occupant notification** unless other requirements are provided by another paragraph of this code.

A minimum of **one manual fire alarm box shall be provided in an approved location to initiate a fire alarm signal for fire alarm systems employing automatic fire detectors or waterflow detection devices.** Where other paragraphs of this code allow elimination of the fire alarm boxes due to sprinklers, a single fire alarm box shall be installed.

There are two exceptions to the previous requirement:

1 The manual fire alarm box is not required for fire alarm systems dedicated to elevator recall control and supervisory service.

2 The **manual fire alarm box is not required for Group R-2 occupancies unless required by the fire code official and in accordance with the building code to provide a means for fire watch personnel to initiate an alarm during a sprinkler system impairment event**. The fire code official shall provide notice to the building official when the manual fire alarm box is required. Where provided, the manual fire alarm box shall not be located in an area that is accessible to the public.

ⓘ A manual fire alarm is not required in an Educational Group occupancy with an occupant load of less than 50 persons. (Ohio Building Code 2017, Section 907.2.3(1))

SECTION 907.2.6

Ohio Building Code 2017 and Ohio Fire Code 2017, Section 907.2.6

Group I

A manual fire alarm system that activates the occupant notification system shall be installed in Group I occupancies. An **automatic smoke detection system that activates the occupant notification system shall be provided**.

Exceptions:

1. Manual fire alarm boxes in resident or patient sleeping areas in Group I - 1 and I - 2 occupancies **shall not** be required at exits if located at all nurses' control stations or other constantly attended staff locations, provided such stations are visible and continuously accessible and that travel distances required are not exceeded.

2. Occupant notification systems are **not** required to be activated where private mode signaling installed in accordance with *NFPA* 72 is approved by the fire code official.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

According to Ohio Building Code 2017, Section 907.2.3(1), a manual fire alarm is not required in an Educational Group occupancy with an occupant load of less than 50 persons.

○ True

○ False

SUBMIT

🔒 Complete the knowledge check above before moving on.

Ohio Building Code 2017 and Ohio Fire Code 2017, Section 907.2.11.3

Installation Near Cooking Appliances

Smoke alarms are not permitted in the following locations, unless this prevents placement of a smoke alarm in a location otherwise required by this Code:

- Ionization smoke alarms shall not be installed less than 20 ft. horizontally from a permanently installed cooking appliance.
- Ionization smoke alarms with an alarm-silencing switch shall not be installed less than 10 feet horizontally from a permanently installed cooking appliance.
- Photoelectric smoke alarms shall not be installed less than 6 feet horizontally from a permanently installed cooking appliance.

ⓘ **Note these important requirements above.**

Ohio Building Code 2017 and Ohio Fire Code 2017, Section 907.2.11.4

Installation Near Bathrooms

For bathrooms, smoke alarms are required to be installed no less than 3 feet horizontally from a door or opening of a bathroom that contains a bathtub or shower, unless this prevents placement of a smoke alarm required by this Code.

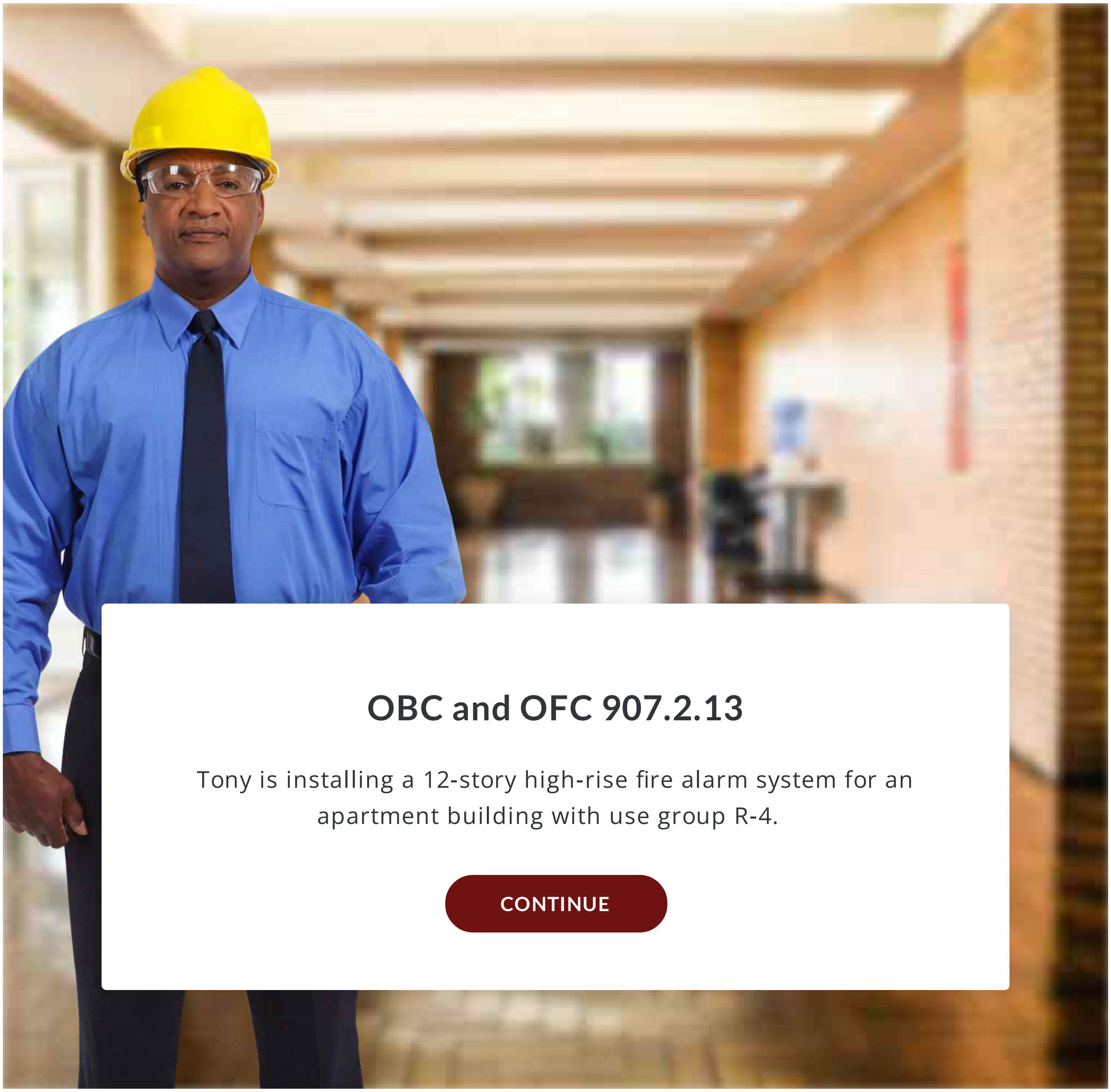
Ohio Building Code 2017 and Ohio Fire Code 2017, Section 907.2.13

High-Rise Buildings

High-rise buildings are required to be provided with an automatic smoke detection system, a fire department communication system, and an emergency voice/alarm communication system.

Note the exceptions:

- Airport traffic control towers
- Open parking garages
- Buildings with a Group A - 5 occupancy
- Low-hazard special occupancies
- Buildings with occupancies in Group H - 1, H - 2, and H - 3
- In Group I - 1 and I - 2 occupancies, the alarm is required to sound at a constantly attended location, and notification shall be broadcast by the emergency voice/alarm communication system.



OBC and OFC 907.2.13

Tony is installing a 12-story high-rise fire alarm system for an apartment building with use group R-4.

Scene 1 Slide 1

Continue → Next Slide

There is a sprinkler system providing protection throughout the building. Tony has reviewed the installation documents and made some observations. Think about what codes they align with.

Scene 1 Slide 2

There is no dedicated fire department communication system because the building has been equipped with a Bi-Direction Amplified that is monitored by the FAS insuring first-responder radio coverage.

1. Since the building is equipped with a radio coverage system, a dedicated fire department communication system would not be required.
2. Even if the building is equipped with a radio coverage system, a dedicated fire department communication system would be required.

Scene 1 Slide 3

0 → Next Slide

1 → Scene 1 Slide 1

In addition to the smoke detector over the control panels and in the electrical rooms, smoke detection is also installed in corridors, waiting areas, lobbies, and elevator machine & control rooms.

Scene 1 Slide 4

However, there is no additional smoke detection in the mechanical rooms other than duct smoke detectors.

1. Mechanical rooms are required to have smoke detection even if the entire building is fire sprinkled.
2. It is not a problem that the mechanical rooms do not have smoke detection because the entire building is fire sprinkled.

Scene 1 Slide 5

0 → Next Slide

1 → Next Slide

Each apartment unit is heated and cooled by dedicated electric HVAC units. However, the common areas and corridors are served by a central heating and cooling unit.

Scene 1 Slide 6

These units are equipped with duct smoke detection in the main return air & exhaust air plenums. Detectors are specified for installation at serviceable locations, no unit serves more than two floors.

1. Additional duct smoke detection would be required in any vertical duct or riser for each floor covered by the HVAC system.
2. Since no HVAC system serves more than two floors, additional duct smoke detection would not be required in any vertical duct or riser.

Scene 1 Slide 7

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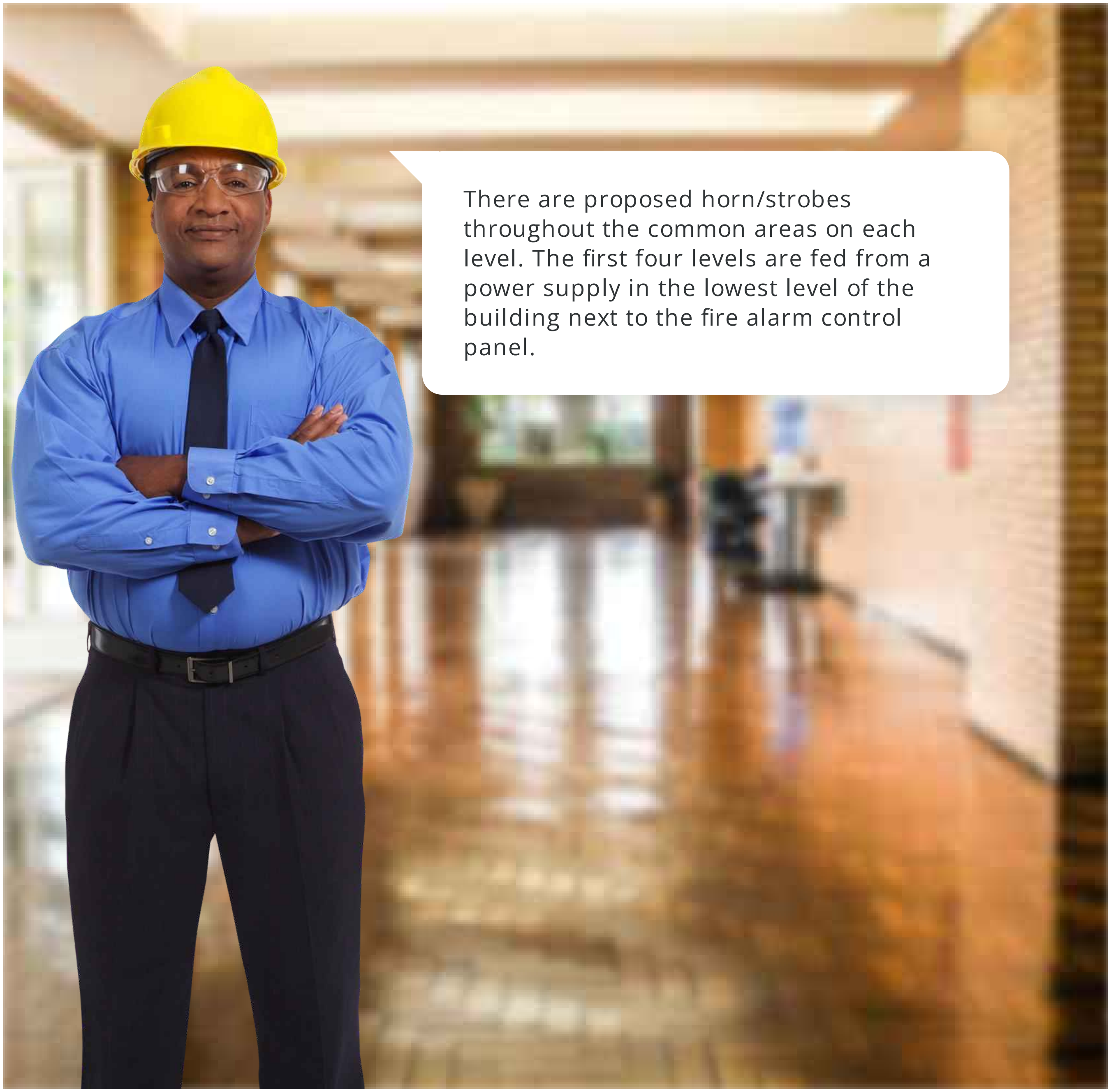


There are proposed horn/strobes throughout the common areas on each level. The first four levels are fed from a power supply in the lowest level of the building next to the fire alarm control panel.

Scene 1 Slide 8

Floors 5-8 are fed from a power supply in the 5th floor electrical room. Floors 9-12 are fed from a power supply in the 9th floor electrical room. All levels are equipped with a smoke detector.

1. Horn/strobes suggest the system is NOT considered an emergency voice/alarm communication system.
2. Horn/strobes suggest the system is considered an emergency voice/alarm communication system.

Scene 1 Slide 9

0 → Next Slide

1 → Next Slide

SECTION 907.2.14

Ohio Building Code 2017 and Ohio Fire Code 2017, Section 907.2.14

Atriums

OBC and OFC 907.2.14

Alice knows that many buildings are required by use group to have smoke detection installed as part of a fire alarm system.

Scene 1 Slide 1

Continue → Next Slide


When she is inspecting buildings, which condition would **NOT** require additional smoke detection equipment?

1 When the building is considered a high-rise.

2 When the building has an atrium open to two stories.

3 When the building is an air traffic control tower.

Scene 1 Slide 2

0 → Next Slide
1 → Next Slide
2 → Next Slide

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Ionization smoke alarms with an alarm-silencing switch shall not be installed more than 10 ft. horizontally from a permanently installed cooking appliance.

○ True

○ False

SUBMIT

According to Ohio Fire Code, Section 907.2.13, high-rise buildings are required to be provided with an automatic smoke detection system, a fire department communication system, and an emergency voice/alarm communication system with the following buildings as exceptions: (Select all that apply)

☐ Buildings with a Group A-1 occupancy

☐ Airport traffic control towers

☐ Open parking garages

☐ Low-hazard special occupancies

SUBMIT

Complete the knowledge check above before moving on.

Ohio Building Code 2017 and Ohio Fire Code 2017, Section 907.4

Initiating Devices

If annual or automatic alarm initiation is required as part of a fire alarm system, the initiating devices are required to be installed per Sections 907.4.1 – 907.4.3.1.

Protection of Fire Alarm Control Unit

In areas not continuously occupied, a single smoke detector is required at the location of each fire alarm control unit, notification appliance circuit power extenders, and supervising station transmitting equipment.

ⓘ **Note the exception: If ambient conditions prohibit installation of a smoke detector, a heat detector is permitted.**

Ohio Building Code 2017 and Ohio Fire Code 2017, Section 907.4

Manual Fire Alarm Boxes

MFAB 1

Location

Manual fire alarm boxes are required to be located no more than 5 ft. from the entrance to each exit. If the building is not protected by an automatic sprinkler system, additional manual fire alarm boxes shall be located so that the exit access travel distance to the nearest box does not exceed 200 ft.

MFAB 2

Height

The height of manual fire alarm boxes shall be no less than 42 inches and no more than 48 in. measured vertically, from the floor level to the activating handle or lever of the box.

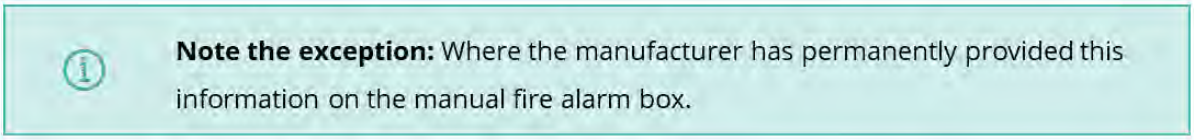
MFAB 3

Color

Manual fire alarms boxes shall be red in color.

MFAB 4

Signs


Note the exception: Where the manufacturer has permanently provided this information on the manual fire alarm box.

Where fire alarm systems are not monitored by a supervising station, an approved permanent sign shall be installed adjacent to each manual fire alarm box that reads:

WHEN ALARM SOUNDS CALL FIRE DEPARTMENT

MFAB 5

Protective Covers

The building official is authorized to require the installation of listed manual fire alarm box protective covers to prevent malicious false alarms or to provide the manual fire alarm box with protection from physical damage. This cover shall be transparent or red with a transparent face to permit visibility of the manual fire alarm box.

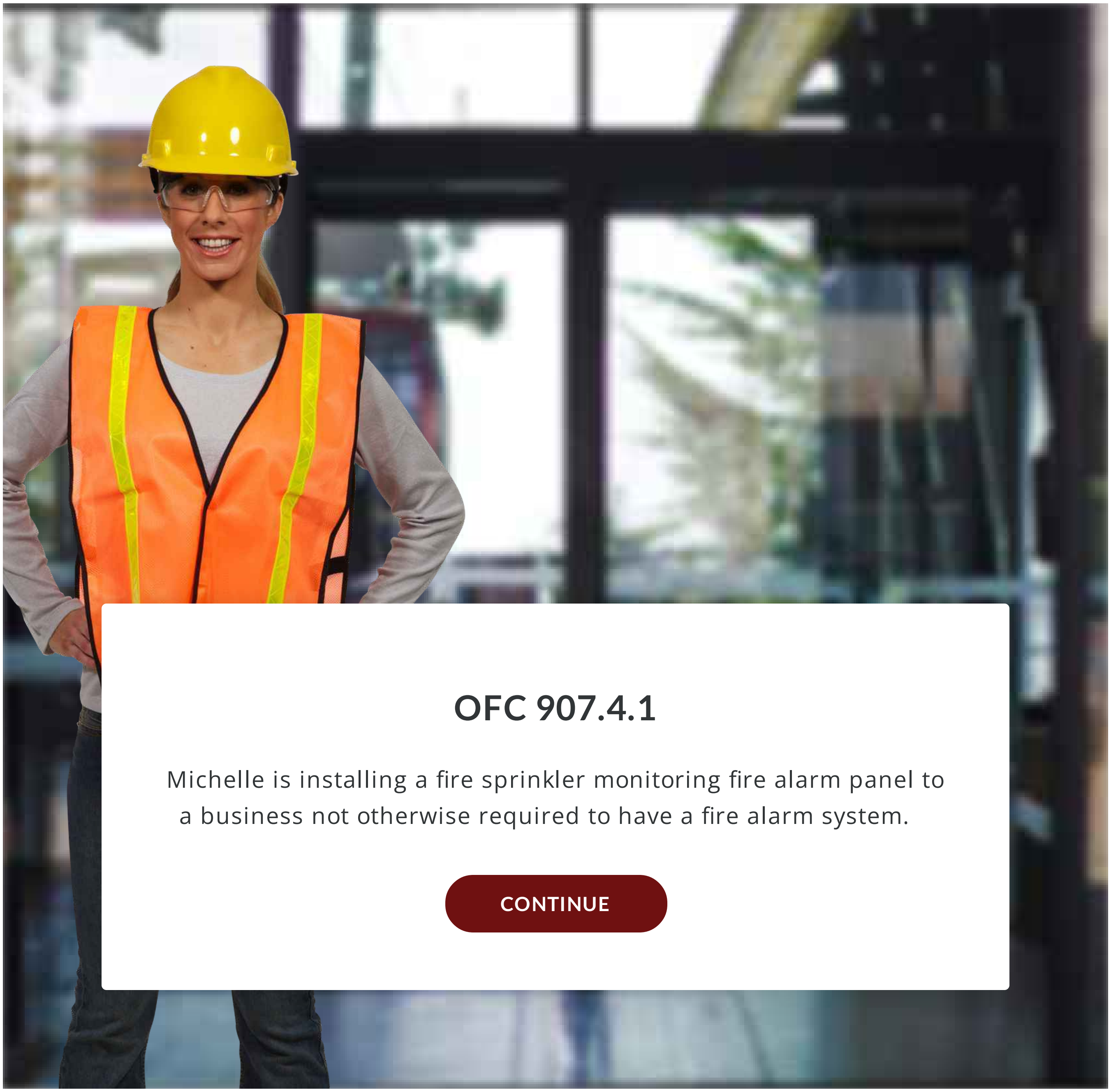
MFAB 6

Unobstructed and Unobscured

Manual fire alarm boxes are required to be accessible, unobstructed, and unobscured at all times.

SECTION 907.4.1

Ohio Fire Code, Section 907.4.1



OFC 907.4.1

Michelle is installing a fire sprinkler monitoring fire alarm panel to a business not otherwise required to have a fire alarm system.

Scene 1 Slide 1

Continue → Next Slide

The sprinkler system’s waterflow devices as well as tamper switches will be interconnected to the system. The panel will be installed near the main sprinkler risers by a rear exit door.

Scene 1 Slide 2

An annunciator will also be installed near the building’s main entrance. A horn/strobe will be placed above the panel and just outside the sprinkler riser room on the outside near the building's FDC.

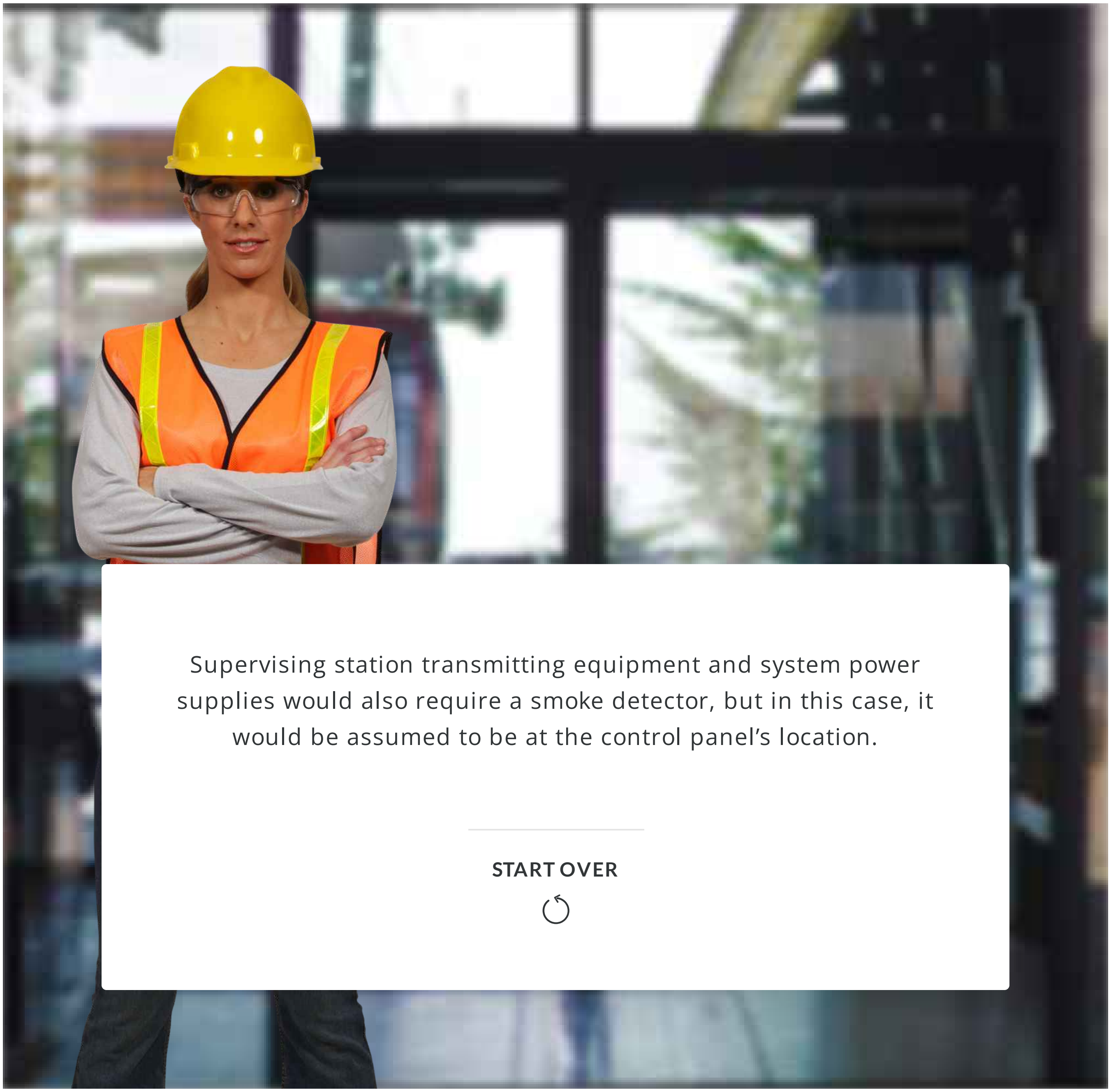
Scene 1 Slide 3

You happen to notice that no other equipment is shown on your prints and work orders and question this. What other device(s) will also most likely be required?

1. One Manual Fire Alarm Box for manual activation of the system & a smoke detector over the fire alarm control panel.
2. Horn/Strobes throughout the facility to initiate an evacuation should the system detect system water flow.
3. A smoke detector over the fire alarm annunciator & one Manual Fire Alarm Box for manual activation of the system.

Scene 1 Slide 4

0 → Next Slide
1 → Next Slide
2 → Next Slide



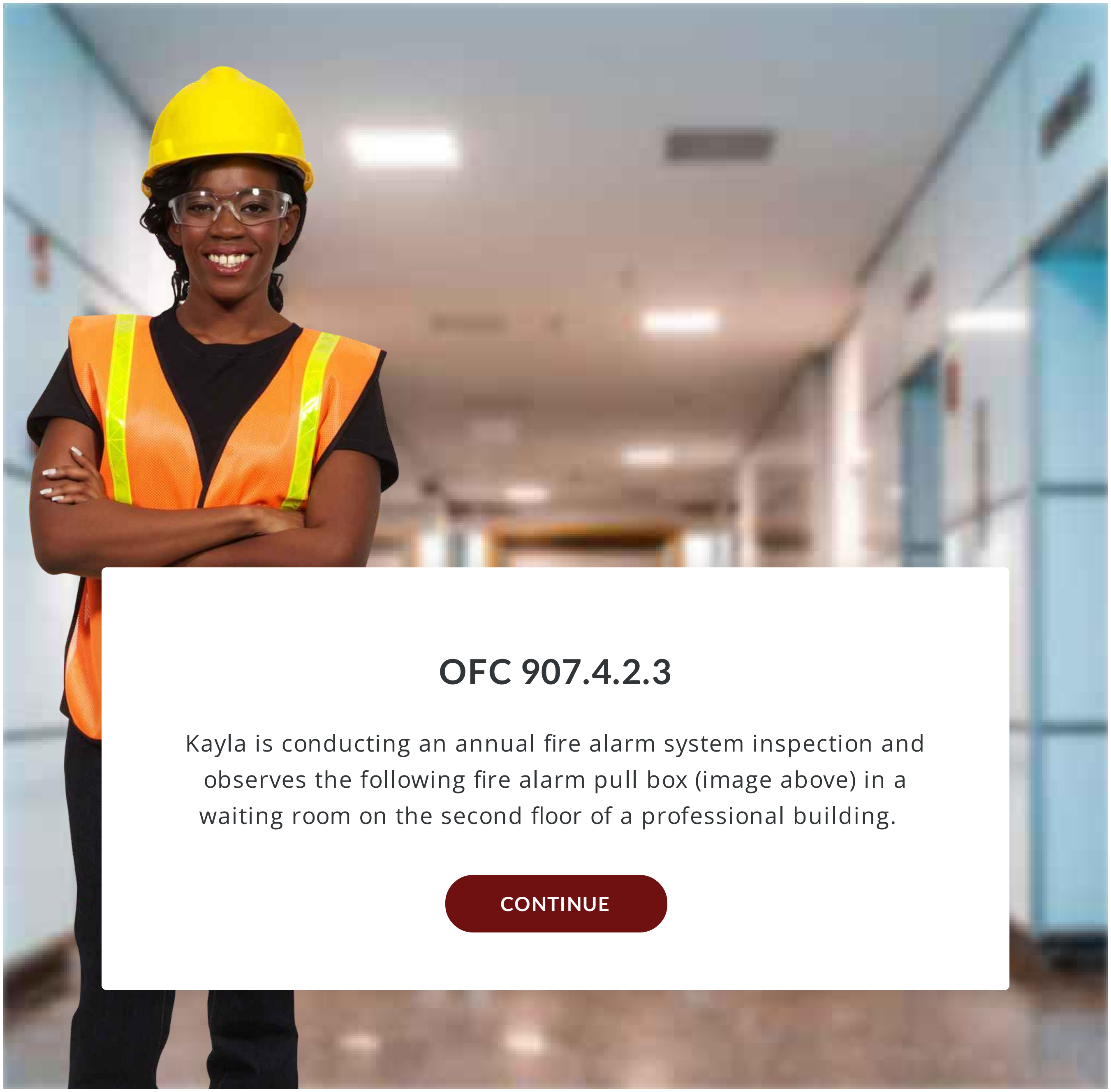
Supervising station transmitting equipment and system power supplies would also require a smoke detector, but in this case, it would be assumed to be at the control panel's location.

Scene 1 Slide 5

Continue → End of Scenario

Ohio Building Code 2017 and Ohio Fire Code 2017, Section 907.4.2.3

Use the image below to reference for the following scenario.



OFC 907.4.2.3

Kayla is conducting an annual fire alarm system inspection and observes the following fire alarm pull box (image above) in a waiting room on the second floor of a professional building.

Scene 1 Slide 1

Continue → Next Slide

There are additional stations near the stairwells. What might she note as a code violation on her inspection report?

1 Protective covers are not permitted unless the device is in an area subject to damage.

2 The pull station itself must be red in color.

3 The pull station is not an approved type, because it is not “dual-action.” The protective cover does not support this requirement.

Scene 1 Slide 2

0 → Next Slide
1 → Next Slide
2 → Next Slide

Ohio Building Code 2017 and Ohio Fire Code 2017, Section 907.5

Occupant Notification Systems

A fire alarm system shall annunciate at the fire alarm control unit, initiating occupant notification upon activation. If a fire alarm system is required by another section of the Ohio Building Code, it shall be activated by:

- Automatic fire detectors
- Automatic sprinkler system waterflow devices
- Manual fire alarm boxes
- Automatic fire-extinguishing systems

ⓘ **Note the exception:** Where notification systems are permitted elsewhere in Section 907 to annunciate at a constantly attended location.

A presignal feature shall not be installed unless approved by the building official and the fire department. If a presignal feature is provided, the signal shall be annunciated at a constantly attended location approved by the fire department so that occupant notification can be activated in the event of a fire or other emergency.

SECTION 907.5.2.1.1

Ohio Building Code 2017 and Ohio Fire Code 2017, Section 907.5.2.1.1

Average Sound Pressure

The audible alarm notification appliances shall provide a **sound pressure level of 15 dBA above the average ambient sound level**, or **5 dBA above the maximum sound level** having a duration of not less than 60 seconds, whichever is greater, **in every occupiable space** within the building.

SECTION 907.5.2.1.2

Ohio Building Code 2017 and Ohio Fire Code 2017, Section 907.5.2.1.2

Maximum Sound Pressure

The maximum sound pressure for audible alarm notification appliances shall be 110 dBA at the minimum hearing distance from the audible appliance. Where the average **ambient noise is greater than 95 dBA, visible alarm notification appliances shall be provided in accordance with *NFPA* 72** and audible alarm notification appliances shall not be required.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

According to Ohio Fire Code, Section 907.4, manual fire alarm boxes are required to: (Select all that apply)

☐ be red in color.

☐ be located no more than 5 ft. from the entrance to each exit.

☐ be no less than 42 in. and no more than 48 in. measured vertically, from the floor level to the activating handle or lever of the box.

☐ be accessible, unobstructed, and unobscured at all times.

SUBMIT

According to Ohio Fire Code, Section 907.5.2.1.1, the audible alarm notification appliances shall provide a sound pressure level of 15 dBA above the average ambient sound level, or 5 dBA above the maximum sound level having a duration of not less than _____ seconds, whichever is greater, in every occupiable space within the building.

○ 30

○ 60

○ 90

○ 120

SUBMIT

Complete the knowledge checks above before moving on.

Ohio Building Code 2017 and Ohio Fire Code 2017, Section 907.6.1

Installation and Monitoring

Wiring

Wiring for a fire alarm system is required to comply with the requirements of *NFPA* 70 and *NFPA* 72. Wireless protection systems using radio-frequency transmitting devices are required to comply with the requirement for supervision of low-power wireless systems in *NFPA* 72.

Power Supply

The primary and secondary power supply for the fire alarm system is to be provided per *NFPA* 72 requirements.

SECTION 914

Ohio Fire Code, Section 914

Fire Protection Based on Special Detailed Requirements of Use and Occupancy

Section 914 specifies where fire protection systems are required based on the detailed requirements of use and occupancy of the building code as listed in rule 1301:7-7-80 of the Administrative Code.

This is a small sample of some of the requirements in **Section 914**.

SECTION 914.2.3

Ohio Fire Code, Section 914.2.3

Emergency Voice/Alarm Communication System

Covered **mall buildings exceeding 50,000 ft^2 (4645 m^2) in total floor area shall be provided with an emergency voice/alarm communication system.** Emergency voice/alarm communication systems serving a mall, required or otherwise, shall be accessible to the fire department.

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SECTION 914.7.2

Ohio Fire Code, Section 914.7.2

Automatic Smoke Detection

Special amusement buildings shall be equipped with an automatic smoke detection system in accordance with paragraph (G)(2)(l)(907.2.12) of this rule.

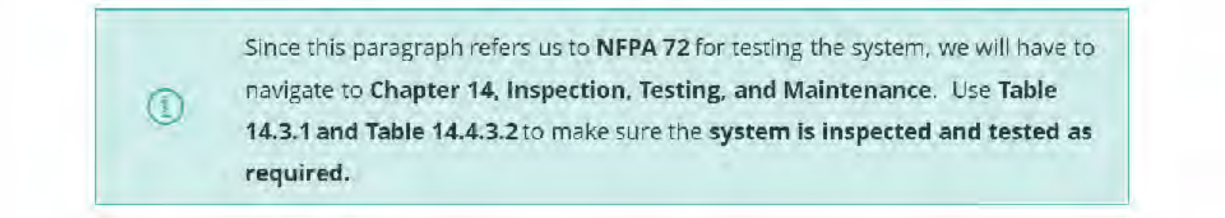
- To see the actual requirements for this paragraph, you will have to navigate to **Paragraph (G)(2)(l)(907.2.12)**.
- **Paragraph (G)(2)(l)(907.2.12)** basically states that activation of a single smoke detector (at the special amusement building) shall immediately cause an alarm signal at the building at a constantly attended location from which an emergency action can be initiated, including the capability of manual initiation of requirements.
- **Paragraph (G)(2)(l)(907.2.12)** also provides information on exit markings and emergency communication messages.

SECTION 1009.6.5.1

Ohio Building Code 2017 and Ohio Fire Code 2017, Section 1009.6.5.1

Testing and Maintenance (of Two-way Communication Systems)

All two-way communication systems shall be tested in the presence of the fire code official upon completion of installation. Communication systems shall be inspected and tested in accordance with *NFPA* 72 2016 to verify that all components are operational.



Since this paragraph refers us to **NFPA 72** for testing the system, we will have to navigate to **Chapter 14, Inspection, Testing, and Maintenance.** Use **Table 14.3.1 and Table 14.4.3.2** to make sure the **system is inspected and tested as required.**

LET'S REVIEW

Let's do a quick check about what has been covered so far.

According to Ohio Fire Code, Section 914.7.2 activation of a single _____ (at the special amusement building) shall immediately cause an alarm signal at the building at a constantly attended location from which emergency action can be initiated, including the capability of manual initiation of requirements.

Type your answer here

SUBMIT

All _____ communication systems shall be tested in the presence of the fire code official upon completion of installation.

Type your answer here

SUBMIT

🔒 Complete the knowledge check above before moving on.

This completes the Ohio Building Code and Ohio Fire Code module.

The **Ohio Building Code and Ohio Fire Code will reference other chapters or sections of the code**, just as *NFPA* 70, and *NFPA* 72 2016 does.

There is far too much information in these Codes for this module to be able to cover everything you may have to know. ***Don't be intimidated by that though.***

The idea is to familiarize yourself with where the information is…namely **Chapter 9**, which covers fire protection systems.

There's some information in **Chapter 10** too.

In many cases, the **Codes are not telling you** ***how to do something*****, they are telling you** ***what the requirements are*** **and** ***what capabilities should be in a particular occupancy***.

When it comes to **how to install it or how to test it**, that is where ***NFPA*** **70** and/or ***NFPA*** **72 2016 come into play.**

CONTINUE

After completing this module, you should now have a better understanding of the Ohio Building Codes and Ohio Fire Codes.

Please press the button to proceed.

Glossary: Fire Alarm and Detection Equipment

This is the glossary for the Fire Alarm and Detection Equipment course. Click on a letter below to see each term and its definition.

- A
- B
- C
- D
- E
- F
- H
- I
- L
- M

N

P

R

S

T

U

A

Addressable Fire Alarm System

A system in which the fire alarm control unit and its associated devices are connected and communicate digitally. Each device is separately addressed.

Alarm Signal

A signal that results from the manual or automatic detection of an alarm condition. (*NFPA* 72 2016, Section 3.3.253.1)

Automatic Fire Detector

A device designed to detect the presence of a fire signature and to initiate action. For the purpose of this Code, automatic fire detectors are classified as follows:
Automatic Fire Extinguishing or Suppression System Operation Detector, Fire-Gas Detector, Heat Detector, Other Fire Detectors, Radiant Energy-Sensing Detector, and Smoke Detector. (*NFPA* 72 2016, Section 3.3.66.2)

Authority Having Jurisdiction (AHJ)

An organization, office, or individual responsible for enforcing requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure. (*NFPA* 72 2016, Section 3.2.2)

Lesson 2 of 16

B

Beam Construction

Ceilings that have solid structural or solid nonstructural members projecting down from the ceiling surface more than 4 in. (100 mm) and spaced more than 36 in. (910 mm), center to center. (*NFPA* 72 2016, Section 3.3.38.1)

Lesson 3 of 16

C

Carbon Monoxide Alarm Signal

A signal indicating a concentration of carbon monoxide at or above the alarm threshold that could pose a risk to the life safety of the occupants and that requires immediate action. (*NFPA* 72 2016, Section 3.3.253.2)

Coded

An audible or visible signal that conveys several discrete bits or units of information. (*NFPA* 72 2016, Section 3.3.48)

Combination System

A fire alarm system in which components are used, in whole or in part, in common with a non-fire signaling system. Examples of non-fire systems are security, card access control, closed circuit television, sound reinforcement, background music, paging, sound masking, building automation, time, and attendance. (*NFPA* 72, 2016, Section 3.3.103.1)

Control Unit (Fire Alarm Control Unit-FACU)

A component of the fire alarm system, provided with primary and secondary power sources, which receives signals from initiating devices or other fire alarm control units, and processes these signals to determine part or all of the required fire alarm system output function(s). (*NFPA* 72 2016, Section 3.3.100)

Also known as the **Fire Alarm Control Panel** (FACP), **control panel**, or **control unit**.

Conventional Fire Alarm System

A fire alarm system that consists of a control panel employing one or more initiating circuits, wired in parallel. The system is not capable of identifying the device that is in alarm, supervisory, or trouble status.

D

Detector

A device suitable for connection to a circuit that has a sensor that responds to a physical stimulus such as heat or smoke. (*NFPA* 72 2016, Section 3.3.66)

Dwelling Unit

A single unit, providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation. (*NFPA* 72 2016, Section 3.3.79)

E

Emergency Communications System (ECS)

A system for the protection of life by indicating the existence of an emergency situation and communicating information necessary to facilitate an appropriate response and action. (*NFPA* 72 2016, Section 3.3.85)

Evacuation Signal

A distinctive alarm signal intended to be recognized by the occupants as requiring evacuation of the building. (*NFPA* 72 2016, Section 3.3.253.4)

F

Fire Alarm Control Unit

A component of the fire alarm system, provided with primary and secondary power sources, which receives signals from initiating devices or other fire alarm control units, and processes these signals to determine part or all of the required fire alarm system output function(s). (*NFPA* 72 2016, Section 3.3.100)

Also known as the **Fire Alarm Control Panel** (FACP), **control panel**, or **control unit**.

Fire Alarm System

A system or portion of a combination system that consists of components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal-initiating devices and to initiate the appropriate response to those signals. (*NFPA* 72 2016, Section 3.3.103)

H

Household Fire Alarm System

A system of devices that uses a fire alarm control unit (panel) to produce an alarm signal in the household for the purpose of notifying the occupants of the presence of a fire so that they will evacuate the premises. (*NFPA* 72 2016, Section 3.3.103.2)

I

Initiating Device

A system component that originates transmission of a change-of-state condition, such as in a smoke detector, manual fire alarm box, or supervisory switch. (*NFPA* 72 2016, Section 3.3.131)

Initiating Device Circuit (IDC)

A circuit to which automatic or manual initiating devices are connected where the signal received does not identify the individual device operated. (*NFPA* 72 2016, Section 3.3.132)

Inspection Personnel

Individuals who conduct a visual examination of a system or portion thereof to verify that it appears to be in operating condition, in proper location, and is free of physical damage or conditions that impair operation. (*NFPA* 72 2016, Section 3.3.190.1)

L

Labeled

Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner. (*NFPA* 72 2016, Section 3.2.4)

Level Ceiling

Ceilings that have a slope of less than or equal to 1 in 8 (*NFPA* 72 2016, Section 3.3.36.1)

Listed

Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose. (*NFPA* 72 2016, Section 3.2.5)

Lesson 10 of 16

M

Malicious Alarm

An unwanted activation of an alarm initiating device caused by a person acting with malice. (*NFPA* 72 2016, Section 3.3.304.1)

Manual Fire Alarm Box

A manually operated device used to initiate a fire alarm signal. (*NFPA* 72 2016, Section 3.3.12.3)

Multiple-Station Alarm Device

Two or more single station alarm devices that can be interconnected so that actuation of one causes all integral or separate audible alarms to operate; or one single station alarm device having connections to other detectors or to a manual fire alarm box. (*NFPA* 72 2016, Section 3.3.161)

Multiplexing

A signaling method characterized by simultaneous or sequential transmission, or both, and reception of multiple signals on a signaling line circuit, a transmission channel, or a communications channel, including means for positively identifying each signal. (*NFPA* 72 2016, Section 3.3.162)

N

Notification Appliance

A fire alarm system component such as a bell, horn, loudspeaker, visual notification appliance, or text display that provides audible, tactile, or visual outputs, or any combination thereof. (*NFPA* 72 2016, Section 3.3.172)

Notification Appliance Circuit (NAC)

A circuit or path directly connected to a notification appliance(s). (*NFPA* 72 2016, Section 3.3.173)

Nuisance Alarm

> An unwanted activation of a signaling system or an alarm initiating device in response to a stimulus or condition that is not the result of a potentially hazardous condition. (*NFPA* 72 2016, Section 3.3.304.2)

P

Private Operating Mode

Audible or visible signaling only to those persons directly concerned with the implementation and direction of emergency action initiation and procedure in the area protected by the fire alarm system. (*NFPA* 72 2016, Section 3.3.183.1)

Public Operating Mode

Audible or visible signaling to occupants or inhabitants of the area protected by the fire alarm system. (*NFPA* 72 2016, Section 3.3.183.2)

R

Record of Completion

A document that acknowledges the features of installation, operation (performance), service, and equipment with representation by the property owner, system installer, system supplier, service organization, and the Authority Having Jurisdiction. (*NFPA* 72 2016, Section 3.3.229)

S

Service Personnel

Individuals who perform those procedures, adjustments, replacement of components, system programming, and maintenance as described in the manufacturer's service instructions that can affect any aspect of the performance of the system. (*NFPA* 72 2016, Section 3.3.190.2)

Shall

Indicates a mandatory requirement. (*NFPA* 72 2016, Section 3.2.6)

Should

Indicates a recommendation or that which is advised but not required. (*NFPA* 72 2016, Section 3.2.7)

Signal

An indication of a condition communicated by electrical, visible, audible, wireless, or other means. (*NFPA* 72 2016, Section 3.3.253)

Signaling Line Circuit (SLC)

A circuit path between any combination of addressable appliances or devices, circuit interfaces, control units, or transmitters over which multiple system input signals or output signals or both are carried. (*NFPA* 72 2016, Section 3.3.255)

Single-Station Alarm Device

An assembly that incorporates the detector, the control equipment, and the alarm-sounding device in one unit operated from a power supply either in the unit or obtained at the point of installation. (*NFPA* 72 2016, Section 3.3.260)

Sloping Ceiling

A ceiling that has a slope of more than 1 in 8. (*NFPA* 72 2016, Section 3.3.36.2)

Sloping Peaked-Type Ceiling

A ceiling in which the ceiling slopes in two directions from the highest point. Curved or domed ceilings can be considered peaked with the slope figured as the slope of the chord from highest to lowest point. (*NFPA* 72 2016, Section 3.3.36.3)

Sloping Shed-Type Ceiling

A ceiling in which the high point is at one side with the slope extending toward the opposite side. (*NFPA* 72 2016, Section 3.3.36.4)

Smoke Alarm

A single or multiple-station alarm responsive to smoke. (*NFPA* 72 2016, Section 3.3.265)

Smoke Detector

A device that detects visible or invisible particles of combustion. (*NFPA* 72 2016, Section 3.3.66.20)

Smooth Ceiling

A ceiling surface uninterrupted by continuous projections, such as solid joists, beams, or ducts, extending more than 4 in. (100 mm) below the ceiling surface. (*NFPA* 72 2016, Section 3.3.38.3)

Solid Joist Construction

Ceilings that have solid structural or solid nonstructural members projecting down from the ceiling surface for a distance of more than 4 in. (100 mm) and spaced at intervals of 36 in. (910 mm) or less, center to center. (*NFPA* 72 2016, Section 3.3.38.4)

Supervising Station

A facility that receives signals from protected premises fire alarm systems and at which personnel are in attendance at all times to respond to these signals. (*NFPA* 72 2016, Section 3.3.280)

Supervisory Signal

A signal that results from the detection of a supervisory condition. (*NFPA* 72 2016, Section 3.3.253.9)

System Designer

Individual responsible for the development of fire alarm and signaling system plans and specifications in accordance with this Code. (*NFPA* 72 2016, Section 3.3.190.3)

System Installer

Individual responsible for the proper installation of fire alarm and signaling systems in accordance with plans, specifications, and manufacturer’s requirements. (*NFPA* 72 2016, Section 3.3.190.4)

Lesson 15 of 16

T

Testing Personnel

Individuals who perform procedures used to determine the status of a system as intended by conducting acceptance, reacceptance, or periodic checks on systems. (*NFPA* 72 2016, Section 3.3.190.5)

Trouble Signal

A signal that results from the detection of a trouble condition. (*NFPA* 72 2016, Section 3.3.253.10)

U

Unintentional Alarm

An unwanted activation of an alarm initiating device caused by a person acting without malice. (*NFPA* 72 2016, Section 3.3.304.3)

Unknown Alarm

An unwanted activation of an alarm initiating device or system output function where the cause has not been identified. (*NFPA* 72 2016, Section 3.3.304.4)

Unwanted Alarm

> Any alarm that occurs that is not the result of a potentially hazardous condition. (*NFPA* 72 2016, Section 3.3.304)

File Attachments for Item:

EC-6 Ohio Fire Pumps (Fire Tech Productions)

All certifications (7.5 hours)

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

APPLICATION FOR CONTINUING EDUCATION APPROVAL
COURSE CONDITIONS AND GUIDELINES

The Ohio Board of Building Standards is committed to the ongoing education and professional development of board-certified personnel through the delivery of high-quality, accurate and engaging professional continuing education content. To this end, the Board reviews and approves Continuing Education Courses for building department personnel.

Board approval is granted for course instruction on current codes and standards, including the OBC, OMC, OPC, and RCO, and any other content areas directly related to the responsibilities of the certification for which credit is being requested.

Promotion: Any person or organization promoting an approved course is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, categories 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 may not falsely state BBS approval before approval is granted. Course providers may state that BBS approval is pending.

Application Submission: All Applications and associated materials shall be submitted by email in .pdf format. Instructions for completing the application are attached.

Certificate of Completion: Course providers shall 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.

Any person or organization administering an approved course shall return a completed BBS Course Attendance form by email.

Participants: Participants must attend the complete course as presented by the instructor to receive credit hours approved by the Board. The organization or instructor of online courses shall plan and execute methods to verify the individual's attendance and completion of the course. No partial credit will be given to any participant who failed to complete the entire course as approved.

Board approval: All courses are approved for the calendar year in which application is made. Courses may be renewed so long as the referenced code is in effect, and the CEUs, certification and content remain unchanged. When the referenced code is updated, courses must be updated, and new approvals obtained.

Facility/training area: BBS Course may be delivered in person or online, or both, at the sponsor's option.
Course facilities shall include the following:

In Person Classes:	**Online Classes:**
Sufficient seating capacity	Web-accessible
ADA accessible facilities	ADA accessible delivery
Appropriate Audio/Visual devices for delivery	Tech support available
Writing surfaces for participants	Live and recorded courses permitted

In-person facilities shall comfortably and safely seat at least the number of attendees present in the room and shall be climate controlled, non-smoking, and sound controlled so that outside noise will not interfere with the training.

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Julie Miller

Organization: Fire Tech Productions

Address: 7976 Clyo Rd., Centerville, OH 45459

E-mail: julie@firetech.com Telephone: 937.434.3473

Website: firetech.com

Conference Sponsor (if applicable)____________ Conference Email:____________

Check here if Course Renewal:________ Prior course number ____________ (*i.e. BBS2018-429*)

Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: Ohio Fire Pumps - NFPA 20 2016 - FPOH 102 2016

Course instructor: Tom Doty

Course description: The Ohio Fire Pumps online self-paced course provides training for the state of Ohio’s Fire Pumps exam so you can pass your test on the first attempt! Based on NFPA 20 2016 and the Ohio Building and Fire Codes 2017.
This course provides the knowledge to:
Properly size and select a fire pump
Analyze system pressure
Determine pump layout and design criteria
Conduct system acceptance tests

Instructional hours per session: 7.5 Number of Sessions:____________

Course Date(s) and Location:____________

Special Content:

Code Administration:______
Existing Buildings: ______
Electrical Instruction: ______
Plumbing Instruction:______

Conference Course: ____________
Conference Name: ____________
Conference location:____________

Course to be offered online? X **On Demand** X **Webinar**________

Course Website: firetech.com

Detail online course participation confirmation method (*i.e. test, quizlets, participant activity confirmation*):
100% completion/review of all lessons/knowledge checks and 70% passing on all quizzes/exams

Course applicable for the following certifications

Residential Certifications Only: ________ Commercial Certifications: X
Administrative Course, All Certifications: ________

Application materials included:

_______ Course Outline or Course Learning Objectives
_______ Presentation Materials/Slides (not required for roundtable courses)
_______ Assessment Materials (for online courses)
_______ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Instructions for new Continuing Education Approval form

Provider Information

1. Please include all contact information.
2. If course is not part of a conference, leave conference sponsor and email blank.

Course Renewal

1. Indicate if the course is being submitted for renewal. Include prior approval letter and write in prior course number.
2. Certification approval for courses has now changed: all existing courses being renewed will be approved within the new classification system.
    a. Courses previously approved for only residential certifications will be approved for all residential certifications.
    b. Courses previously approved for at least on commercial certification will now be approved for all commercial certifications and all residential certifications.
    c. Courses on required instruction topics, Ohio Ethics, Code Administration and Existing Buildings, will be noted as Administrative Courses and be approved for all certifications.
3. Courses being renewed should skip the New Course information section and are not required to submit outline, agenda, slides or other instructional materials for review. Skip to Special Content, and mark any item that applies to the course.

New Course Information

1. Enter course title, name of instructor, and a brief description of the course content. Learning objectives may be substituted for course description, if desired.
2. Number of instructional hours per session is the length of instructional time.
3. Number of sessions: can be 1 or the number of sessions planned.
4. Course date(s) and location: not necessary at this time, enter if known.

Special Content

1. Indicate if the course will meet instructional time in Code Administration or Existing Buildings.
2. Indicate if the course is a plumbing or electrical course, for ESIAC review and trainee course tracking.
3. If the course is associated with a conference, indicate the conference name and location, as this will allow BBS to coordinate approvals with the conference provider.
4. If the course will be offered online, specify whether it will be on demand or offered as a virtual webinar, or both. Include website where the course will be provided.

Course applicable for the following certifications

This section represents a major change from previous BBS course approval forms.

1. If the course is only for residential certifications, check 'Residential Certifications Only'. The course, if approved, will be approved for all residential certifications.
2. If the course is appropriate for any commercial certifications, check Commercial Certifications. The course, if approved, will be approved for all commercial certification **AND** all residential certifications.
3. If the course is intended to meet required instruction in Code Administration (Chapter 1) or Existing Buildings (commercial or residential) check 'Administrative Course, All Certifications'.

Application Materials Included

This is a checklist for the course submitter's use, to be sure all materials necessary for review are included with the application. All materials should be submitted in .pdf format, along with the application, via email to Michael.Lane@com.ohio.gov or BBS@com.ohio.gov

Ohio Course Submission

Included in this document: Course Outline, Instructor resume(s)

Course: Ohio Fire Pumps - NFPA 20 2016 - FPOH 102 2016

Course Outline:

- **01.**

Course Navigation Video (Optional)
  - Course Navigation Video (Optional)

- **02.**

Course Title
  - Introduction
  - Fire Pump General Requirements
  - Fire Pump Installation Requirements
  - Fire Pump Acceptance Testing
  - Ohio Codes

- **03.**

Practice Exam
  - Practice Exam

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Seasoned fire protection professional following strong adherence to the codes and top-notch attention to customer service.

Certifications include: Sprinkler/Standpipe • Fire Alarm and Detection Systems • Fire Pumps • Fire Service Mains • Portable Fire Extinguishers • Pre-Engineered Extinguishers – OTW • State of Kentucky Certified

PROFESSIONAL EXPERIENCE

- CertaSite, 2801 Thunderhawk Court, Dayton, Ohio 45414
  Installation Manager - 2021- Present

- Fire Tech Productions, Inc., 7986B Clyo Rd., Centerville, Ohio 45459
  President - 2015 - 2022

  Instructor/Developer - 2015 - Present

- Craynon Fire Protection Inc., 2801 Thunderhawk Court, Dayton, Ohio 45414
  Partner/Vice-President – 2011 – 2021

  Operations Manager -- 12/11/2005 – 2021

- Guardian Fire Protection, 480 Randy Lane, Monroe, Ohio 45050
  Owner – 11/30/2003 – 12/11/2005

- Sprinkler Inspection Services, Inc., 8 Perkins Drive, Alexandria, KY 41001
  Superintendent / Operations Manager – 10/07/1995 – 11/30/2003

- Bestol Plumbing Company, P.O. Box 4192, Branson, MO
  Foreman – 2/1995 – 10/1995

- Grinnell Fire Protection Systems, Inc., San Diego, CA
  Service Foreman – 8/1993 – 2/1995

- Advanced Fire Protection Company, 1657 Monte Vista Drive, Vista, CA 92084
  Owner – 10/1990 – 8/1993

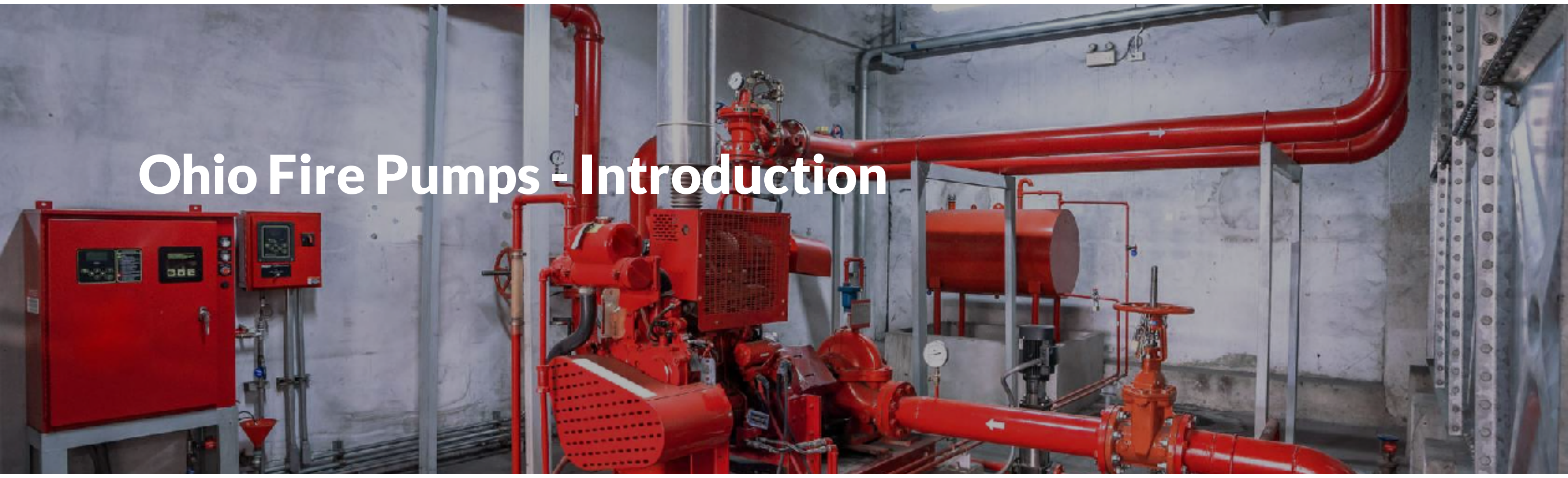
- Ryan Automatic Sprinkler Company, San Marcos, CA
  Superintendent – 4/1988 – 10/1990

- Vanguard Fire Protection, Carlsbad, CA

Foreman – 3/1985 – 4/1988

- Sentinel Fire Protection, San Diego, CA -- 8/1983 – 3/1985
- Local Union 669 – 5/1981 – 8/1983
- Local #821, Central Florida – 4/1980 – 5/1981
- American Automatic Fire Protection – 1/1979 – 4/1980
- Illinois Central Gulf Railroad – 4/1978 – 12/1978
- Orlando Automatic Sprinkler Company – 10/1976 – 3/1978

Ohio Fire Pumps - Introduction



Welcome to the Ohio Fire Pumps course! When you are ready to get started, click on the "**Begin**" button.

This introduction provides a brief overview of what will be covered in the course.

You can come back to this module and reference this information anytime.

Topics that are covered in this introduction are as follows:

- Key References
- Training Modules
- Preparing for the Exam
- ***NFPA*** 20 2016 Definitions

Overview

Glossary

Lesson 1 of 2

Overview

Welcome

Please review this introduction before getting started on the course.

We will look at key references and study tips. In addition, we will highlight key vocabulary terms in the glossary.

REFERENCES

Key References

As you work through this course, it is important to refer to your standards and **codes** as the following references will be discussed.

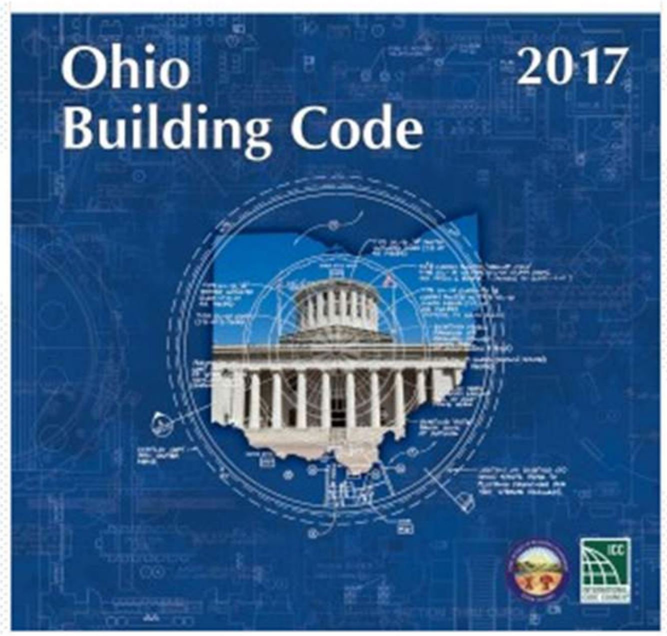
OHIO BUILDING CODE

OHIO FIRE CODE

NFPA 20

NFPA 24

The ***Ohio Building Code,* 2017** establishes uniform minimum requirements for building construction, repair, alteration, and maintenance. These rules govern the intended use and occupancy of the buildings with respect to performance, extent of use, and standardization. The ***Ohio Building Code,* 2017** can be accessed through this link:
https://codes.iccsafe.org/content/OHBCU2017



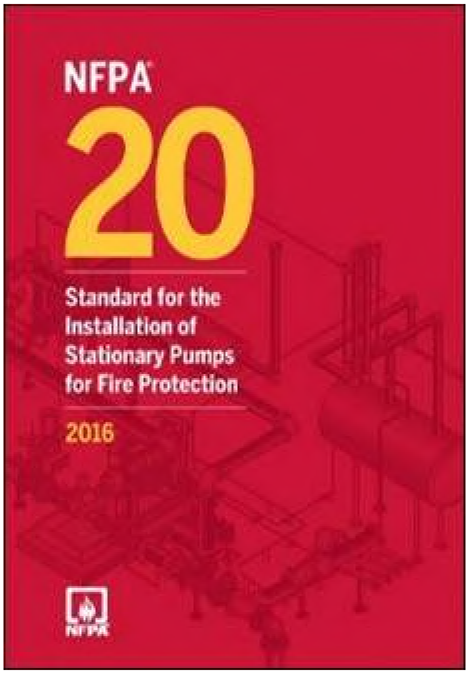
OHIO BUILDING CODE | OHIO FIRE CODE | NFPA 20 | NFPA 24

The ***Ohio Fire Code,* 2017**, establishes state fire marshal rules for the administration and enforcement of authorities. These rules govern the occupancy and maintenance of all structures and premises for precautions against fire and the spread of fire and general requirements of fire safety.

The Ohio Fire Code can be accessed through this link: https://codes.iccsafe.org/content/OHFCJAN2019E/ohio-administrative-code-1301-7-7-09-fire-protection-systems

OHIO BUILDING CODE | OHIO FIRE CODE | NFPA 20 | NFPA 24

NFPA* 20 2016 – *Standard for the Installation of Stationary Pumps for Fire Protection: The purpose of the standard is to specify how to install a fire pump properly when one is needed and which components, equipment, and power supplies are acceptable for use in a fire pump installation. In other words, *NFPA* 20 indicates how to properly arrange and install a fire pump and its supporting equipment.



OHIO BUILDING CODE | OHIO FIRE CODE | NFPA 20 | NFPA 24

NFPA* 24 2016 – *Standard for the Installation of Private Fire Service Mains and Their Appurtenances: This standard covers the requirements for this type of water supply piping, along with additional system components that are typically associated with underground piping. Designing private fire service mains properly is critical, as this is typically the first section of piping to carry water to a sprinkler or standpipe system after it leaves the municipal water mains. This standard covers the design, installation, and acceptance testing of these private service mains along with the fire hydrants that are connected to them.

OHIO BUILDING CODE
OHIO FIRE CODE
NFPA 20
NFPA 24

NFPA* 25 2014 – *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems: This standard covers the administrative requirements for the periodic inspection, testing, and maintenance (ITM) of water-based fire protection systems. The purpose of the standard is to verify the operational status of a system and to provide a reasonable degree of certainty that the system will perform when needed.

ⓘ Each *NFPA* standard contains several Annexes with valuable examples and information. It is recommended you study this material as well.

OHIO CODES

Ohio Codes

The Ohio Fire Protection Exams are prepared from the *Ohio Building Code* Chapter 9, 2017 edition, the Ohio Administrative Code Section 1301:7-7-09 (*Ohio Fire Code*) 2017 edition, as well as the pertinent NFPA standards previously discussed. This course will focus on those referenced sections found in the *Ohio Building Code* and the *Ohio Fire Code*.

The Ohio Fire Code states that fire pumps shall be installed, inspected, tested, and maintained per *NFPA* 20 2016 and *NFPA* 25 2014. The code also defines specific rules for Ohio as well as reinforce some of the *NFPA* 20 2016 requirements.

- One of these requirements is to be certified and licensed by the state of Ohio.
- The only exception is for a provisional person in an approved formal apprenticeship program. They are permitted to work under the constant supervision of a certified person. The certified person is only allowed to supervise one provisional person.

CONTINUE

Additional Resources

Below is additional information and resources for the Ohio exam.

Ohio Department of Commerce – Division of State Fire Marshal:

Ohio Department of Commerce

To access the Ohio Department of Commerce – Division of State Fire Marshal, click on this "Click Here" button.

CLICK HERE

Ohio Department of Commerce phone: **(614) 752-7126**

The following downloadable PDF is for the Fire Protection Exam Application through the Ohio Department of Commerce:

PDF **FireProtectionExamApplication.pdf**
548.9 KB

PSI Candidate Information Bulletin

A very important source of information is the PSI Candidate Information Bulletin from PSI Services LLC. Take time to read it below in its **ENTIRETY**.

PDF **OhioCertificationExaminationBulletin.pdf**
230.9 KB

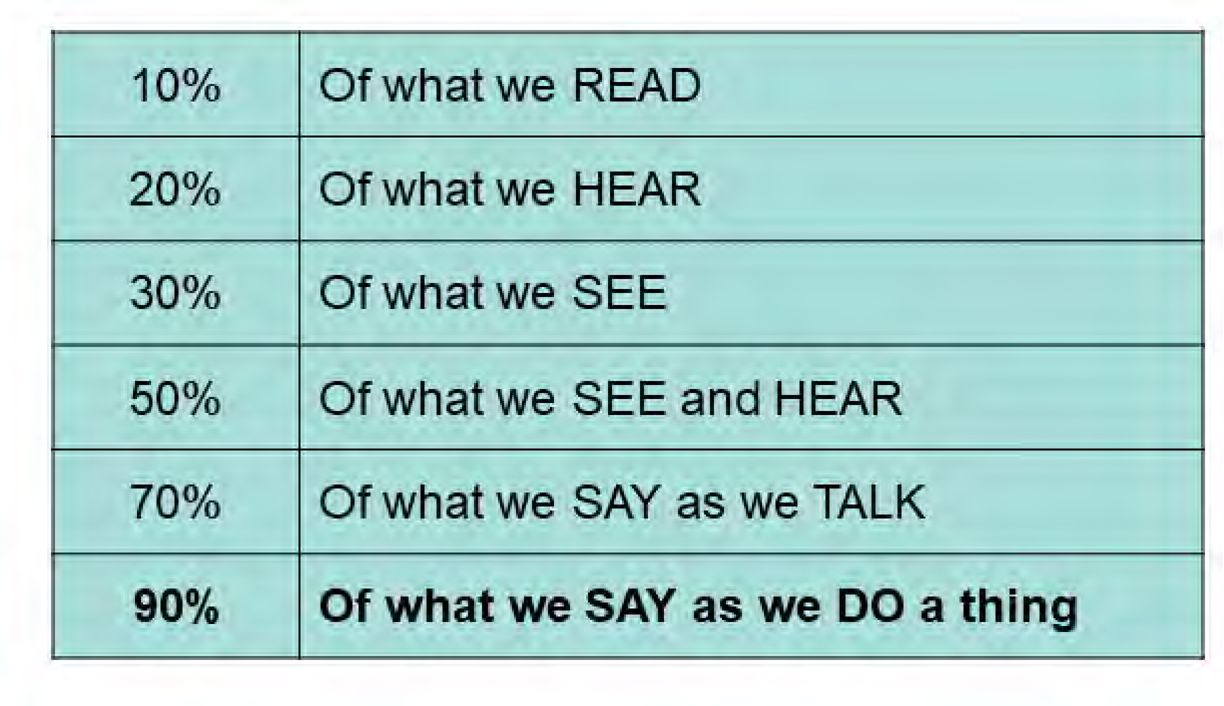
PSI Online Exams

To check for the most updated information on PSI Services, visit their website by clicking on this "Click Here" button.

CLICK HERE

HOW WE LEARN

Thinking about How We Learn



10%	Of what we READ
20%	Of what we HEAR
30%	Of what we SEE
50%	Of what we SEE and HEAR
70%	Of what we SAY as we TALK
90%	**Of what we SAY as we DO a thing**

Source: ***Skill With People*** by Les Giblin

Different people learn in different ways.

It is important to discover what works **best for you** and use your strengths to ensure you retain the material.

TRAINING MODULES

Training Modules

As you are studying, be prepared to **refer to your copy of the referenced NFPA standards constantly** throughout these modules. Be comfortable with the technical material.

Each training module is carefully planned and designed to **highlight areas of the standards that you need to know in order to increase your chances of success on the exam.** The goal of these training modules is to help you become knowledgeable of important areas of the standards and to gain a working understanding of how to apply these requirements on the job.

Take notes as you are studying, and **highlight** areas of the standards that are important to know.

The more familiar you are with the requirements, tables, and figures, the better your chances of success on the exam.

QUIZZES

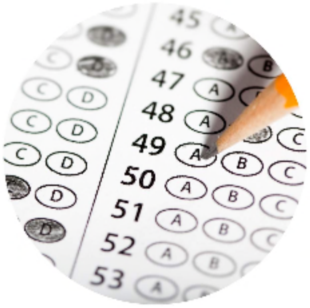
The Quizzes

Fire Tech provides a practice quiz associated with each training module, which should be taken following completion of the module. As you take each practice quiz, use your copy of the referenced NFPA standards to **look up every answer to each quiz question**. This will assist you in **becoming more familiar with the requirements and where they are located** in each of the codes and standards.

You will achieve the highest chances of success by **learning and understanding the training material.**

Fire Tech ***does not*** recommend that you solely attempt to memorize practice quiz questions. These questions are examples only and do not reflect actual test questions.

Additionally, **read each question carefully**. Sift through what is pertinent to the question and what is irrelevant information that may be included as a distractor.



KNOWLEDGE CHECKS

Knowledge Checks

To help you apply course material and prepare for the quizzes, **knowledge checks** are sprinkled throughout each course.

Completing these knowledge checks is **required** to proceed further in the lesson. If you're stuck on a question, refer to previous lesson material and use your NFPA standard to find the answer.

True or false: Knowledge checks will help you apply course material and prepare for course quizzes.

○ True

○ False

SUBMIT

🔒 Complete the knowledge check above before moving on.

Practice Exam

Once you have read all of the lessons in this course and passed all of the quizzes, you will be ready to take the **Practice Exam**.

The Practice Exam consists of questions from the quizzes and is presented in a randomized manner.

LEARNING STRATEGIES

Learning Strategies

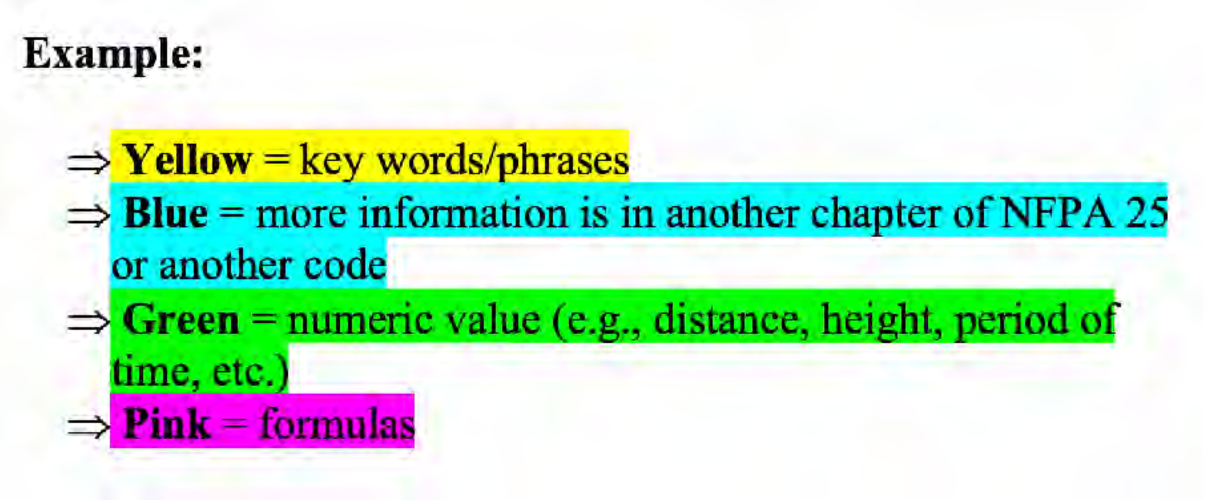
Click each of the strategies below and begin to incorporate them as you prepare for the Practice Exam.

Learning Strategies

Use these strategies to help you utilize the course materials.

Strategy 1

Create a color-coded highlighting system



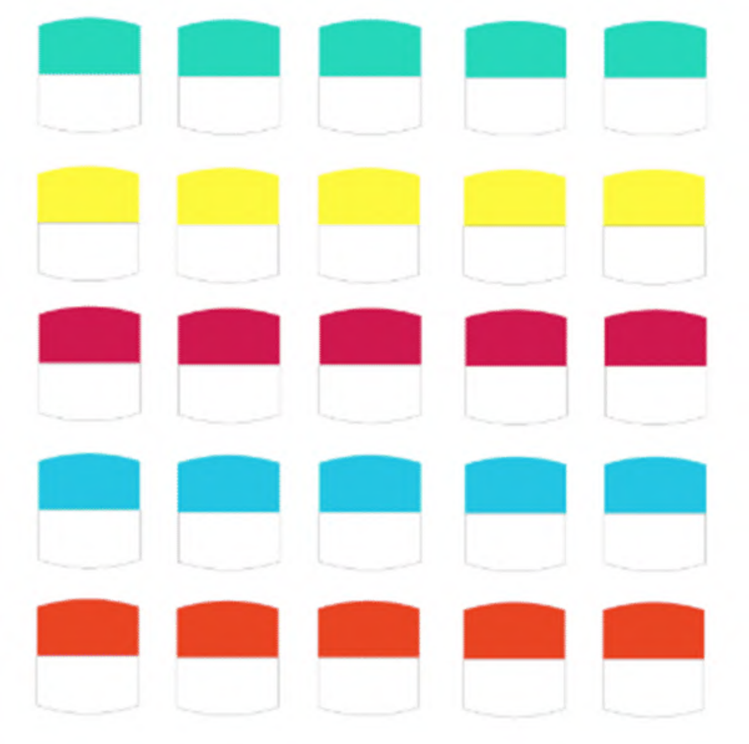
Example:

- ⇒ **Yellow** = key words/phrases
- ⇒ **Blue** = more information is in another chapter of NFPA 25 or another code
- ⇒ **Green** = numeric value (e.g., distance, height, period of time, etc.)
- ⇒ **Pink** = formulas

Fire Tech recommends highlighting important areas of the code. Some customers use up to four colors and different methods of highlighting. A simple strategy is to highlight based on type of information. Use one color for major sections or topics and another color for details and exceptions.

Strategy 2

Use tabs on your standards



Helps you look things up much faster! This can be especially helpful if you are looking up a reference for a customer.

Add tabs yourself or:

- purchase pre-tabbed standards from Fire Tech Productions
- purchase labeled tabs to add to your standard from Fire Tech Productions

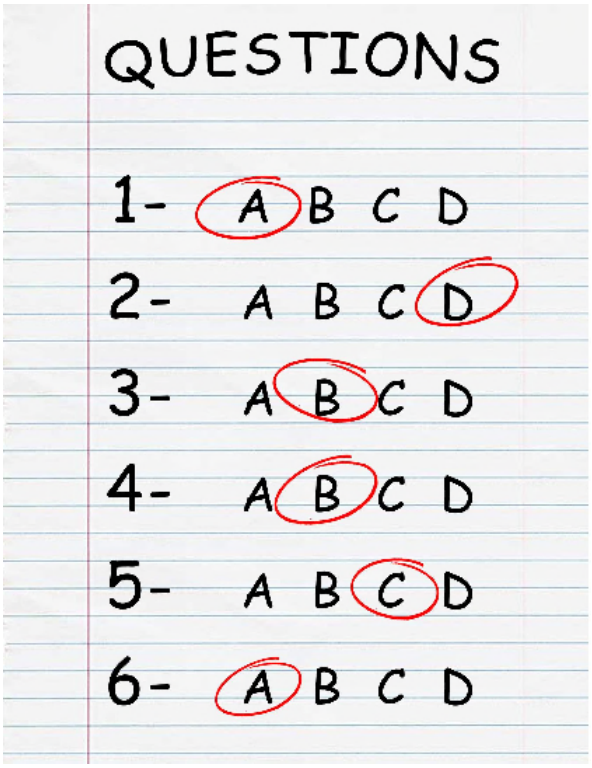
Strategy 3

Find a learning partner or a mentor

Have someone hold you accountable or quiz you, even if they’re not taking the course themselves. Driving to and from a job site with a co-worker is a great opportunity to do this.

Strategy 4

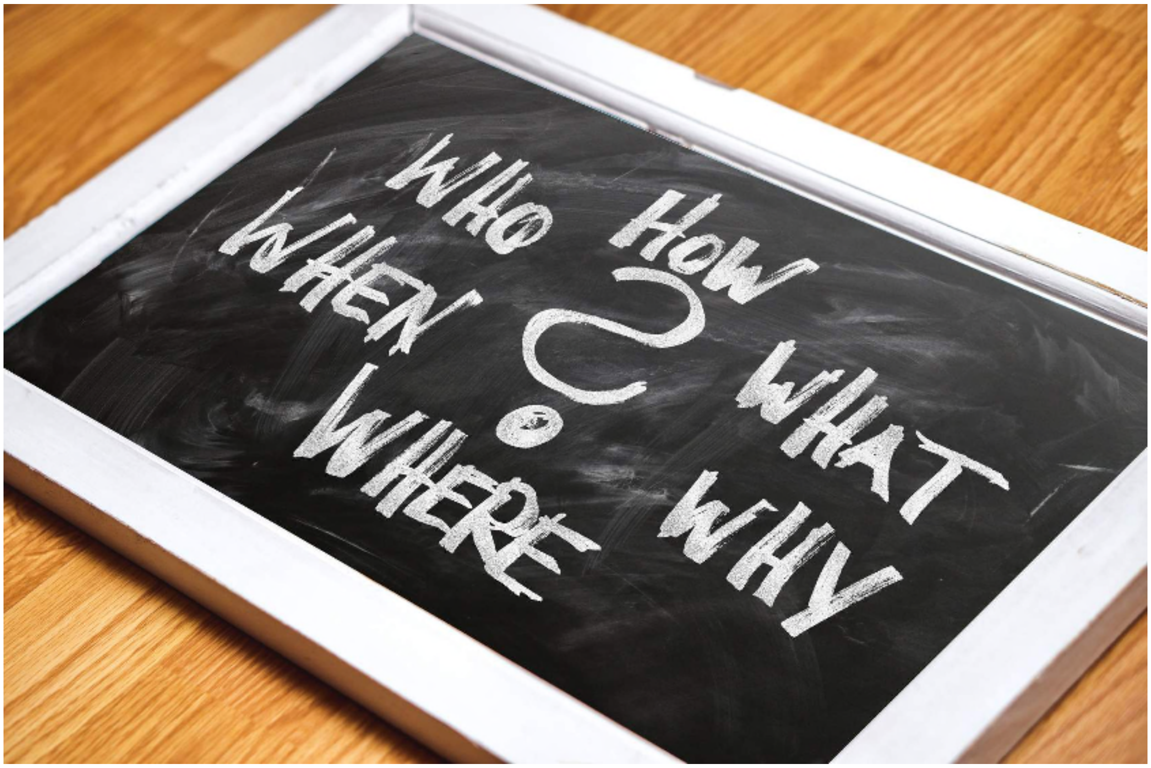
Practice



Take the practice quizzes and tests in the Fire Tech online course. Many studies show that recalling information helps to “make it stick”.

Strategy 5

Write your own questions



As you go through the material, turn the information into possible questions that you can go back and answer later. This will help you check how well you are retaining the information in the course.

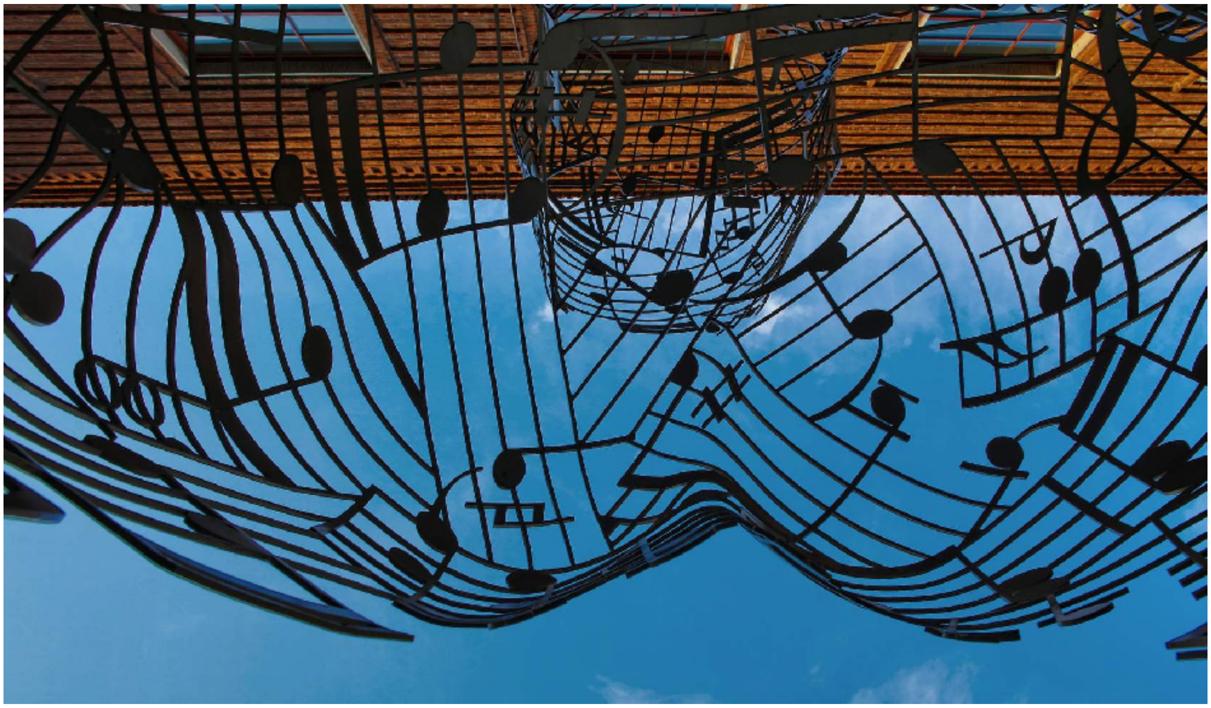
Strategy 6

Make time for your course

Work on your course for at least **20 minutes** every day. Spreading out the course material over time is a much more effective way to learn.

Strategy 7

Make up songs



Our brains remember music really well. Put those formulas, definitions, or requirements to music.

Strategy 8

Teach someone else

It will solidify ideas in your brain and improve your understanding.

GLOSSARY

Lesson 2 of 2

Glossary

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Define key terms associated with fire pumps.

Key References

- *NFPA 20 - Standard for the Installation of Stationary Pumps for Fire Protection*, 2016

LET'S BEGIN

Key Terms

NFPA 20 2016, Chapter 3

Below are key glossary terms that will be highlighted throughout this course. Click on each **+** symbol to see the definition for each word below.

Additive Pump

A pump that is used to inject additives into the water stream. (*NFPA* 20 2016, Section 3.3.44.1)

Aquifer

An underground formation that contains sufficient saturated permeable material to yield significant quantities of water. (*NFPA* 20 2016, Section 3.3.2)

Authority Having Jurisdiction (AHJ)

An organization, office, or individual responsible for enforcing requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure. (*NFPA* 20 2016, Section 3.2.2)

Can Pump

A vertical shaft turbine-type pump in a can (suction vessel) for installation in a pipeline to raise water pressure. (*NFPA* 20 2016, Section 3.3.44.2)

Cavitation

A complex phenomenon related to pumps which results from suction pressure falling below the vapor pressure corresponding to the water temperature.

Centrifugal Pump

A pump in which the pressure is developed principally by the action of centrifugal force. (*NFPA* 20 2016, Section 3.3.44.3)

Circulation Relief Valve

A valve used to cool a pump by discharging a small quantity of water. This valve is separate from and independent of the main relief valve. (*NFPA* 20 2016, Section 3.3.67.5.1)

Dump Valve

An automatic valve installed on the discharge side of a positive displacement pump to relieve pressure prior to the pump driver reaching operating speed. (*NFPA* 20 2016, Section 3.3.67.1)

End Suction Pump

A single suction pump having its suction nozzle on the opposite side of the casing from the stuffing box and having the face of the suction nozzle perpendicular to the longitudinal axis of the shaft. (*NFPA* 20 2016, Section 3.3.44.4)

Fire Pump

A pump that is a provider of liquid flow and pressure dedicated to fire protection. (*NFPA* 20 2016, Section 3.3.44.5)

Gear Pump

A positive displacement pump characterized by the use of gear teeth and casing to displace liquid. (*NFPA* 20 2016, Section 3.3.44.7)

High-Rise Building

A building where the floor of an occupiable story is greater than 75 ft. above the lowest level of fire department vehicle access. (*NFPA* 20 2016, Section 3.3.26)

Horizontal Pump

A pump with the shaft normally in a horizontal position. (*NFPA* 20 2016, Section 3.3.44.8)

Horizontal Split-Case Pump

A centrifugal pump characterized by a housing that is split parallel to the shaft. (*NFPA* 20 2016, Section 3.3.44.9)

In-Line Pump

A centrifugal pump whose drive unit is supported by the pump having its suction and discharge flanges on approximately the same centerline. (*NFPA* 20 2016, Section 3.3.44.10)

Listed

Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose. (*NFPA* 20 2016, Section 3.2.3)

Piston Plunger Pump

A positive displacement pump characterized by the use of a piston or plunger and a cylinder to displace liquid. (*NFPA* 20 2016, Section 3.3.44.13)

Positive Displacement Pump

A pump that is characterized by a method of producing flow by capturing a specific volume of fluid per pump revolution and reducing the fluid void by a mechanical means to displace the pumping fluid. (*NFPA* 20 2016, Section 3.3.44.14)

Pressure Control Valve

A pilot-operated pressure-reducing valve designed for the purpose of reducing the downstream water pressure to a specific value under both flowing (residual) and non-flowing (static) conditions. (*NFPA* 20 2016, Section 3.3.67.3)

Pressure Maintenance (Jockey or Make-Up) Pump

A pump designed to maintain the pressure on the fire protection system(s) between preset limits when the system is not flowing water. (*NFPA* 20 2016, Section 3.3.44.15)

A pressure maintenance pump is also referred to as a Jockey or Make-up Pump.

Pressure-Reducing Valve

A valve designed for the purpose of reducing the downstream water pressure under both flowing (residual) and non-flowing (static) conditions. (*NFPA* 20 2016, Section 3.3.67.4)

Pumping Liquid Level

The level, with respect to the pump, of the body of liquid from which it takes suction when the pump is in operation. Measurements are made the same as with the static liquid level. (*NFPA* 20 2016, Section 3.3.31.1)

Relief Valve

A device that allows the diversion of liquid to limit excess pressure in a system. (*NFPA* 20 2016, Section 3.3.67.5)

Rotary Lobe Pump

A positive displacement pump characterized by the use of a rotor lobe to carry fluid between the lobe void and the pump casing from the inlet to the outlet. (*NFPA* 20 2016, Section 3.3.44.16)

Rotary Vane Pump

A positive displacement pump characterized by the use of a single rotor with vanes that move with pump rotation to create a void and displace liquid. (*NFPA* 20 2016, Section 3.3.44.17)

Shall

Indicates a mandatory requirement. (*NFPA* 20 2016, Section 3.2.4)

Should

Indicates a recommendation or that which is advised but not required. (*NFPA* 20 2016, Section 3.2.5)

Standard

An NFPA Standard, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides. (*NFPA* 20 2016, Section 3.2.6)

Static Liquid Level

The level, with respect to the pump, of the body of liquid from which it takes suction when the pump is not in operation. For vertical shaft turbine-type pumps, the distance to the liquid level is measured vertically from the horizontal centerline of the discharge head or tee. (*NFPA* 20 2016, Section 3.3.31.2)

Suction Pressure Regulating Valve

A pilot-operated valve installed in discharge piping that maintains positive pressure in the suction piping, while monitoring pressure in the suction piping through a sensing line. (*NFPA* 20 2016, Section 3.3.67.2)

Total Head, Horizontal Pumps

The measure of the work increase, per pound of liquid, imparted to the liquid by the pump, and therefore the algebraic difference between the total discharge head and the total suction head. Total head, as determined on test where suction lift exists, is the sum of the total discharge head and total suction lift. Where positive suction head exists, the total head is the total discharge head minus the total suction head. (*NFPA* 20 2016, Section 3.3.25.3.1)

Refer to *NFPA* 20 2016, Figure A.3.3.25.3.1

Total Head, Vertical Turbine Pumps

The distance from the pumping liquid level to the center of the discharge gauge plus the total discharge head. (*NFPA* 20 2016, Section 3.3.25.3.2)

Refer to *NFPA* 20 2016, Figure A.3.3.25.3.2

Total Rated Head

The total head developed at rated capacity and rated speed for a centrifugal pump. (*NFPA* 20 2016, Section 3.3.25.4)

Total Suction Head

Suction head exists where the total suction head is above atmospheric pressure. Total suction head, as determined on test, is the reading of a gauge at the suction of the pump, converted to feet of liquid, and referred to datum, plus the velocity head at the point of gauge attachment. (*NFPA* 20 2016, Section 3.3.25.5)

Total Suction Lift

Suction lift that exists where the total suction head is below atmospheric pressure. Total suction lift, as determined on test, is the reading of a liquid manometer at the suction nozzle of the pump, converted to feet of liquid, and referred to datum, minus the velocity head at the point of gauge attachment. (*NFPA* 20 2016, Section 3.3.66)

Tuberculation

The development of small mounds of corrosion products on the inside of iron pipe.

Unloader Valve

A valve that is designed to relieve excess flow below pump capacity at set pump pressure. (*NFPA* 20 2016, Section 3.3.67.6)

Velocity Head

The kinetic energy of a unit weight of fluid moving with velocity (v) determined at the point of the gauge connection. (*NFPA* 20 2016, Section 3.3.25.6)

Velocity head is calculated using the following formula:

$\mathbf{h_v = v^2 / 2g}$

Where:

v = velocity in the pipe in feet per second

g = acceleration due to gravity (32.17 ft/sec^2 at sea level and 45º latitude)

Vertical Lineshaft Turbine Pump

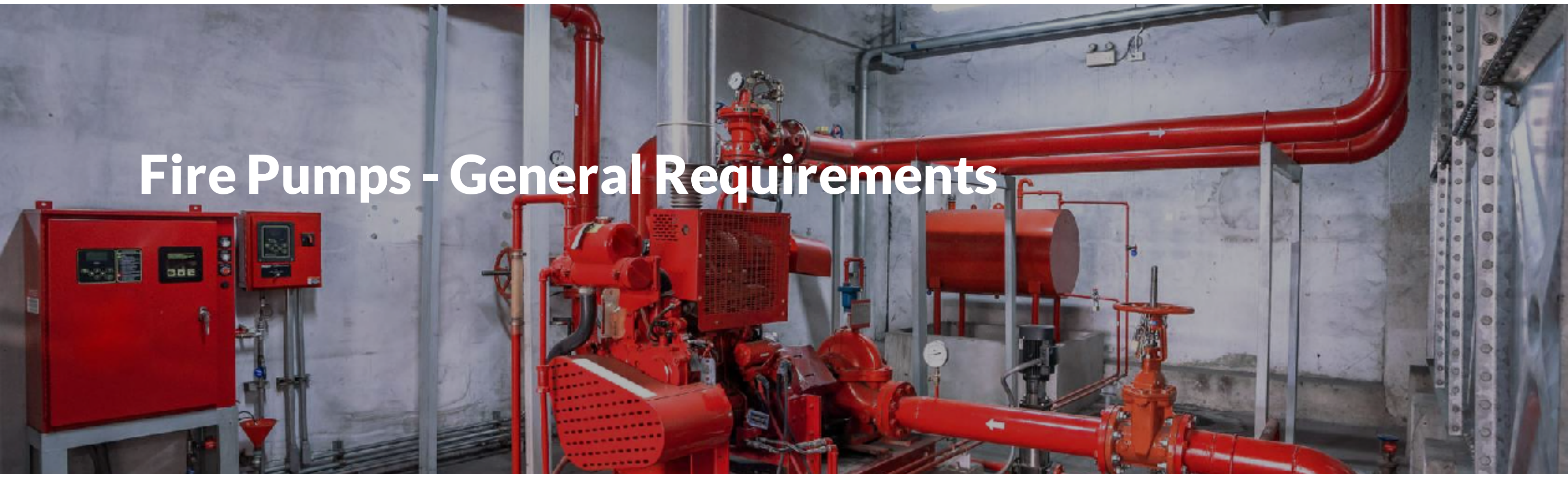
A vertical shaft centrifugal pump with rotating impeller or impellers and with discharge from the pumping element coaxial with the shaft. The pumping element is suspended by the conductor system, which encloses a system of vertical shafting used to transmit power to the impellers, the prime mover being external to the flow stream. (*NFPA* 20 2016, Section 3.3.44.18)

Wet Pit

A timber, concrete, or masonry enclosure having a screened inlet kept partially filled with water by an open body of water such as a pond, lake, or stream. (*NFPA* 20 2016, Section 3.3.71)

CONTINUE

Please press the button to proceed.



Fire Pumps - General Requirements

By the end of this module, you will be able to do the following:

- Describe the purpose of a fire pump as a part of a fire protection system.
- Calculate the energy that a fire pump can add to a sprinkler system.
- Recognize different types of fire pumps and their components.
- Compare the types of drivers for fire pumps.
- Specify the operational capacities for listed pumps.
- Recall the purpose of circulation relief valves.
- Apply the necessary requirements to ensure proper protection of fire pumps.
- Recognize the general requirements for suction pipes, including pipe size, protection, and fittings.
- Select the appropriate requirements for the valves in fire pump systems.

Key References for this module:

- *NFPA* 13 – *Standard for the Installation of Sprinkler Systems*, 2016
- *NFPA* 20 – *Standard for the Installation of Stationary Pumps for Fire Protection*, 2016
- *NFPA Fire Protection Handbook*, 2008

When you are ready to begin, click on the button above to start the course.

What are Fire Pumps

General Fire Pump Requirements

Suction Pipe and Valve Requirements

Lesson 1 of 3

What are Fire Pumps

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Describe the purpose of a fire pump as a part of a fire protection system.

☐ Calculate the energy that a fire pump can add to a sprinkler system.

☐ Recognize different types of fire pumps and their components.

Key References

- *NFPA* 13 – *Standard for the Installation of Sprinkler Systems*, 2016
- *NFPA* 20 – *Standard for the Installation of Stationary Pumps for Fire Protection*, 2016
- *NFPA Fire Protection Handbook*, 2008

LET'S BEGIN

Pump versus Fluid

Before diving into the requirements found in *NFPA* 20 2016, here is a quick review of some key terms and concepts:

Pump

A pump is simply a device that adds energy to a fluid. The key here is that **energy from the pump is being added to the energy which already exists in the liquid**.

Fluid

A fluid can either be **compressible or incompressible**. In this specific instance, we're talking about an **incompressible fluid, namely; water**.

WHAT IS A FIRE PUMP?

What is a Fire Pump?

As defined in *NFPA* 20 2016, a fire pump is a *pump that is a provider of liquid flow and pressure dedicated to fire protection*. In other words, a pump's purpose is to increase the pressure and flow of the sprinkler system's water source when it is not adequate.

When are Pumps Needed?

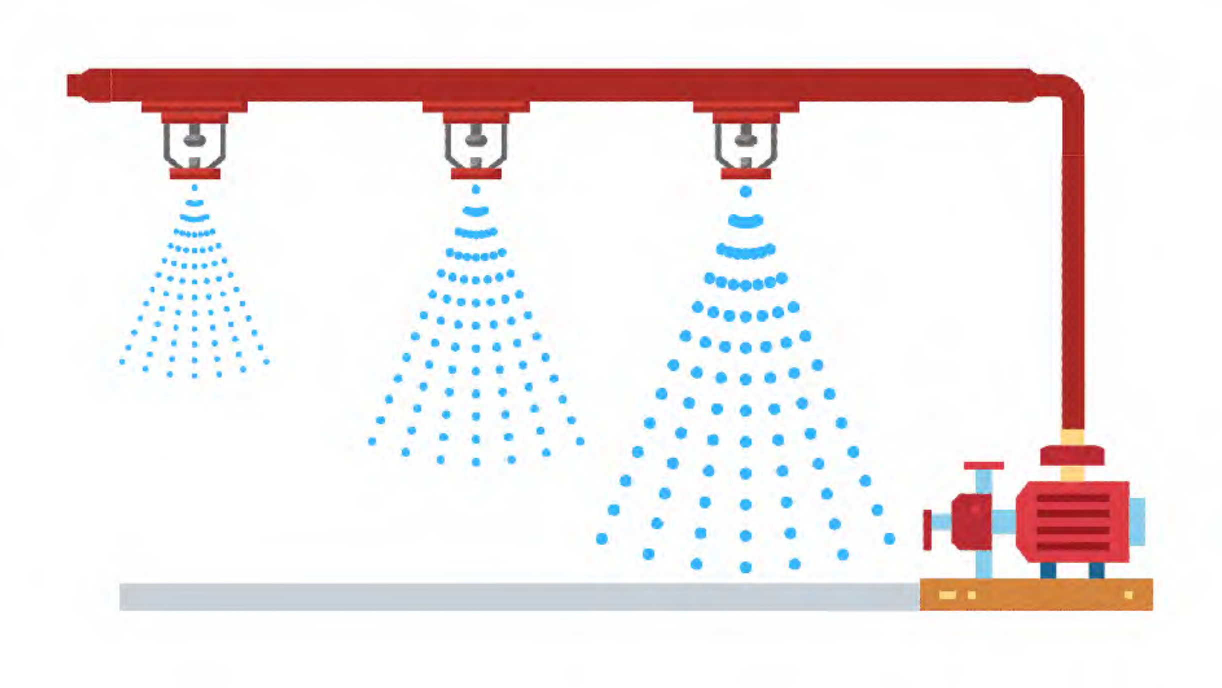
Fire pumps are needed when the water supply is unable to meet the pressure and flow demands of the **entire sprinkler system**. They are also necessary when the water supply is **unable to provide sufficient pressure**, such as when it draws from a pond or other body of water.

Fire pumps are **not intended to be constantly running**. They are designed to **start when there is a pressure drop** in the sprinkler system.

When a sprinkler opens in a fire condition, water flows from the sprinkler, and the pressure in the system drops. **The pressure drop results in the fire pump starting.**

Sprinkler systems are designed to meet defined pressure and flow criteria. As water travels through the sprinkler system, moving further away from the water supply, the water pressure and flow decrease.

In the diagram below, you can see how the sprinklers closest to the water supply have higher pressure and flow than those furthest from the water supply.



LET'S REVIEW

Let's do a quick check about what has been covered so far.

Is water considered a compressible or incompressible fluid?

○ Compressible

○ Incompressible

SUBMIT

True or false: A fire pump is designed to constantly run.

○ True

○ False

SUBMIT

Complete the knowledge checks above before moving on.

Pumps Add Energy

Since the pressure and flow continually decrease as water moves through a sprinkler system, it is the fire pump's job to add energy to the water supply. This process, in turn, allows the sprinkler system to meet its intended pressure and flow criteria.

Visual Explanation

Click on the "Start" button to see how a fire pump adds energy to a sprinkler system.

1

Existing Water Supply

A city water supply has a pressure of 30 PSI for the given sprinkler system.

2

Adding a Pump

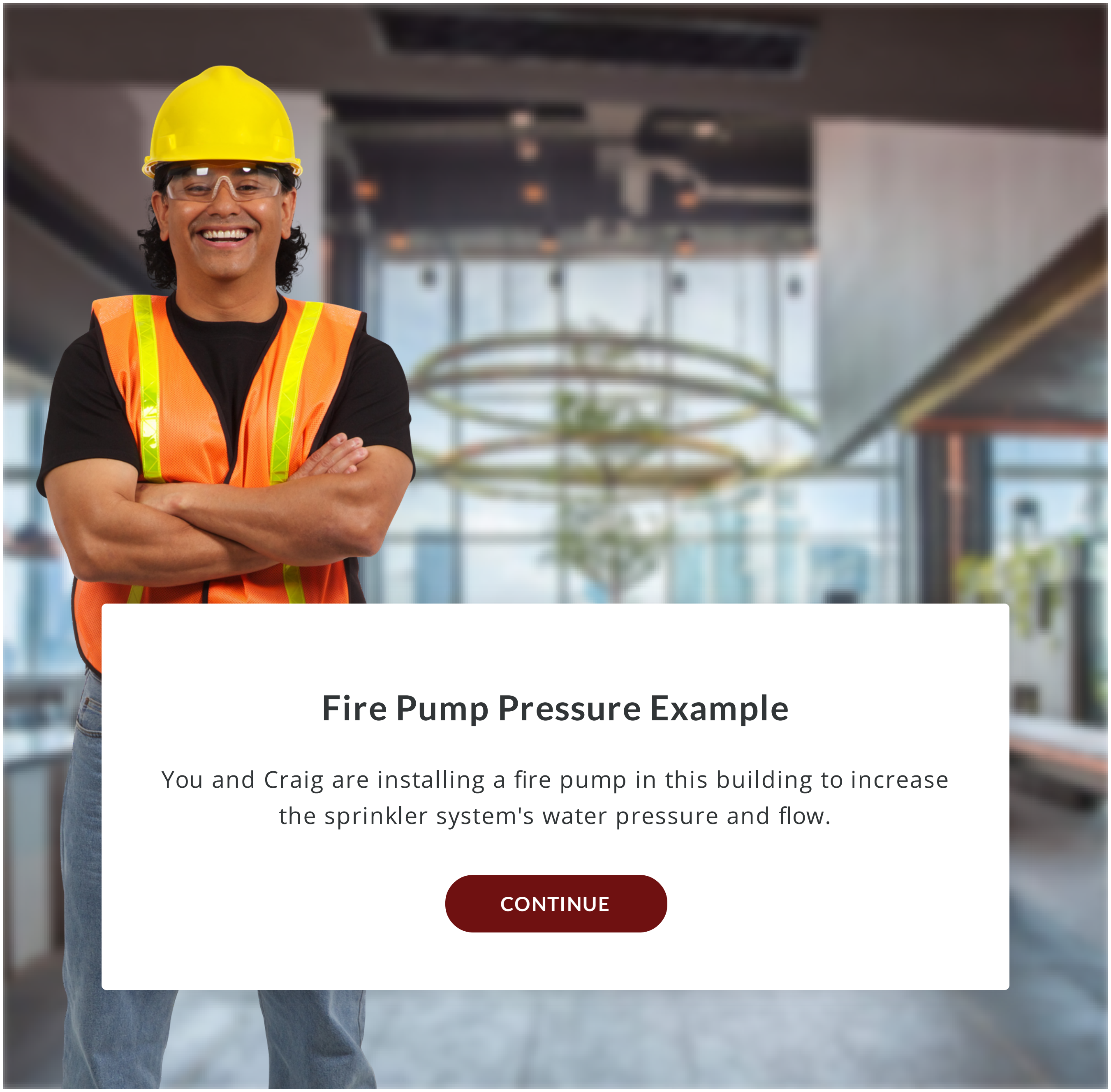
The pump added to the system has the capability of achieving a pressure of 100 PSI.

Energy Output

With the addition of this pump and the energy it provides to the system, the water pressure output/discharge will increase to 130 PSI.

CONTINUE

The following scenario will provide an example of how fire pumps add energy and pressure to a sprinkler system.



Fire Pump Pressure Example

You and Craig are installing a fire pump in this building to increase the sprinkler system's water pressure and flow.

Scene 1 Slide 1

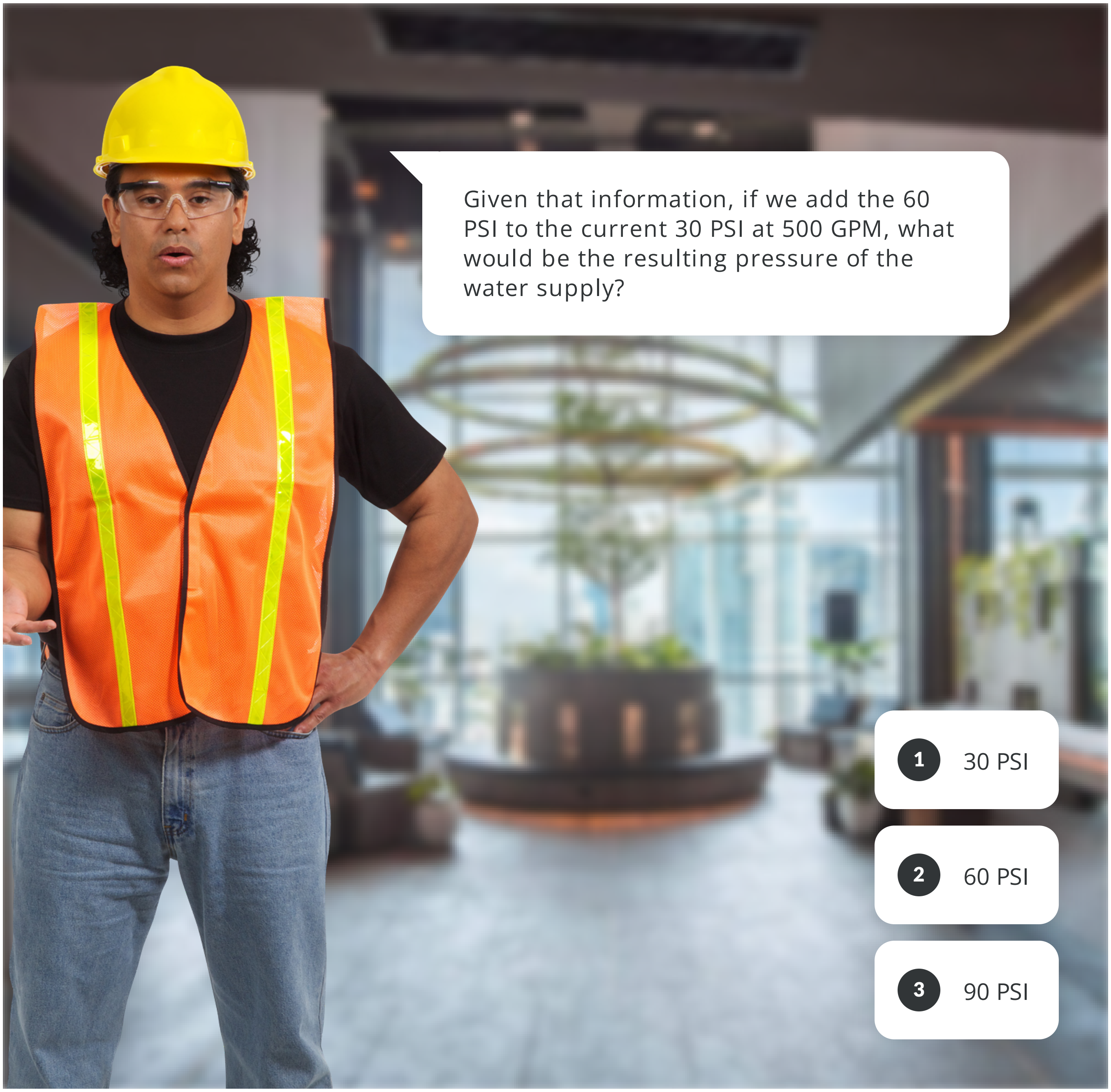
Continue → Next Slide

Hey! It looks like we'll be installing a pump that is rated at 500 GPM at 60 PSI.

Scene 1 Slide 2

And it looks like the building's current water supply can only provide 30 PSI at 500 GPM.

Scene 1 Slide 3



Given that information, if we add the 60 PSI to the current 30 PSI at 500 GPM, what would be the resulting pressure of the water supply?

1 30 PSI

2 60 PSI

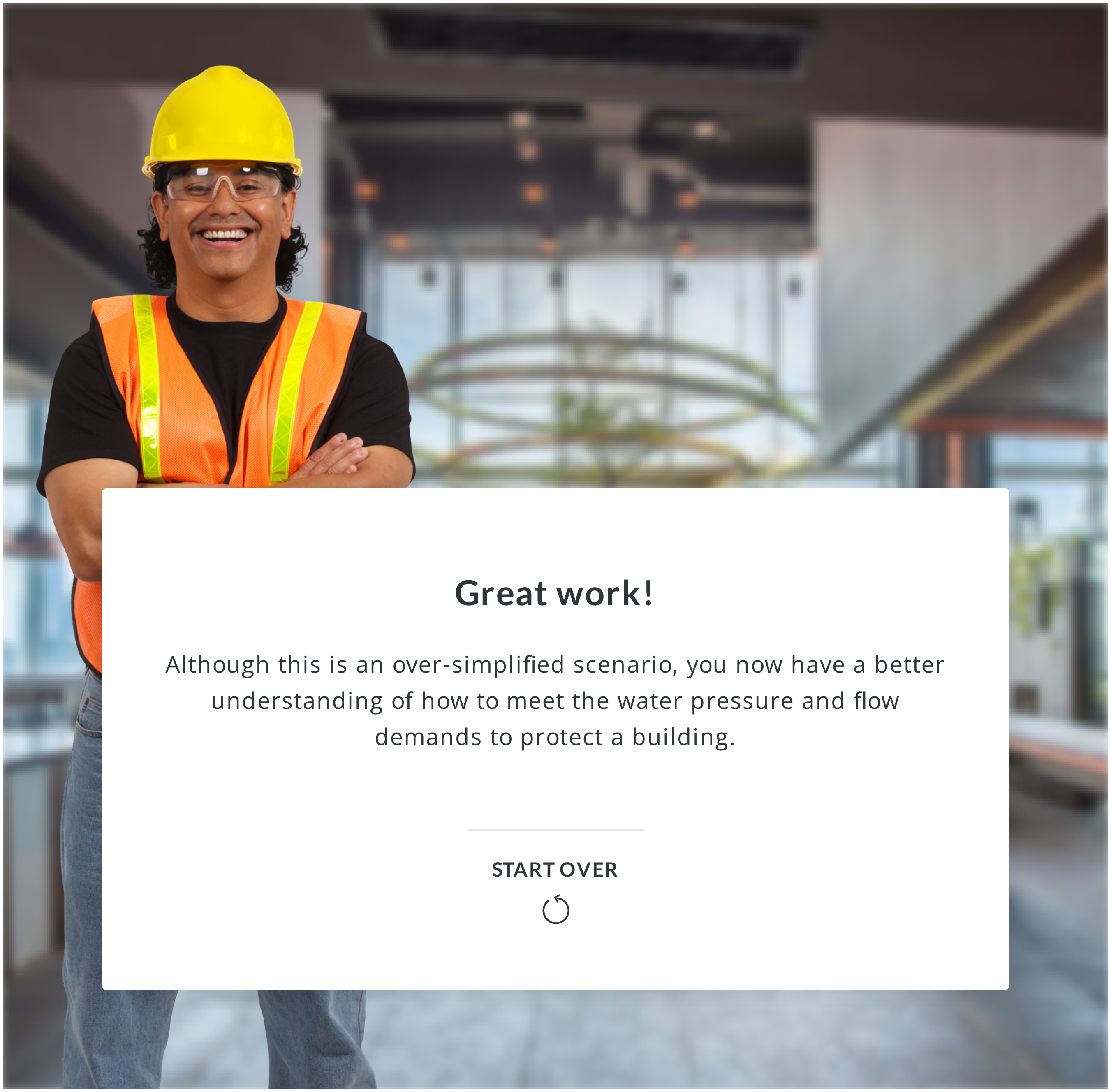
3 90 PSI

Scene 1 Slide 4

0 → Next Slide

1 → Next Slide

2 → Next Slide



Great work!

Although this is an over-simplified scenario, you now have a better understanding of how to meet the water pressure and flow demands to protect a building.

START OVER

↻

Scene 1 Slide 5

Continue → End of Scenario

PUMP SELECTION

Pump Selection

The pumps most often used in the water supply are the horizontal or vertical centrifugal fire pumps.

A centrifugal fire pump is one in which the pressure is developed principally by the action of centrifugal force, or spinning (*NFPA* 20 2016, Section 3.3.44.3). Water in centrifugal pumps enters the suction inlet and passes to the center of the impeller. Rotation of the impeller drives the water by centrifugal force to the rim, where it discharges.

Positive displacement pumps can also be used. This type of pump is one that is characterized by a method of producing flow by capturing a specific volume of fluid per pump revolution and reducing the fluid void by a mechanical means to displace the pumping fluid. (*NFPA* 20 2016, Section 3.3.44.14)

Click through each of the following common types of fire pumps.

HORIZONTAL SPLIT-CASE PUMP | IN-LINE PUMP | END SUCTION PUMP | VERTICAL TURBINE PUMP | MA

As the name implies, a horizontal pump is a pump with the shaft normally in a horizontal position (*NFPA* 20 2016, Section 3.3.44.8).

A horizontal split-case pump is a centrifugal pump characterized by a housing that is split parallel to the shaft (*NFPA* 20 2016, Section 3.3.44.9).

The horizontal split-case pump also has **double-suction**, where water flows into both sides of the impeller. This pump requires 10-pipe diameters of straight piping prior to the suction flange, so they typically **need the most space** of all types of fire pumps.

HORIZONTAL SPLIT-CASE PUMP

IN-LINE PUMP

END SUCTION PUMP

VERTICAL TURBINE PUMP

An in-line pump is a centrifugal pump whose drive unit is supported by the pump having its suction and discharge flanges on approximately the same centerline (*NFPA* 20 2016, Section 3.3.44.10).

These can be driven by both a vertical or horizontal shaft (end suction type). **Vertical shaft types**, which are the most common, have the driver located directly above the pump.

HORIZONTAL SPLIT-CASE PUMP

IN-LINE PUMP

END SUCTION PUMP

VERTICAL TURBINE PUMP

MA

An end suction pump is a single suction pump having its suction nozzle on the opposite side of the casing from the stuffing box and having the face of the suction nozzle perpendicular to the longitudinal axis of the shaft (*NFPA* 20 2016, Section 3.3.44.4).

Simply, this type of pump has a casing with the suction coming in one end and the discharge going out the top, with the suction and discharge piping located at 90 degrees from each other.

Compared to horizontal split-case fire pumps, they are **more compact** and require **less installation space** in a fire pump room, where available space is a concern.

HORIZONTAL SPLIT-CASE PUMP

IN-LINE PUMP

END SUCTION PUMP

VERTICAL TURBINE PUMP

P
MA

A vertical lineshaft turbine pump is designed to move water from an underground well or reservoir and with raw water sources such as ponds, lakes, and rivers. The pumping element is suspended by the conductor system, which encloses a system of vertical shafting used to transmit power to the impellers (*NFPA* 20 2016, Section 3.3.44.18).

A vertical shaft turbine-type pump is typically used in situations where the **water supply is lower than the discharge flange** and the **water supply is not pressurized**.

HORIZONTAL SPLIT-CASE PUMP

IN-LINE PUMP

END SUCTION PUMP

VERTICAL TURBINE PUMP

P MA

A pressure maintenance pump, also known as a **jockey pump**, is one designed to maintain the pressure on the fire protection system(s) between preset limits when the system is not flowing water (*NFPA* 20 2016, Section 3.3.44.15).

These pumps are used when constant or relatively high pressure on the fire protection system is needed.

These **small-capacity, high-pressure** pumps take suction from the fire pump suction line and discharge into the fire pump discharge line on the system side of the indicating control valve.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Rotation of which component on a centrifugal fire pump drives the water to the rim?

○ Shaft

○ Flange

○ Impeller

○ Valve

SUBMIT

Match the following fire pumps to their correct descriptions.

SUBMIT

Complete the knowledge checks above before moving on.

Pump Selection Criteria

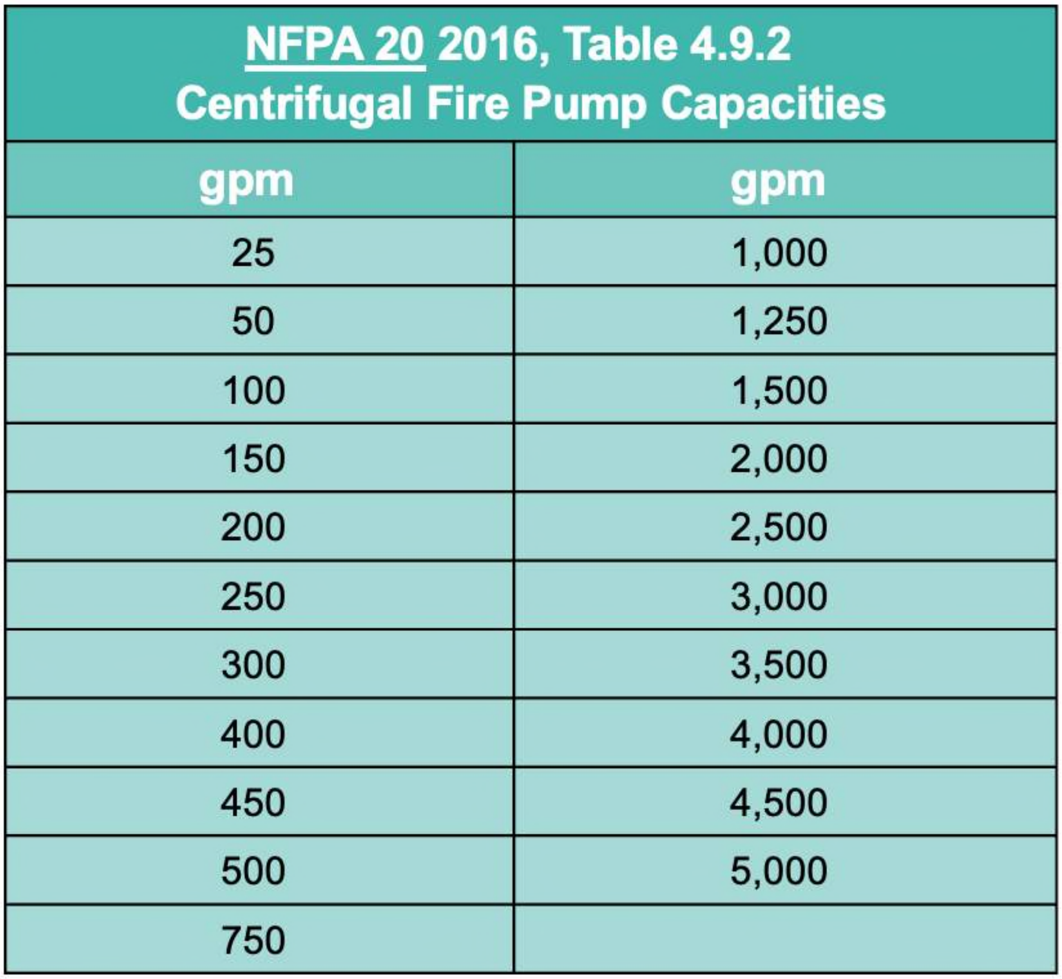
The capacity and pressure of the fire pump must meet the flow and pressure requirements with the water supply available. The fire pump must also supply additional pressure needed to meet the system demand pressure that is above the required water supply pressure at the desired system capacity, while also covering frictional losses and head pressure requirements.

With all the different types of pumps to choose from, the pump sizing starts with an analysis of the water supply.

The following formula utilizes the water supply's pressure requirements to determine proper pump selection.

$$P_{\text{pump}} + P_{\text{water supply}} \geq P_{\text{system demand}} + P_{\text{friction losses}} + P_{\text{head}}$$

NFPA 20 2016 stipulates pumps must have a **minimum pressure of 40 PSI** and have only **certain capacities as shown in Table 4.9.2** (seen below). It is important that you select a listed pump as shown in the table, even though this may provide more capacity than is needed from purely a design standpoint.



NFPA 20 2016, Table 4.9.2
Centrifugal Fire Pump Capacities

gpm	gpm
25	1,000
50	1,250
100	1,500
150	2,000
200	2,500
250	3,000
300	3,500
400	4,000
450	4,500
500	5,000
750	

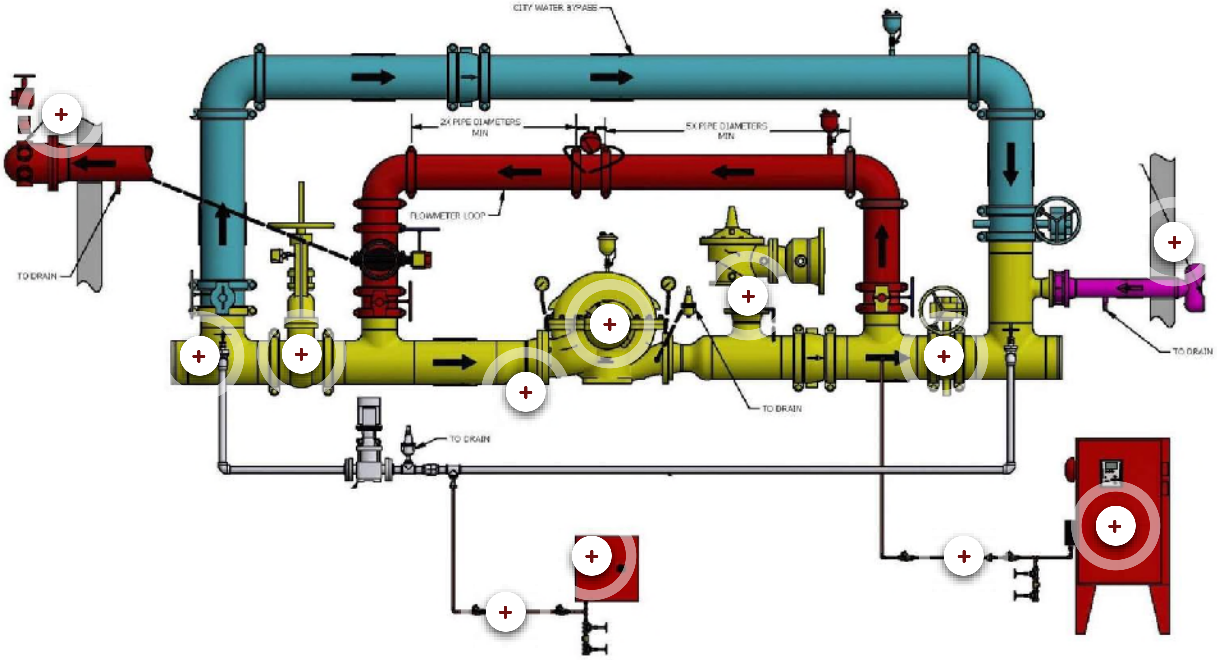
FIRE PUMP COMPONENTS

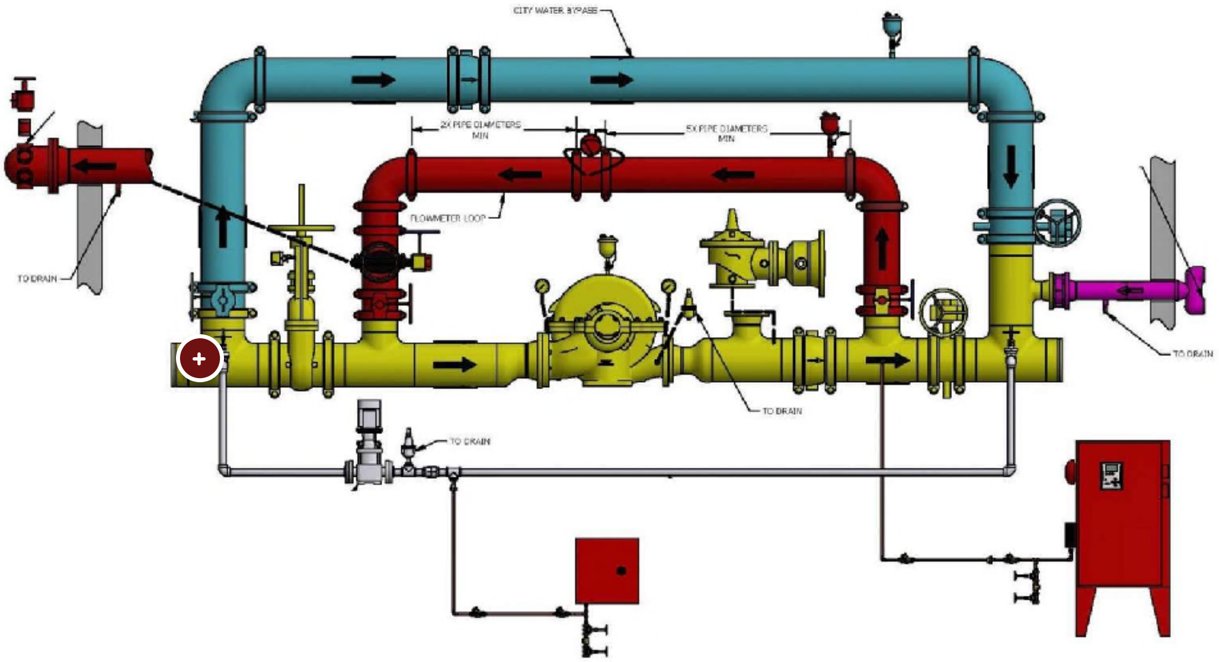
Fire Pump Components

In addition to selecting the correct type of pump, each pump is comprised of specific components that allow them to operate and produce enough pressure for its assigned fire protection system.

These components will be discussed in greater detail as they pertain to the general requirements of fire pumps as outlined in *NFPA* 20 2016.

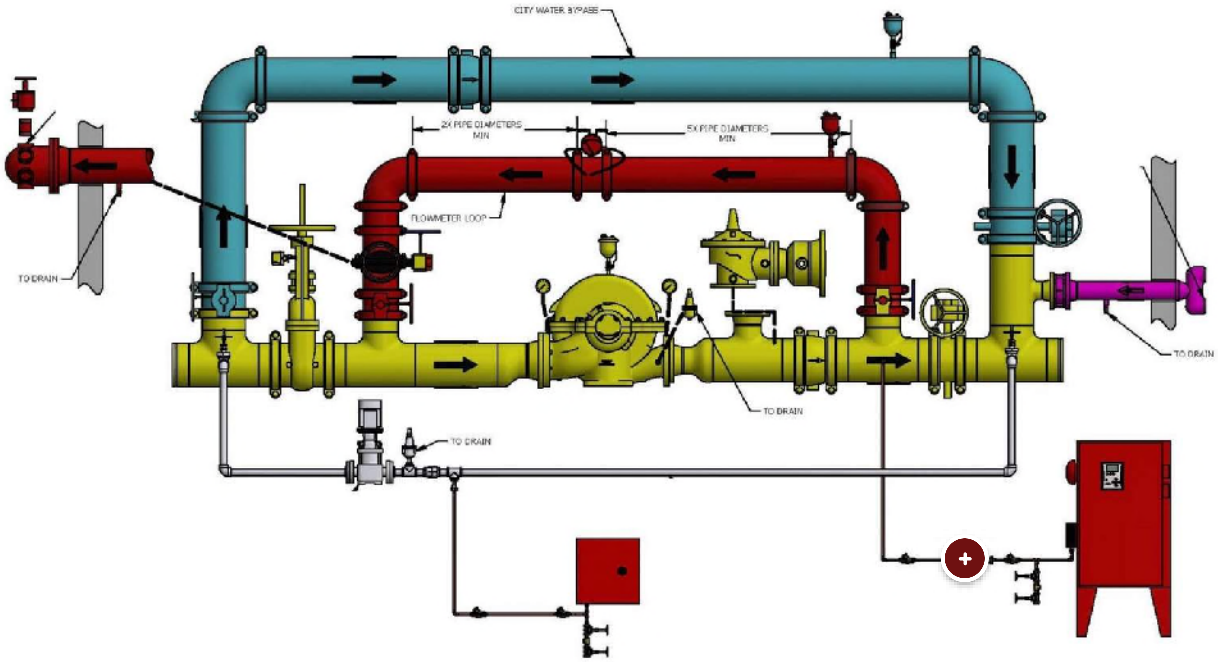
Click on the "+" icons to view the components of a fire pump within a sprinkler system.





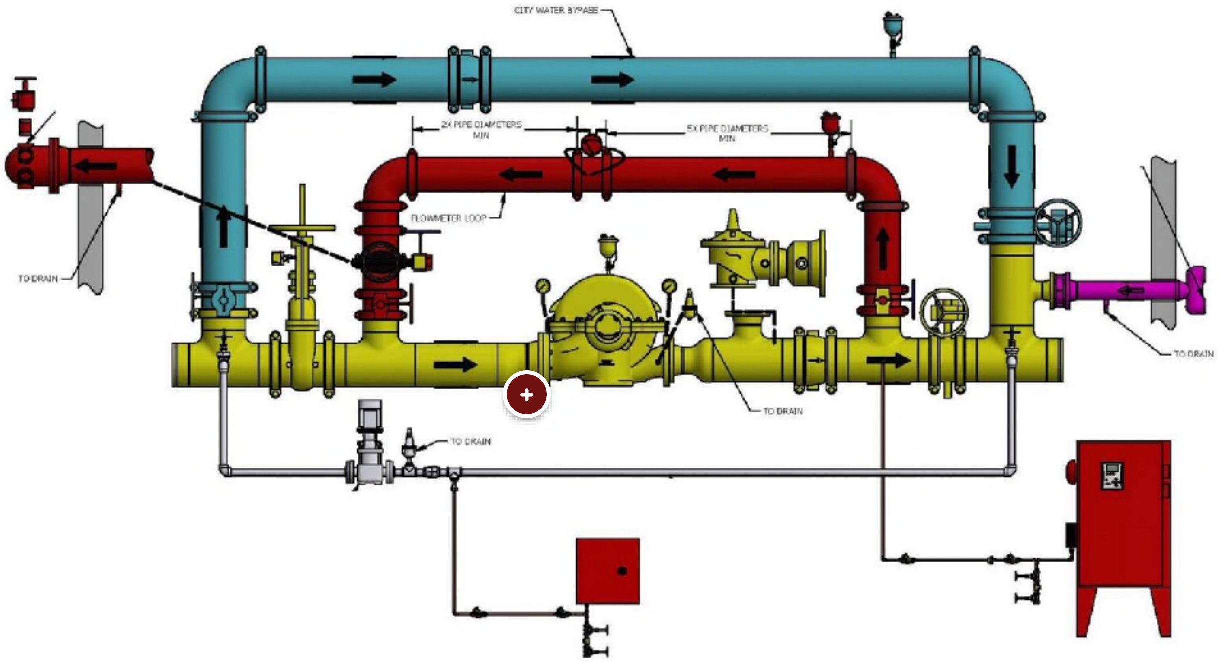
Jockey Pump Connection

Where a jockey pump is connected to the system.



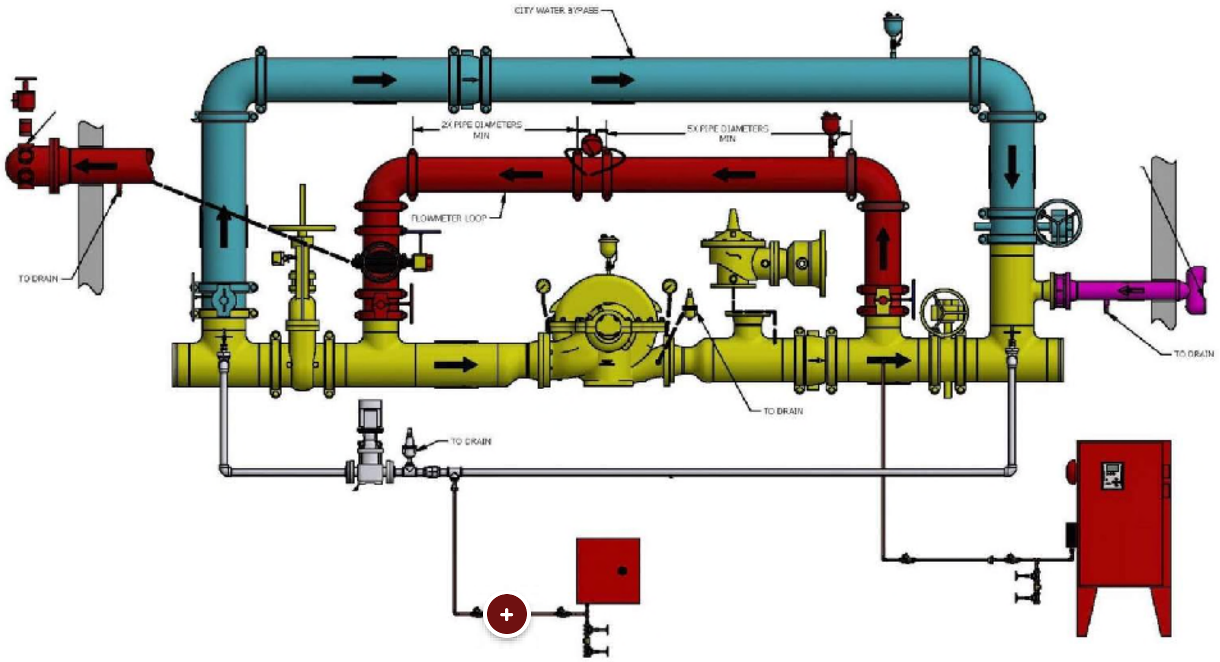
Sensing Line (Fire Pump Controller)

This provides the controller the ability to sense pressure change in the fire protection system when the fire pump is fully in service, but also allows testing of the pressure settings even if the pump discharge control valve is closed.



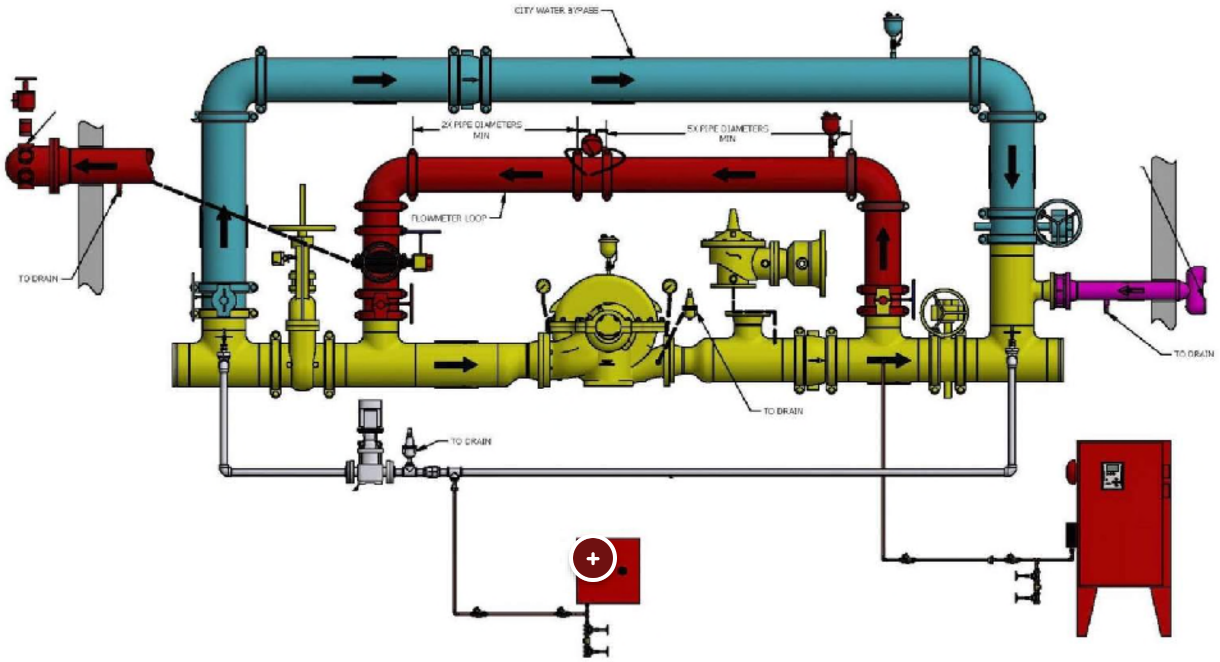
Eccentric Tapered Reducer

An eccentric reducer is used on the suction side of a pump to reduce the likelihood of air pockets entering the pump impeller.



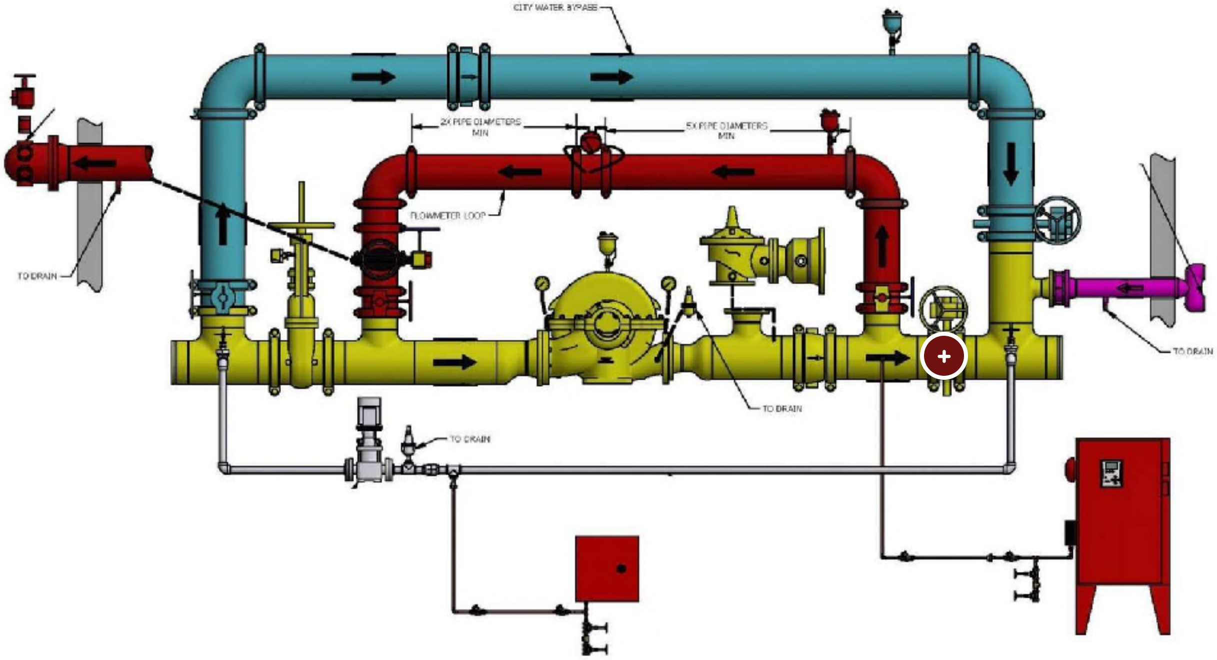
Sensing Line (Jockey Pump)

This provides the jockey pump controller the ability to sense any pressure changes in the fire protection system when the jockey pump is fully in service.



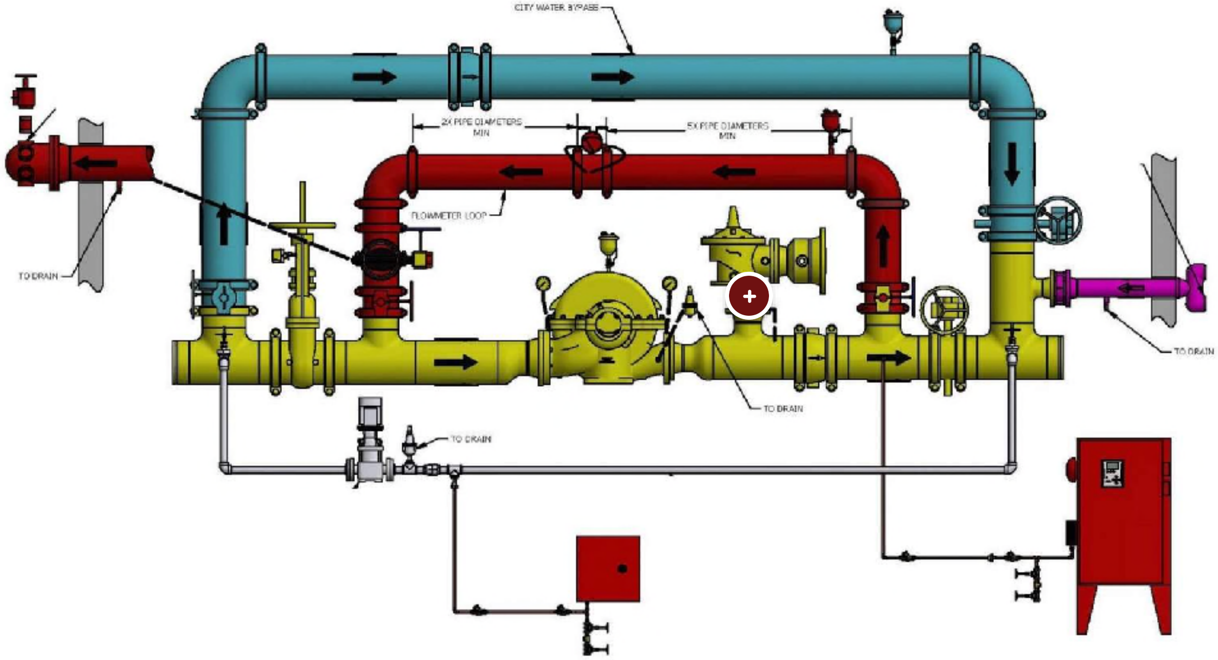
Jockey Pump Controller

If a jockey pump is used, it must have its own controller. It is used to start the jockey pump when the pressure in the fire protection system decreases to a preset level and to stop the jockey pump when the pressure increases to a preset level.



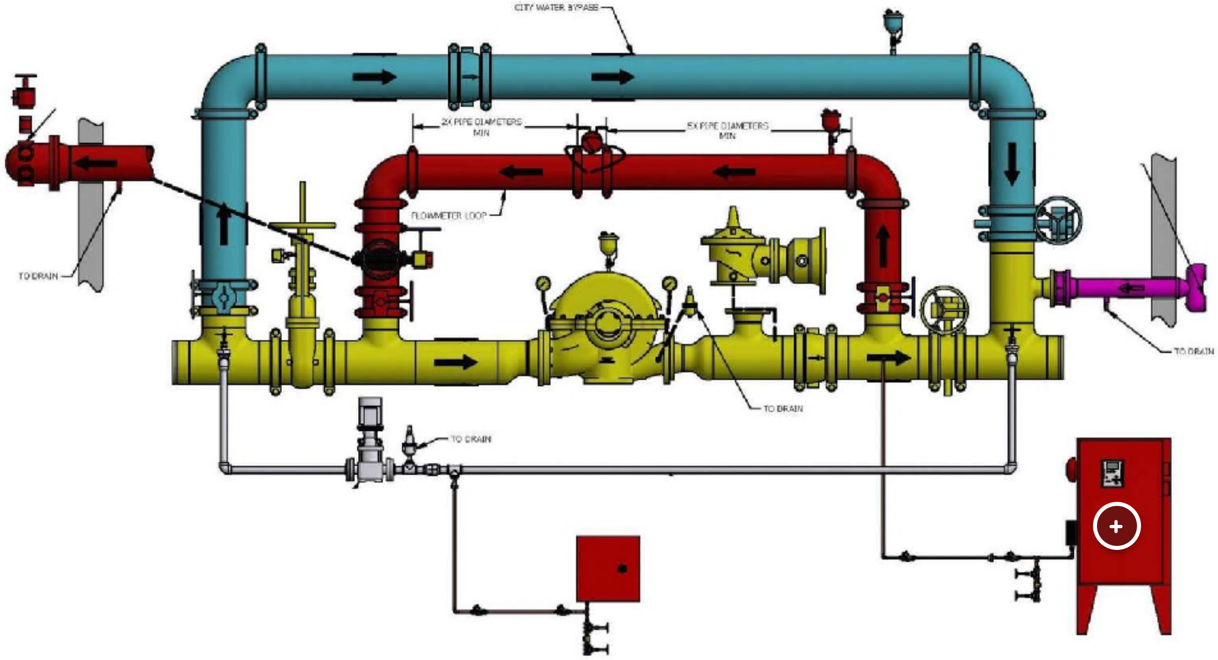
Control valve

Can be "opened" and "closed" to control the pump discharge flow into the system.



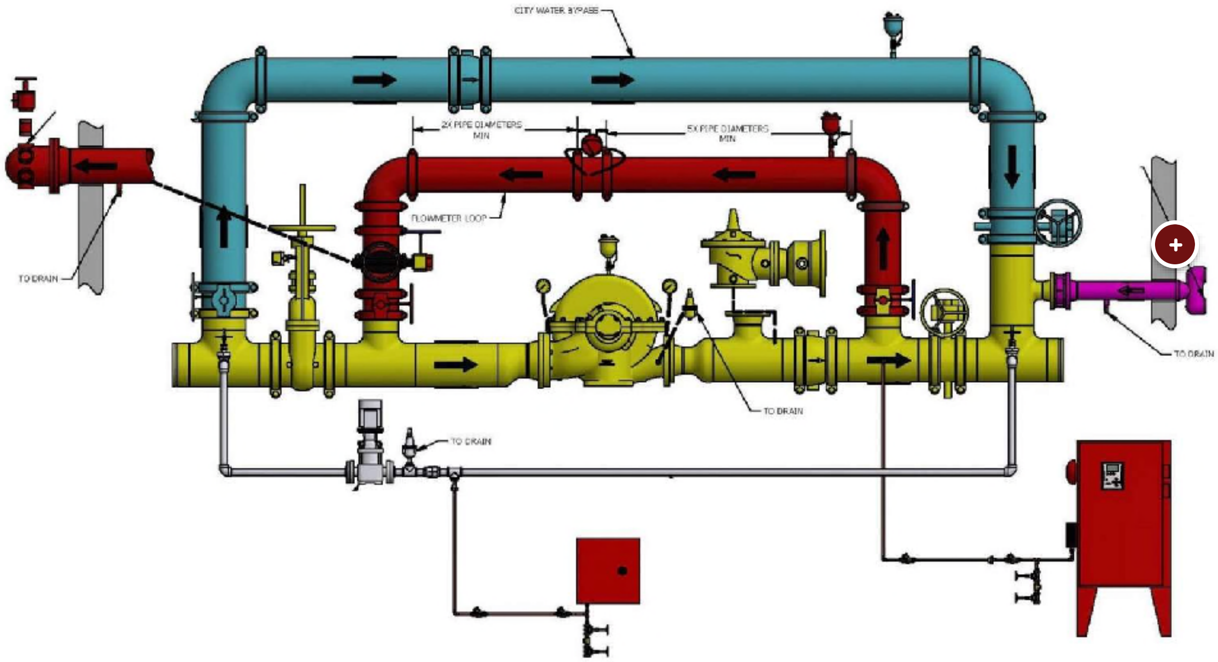
Main Relief Valve

A relief valve is intended to relieve pressure when a diesel engine is turning faster than normal, or when failure of the variable speed controls causes a pump to operate at rated speed.



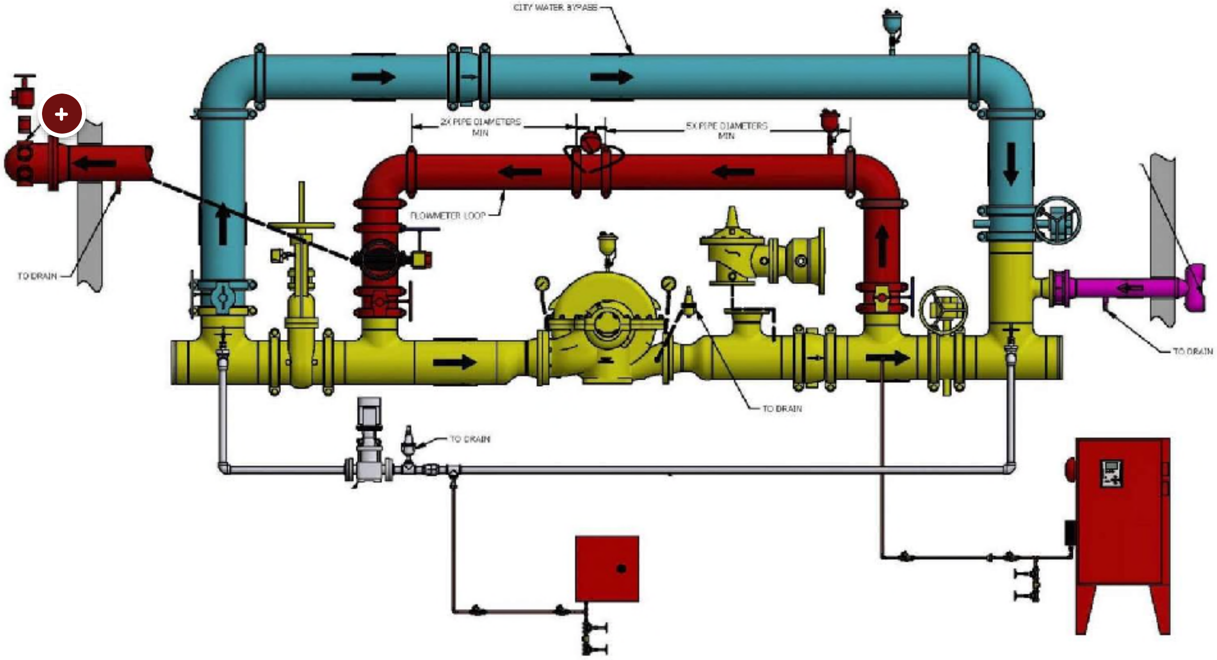
Fire Pump Controller

The fire pump controllers are used to monitor and to start and stop fire pumps.



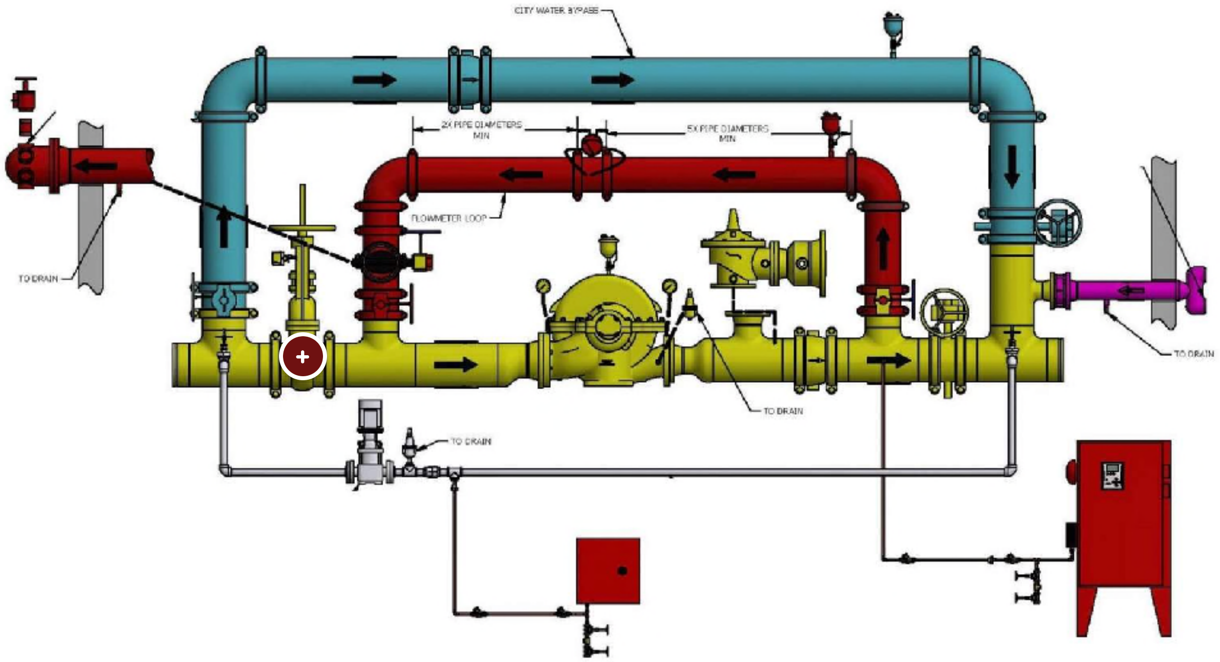
Fire Department Connection (FDC)

The FDC provides a point of connection where pressures and flows can be supplemented by the fire department engine pumper during fire-fighting operations.



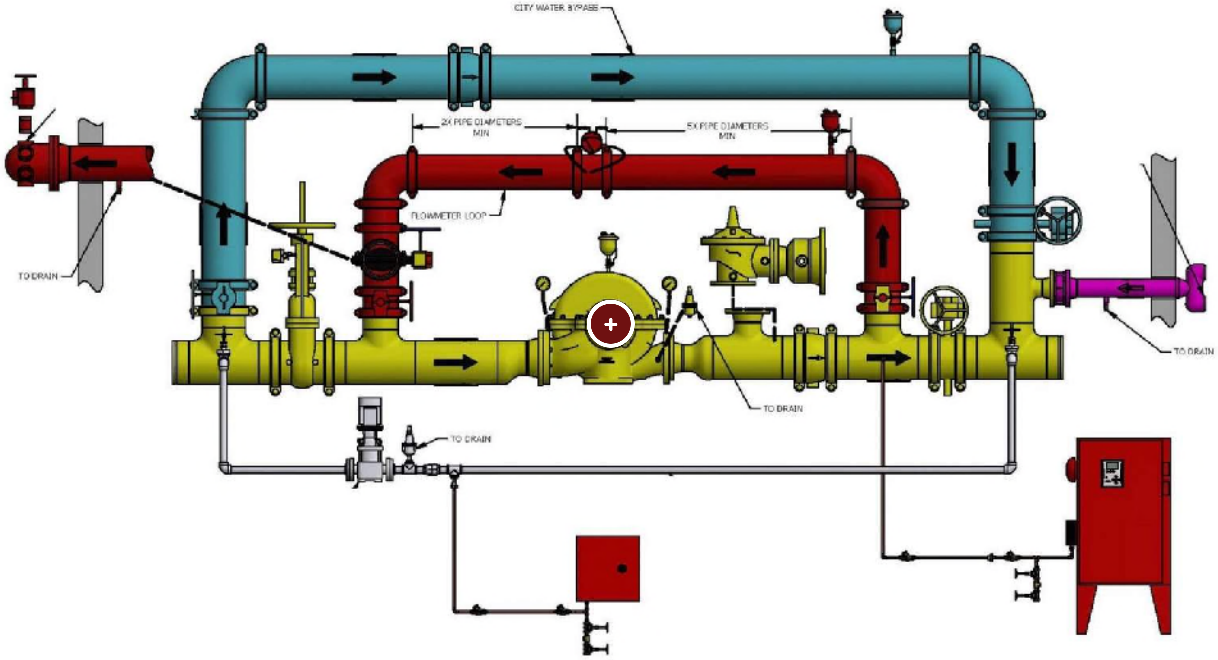
Hose Valve Header

Allows for the flowing of large quantities of water through multiple hoses.



OS&Y Gate Valve (Pump Suction)

The OS&Y gate valve serves two purposes. When the valve is in the fully open position, the liquid passageway is clear of any obstructions that may cause turbulence to the fire pump. The OS&Y valve also provides a way to isolate the fire pump from the liquid supply so a repair can be made to the pump.



Horizontal Split-Case Fire Pump

A centrifugal pump characterized by a housing that is split parallel to the shaft.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Which of the following are factors in determining proper pump selection? (Select all that apply)

☐ Water supply

☐ Water temperature

☐ System demand

☐ Friction loss

☐ Velocity

☐ Head pressure

☐ Suction head

SUBMIT

According to *NFPA* 20 2016, pumps must have a minimum pressure of ___ PSI.

○ 25

○ 40

○ 50

○ 150

SUBMIT

Which component of the fire pump system is used to control the pump discharge flow into the system?

○ Hose valve header

○ OS&Y gate valve

○ Main relief valve

○ Control valve

SUBMIT

🔒 Complete the knowledge checks above before moving on.

Lesson 2 of 3

General Fire Pump Requirements

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Compare the types of drivers for fire pumps.

☐ Specify the operational capacities for listed pumps.

☐ Recall the purpose of circulation relief valves.

☐ Apply the necessary requirements to ensure proper protection of fire pumps.

Key References

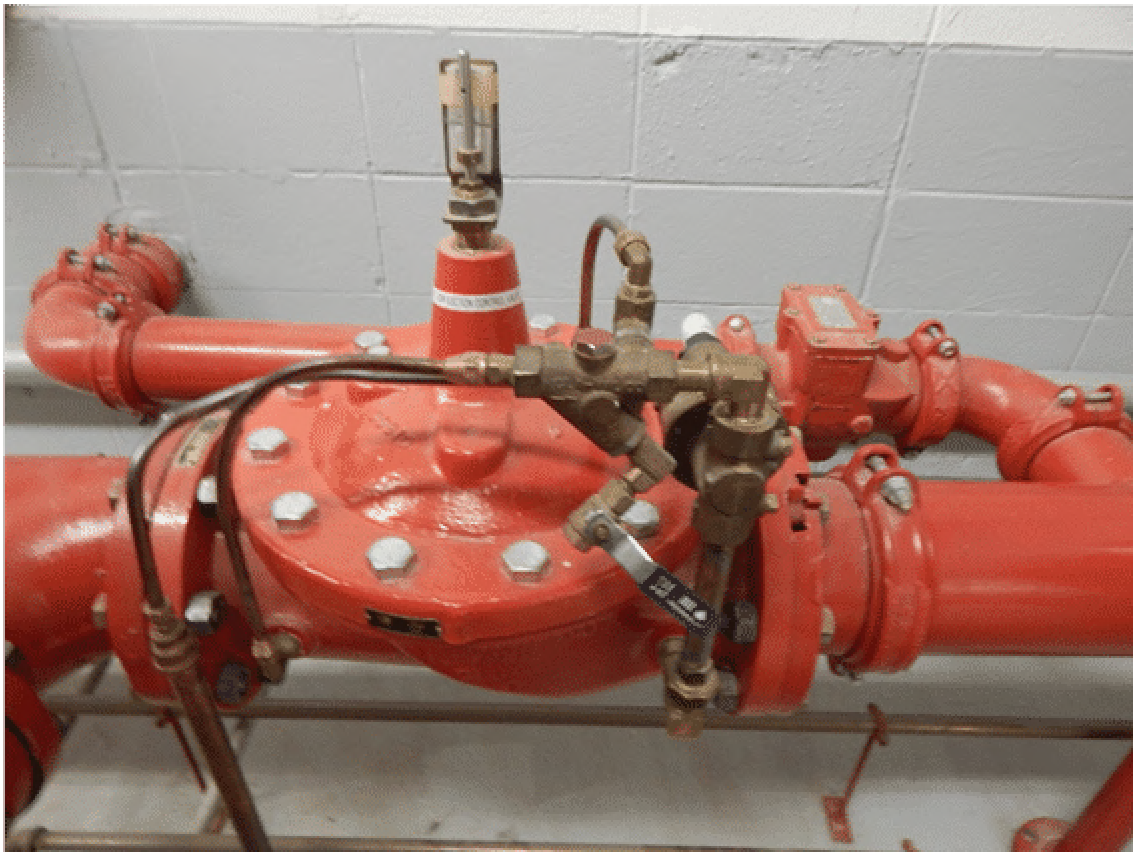
- *NFPA* 20 – *Standard for the Installation of Stationary Pumps for Fire Protection*, 2016
- *NFPA Fire Protection Handbook*, 2008

LET'S BEGIN

NFPA 20 2016, Chapter 4

Chapter 4 discusses the general requirements found in *NFPA* 20 2016. Know and understand the topics covered, including water supplies, listed pump capacities, gauges, suction and discharge piping, relief valves, and pressure maintenance (jockey) pumps.

This lesson will cover the topics of water supplies, listed pump capacities, and equipment protection.



The requirements in the standard apply to horizontal or vertical shaft centrifugal single-stage and multistage pumps and horizontal or vertical shaft positive displacement pumps.

Pumps other than those described in the standard are permitted but are limited to capacities **less than 500 GPM**.

WATER SUPPLY

Water Supply

NFPA 20 2016, Section 4.6

When it comes to fire sprinkler systems, you must have a **reliable water supply**. The water supply should be **capable of providing the required flow and pressure** to a piping system, onto which the fire sprinklers are connected.

Here are a few of the different types of water supplies for fire pumps.

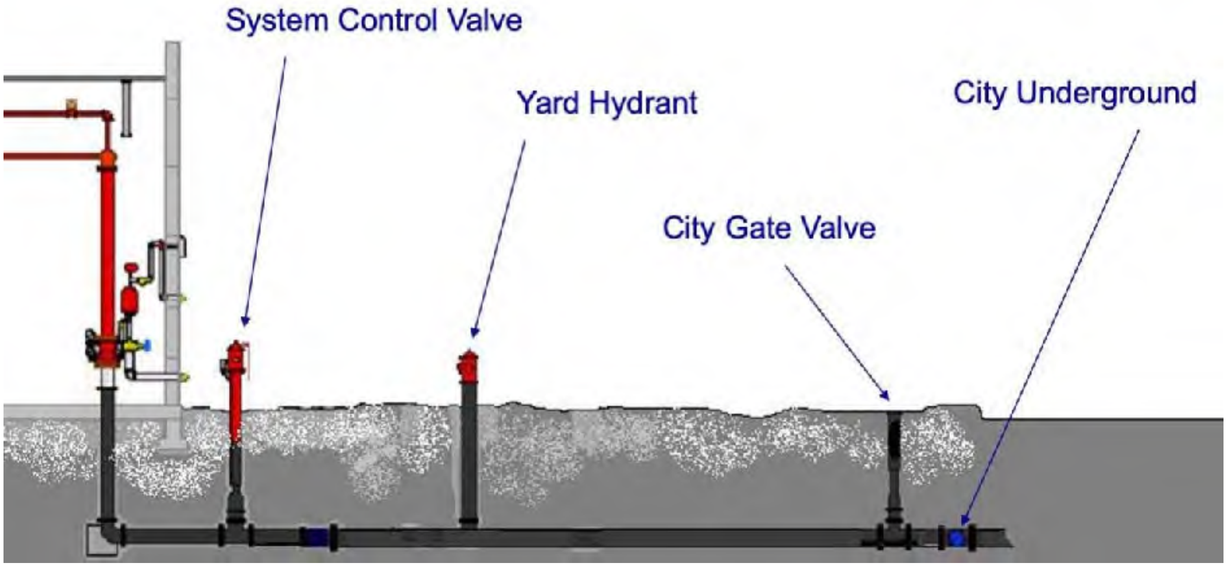
MUNICIPALITY

CITY AND FIRE PUMP HOUSE

STORAGE TANK AND FIRE PUMP

GRAVITY TANK

Water can be supplied by the municipality.



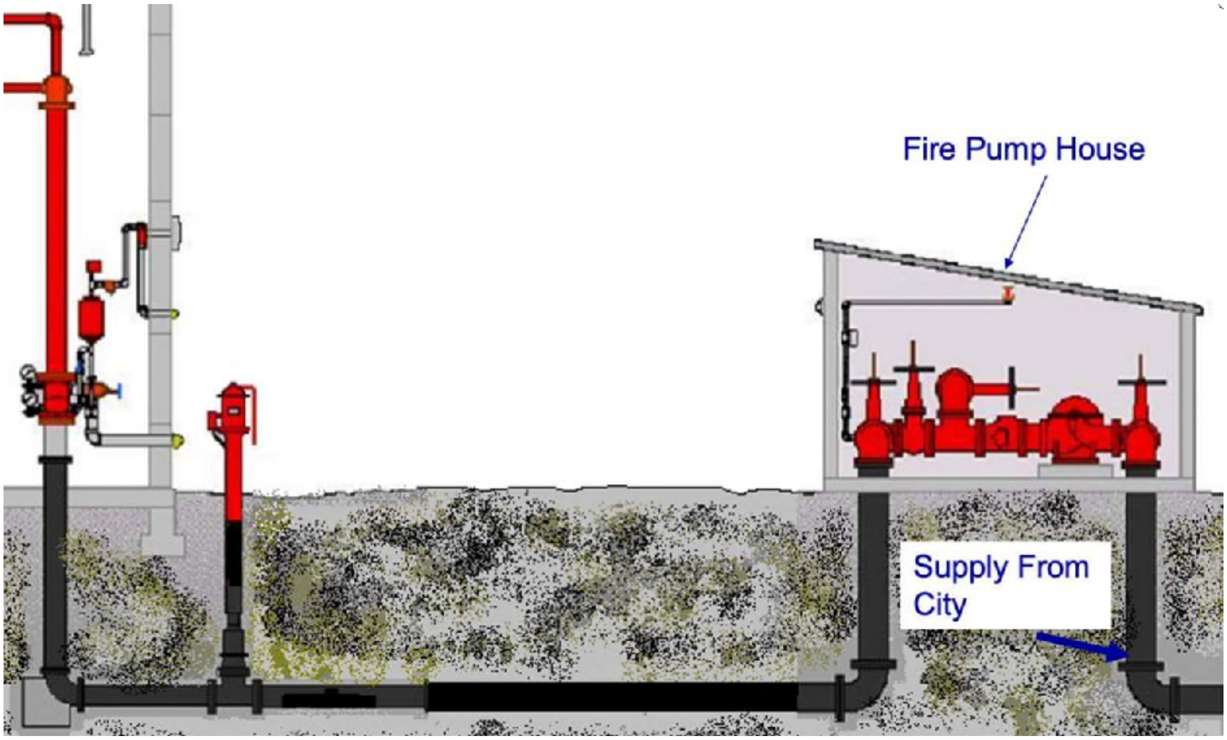
MUNICIPALITY

CITY AND FIRE PUMP HOUSE

STORAGE TANK AND FIRE PUMP

GRAVITY TANK

Water can be supplied by the city water and boosted by fire pump.



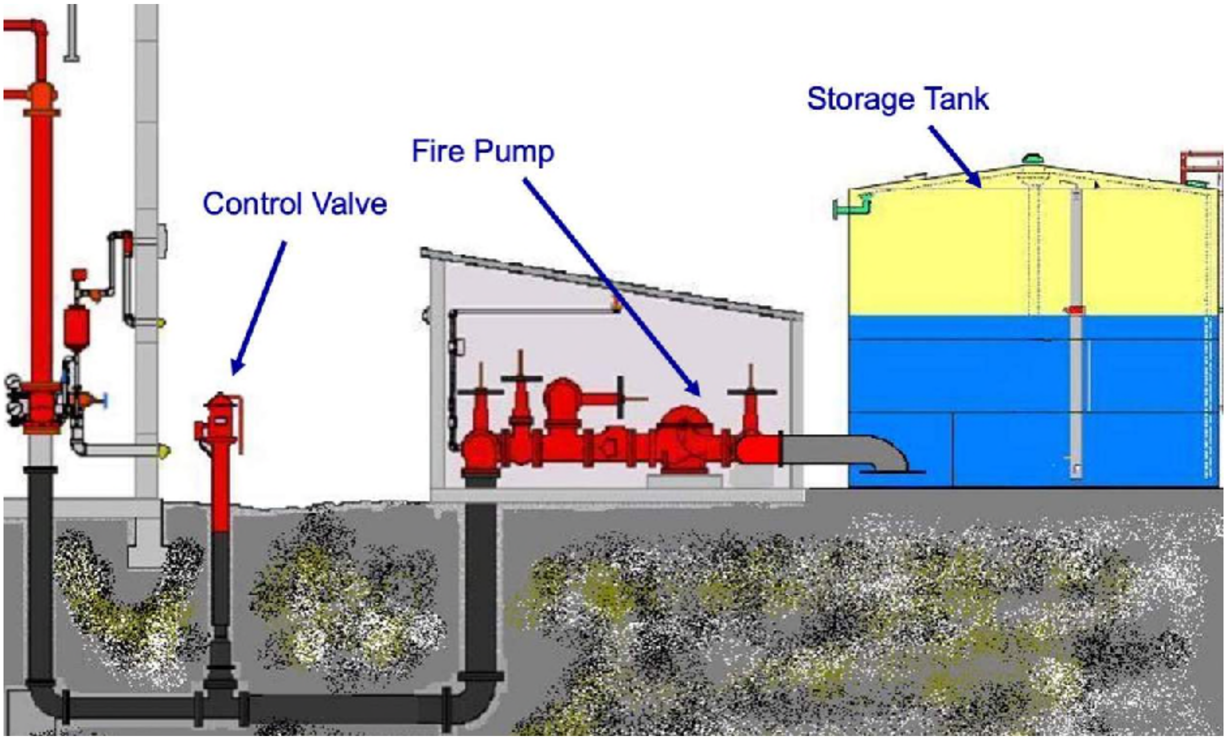
MUNICIPALITY

CITY AND FIRE PUMP HOUSE

STORAGE TANK AND FIRE PUMP

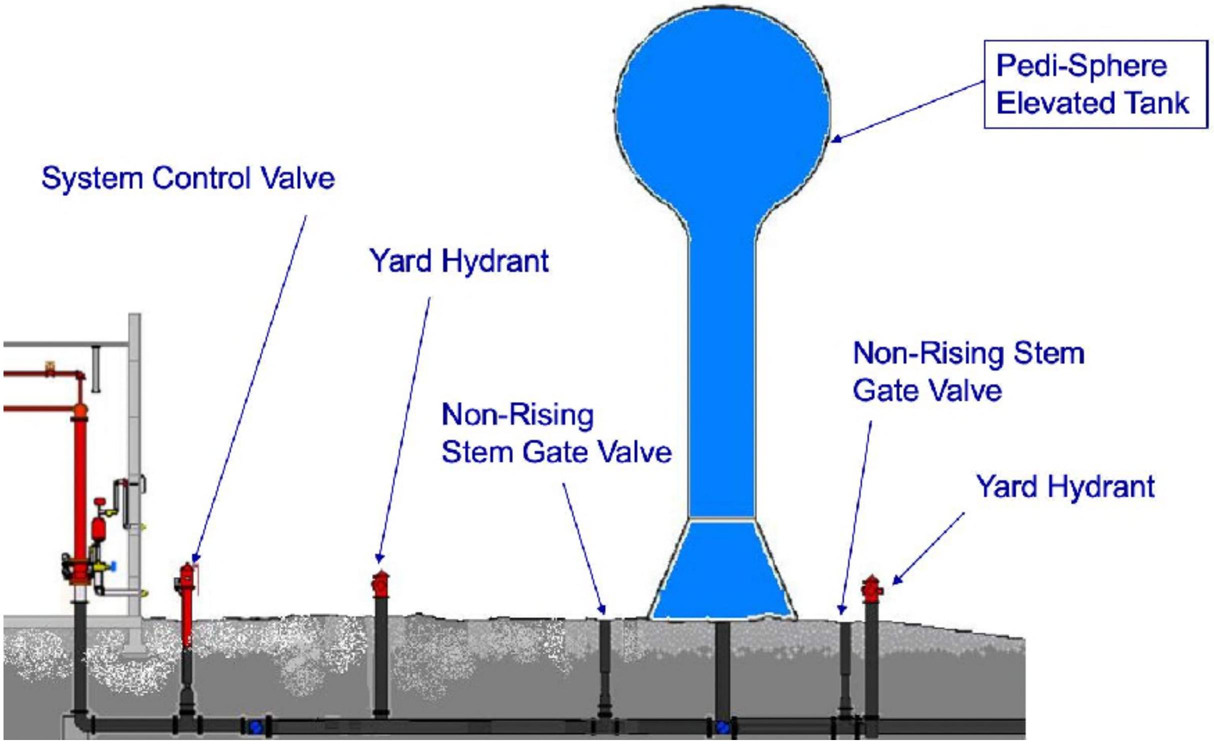
GRAVITY TANK

Water can be supplied by a storage tank and cycled through a fire pump.



MUNICIPALITY	CITY AND FIRE PUMP HOUSE	STORAGE TANK AND FIRE PUMP	GRAVITY TANK

Gravity tanks can be a city water supply for municipalities, which can supply fire pumps.



Images courtesy of Viking Group, Inc.

The head available from a water supply is determined by a **flow test** and is determined on the **basis of a flow of 150% of the rated capacity** of the fire pump.

ⓘ **If a water flow test is used to determine water supply adequacy, it is required to be completed no more than 1 year before submitting the working plans, unless permitted by the AHJ. (*NFPA* 20 2016, Section 4.6.1.2)**

Specific water supply requirements are not contained in *NFPA* 20 2016. Water supply capacity and pressure requirements are contained in the following NFPA standards:

- *NFPA* 13 - *Standard for the Installation of Sprinkler Systems*
- *NFPA* 14 - *Standard for the Installation of Standpipe and Hose Systems*
- *NFPA* 15 - *Standard for Water Spray Fixed Systems for Fire Protection*
- *NFPA* 16 - *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*
- *NFPA* 24 - *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*

LET'S REVIEW

Let's do a quick check about what has been covered so far.

True or false: A lake can be used as a water supply source for a fire pump.

○ True

○ False

SUBMIT

🔒 Complete the knowledge check above before moving on.

Pumps, Drivers, and Controllers

NFPA 20 2016, Section 4.7

Acceptable drivers for fire pumps include the following:

- Electric motors
- Diesel engines
- Steam turbines
- A combination of the above

Each pump is required to have its own dedicated driver, and a pump can only be equipped with one driver.

ELECTRIC MOTORS

Electric Motors

The objective of an electric motor is the **continuity of power** to drive the fire pump motor in the event of a fire. They are typically used where there is a **reliable source of power**.

There are various factors that determine the **size of an electric fire pump**:

- Desired flow and head
- Site voltage

- Full versus reduced voltage starting method based on electrical design

Watch the following video to get a better understanding of electric-driven fire pumps.

Run time 4:11

DIESEL ENGINES

Diesel Engines

Diesel engine–driven fire pumps are often used where there is **insufficient or unreliable electrical power** for an electric motor–driven fire pump. They are used in conjunction with, or in addition to, electric motor–driven fire pumps as the best combination for reliable pumping systems.

When combined with on-site water storage — such as a ground storage tank, an underground reservoir, a tower, a pond, or a well — a diesel-driven fire pump is completely **self-contained**.

Diesel engine fire pumps are especially nice because of their **reliability** and their **inexpensive control panel**.

Properly designed and installed diesel-driven fire pump units **can also survive extended periods in the absence of AC power**. Some installations can remain in extended service when the fire pump controller, engine, and other battery loads are low enough for the weekly run function to replenish the batteries, depending on the availability of fuel.

Watch the following video to get a better understanding of diesel-driven fire pumps.

Run time 2:00

STEAM TURBINES

Steam Turbines

Steam-driven fire pump technology has evolved to its current state over many years. The application of steam as a driver for fire pumps is **not as common** as that of electric driver or diesel engine driver, because **steam is not as readily available as it once was**. Furthermore, steam generation is **not very energy efficient**, so other forms of heating have been developed for most modern buildings. In fact, the number of new installations of steam-driven fire pumps worldwide is decreasing steadily each year.

Steam has to be generated by a separate unit (boiler, steam generator, etc.) and steam must either be available at all times or there is a **delay while the steam is generated** and the generators need to be provided with emergency fuel and power.

The only places these pumps are seen are in older installations that are using steam for other process, such as **power plants, factories and other industrial settings**.

LET'S REVIEW

Let's do a quick check about what has been covered so far regarding acceptable drivers for pumps.

Electric Motor

Typically used where there is a reliable source of power

Full vs reduced voltage starting methods

Diesel Engine

Used where there is insufficient or unreliable electrical power

Completely self-contained when combined with on-site water storage

Utilizes an inexpensive control panel

Steam Turbine

Not as common of a driver as it used to be

May rely on emergency fuel and power

Typically found in power plants and factories

Complete the card matching above before moving on.

Centrifugal Pump Capacities

NFPA 20 2016, Section 4.9

A centrifugal fire pump for fire protection shall be selected to operate at **less than or equal to 150% of the rated capacity**.

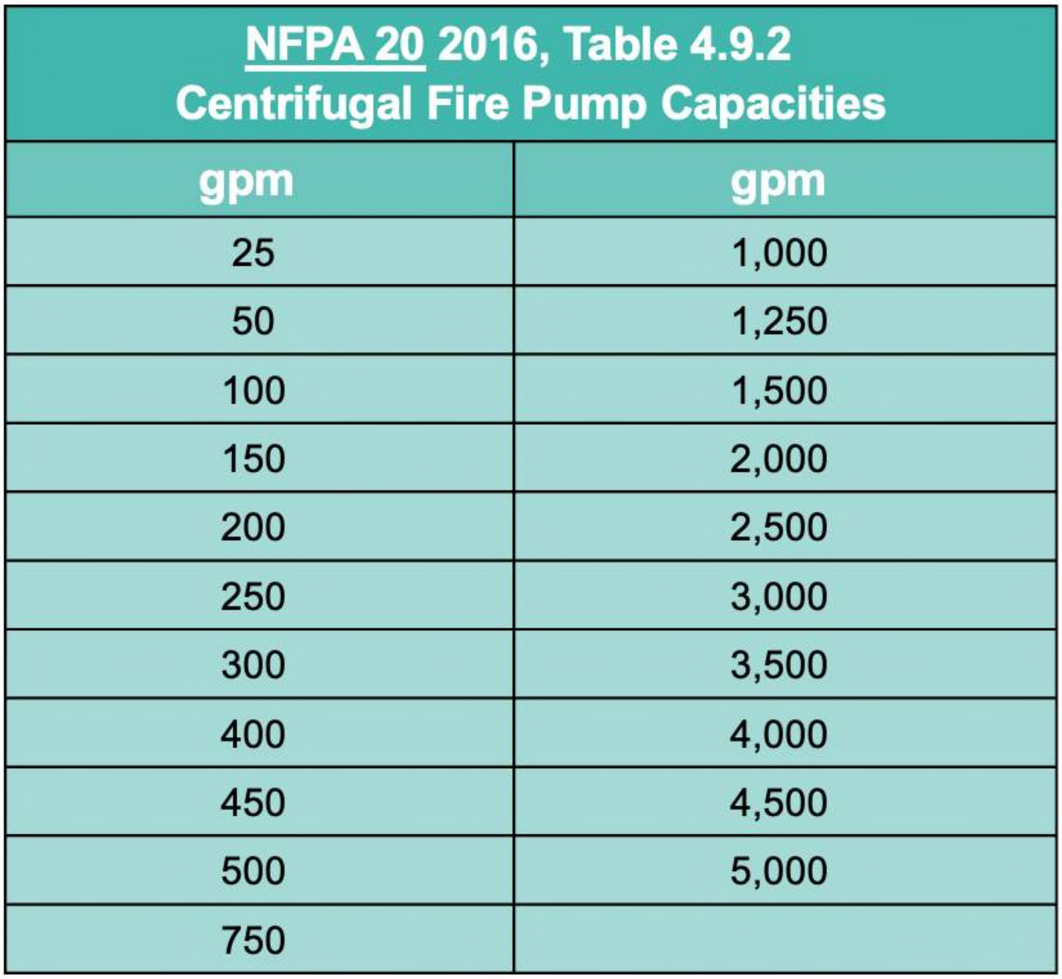
The Annex provides further guidance:

- The performance of the pump when applied at capacities **over 140% of rated capacity** can be **adversely affected by the suction conditions**.
- Application of the pump at capacities **less than 90%** of the rated capacity is **not recommended**.

The selection and use of the fire pump should **not be confused with pump operating conditions**. Under proper suction conditions, the pump can operate at any point on its characteristic curve from **shutoff to 150% of its rated capacity**.

Centrifugal fire pumps are required to have one of the rated capacities contained in the following table and be rated at **net pressures of 40 PSI or above**. Centrifugal fire pumps with **ratings above 5000 GPM** are subject to **individual review by the** AHJ **or a listing laboratory**.

Table 4.9.2 shows the requirements for centrifugal fire pump capacities.



NFPA 20 2016, Table 4.9.2
Centrifugal Fire Pump Capacities

gpm	gpm
25	1,000
50	1,250
100	1,500
150	2,000
200	2,500
250	3,000
300	3,500
400	4,000
450	4,500
500	5,000
750	

CIRCULATION RELIEF VALVES

Circulation Relief Valves

NFPA 20 2016, Section 4.12

When a centrifugal fire pump is operating at churn, energy is **continuously imparted to the water in the impeller**, causing the **water to heat**. For electric driver fire pumps and radiator-cooled engine–driven fire pumps, a listed circulation relief valve is needed to provide cooling water when the pump is operating at churn. Failure or the omission of this valve can result in overheating and subsequent damage to the fire pump.

The automatic circulation relief valve is required to be set at a **minimum of 5 PSI lower than the operation set pressure**, if an electric variable speed pressure limiting controller is installed.

Each pump is **required** to have an automatic relief valve listed for the fire pump service installed and set below the shutoff pressure at the minimum expected suction pressure. The valve shall be **installed on the discharge side of the pump** before the discharge check valve and shall provide sufficient flow to prevent the pump from overheating when operating with no discharge.

Casing/Circulation relief valve. Image courtesy of SPP Pumps

EQUIPMENT PROTECTION

Equipment Protection

NFPA 20 2016, Section 4.13

This section provides requirements and guidance on the proper placement of a fire pump and related equipment. It is also intended to provide a relatively safe environment for the equipment operator.

The fire pump, driver, controller, water supply, and power supply are required to be **protected from possible interruption of service** through damage caused by any of the following conditions:

- Explosion
- Fire
- Flood
- Earthquake
- Rodents
- Insects
- Windstorm
- Freezing
- Vandalism
- Other adverse conditions

Equipment Protection Requirements

Click on the "Start" button to view the requirements that ensure proper protection of fire pumps.

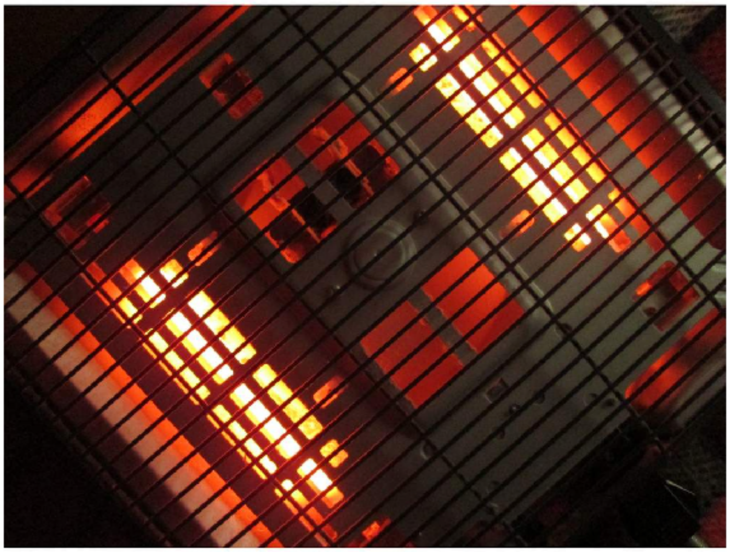
Protection Requirement 1

High-Rise Buildings

Fire pumps in high-rise buildings are required to be protected from surrounding occupancies by a minimum of 2-hour fire-rated construction or be physically removed from the building by a minimum of 50 ft.

Protection Requirement 2

Source of Heat



An approved source of heat is required to maintain the pump room or pump house at a temperature above 40 degrees.

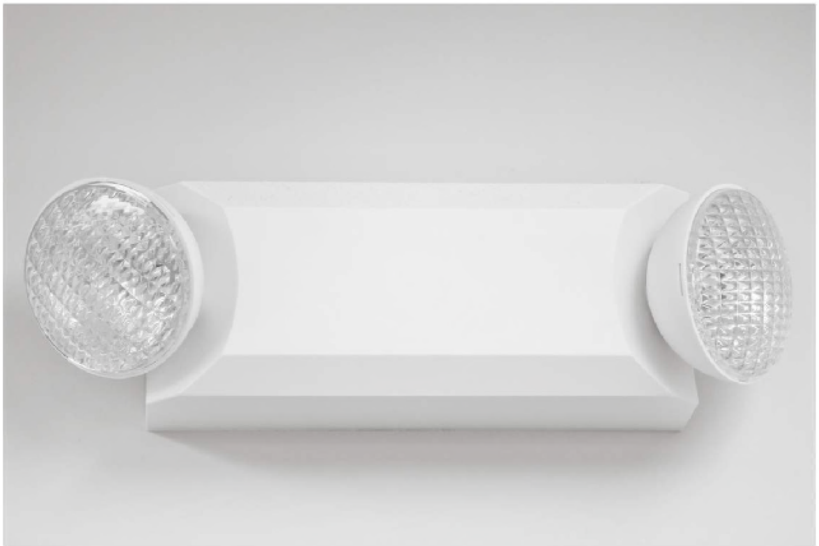
Protection Requirement 3

Artificial Light

The standard requires that artificial light be provided in the pump room or pump house.

Protection Requirement 4

Emergency Lighting



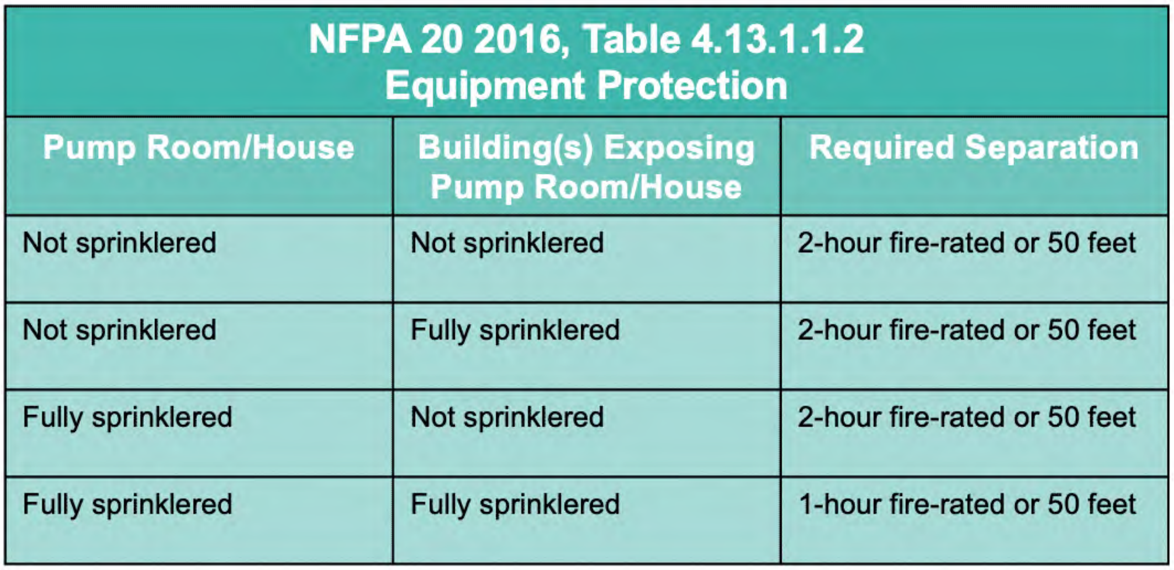
Emergency lighting is also required to be provided, capable of maintaining the lighting level for a minimum of 2 hours.

Protection Requirement 5

Indoor Fire Pump Rooms

Indoor fire pump rooms that are not situated in high-rise buildings or are located in separate fire pump buildings are required to be either physically separated or protected per the requirements found in Table 4.13.1.1.2.

Table 4.13.1.1.2 lists the requirements for fire pump rooms and houses.



NFPA 20 2016, Table 4.13.1.1.2 Equipment Protection		
Pump Room/House	**Building(s) Exposing Pump Room/House**	**Required Separation**
Not sprinklered	Not sprinklered	2-hour fire-rated or 50 feet
Not sprinklered	Fully sprinklered	2-hour fire-rated or 50 feet
Fully sprinklered	Not sprinklered	2-hour fire-rated or 50 feet
Fully sprinklered	Fully sprinklered	1-hour fire-rated or 50 feet

LET'S REVIEW

Let's do a quick check about what has been covered so far.

A centrifugal fire pump for fire protection shall be selected to operate at less than or equal to ___% of the rated capacity.

○ 90

○ 100

○ 140

○ 150

SUBMIT

Emergency lighting in a fire pump room must be capable of maintaining light for a minimum duration of ______.

○ 30 minutes

○ 1 hour

○ 2 hours

○ 24 hours

SUBMIT

According to Table 4.13.1.1.2, what is the required separation of a fully sprinklered pump room and a fully sprinklered building?

○ 1-hour fire-rated or 50 ft.

○ 1-hour fire-rated or 100 ft.

○ 2-hour fire-rated or 50 ft.

○ 2-hour fire-rated or 100 ft.

SUBMIT

Complete the knowledge checks above before moving on.

Steel Pipe

NFPA 20 2016, Section 4.14.1

The standard requires steel pipe to be used aboveground, with the exception of connecting to underground suction and underground discharge piping.

The Annex explains that the exterior of **all aboveground steel piping <u>should</u> be painted**.

If corrosive conditions are present, the steel suction pipe is required to be **galvanized or painted on the inside prior to installation** with a paint recommended for submerged surfaces.

Thick bituminous linings are **not** permitted.

CUTTING AND WELDING

Cutting and Welding

NFPA 20 2016, Section 4.14.6

Torch cutting or welding in the pump house is permitted should pipe repairs or modifications be needed. This must follow the requirements found in *NFPA* 51B – *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*.

Keep in mind that if welding is performed on the pump suction or discharge piping while the pump is in place, the welding ground should be on the **same side of the pump** as the welding.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

True or false: If corrosive conditions are present, the steel suction pipe is required to be painted on the outside after installation.

○ True

○ False

SUBMIT

Complete the knowledge check above before moving on.

Lesson 3 of 3

Suction Pipe and Valve Requirements

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Recognize the general requirements for suction pipes, including pipe size, protection, and fittings.

☐ Select the appropriate requirements for the valves in fire pump systems.

Key References

- *NFPA* 20 – *Standard for the Installation of Stationary Pumps for Fire Protection*, 2016
- *NFPA Fire Protection Handbook*, 2008

LET'S BEGIN

NFPA 20 2016, Chapter 4, Continued

As mentioned in the previous lesson, Chapter 4 discusses the general requirements found in *NFPA* 20 2016.

This lesson will cover the topics of suction and discharge piping, relief valves, and pressure maintenance (jockey) pumps.

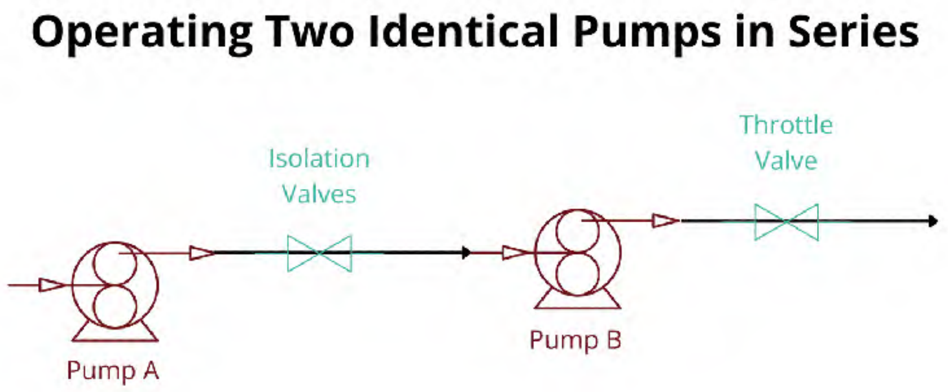
SUCTION PIPE AND FITTINGS

Suction Pipe and Fittings

NFPA 20 2016, Section 4.15

Suction pipe shall be installed and tested in accordance with *NFPA* 24 – *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*.

When pumps are installed in **series**, the suction pipe for the subsequent pump is required to **begin at the system side of the discharge valve of the previous pump**.



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PUMPS WITH BYPASS

Pumps with Bypass

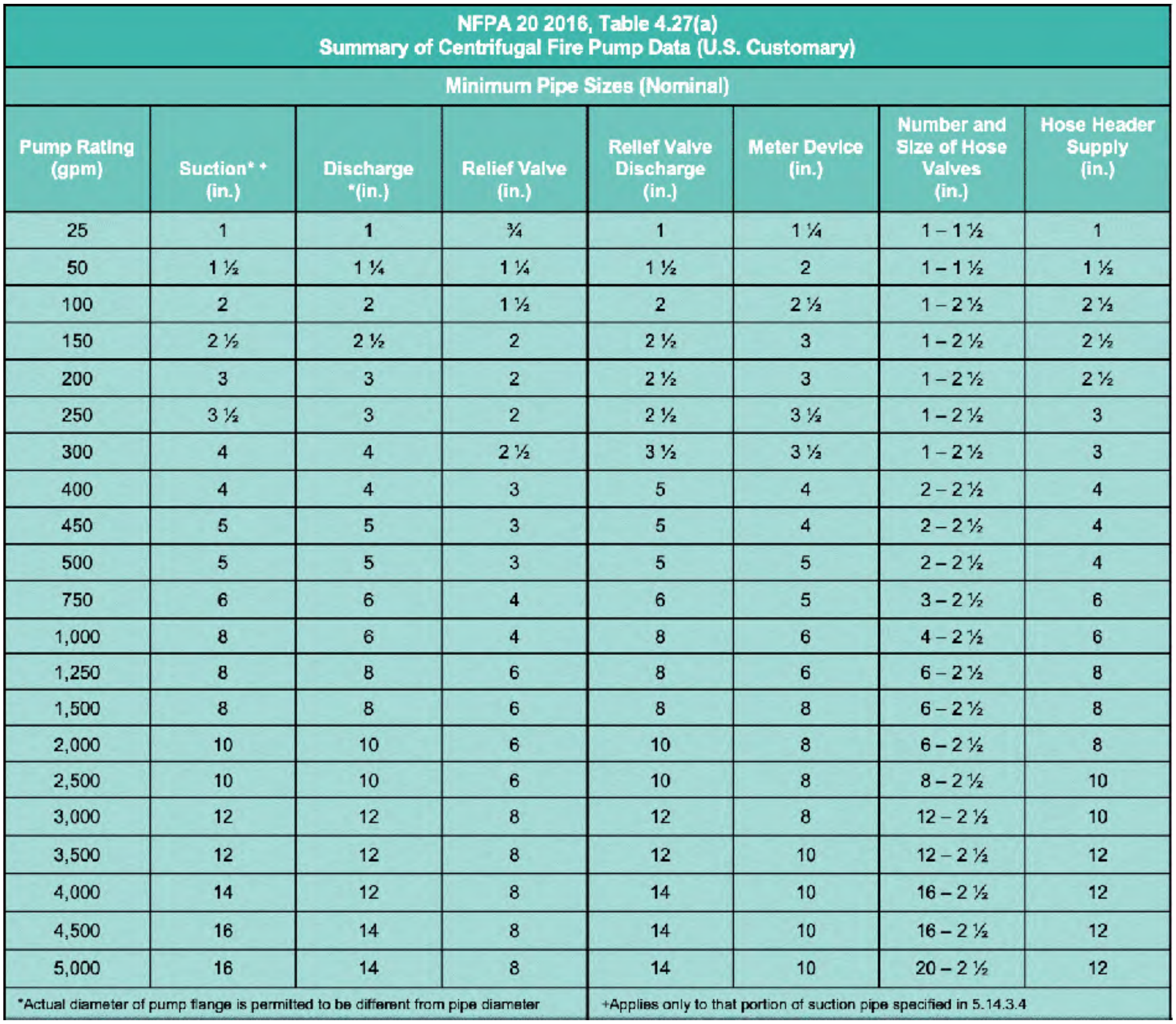
NFPA 20 2016, Sections 4.15.4 and 4.27

A bypass is required to be installed to the pump if the suction supply is of **sufficient pressure to be of material value without the pump**.

The size of the bypass is required to be **at least as large as the pipe size required for discharge pipe** as specified by **Table 4.27(a)**. This table is an **important reference**, as it tabulates information such as pump rating in gallons per minute and minimum pipe sizes, which are required for various attachments to the pump, including:

- Suction lines

- Discharge lines
- Relief valves
- Relief valve discharge
- Metering devices
- The number and size of hose valves
- The hose header supply



NFPA 20 2016, Table 4.27(a)
Summary of Centrifugal Fire Pump Data (U.S. Customary)

Minimum Pipe Sizes (Nominal)

Pump Rating (gpm)	Suction* + (in.)	Discharge *(in.)	Relief Valve (in.)	Relief Valve Discharge (in.)	Meter Device (in.)	Number and Size of Hose Valves (in.)	Hose Header Supply (in.)
25	1	1	¾	1	1 ¼	1 – 1 ½	1
50	1 ½	1 ¼	1 ¼	1 ½	2	1 – 1 ½	1 ½
100	2	2	1 ½	2	2 ½	1 – 2 ½	2 ½
150	2 ½	2 ½	2	2 ½	3	1 – 2 ½	2 ½
200	3	3	2	2 ½	3	1 – 2 ½	2 ½
250	3 ½	3	2	2 ½	3 ½	1 – 2 ½	3
300	4	4	2 ½	3 ½	3 ½	1 – 2 ½	3
400	4	4	3	5	4	2 – 2 ½	4
450	5	5	3	5	4	2 – 2 ½	4
500	5	5	3	5	5	2 – 2 ½	4
750	6	6	4	6	5	3 – 2 ½	6
1,000	8	6	4	8	6	4 – 2 ½	6
1,250	8	8	6	8	6	6 – 2 ½	8
1,500	8	8	6	8	8	6 – 2 ½	8
2,000	10	10	6	10	8	6 – 2 ½	8
2,500	10	10	6	10	8	8 – 2 ½	10
3,000	12	12	8	12	8	12 – 2 ½	10
3,500	12	12	8	12	10	12 – 2 ½	12
4,000	14	12	8	14	10	16 – 2 ½	12
4,500	16	14	8	14	10	16 – 2 ½	12
5,000	16	14	8	14	10	20 – 2 ½	12

*Actual diameter of pump flange is permitted to be different from pipe diameter

+Applies only to that portion of suction pipe specified in 5.14.3.4

Figure A.4.15.4 shows a suggested arrangement for a fire pump with a bypass. Note that the Annex material provides additional information regarding this figure.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

If multiple pumps are installed in series, the suction pipe for the subsequent pump is required to begin at the system side of the ______ valve of the previous pump.

○ suction

○ relief

○ discharge

○ control

SUBMIT

If a pump has a rating of 400 GPM, what is the minimum size of the discharge pipe?

○ 3 in.

○ 3 ½ in.

○ 4 in.

○ 4 ½ in.

SUBMIT

Complete the knowledge checks above before moving on.

Valves

NFPA 20 2016, Section 4.15.5

A listed **outside screw and yoke (OS&Y) gate valve** is required to be installed in the suction pipe.

No control valve other than a listed OS&Y valve and the devices permitted by Section 4.28.3 shall be installed in the suction pipe **within 50 ft.** of the pump suction flange.

The suction pipe shall be installed **below the frost line** or in **frost-proof casings**.

ⓘ Where the pump and its suction supply are on separate foundations with rigid interconnecting pipe, the pipe shall be provided with strain relief, as shown in Figure A.6.3.1(a).

PROTECTION FROM FREEZING

Protection from Freezing

NFPA 20 2016, Section 4.15.6

As previously mentioned, the suction pipe is required to be installed **below the frost line** or **in frost-proof casings**.

If a pipe is entering a stream, pond, or reservoir, **extra precautions** must be taken to prevent freezing from occurring either underground or underwater.

Suction Screening

NFPA 20 2016, Section 4.15.8

If the water supply is obtained from an open source such as a pond or a wet pit, then precautions must be taken to ensure **limiting obstructions** that could clog the pump.

Screen requirements are discussed in this portion of the standard.

Screens are required to be **removable** and be arranged so they can be **cleaned or repaired without disturbing the suction pipe**.

Screens shall have **at least 62.5% open area**, with the overall area of the screen **1.6 times** the net screen opening area.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

The suction pipe is required to be installed ___ the frost line.

Type your answer here

SUBMIT

What are the requirements of a suction screen? (Check all that apply)

☐ Removable

☐ Permanent

☐ Self-cleaning

☐ at least 62.5% open area

☐ An overall area of 2 times the net screen opening area

SUBMIT

🔒 Complete the knowledge checks above before moving on.

Devices in Suction Piping

NFPA 20 2016, Section 4.15.9

The purpose of the requirement in this section is to **prohibit the use of certain devices** in the suction pipe of a fire pump that would cause **turbulence or excess friction loss or cut off waterflow** to the pump when flowing at 150% of rated capacity.

The following devices are **permitted** in the suction piping if they **satisfy the criteria** listed below:

☐ **Check valves** and **backflow prevention devices** and assemblies are permitted where required by other NFPA standards or the AHJ, and installed per Section 4.28.

☐ **A pressure-sensitive line for a low suction throttling valve** (listed for fire pump service) is permitted to be connected to the suction piping if the AHJ requires positive pressure to be maintained on the suction piping.

☐ **Devices** are permitted to be installed in the suction supply piping or stored water supply and arranged to activate a signal if the pump suction pressure or water level falls below a defined minimum.

☐ **Suction strainers** are permitted to be installed in the suction piping if required by other sections of this standard.

☐ Other devices are permitted **if specifically permitted or required** by this standard.

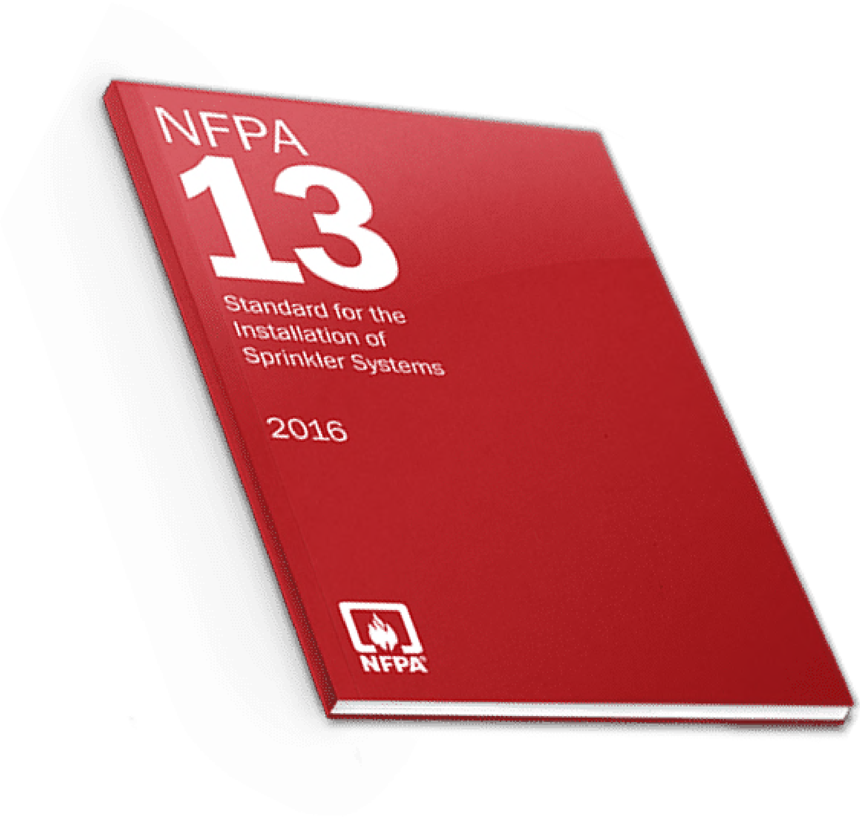
DISCHARGE PIPE AND FITTINGS

Discharge Pipe and Fittings

NFPA 20 2016, Section 4.16

The discharge components include pipe, valves, and fittings extending from the pump discharge flange to the system side of the discharge valve.

ⓘ **_NFPA_ 13, _NFPA_ 14, and other codes or standards contain requirements after the discharge valve. _NFPA_ 25 contains requirements for testing backflow prevention devices and pressure-reducing valves permitted and/or required in other standards.**



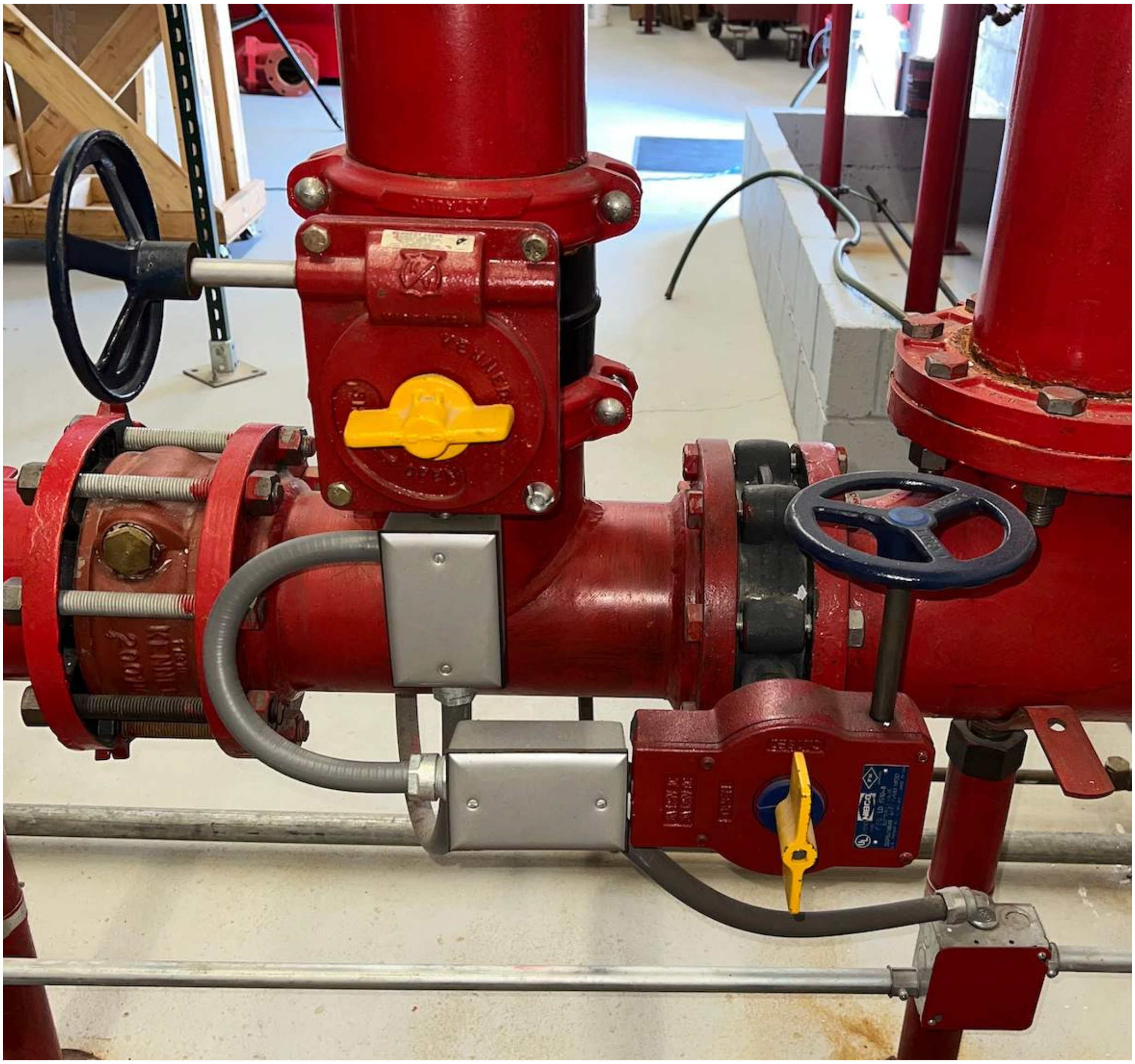
All pump discharge pipe shall be hydrostatically tested per *NFPA* 13 2016 – *Standard for the Installation of Sprinkler Systems* –requirements.

The size of the pump discharge pipe and fittings **shall not be less than** those provided in Table 4.27(a).

A listed **check valve or backflow preventer** is required in the pump discharge assembly.

A listed **indicating gate or butterfly valve** is required on the fire protection system side of the pump discharge check valve.

For pumps installed in series, a **butterfly valve is not permitted** to be installed between the pumps.



Wafer check valve and buttterfly valves are depicted in this image.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

When would a pressure-sensitive line for a low suction throttling valve be permitted?

○ If the AHJ requires positive pressure to be maintained on the suction piping

○ If the AHJ requires negative pressure to be maintained on the suction piping

○ If the AHJ requires it to be installed per *NFPA* 20, Section 4.28

○ If the pump suction pressure or water level falls below a defined minimum

SUBMIT

Complete the knowledge check above before moving on.

Valve Supervision

NFPA 20 2016, Section 4.17

The four methods of supervision represented in this section help to ensure that a common mode of sprinkler system failure is reduced to a minimum. **Approximately one-third of system failures are attributable to closed or partially closed sprinkler system control valves.**

The suction valve, discharge valve, bypass valves, and isolation valves on the backflow prevention device or assembly are required to be supervised open using one of the following methods (listed in descending order of preference):

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 point
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

The test outlet control valves shall be supervised closed by one of these methods listed above.

ⓘ The Annex material contains additional recommendations when a backflow preventer is substituted for a discharge check valve. Isolation valves and control valves are considered to be identical when used in conjunction with a backflow prevention assembly.

PROTECTION AGAINST DAMAGE DUE TO MOVEMENT

Protection of Piping Against Damage Due to Movement

NFPA 20 2016, Section 4.18

The chances of pipe breakage can be prevented or at least greatly reduced by **increasing flexibility between major parts of the piping**. Do not hold one part of the piping rigid while allowing another portion to move, unless provisions are provided for relieving the strain.

Flexibility can be provided by using **flexible couplings** at critical points and by allowing clearances at walls and floors.

A **clearance** shall be provided around pipes that pass through walls or floors.

The holes are to be sized so that the **diameter of the hole is 2 in. larger** than the pipe.

If the clearance is provided by a **pipe sleeve**, then a hole **diameter 2 in. larger** than the pipe diameter is acceptable.

If flexible couplings are located **within 1 ft.** of each side of the wall, ceiling, or floor, then **no clearance is required**.

ⓘ **The Annex material contains additional recommendations regarding the holes through pump room fire walls.**

RELIEF VALVES

Relief Valves for Centrifugal Pumps

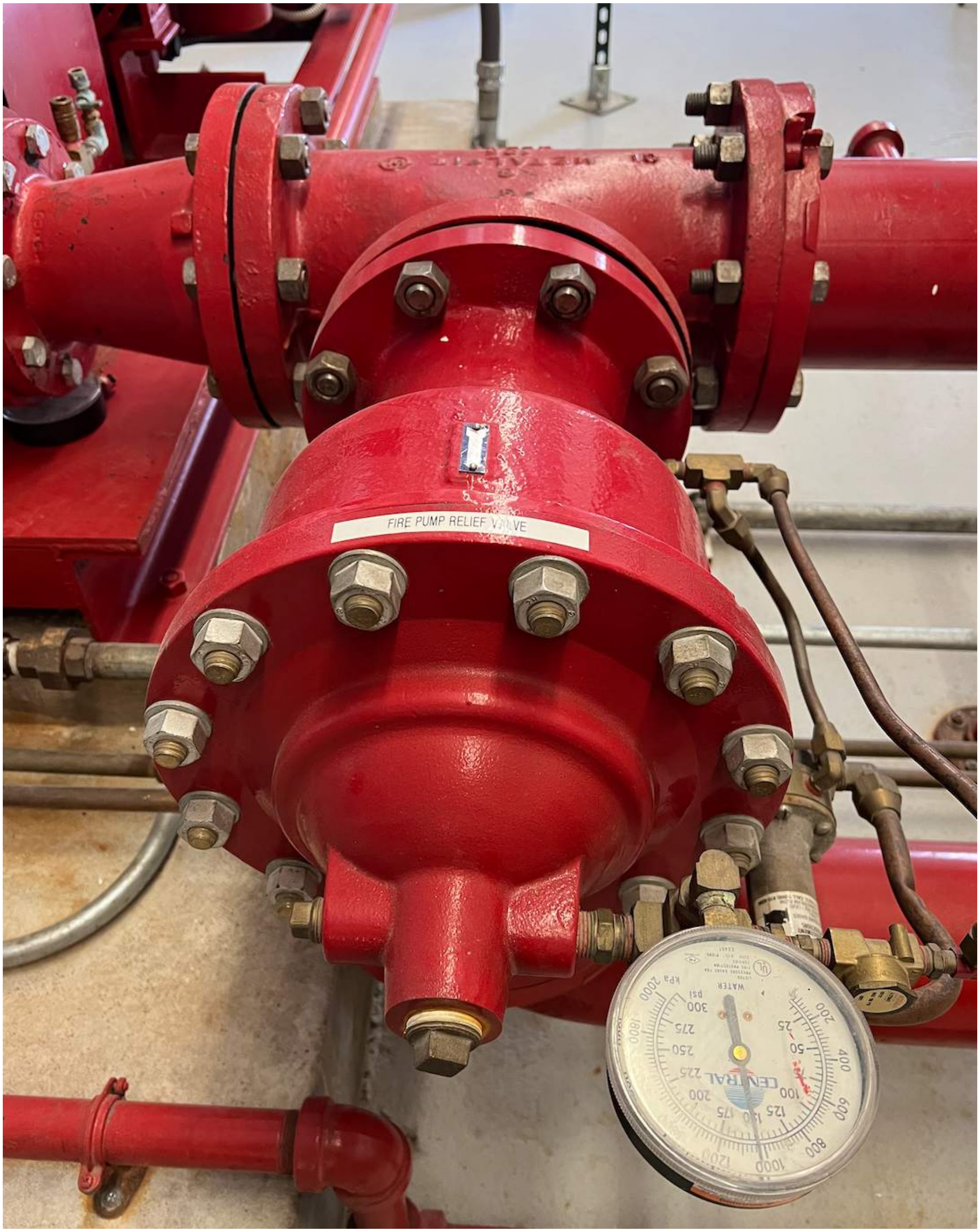
NFPA 20 2016, Section 4.19

The requirements pertaining to relief valves for centrifugal pumps are also important to understand.

A pressure relief valve is **required if a diesel engine fire pump is installed**, and the total of **121% of the net rated shutoff (churn) pressure plus the maximum static suction pressure**, adjusted for elevation, is greater than the rating of the pressure of the system components.

The relief valve is permitted to be **sized hydraulically to discharge sufficient water** to prevent the pump discharge pressure, adjusted for elevation, from exceeding the pressure rating of the system components. If the relief valve is not sized hydraulically, its size shall **not be less than the sizing provided in Table 4.27(a)**.

The relief valve is required to be **located between the pump and the pump discharge check valve** and attached so it can be **easily removed for repairs** without disturbing the piping.



A shutoff valve is not permitted in the relief valve supply or discharge piping.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

How can pipe breakage be prevented or at least greatly reduced? (Select all that apply)

☐ Adding a pressure relief valve

☐ Increasing the temperature of the water flow

☐ Increasing the speed of the water flow

☐ Increasing the flexibility between major parts of the piping

SUBMIT

A pressure relief valve is required to be installed for what type of fire pump driver?

○ Diesel engine

○ Electric motor

○ Steam turbine

SUBMIT

Complete the knowledge checks above before moving on.

Water Flow Test Devices

NFPA 20 2016, Section 4.21

Acceptance testing includes **testing at rated speed without flow through a pressure relief valve**; pressure relief valves may be required on variable speed pumps and diesel engine driver pumps. The pipe, valves, and fittings in the pump discharge piping must be rated for the maximum discharge pressure. Pipe size requirements are discussed in this section of the standard.

Listed metering devices or fixed nozzles are required to permit water flow of **at least 175% of the rated pump capacity**. While all meter system piping is permitted per the standard to be **sized hydraulically**, it is required to be **larger than the size specified by the meter manufacturer**.

Hose valve header. Image courtesy of SPP Pumps.

A **listed indicating butterfly or gate valve** is required to the **hose valve header** in the pipeline. A **drain valve or automatic ball drip is required** in the pipeline at a low point between the valve and the header, as shown in Figures A.6.3.1(a) and A.7.2.2.1.

ⓘ **See the Annex material in this section for figures illustrating arrangements for measuring fire pump water flow with the meter and for Sample Pump Test Header Size Calculation (Figure A.4.21.3.4(2)).**

PRESSURE MAINTENANCE (JOCKEY) PUMPS

Pressure Maintenance (Jockey) Pumps

NFPA 20 2016, Section 4.26

Pressure maintenance (jockey) pumps are used when **constant or relatively high pressure** on the fire protection system is needed. These **small-capacity, high-pressure pumps** take suction from the fire pump suction line and discharge into the fire pump discharge line on the system side of the indicating control valve.

Jockey pumps are required to have a **rated capacity not less than any normal leakage rate** while maintaining an adequate discharge pressure to provide the desired fire protection system pressure.

They can be sized to make up the allowable leakage rate **within 10 minutes or 1 GPM**, whichever is larger.

A **check valve is required** to be installed in the discharge pipe, while indicating **butterfly or gate valves are required** to be installed in places needed to make the pump, check valve, and other fittings accessible for repair.

A **domestic water pump in a dual-purpose water supply system** can function as a means of maintaining pressure.

Refer to *NFPA* 20 2016, Figure A.4.26.6.5, Jockey Pump Installation with Fire Pump, and the Annex material for additional recommendations regarding jockey pumps.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Listed metering devices are required to permit water flow of at least ___% of the rated pump capacity.

○ 100

○ 120

○ 150

○ 175

SUBMIT

BACKFLOW PREVENTERS

Backflow Preventers and Check Valves

NFPA 20 2016, Section 4.28

Relief valves on reduced pressure backflow preventers can discharge a large volume of water. The drain for these devices needs to be **sized adequately to handle this flow**.

Check valves and backflow prevention devices or assemblies located in the suction pipe of the pump shall be located a **minimum of 10 pipe diameters** from the pump suction flange.

Where a backflow prevention device is installed, the arrangement shall provide **effective pump performance** with **minimum suction pressure of 0 PSI** at the gauge at 150% of rated capacity.

The discharge is required to **exceed** the fire protection system design flow.

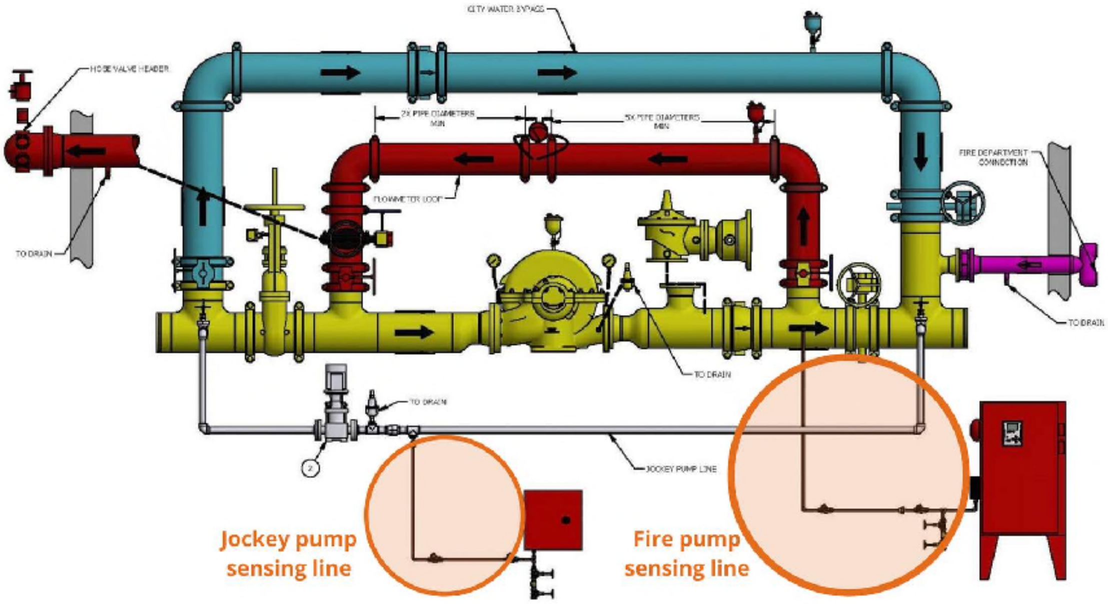
PRESSURE SENSING LINES

Pressure Actuated Controller Pressure Sensing Lines

NFPA 20 2016, Section 4.31

Each fire pump controller is required to have its **own individual pressure sensing line**. This applies to all pump installations, including pressure maintenance (jockey) pumps.

The pressure sensing line connection for each pump is required to be made **between the pump's discharge check valve and the discharge isolation valve**.



The sensing lines are circled in orange

The pressure sensing line is to be **brass, rigid copper pipe (Types K, L, or M), or Series 300 stainless steel pipe or tube**.

BREAK TANKS

Break Tanks

NFPA 20 2016, Section 4.32

Break tanks are typically used for one or more of the following reasons:

- As a **backflow prevention device** between the city water supply and the fire pump suction
- To **eliminate pressure fluctuations** in the city water supply and provide a steady suction pressure to the fire pump
- To **augment** the city water supply when the volume of water available from the city is inadequate for the fire protection demand

Break tank installation requirements can be found in *NFPA* 22 2015.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Check valves and backflow prevention devices or assemblies located in the suction pipe of the pump must be located a minimum of ____ pipe diameters from the pump suction flange.

Type your answer here

SUBMIT

The pressure sensing line connection for each pump is required to be made between the pump's _____ check valve and the _____ isolation valve.

○ suction; suction

○ suction; discharge

○ discharge; suction

○ discharge; discharge

SUBMIT

Complete the knowledge checks above before moving on.

After completing this module, you should now have a better understanding of the general requirements for fire pumps and their components.

Click on the “Next” arrow up on the right-hand corner of the screen to continue to the quiz.

Fire Pumps - Installation

By the end of this module, you will be able to do the following:

- Identify the impact of building height on a fire pump system.
- Recognize the purpose of and requirements for water supply tanks in high-rise building fire protection systems.
- Calculate the maximum allowable shutoff head for a fire pump.
- Apply the installation requirements for centrifugal pumps, including vertical shaft turbine-type pumps, and for positive displacement pumps.
- Compare the requirements for electric and diesel engine drivers and their controllers.

Key References for this module:

- *NFPA* 13 – *Standard for the Installation of Sprinkler Systems*, 2016
- *NFPA* 20 – *Standard for the Installation of Stationary Pumps for Fire Protection*, 2016
- *NFPA Fire Protection Handbook*, 2008

When you are ready to begin, click on the button above to start the course.

Fire Pumps for High-Rise Buildings

Installation of Centrifugal Pumps

Lesson 1 of 3

Fire Pumps for High-Rise Buildings

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Identify the impact of building height on a fire pump system.

☐ Recognize the purpose of and requirements for water supply tanks in high-rise building fire protection systems.

Key References

- *NFPA* 13 – *Standard for the Installation of Sprinkler Systems*, 2016
- *NFPA* 20 – *Standard for the Installation of Stationary Pumps for Fire Protection*, 2016
- *NFPA Fire Protection Handbook*, 2008

LET'S BEGIN

NFPA 20 2016, Chapter 5

Chapter 5 discusses requirements for those buildings defined as a **high-rise** per NFPA, namely, a building where the floor of an occupiable story is **greater than 75 ft. above the lowest level** of fire department vehicle access.

Most of the requirements found in this short chapter pertain to **water supply tanks**. The installation requirements for water tanks found in *NFPA* 22 must be met.

LOCATION AND ACCESS

Location and Access

NFPA 20 2016, Sections 5.2 and A.5.2

Location and access to the fire pump room in a high-rise building is to be **coordinated with the fire department**, since fire fighting personnel will be sent to the pump room to monitor pump operations in the event of a fire.

The best way to protect these individuals is to have the **pump room directly accessible from the outside**. However, that is not always possible in high-rise buildings. In many cases, pump rooms in high-rise buildings will need to be **located many floors above grade, at a location below grade, or both**.

If the pump room is not at grade level, *NFPA* 20 2016 requires **protected passageways** of a fire resistance rating that meets the **minimum requirements for exit stairwells** at the level of the pump room from the exit stairwell to the pump room.

Keep in mind that some Codes **may not allow the pump room to open directly onto an exit stairwell**. The distance between an exit stairwell and the pump room on upper or lower floors needs to be **as short as possible**, with **minimal openings to other building areas**.

WATER TANKS

Water Tanks

NFPA 20 2016, Section 5.3

If water tanks are installed, they are required to comply with *NFPA* 22 requirements.

If the water tank serves **both domestic and fire protection systems**, then the domestic supply connection is required to be **connected above the level** required for the fire protection demand.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

If not directly accessible from the outside, where may you find a pump room in high-rise buildings. (Select all that apply)

☐ Located in the exit stairwell

☐ Located on a floor above grade

☐ Located on a floor below grade

☐ Located in the building across the street

SUBMIT

Complete the knowledge check above before moving on.

Water Supply Tanks

NFPA 20 2016, Section 5.6

One concern when designing sprinkler systems for very tall buildings is the **height of the building**. At times, the building height is such that it is not possible for the fire department apparatus to overcome the **associated friction and elevation losses** and still achieve **100 PSI** at the hose outlets in the building.

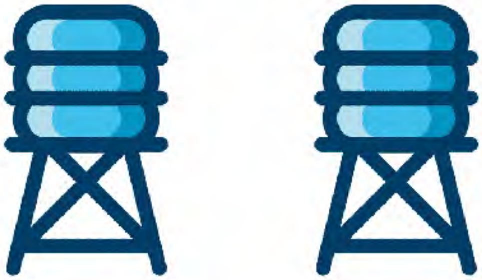
If this is the case, then the fire protection system may need to be **supplemented** by an auxiliary water supply in order to effectively fight a fire.

Tanks as Primary Auxiliary Supply Source

Click the "Start" button below to view the requirements for when water tanks are the primary auxiliary supply source for the fire protection system of a very tall building.

Requirement 1

2 or More Tanks

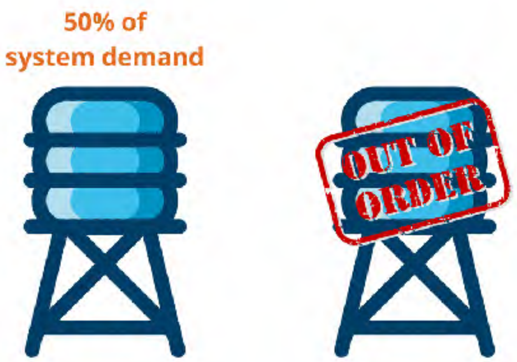


If a tank is the primary supply source, then **two or more tanks** are **required**.

The tank may be **divided into compartments** so that the compartments serve as individual tanks.

Requirement 2

50% System Demand



Each individual tank or compartment is required to be sized so that **at least 50% of the system demand** is stored with one compartment or tank out of service.

Requirement 3

Relief Valves

Automatic and manual refill valves are required for each tank or tank compartment.

The intent of the requirements found in this section is to ensure the following:

1. The stored water supply satisfies the fire protection water demand.
2. The tanks automatically refill at the minimum rate of the fire protection water demand.

3 If a single tank or tank compartment (and automatic refill valve for that tank) is out of service, the full fire protection water demand can still be met through stored water and automatic tank refill.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

If a tank is the primary auxiliary water supply source in a high-rise building, then how many tanks are required?

○ Only one tank

○ Exactly two tanks

○ Two or more tanks

○ A tank for each floor level

SUBMIT

Complete the knowledge check above before moving on.

Lesson 2 of 3

Installation of Centrifugal Pumps

Lesson Goals

By the end of this lesson, you will be able to do the following:

- ☐ Calculate the maximum allowable shutoff head for a fire pump.
- ☐ Apply the installation requirements for centrifugal pumps, including vertical shaft turbine-type pumps, and for positive displacement pumps.

Key References

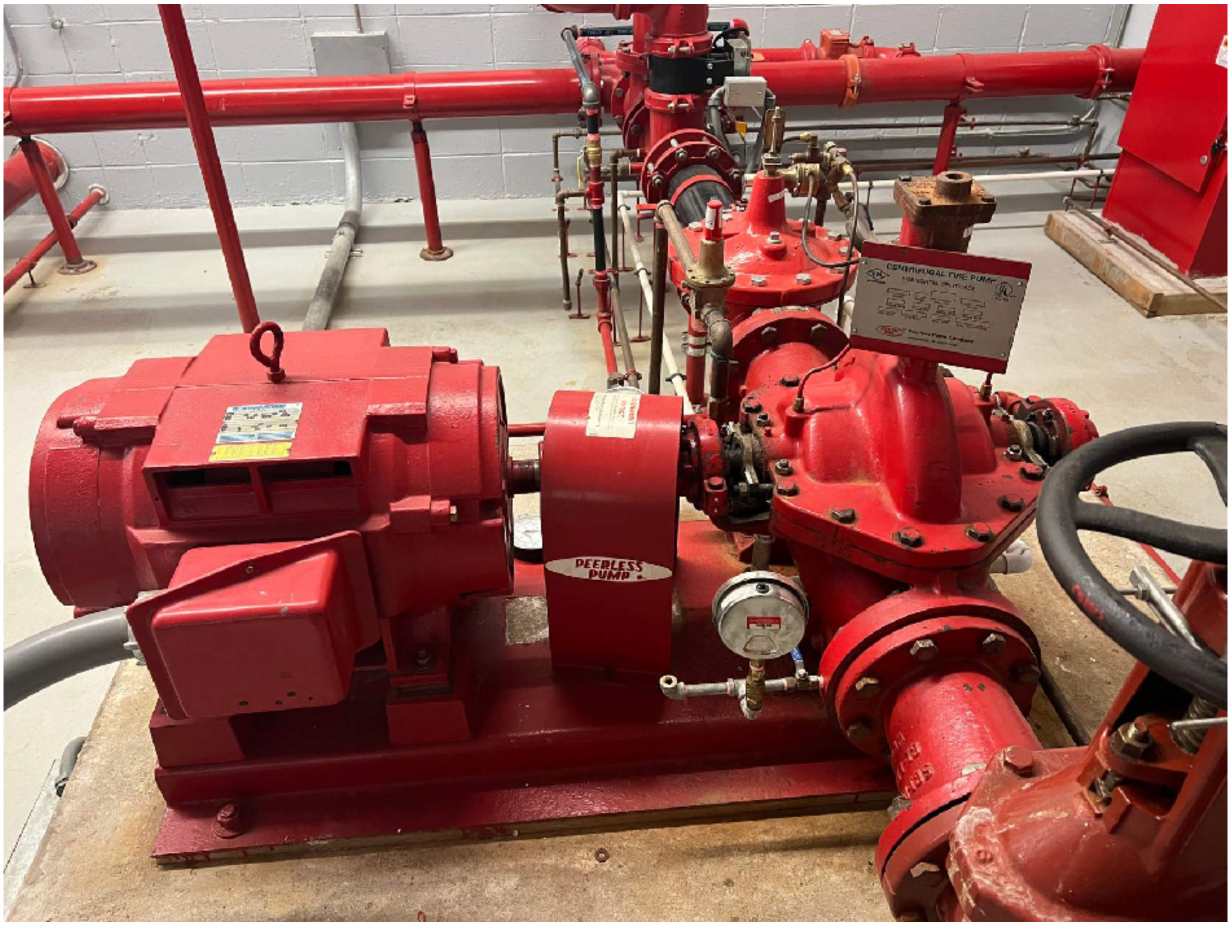
- *NFPA* 13 – *Standard for the Installation of Sprinkler Systems*, 2016
- *NFPA* 20 – *Standard for the Installation of Stationary Pumps for Fire Protection*, 2016
- *NFPA Fire Protection Handbook*, 2008

LET'S BEGIN

Centrifugal Pumps

NFPA 20 2016, Chapter 6

Chapter 6 covers the subject of horizontal pumps. Included are the general requirements, performance requirements, the fittings which are allowed, and the installation of these devices.

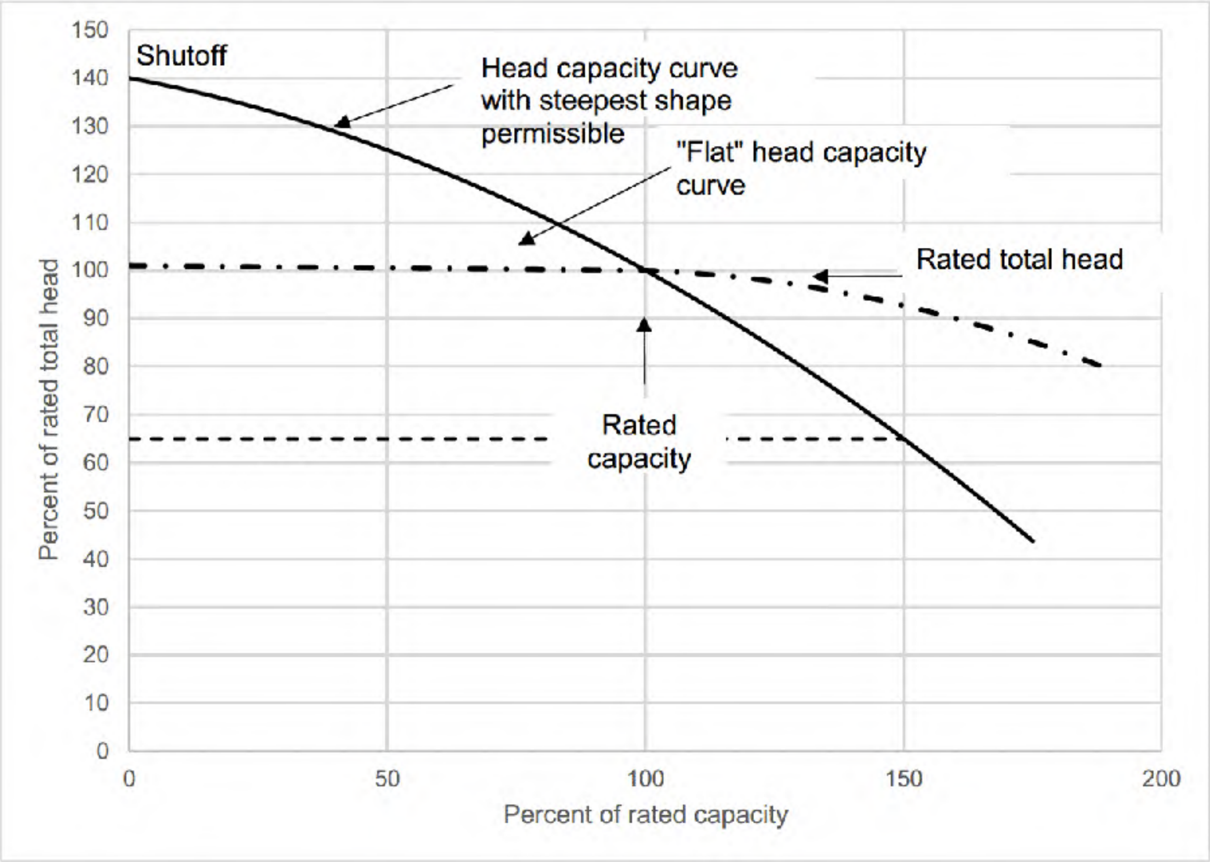


Centrifugal pumps shall not be used where a static suction lift is required. The pumps are required to furnish **not less than 150% of rated capacity** at **not less than 65% of total head**. The shutoff head shall **not exceed 140% of rated head** for any type pump.

Centrifugal pumps are **not permitted** where a static suction lift is required.

The Annex material provides a pump characteristics curve showing the extremes of the curve shapes.

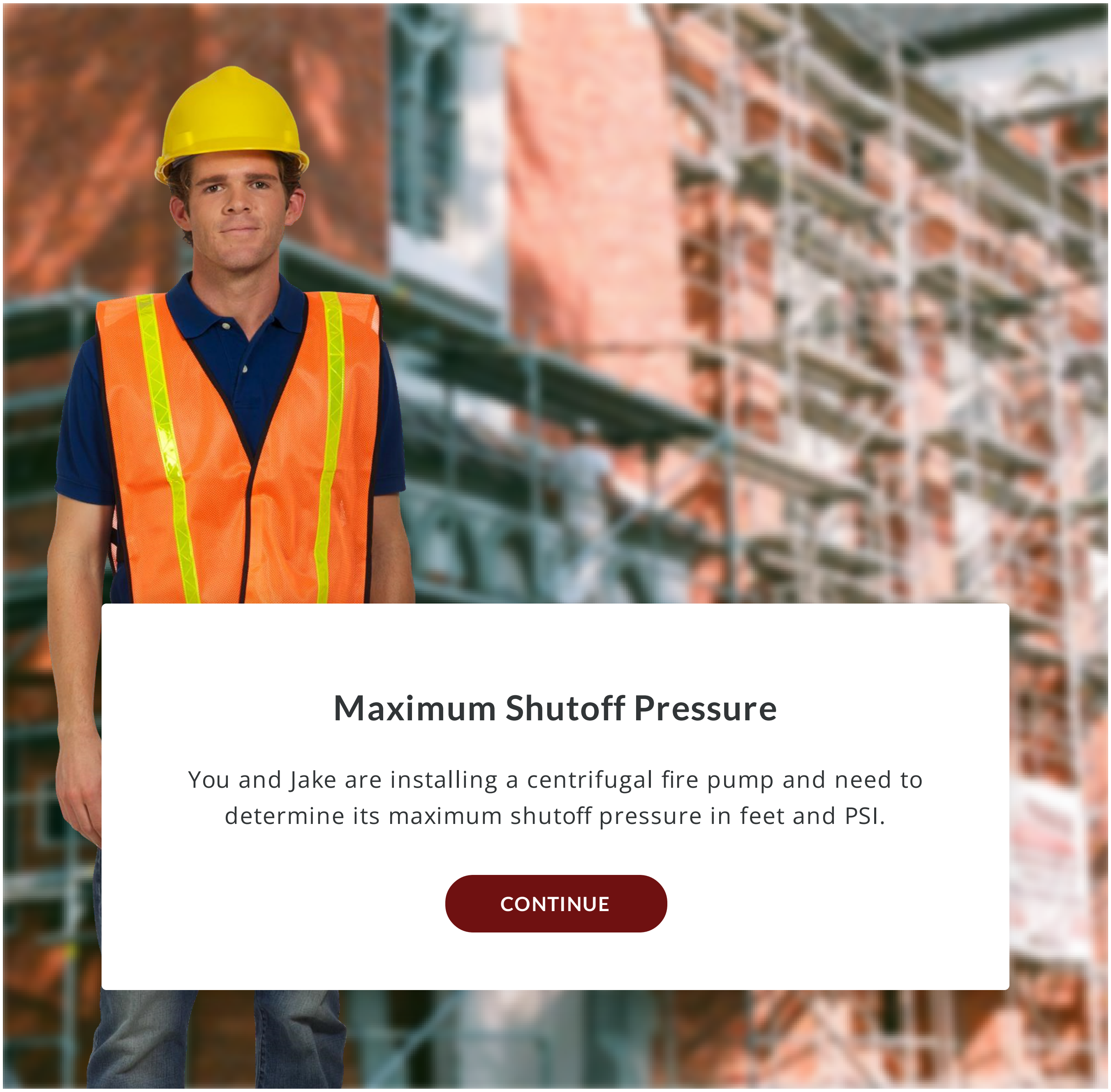
Shutoff head will range from a minimum of 101% to a maximum of 140% of rated head. At 150% of rated capacity, head will range from a minimum of 65% to the maximum of just below rated head.



MAXIMUM ALLOWABLE SHUTOFF HEAD

Determining Maximum Allowable Shutoff Head

From the previously mentioned requirements, you should be able to determine the maximum allowable shutoff head (in either ft. or PSI) for a pump. Let's practice in the following scenario.



Maximum Shutoff Pressure

You and Jake are installing a centrifugal fire pump and need to determine its maximum shutoff pressure in feet and PSI.

Scene 1 Slide 1

Continue → Next Slide

The fire pump we're installing is rated at 750 GPM with a rated head of 100 ft. What is the maximum shutoff pressure if it is 140% of the rated head?

1 140% of 750 GPM is 1050 GPM, so the maximum shutoff pressure is 1050 GPM.

2 140% of 100 ft. is 140 ft., so the maximum shutoff pressure is 140 ft.

Scene 1 Slide 2

0 → Next Slide

1 → Next Slide

If the maximum shutoff pressure in feet is 140 ft. and we want to convert it to PSI, we have to use the following formula: **Head (ft) = P (PSI) ÷ 0.433 (PSI/ft)**

Scene 1 Slide 3

By plugging our information into the formula, we'll get:

140 ft. = P (PSI) ÷ 0.433 (PSI/ft), which will convert to:

P = 140 ft. x 0.433 (PSI/ft)

Scene 1 Slide 4

Now solve for P from our final formula:
P = 140 ft. x 0.433 (PSI/ft)

- ❶ 43.3 PSI
- ❷ 60.62 ft.
- ❸ 60.62 PSI

Scene 1 Slide 5

0 → Scene 1 Slide 1

1 → Next Slide

2 → Next Slide

CONTINUE

Breakdown of Finding the Maximum Shutoff Pressure

Example: Determine the maximum shutoff pressure (in measurements of both feet and PSI) for a fire pump rated at 750 GPM with a rated head of 100 ft.

Solution: The maximum shutoff pressure will be **140%** of the rated head.

1.4 x 100 ft. = **140 ft.**

To determine the rated head in terms of PSI, use the following conversion factor:

Head (ft) = **P (PSI)** ÷ **0.433 (PSI/ft)**

140 ft. = **P (PSI)** ÷ **0.433 (PSI/ft)**

P = **140 ft.** x **0.433 (PSI/ft)**

P = 60.62 PSI

The answer is: **P = 140 ft. or 60.62 PSI**

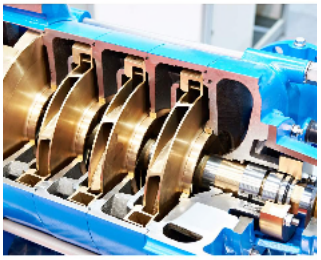
CONTINUE

Centrifugal Pump Requirements

NFPA 20 2016, Section 6.4

Continuing on with the requirements, the **overhung impeller** and **impeller between bearings** design pumps and driver shall be mounted on a common **grouted base plate**. The base plate is required to be securely attached to a solid foundation to ensure proper pump and driver shaft alignment.

The foundation shall be substantial enough to form a permanent and rigid support for the base plate. The base plate, with pump and driver mounted on it, shall be **set level on the foundation**.



Between Bearing Pump

Overhang Impeller Pump

ⓘ **The Annex material provides numerous figures showing different types of centrifugal pumps. Take time to review these figures.**

LET'S REVIEW

Let's do a quick check about what has been covered so far.

According to Section 6.4 of *NFPA* 20 2016, the pump and driver are to be mounted on a common grouted _____ _____.

Type your answer here

SUBMIT

Complete the knowledge check above before moving on.

Vertical Shaft Turbine Requirements

NFPA 20 2016, Chapter 7

Chapter 7 discusses vertical lineshaft turbine pump and covers the general nature of this type of pump. Here *NFPA* 20 2016 covers areas related to the water supply, namely those involving wells, pits, and well construction. Also covered are strainers, fittings, and the installation of the pumps themselves.

Image courtesy of Peerless Pumps

The vertical shaft turbine-type pump is suitable for fire pump service where the **water source is located below ground** and where it would be difficult to install any other type of pump below the minimum water level.

It is permitted to be used to **lift water from lakes, streams, open swamps, and other subsurface sources**.

However, **stored water supplies** from reservoirs or tanks supplying wet pits are **preferred**.

CONTINUE

NFPA 20 2016, Section 7.2

The requirements for pump characteristics should be familiar to you by now. The pumps are required to furnish **not less than 150% of rated capacity at not less than 65% of total head**. The shutoff head shall **not exceed 140% of rated head** on vertical turbine pumps.

The water supply is required to be

- adequate
- dependable
- acceptable to the AHJ

WELL AND WET PIT INSTALLATION

NFPA 20 2016, Sections 7.2.2.1 and 7.2.2.2

Submergence requirements for both **well and wet pit installations** are provided in this portion of the standard.

For wet pit installations, pumps with rated capacities of **2000 GPM or greater require additional submergence** to **prevent excessive cavitation**.

Additionally, the distance between the bottom of the strainer and the bottom of the wet pit is required to be **at least one-half of the pump bowl diameter**, but **not less than 12 in**.

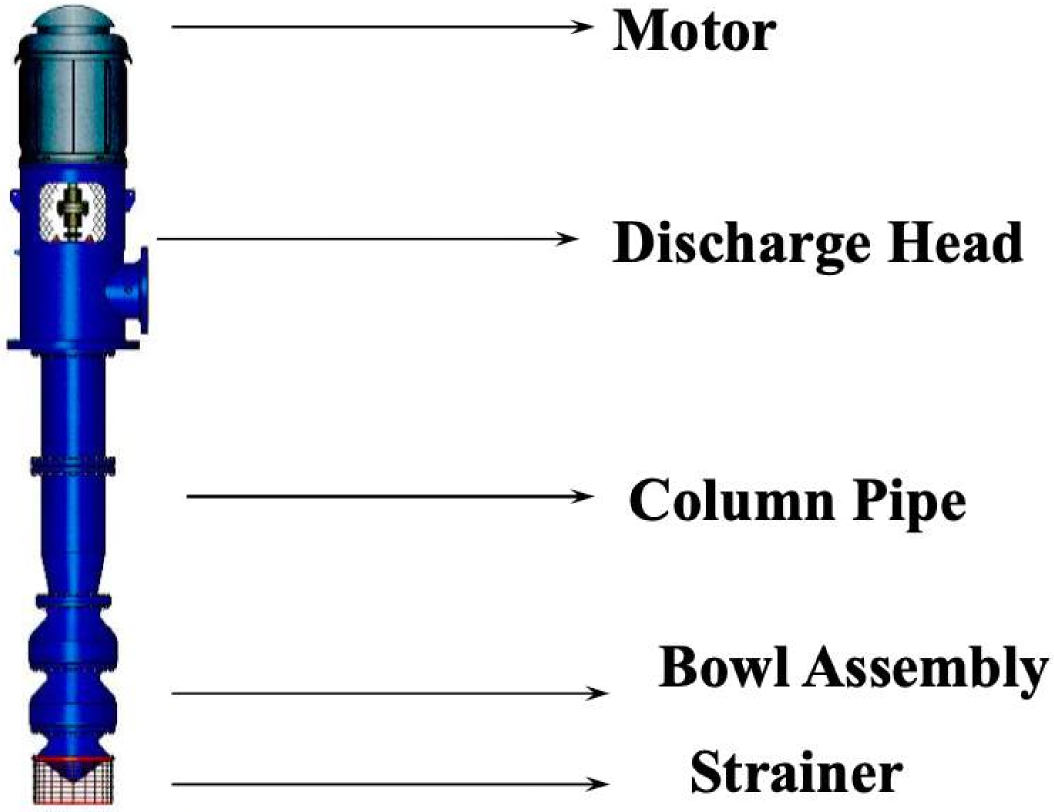


Image courtesy of Peerless Pumps

ⓘ Refer to *NFPA* 20 2016, Figure A.7.2.2.1, Vertical Shaft Turbine-Type Pump Installation in a Well, and Figure A.7.2.2.2, Vertical Shaft Turbine-Type Pump Installation in a Wet Pit

CONTINUE

NFPA 20 2016, Section 7.2.7

A **test of a well's water production** is required, using an orifice, a venturi meter, or a calibrated pitot tube.

This continuous test is required to be run for a period of **at least 8 hours at 150% of the pump's rated capacity with 15-minute interval readings** made over the test period.

All wells within a **1000 ft. radius** of the fire well are required to be monitored during this test period.

CONTINUE

NFPA 20 2016, Section 7.4

If the pump is mounted over a **sump or pit**, then **I-beams are permitted**.

If a **right-angle gear** is used, then the **driver is required** to be installed **parallel** to the beams.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

The water supply for a vertical shaft turbine-type pump is required to be acceptable to the _____.

Type your answer here

SUBMIT

The distance between the bottom of the strainer and the bottom of the wet pit is required to be at least ___ of the pump bowl diameter.

○ one-fourth

○ one-half

○ the same size

○ twice the size

SUBMIT

Complete the knowledge checks above before moving on.

Positive Displacement Pump Requirements

NFPA 20 2016, Chapter 8

Positive displacement pumps are **permitted to pump liquids** for fire protection applications. However, be aware that all of the Chapter 4 requirements found in *NFPA* 20 2016 **may not apply to these types of pumps**.

This section of the standard includes requirements pertaining to foam concentrate, additive pumps, and water mist system pumps.

The following are requirements for positive displacement pumps as outlined in Chapter 8. Click on the "**+**" to view each.

Dump Valve –

A dump valve is required on all closed head systems to allow the positive displacement pump to bleed off excess pressure and achieve operating speed before subjecting the driver to full load.

Foam Concentrate Pumps –

Foam concentrate pumps shall be capable of dry running for 10 minutes without damage.

The exception is this requirement does not apply to water mist pumps.

Suction Strainers –

Pumps shall be equipped with a removable and cleanable suction strainer installed at least 10 pipe diameters from the pump suction inlet.

Suction strainer pressure drop shall be calculated to ensure sufficient Net Positive Suction Head (NPSH) is available to the pump. The net open area of the strainer shall be at least four times the area of the suction piping.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Foam concentrate pumps must be capable of dry running for ___ minutes without damage.

○ 5

○ 10

○ 30

○ 60

SUBMIT

Complete the knowledge check above before moving on.

Lesson 3 of 3

Fire Pump Drivers and Controllers

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Compare the requirements for electric and diesel engine drivers and their controllers.

Key References

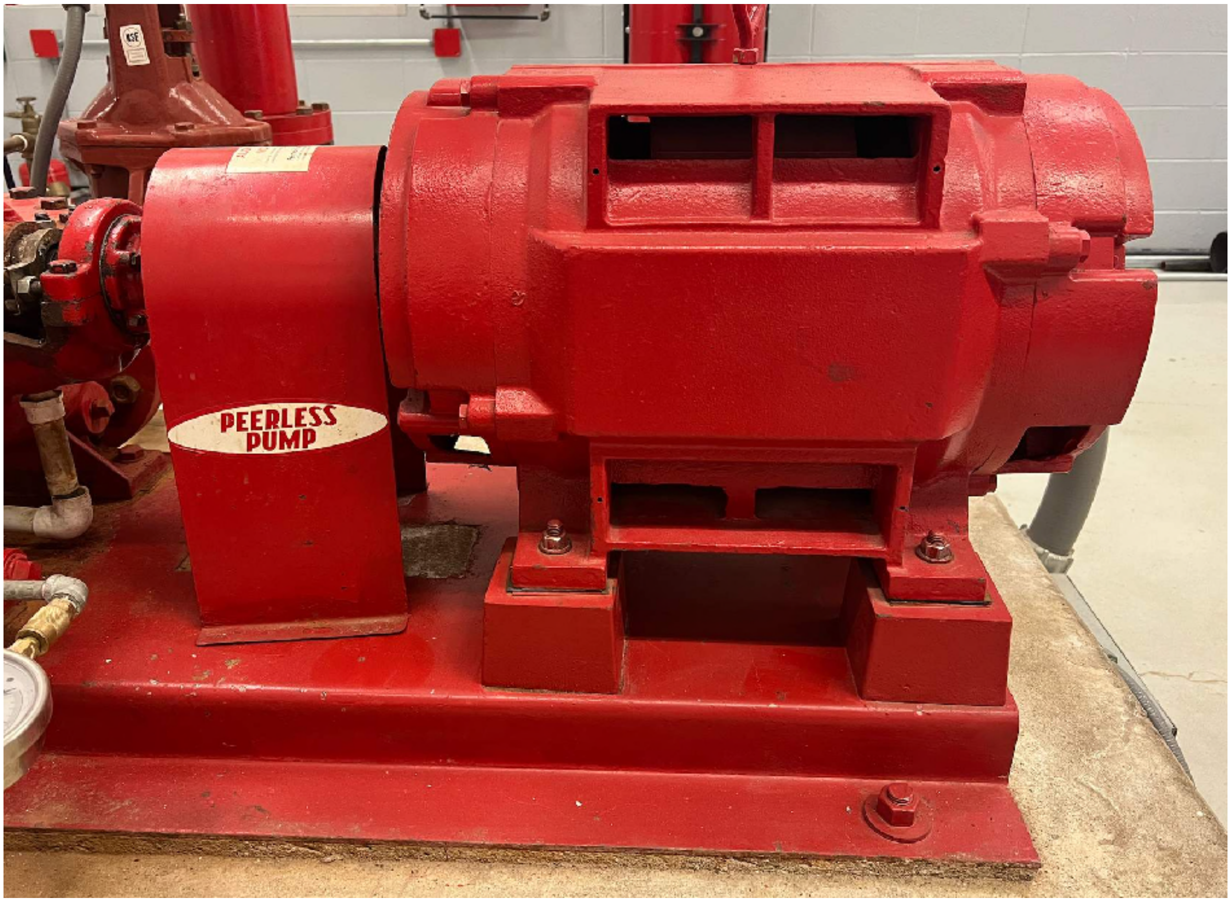
- *NFPA* 13 – *Standard for the Installation of Sprinkler Systems*, 2016
- *NFPA* 20 – *Standard for the Installation of Stationary Pumps for Fire Protection*, 2016
- *NFPA Fire Protection Handbook*, 2008

LET'S BEGIN

Electric Driver

NFPA 20 2016, Chapter 9

Chapter 9 covers minimum performance and testing requirements of the sources and transmission of electrical power to motors driving fire pumps, including all intermediate equipment between the source and the pump. This also includes the motor. Be aware of the **differences between the normal and alternate power requirements** contained in this section.



Pump Driver

Requirements for the electric fire pump controller, transfer switch and accessories are contained in Chapter 10 of this standard.

The following are specific requirements for electric drivers as outlined in Chapter 9. Click on the "**+**" to view each.

Voltage at Controller Line Terminals –

The voltage at the controller line terminals **shall not drop more than 15% below normal** under motor-starting conditions. This does not apply to emergency-starting conditions.

Voltage at Motor Terminals

The voltage at the motor terminals **shall not drop more than 5% below** the voltage rating of the motor when the motor is operating at 115% of the full-load current rating of the motor.

On-Site Generator Systems

On-site generator systems **shall comply with the requirements found in *NFPA* 110** – *Standard for Emergency and Standby Power Systems for Level 1, Type 10, Class X systems*.

Generator Fuel Supply

The generator fuel supply capacity is required to 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.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

The voltage at the controller line terminals must not drop more than ___% below normal under motor-starting conditions.

○ 5

○ 10

○ 15

○ 150

SUBMIT

🔒 Complete the knowledge check above before moving on.

Controllers

NFPA 20 2016, Sections 10.2 and 12.2

Chapters 10 and 12 cover electric motor and diesel engine fire pump controllers.

Electric Motor Controller

Diesel Engine Controller

Controller Requirements

While the controllers for diesel engines cannot be interchanged with the controllers for electric motors, these devices contain some common requirements. Click on the "Start" button below to view them.

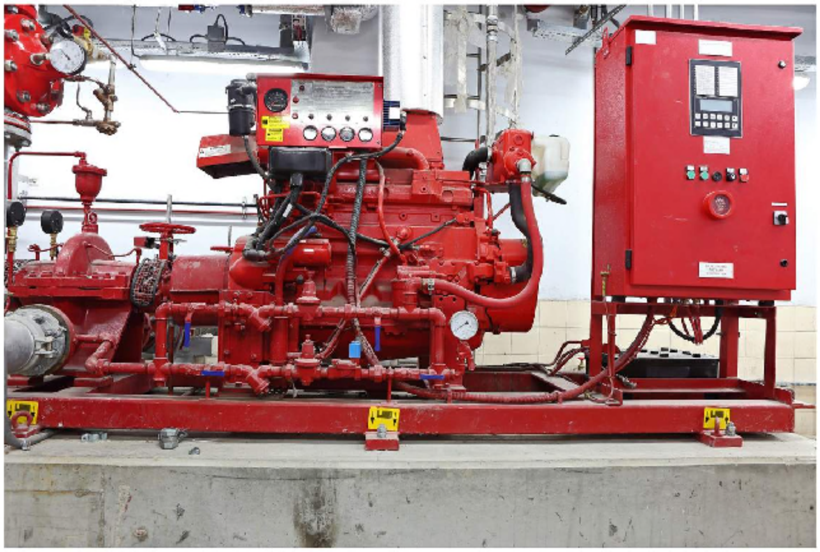
Requirement 1

Listed

All controllers must be specifically listed for their respective type of fire pump service.

Requirement 2

Distance from Engine



The controllers are required to be located as close as is practical to the engines they control and shall be within sight of the engines.

Requirement 3

If Outside the Pump Room

If the controller must be located outside the pump room, a glazed opening should be provided in the pump room wall for observation of the motor and pump during starting.

The pressure control pipe line should be protected against freezing and mechanical injury.

Requirement 4

Protection from Water Escaping

Controllers shall be protected from water escaping from pumps or pump connections.

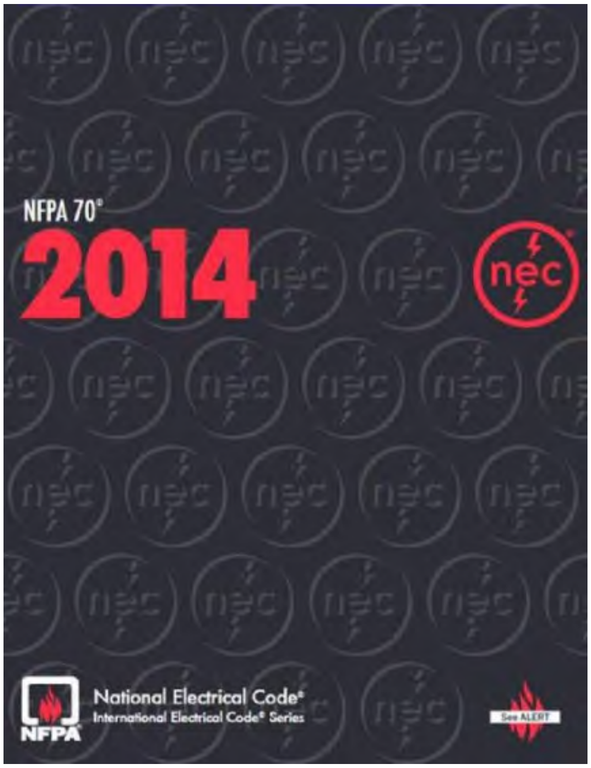
Requirement 5

Current Carrying Parts

Current carrying parts of controllers shall not be less than 12 in. above floor level.

Requirement 6

Clearances



Working clearances around controllers shall comply with the requirements in *NFPA* 70 - National Electric Code, Article 110.

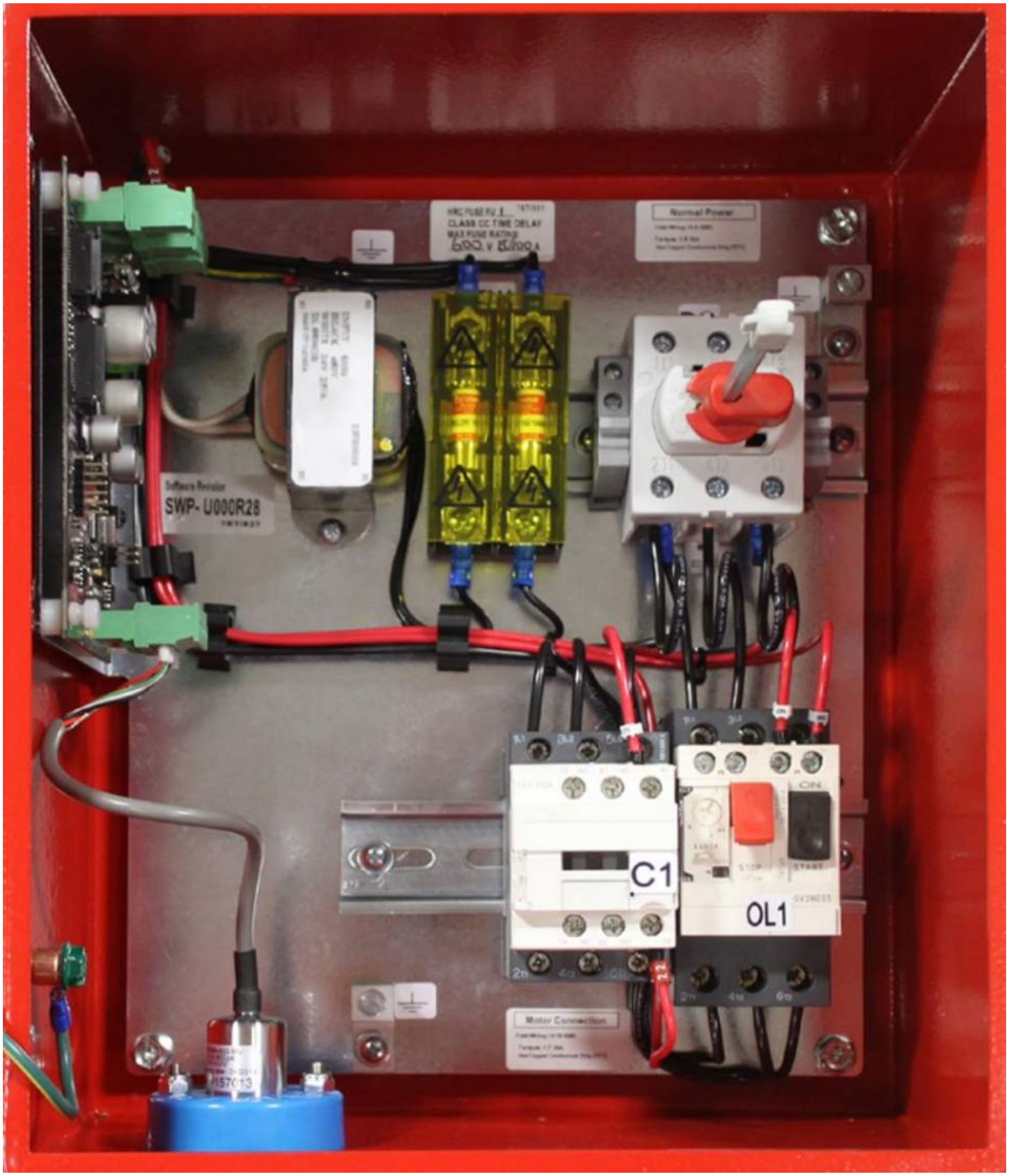
CONTINUE

NFPA 20 2016, Sections 10.3 and 12.3

All equipment shall be suitable for use in locations subject to a **moderate degree of moisture**, such as a damp basement.

The structure or panel is required to be securely mounted in a **NEMA Type 2 drip proof enclosure(s)**, as a minimum. Suitably rated enclosures are required for outside locations or special environments.

A fire pump controller is **not permitted to be used as a junction box** to supply other equipment. No undervoltage, phase loss, frequency sensitive, or other sensor(s) shall be installed that automatically or manually prohibits electrical actuation of the engine starting contactor.



In the area of electrical diagrams and instructions, the standard provides the reminder that **all field wiring terminals are required to be plainly marked** to correspond with the field connection diagram furnished. The devices and components shall be marked, with the markings located so they are **visible after installation**.

Means shall be provided on the exterior of the controller to read all line currents and all line voltages with an accuracy of +5% of motor nameplate voltage and current. (*NFPA* 20 2016, Section 10.3.4.3)

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Working clearances around controllers shall comply with the requirements in Article 110 of which standard?

○ *NFPA* 13

○ *NFPA* 20

○ *NFPA* 70

○ *NFPA* 72

SUBMIT

True or false. A fire pump controller is versatile enough to be used as a junction box to supply other equipment.

○ True

○ False

SUBMIT

Complete the knowledge checks above before moving on.

NFPA 20 2016, Sections A.10.5 and A.12.5

Requirements for starting and control for automatic and non-automatic controllers reference definitions found in *NFPA* 70 2014 – The National Electric Code:

- **Automatic**: Self-acting, operating by its own mechanism when actuated by some impersonal influence, as, for example, a change in current strength, pressure, temperature, or mechanical configuration.
- **Non-automatic**: Action requiring intervention for its control. As applied to an electric controller, non-automatic control does not necessarily imply a manual controller, but only that personal intervention is necessary.
    - An automatic controller shall also be operable as a non-automatic controller.

Pressure-actuated switches shall be responsive to water pressure in the fire protection system. However, **no pressure snubber or restrictive orifice** shall be employed within the pressure switch.

For non-automatic controllers, a **manually operated switch** shall be provided on the control panel and arranged so when the motor is started manually, its operation cannot be affected by the pressure actuated switch. This arrangement shall also ensure that the **unit will remain in operation until it is manually shut down**.

Pressure-actuated switch

CONTINUE

NFPA 20 2016, Section 10.3.4

Requirements specific to electric motor controllers to note include:

- **Means** shall be provided on the exterior of the controller to read **all line currents and all line voltages** with an accuracy **within ±5 percent** of motor nameplate voltage and current.
- Electric supply conductors for **pressure maintenance (jockey) pump(s) shall not be connected to the fire pump controller**.

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CONTINUE

NFPA 20 2016, Sections 11.1 and 11.2

Requirements specific to diesel engines to note include:

- Diesel engines for fire pump drivers are **required to be compression–ignition**. Spark-ignited internal combustion engines are **not permitted**.
- The horsepower capability of the engine, when equipped for fire pump service, shall have a **4-hour minimum** horsepower rating **not less than 10% greater** than the listed horsepower on the engine nameplate.
- Engines shall be provided with a governor capable of regulating engine speed within a **range of 10% between shutoff and maximum load condition** of the pump. The governor shall be field adjustable, set, and secured to maintain rated pump speed at maximum pump load.
- Engines are required to accelerate to rated output speed **within 20 seconds**.
- Engines shall be provided with an overspeed shutdown device. The overspeed device shall be arranged to shut down the engine in a speed range of **10 - 20% above rated engine speed** and to be **manually reset**.

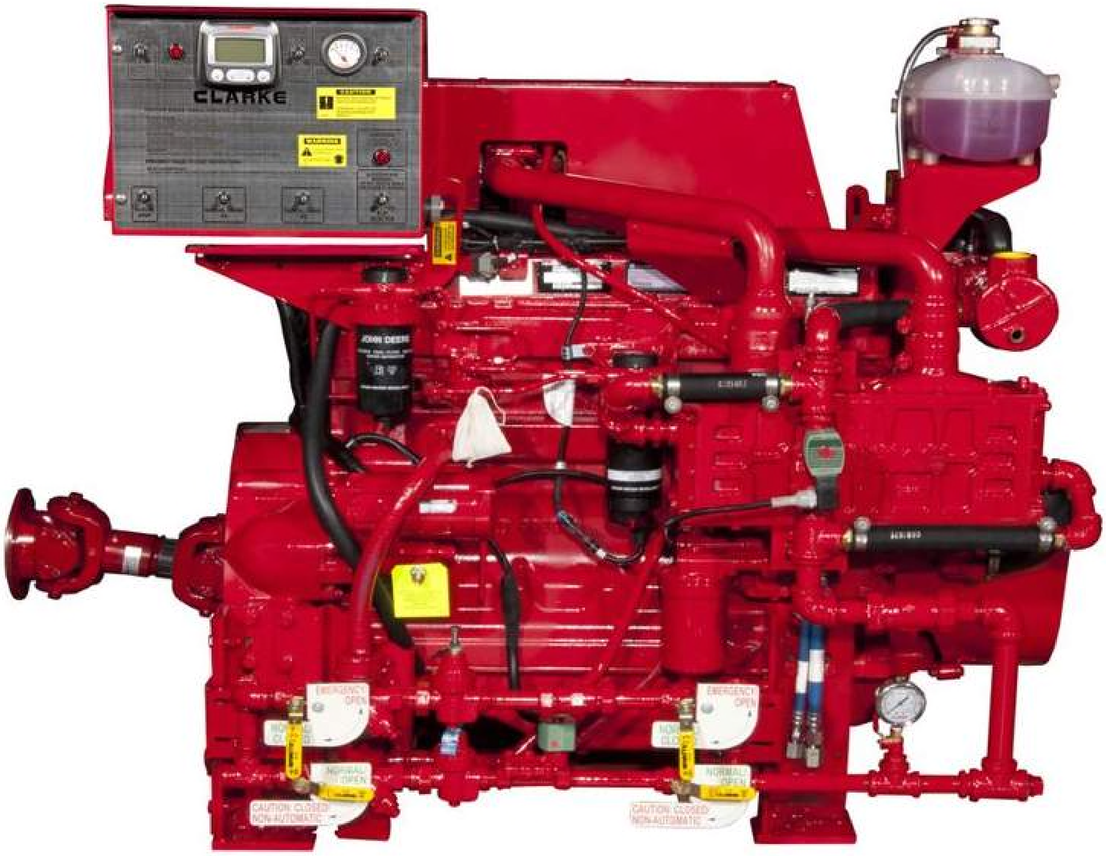


Image courtesy of SPP Pumps.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Which type of controller requires a manually operated switch on its control panel?

○ Automatic

○ Non-automatic

○ Both

SUBMIT

Can electric supply conductors for a pressure maintenance pump be connected to the fire pump controller?

○ Yes

○ No

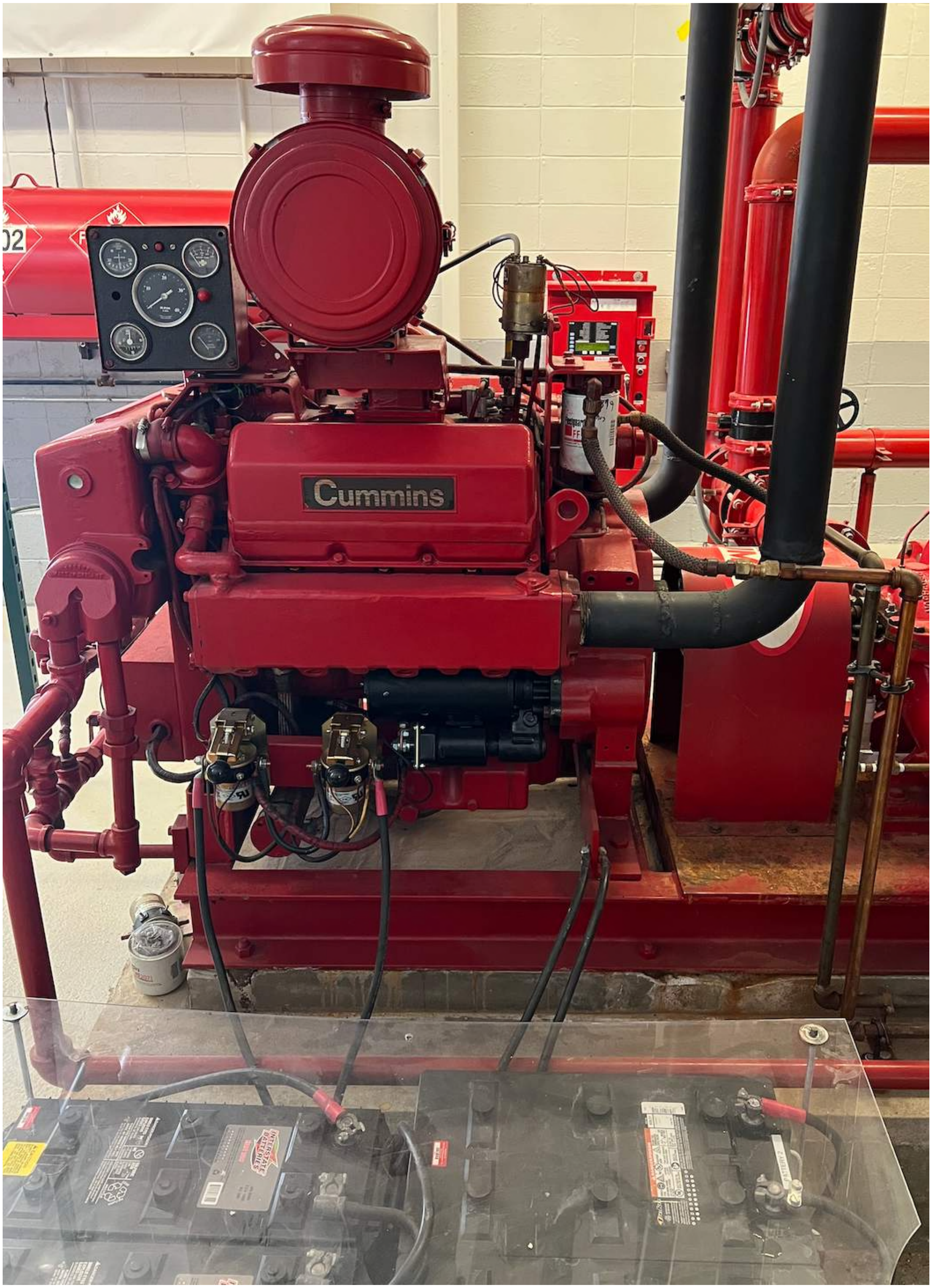
SUBMIT

Complete the knowledge checks above before moving on.

Diesel Engine Drivers

NFPA 20 2016, Chapter 11

Chapter 11 describes the requirements for diesel engine drivers. Included in this chapter are requirements for diesel engines, fire pump and engine protection, diesel engine fuel supply and arrangement, engine exhaust, and drivers operation.



Fire Pump Diesel Engine

HYDRAULIC AND AIR STARTING

Hydraulic and Air Starting

NFPA 20 2016, Sections 11.2.7.3 and 11.2.7.4

Here, the standard discusses hydraulic and air starting. Click on the "**+**" below to view a few of the requirements for these different engines.

For Hydraulic Starting —

The accumulators and other accessories are required to be enclosed or protected so that they are not subject to mechanical injury. The enclosure shall be installed as close to the engine as practical to prevent large pressure drops between the engine and the cabinet.

The requirements for the hydraulic starting conditions are further detailed in **Section 11.2.7.3** of the standard.

For Air Starting —

The air supply container is required to be sized for 180 seconds of continuous cranking without recharging.

> A separate, suitably powered automatic air compressor independent of the compressor driven by the fire pump engine is required.
>
> The requirements for the air starting conditions are further detailed in **Section 11.2.7.4** of the standard.

PRESSURE REGULATOR

Pressure Regulator

NFPA 20 2016, Section 11.2.8.5.3.5

The pressure regulator shall be of the size and type that it is capable of and adjusted for **passing approximately 120% of the cooling water required** when the engine is operating at maximum brake horsepower and when the regulator is supplied water at the pressure of the pump when it is pumping at 150% of its rated capacity.

CONTINUE

Fuel Supply and Arrangement

NFPA 20 2016, Section 11.4

Fuel supply tanks shall have a capacity at least equal to **1 gallon per horsepower, plus 5% volume for expansion and 5% volume for sump**. The quantity 1 gallon per horsepower is equivalent to **1 pint per horsepower per hour for 8 hours.** If a quick fuel supply replenishment is unlikely, a reserve supply should be provided along with facilities for transfer to the main tanks.

The need for larger-capacity fuel supply tanks is to be **determined by prevailing conditions**, such as refill cycle and fuel heating due to recirculation, and is subject to special conditions in each case.

The fuel supply tank and fuel are required to be reserved exclusively for the fire pump diesel engine.

If multiple pumps are used, a **separate fuel line and separate fuel supply tank** for each engine are required.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

For air supplying diesel engine drivers, the air supply container is required to be sized for ___ minutes of continuous cranking without recharging.

○ 1

○ 2

○ 3

○ 10

SUBMIT

What is equivalent to the quantity of 1 gallon per horsepower in terms of a diesel engine drive's fuel tank supply?

○ 1 pint per horsepower per hour for 4 hours

○ 1 pint per horsepower per hour for 8 hours

○ 2 pints per horsepower per hour for 4 hours

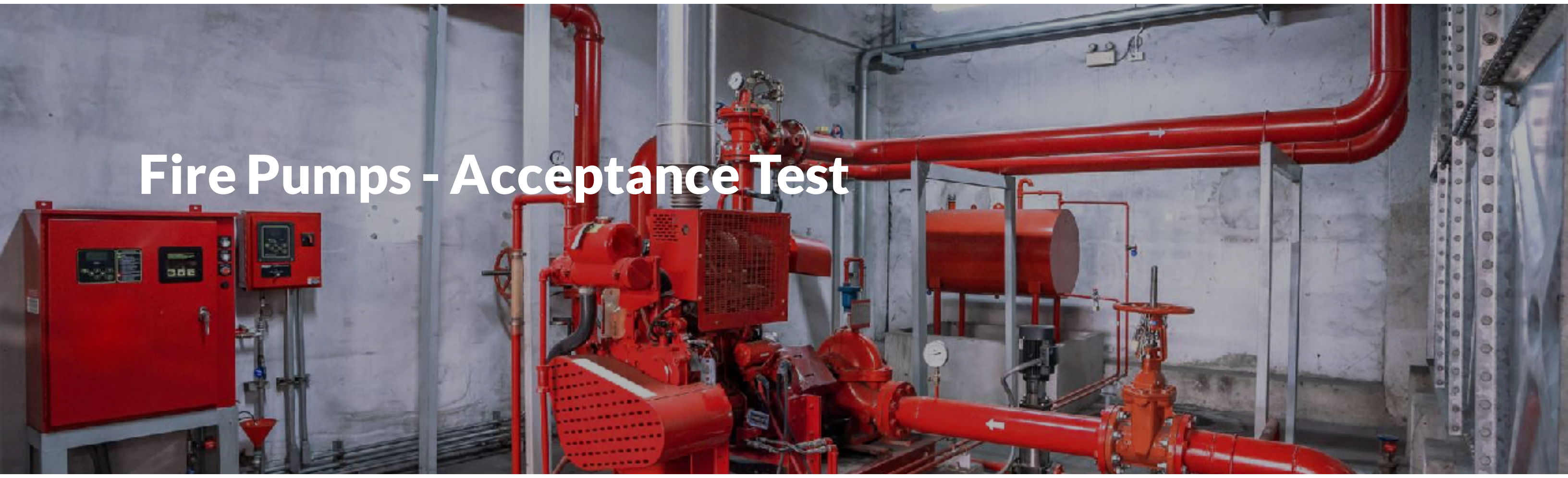
○ 2 pints per horsepower per hour for 8 hours

SUBMIT

Complete the knowledge checks above before moving on.

After completing this module, you should now have a better understanding of the installation requirements for fire pumps and their drivers.

Click on the “Next” arrow up on the right-hand corner of the screen to continue to the quiz.



Fire Pumps - Acceptance Test

By the end of this module, you will be able to do the following:

- Describe the requirements for fire pump hydrostatic tests and field acceptance tests.
- Review the requirements listed in the Contractor's Material and Test Certificate for Fire Pump Systems.
- Compare the acceptance test requirements for different fire pump power supply sources.
- Follow proper procedures to obtain appropriate measurements during fire pump testing.
- Employ the appropriate testing criteria when replacing fire pump components.
- Navigate the *NFPA Fire Protection Handbook* for additional resources on fire pump systems.

Key References for this module:

- *NFPA* 13 – *Standard for the Installation of Sprinkler Systems*, 2016
- *NFPA* 20 – *Standard for the Installation of Stationary Pumps for Fire Protection*, 2016
- *NFPA* 25 – *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2014
- *NFPA Fire Protection Handbook*, 2008

When you are ready to begin, click on the button above to start the course.

- **Fire Pump Acceptance Tests**
- **Measurement Procedures**
- **Inspection, Testing, and Maintenance of Fire Pumps**

Lesson 1 of 3

Fire Pump Acceptance Tests

Lesson Goals

By the end of this lesson, you will be able to do the following:

☐ Describe the requirements for fire pump hydrostatic tests and field acceptance tests.

☐ Review the requirements listed in the Contractor’s Material and Test Certificate for Fire Pump Systems.

☐ Compare the acceptance test requirements for different fire pump power supply sources.

Key References

- *NFPA 20 – Standard for the Installation of Stationary Pumps for Fire Protection, 2016*
- *NFPA Fire Protection Handbook*, 2008

LET'S BEGIN

Introduction

This portion of the standard covers areas such as hydrostatic tests, flushing, field acceptance tests, and component replacement.

Acceptance tests **evaluate the pump's performance** to confirm that the pump will operate as needed if a fire occurs. An acceptance test is intended to verify the following:

1. Adequacy of the pump to deliver water per the manufacturer's test characteristic curve.
2. Proper pump driver performance under all anticipated conditions.
3. Acceptable primary and alternative power supply equipment (if supplied) operations under all anticipated conditions. This includes either automatic or manual operation of the controller.
4. Correct operation and pressure settings of the variable speed pressure limiting control (VSPLC) system.

All defects and/or performance issues must be **corrected before final acceptance is permitted**.

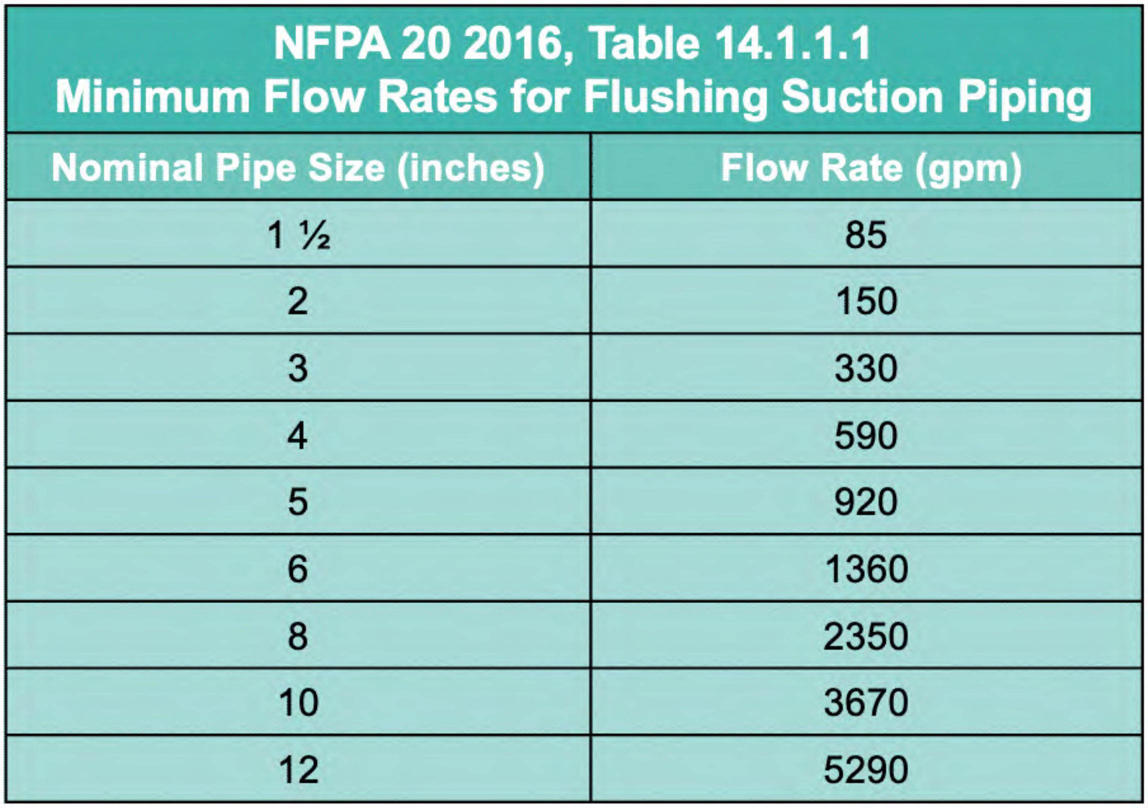
HYDRAULIC TESTS AND FLUSHING

Hydraulic Tests and Flushing

NFPA 20 2016, Chapter 14.1

The typical hydrostatic test requirement is **200 PSI minimum pressure** maintained for a period of **two hours**, or you must boost your test pressure to **50 PSI over the maximum** operating pressure, **whichever is greater**.

Flushing must be conducted prior to hydrostatic testing, at a flow rate no less than found in Table 14.1.1.1 or at the hydraulically calculated water demand rate of the system, whichever is greater.



NFPA 20 2016, Table 14.1.1.1
Minimum Flow Rates for Flushing Suction Piping

Nominal Pipe Size (inches)	Flow Rate (gpm)
1 ½	85
2	150
3	330
4	590
5	920
6	1360
8	2350
10	3670
12	5290

This produces a **velocity of approximately 15 ft./sec**. If the flow rate cannot be achieved with the existing water supply, a **supplemental source** could be necessary.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

If a flushing suction piping has a size of 4 in., the minimum flow rate for the piping is ___ GPM.

○ 85

○ 330

○ 590

○ 1360

SUBMIT

Complete the knowledge check above before moving on.

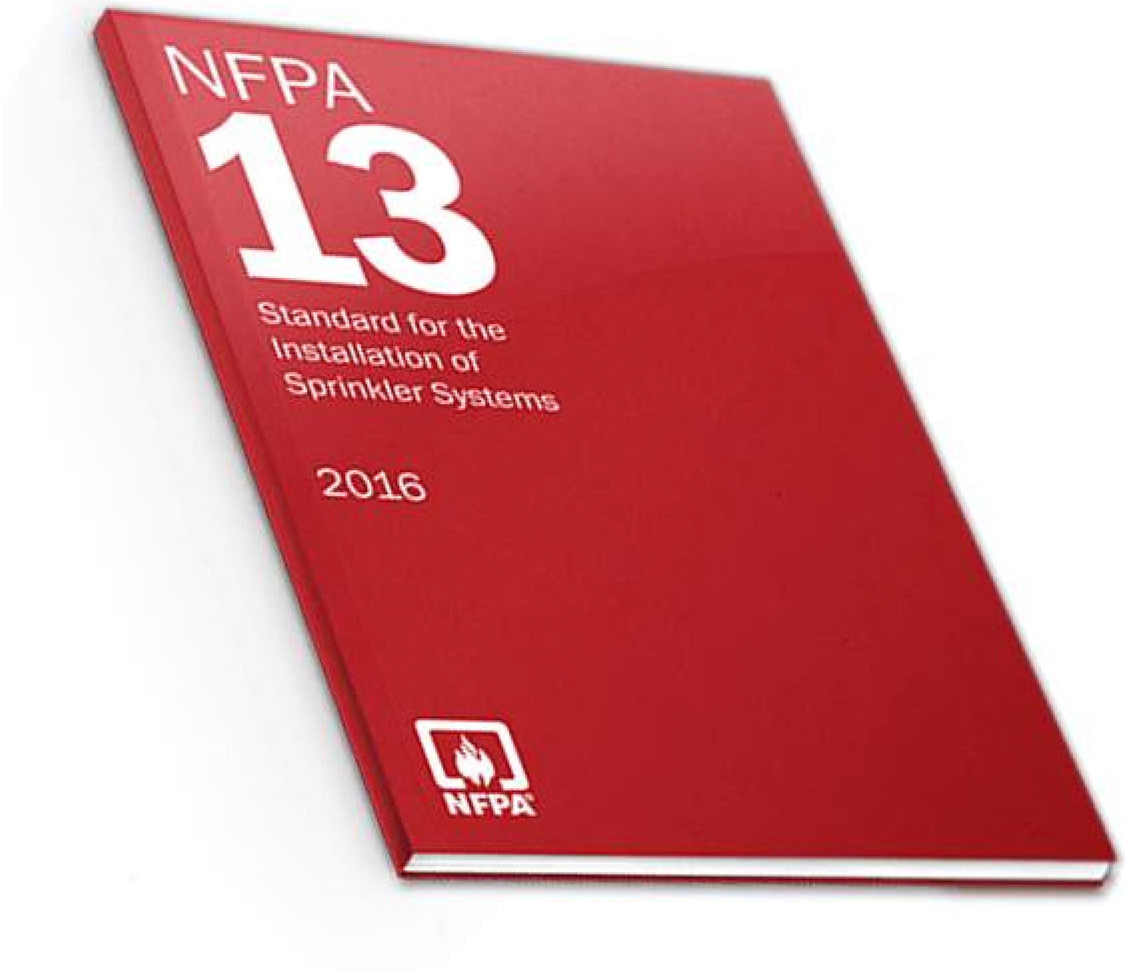
Hydrostatic test pressure is measured at the **lowest elevation** of the system or portion of the system being tested. The hydrostatic test should **include all suction and discharge piping** between the suction pipe control valve and the discharge pipe control valve, as well as any bypass, meter, pressure maintenance (jockey) pump, cooling water piping, and hose header piping. The hose header valve should be **open** during this test.

NFPA 24
Standard for the
Installation of Private
Fire Service Mains and
Their Appurtenances
2016 Edition

Suction piping on the upstream side of the suction piping control valve on booster pumps, and discharge piping on the system side of the discharge piping control valve which feed into underground mains are **required to be hydrostatically tested**. See *NFPA* 24 for additional requirements.

Hydrostatic tests for **discharge piping on the system side** are to be conducted per *NFPA* 13 and *NFPA* 14 requirements.

Keep in mind that **underground** and **aboveground** piping should be **isolated** during the hydrostatic test, with leakage in underground piping approximated by measuring the amount of water needed to restore the initial pressure at the end of the test.



LET'S REVIEW

Let's do a quick check about what has been covered so far.

For a typical hydrostatic test, a minimum pressure of ____ PSI for two hours is required, or you must boost your test pressure to 50 PSI over the maximum operating pressure, whichever is greater.

Type your answer here

SUBMIT

During a hydrostatic test, the hose header valve should remain ____.

○ open

○ closed

SUBMIT

Complete the knowledge checks above before moving on.

Material and Test Certificate

NFPA 20 2016, Figure A.14.1.3

Annex **Figure A.14.1.3(a)** provides the Contractor's Material and Test Certificate for Fire Pump Systems.

Note the following found in the certificate:

Procedure

Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and the system left in service before the contractor's personnel finally leave the job.

Certificate

A certificate shall be filled out and signed by **both** representatives.

Copies shall be prepared for approving authorities, owners, and contractor. It is understood the owner's representative's signature in no way prejudices any claim against the contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.

Flushing

Flow the required rate until water is clear as indicated by no collection of foreign material in burlap bags at outlets such as hydrants and blow-offs.
Flush at flows not less than:

- 390 GPM for 4 in. pipe
- 610 GPM for 5 in. pipe
- 880 GPM for 6 in. pipe
- 1560 GPM for 8 in. pipe
- 2440 GPM for 10 in. pipe
- 3520 GPM for 12 in. pipe

When the supply cannot produce stipulated flow rates, obtain maximum available.

ⓘ Refer to *NFPA* 20 2016, Figure A.14.1.3(a) Sample of Contractor's Material and Test Certificate for Fire Pump Systems

CONTINUE

A sample of the Contractor's Material and Test Certificate for Private Fire Service Mains is found in **Figure A.14.1.3(b)**. Review this certificate as well.

Note the following Test Description Requirements found in this certificate:

Hydrostatic Tests

Hydrostatic tests shall be made at not less than 200 PSI for 2 hours or 50 PSI above static pressure in excess of 150 PSI for 2 hours.

Leakage

- New pipe laid with rubber gasketed joints, shall, if the workmanship is satisfactory, have little or no leakage at the joints. The amount of leakage at the joints shall not exceed 2 qt./hr. per 100 joints irrespective of pipe diameter.
- The amount of allowable leakage specified above can be increased by 1 fl. oz. per in. valve diameter per hour for each metal seated valve isolating the test section.
- If dry barrel hydrants are tested with the main valve open so the hydrants are under pressure, an additional 5 oz. per minute leakage is permitted for each hydrant.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

According to the Contractor's Material and Test Certificate for Fire Pump Systems, inspection and tests are to be made by the _____ representative and witnessed by a(n) ______ representative.

○ owner's; contractor's

○ contractor's; owner's

SUBMIT

The amount of leakage at the gasketed joints of new pipe cannot exceed ___ qt./hr. per 100 joints irrespective of pipe diameter.

○ 1

○ 2

○ 3

○ 4

SUBMIT

Complete the knowledge checks above before moving on.

Field Acceptance Tests

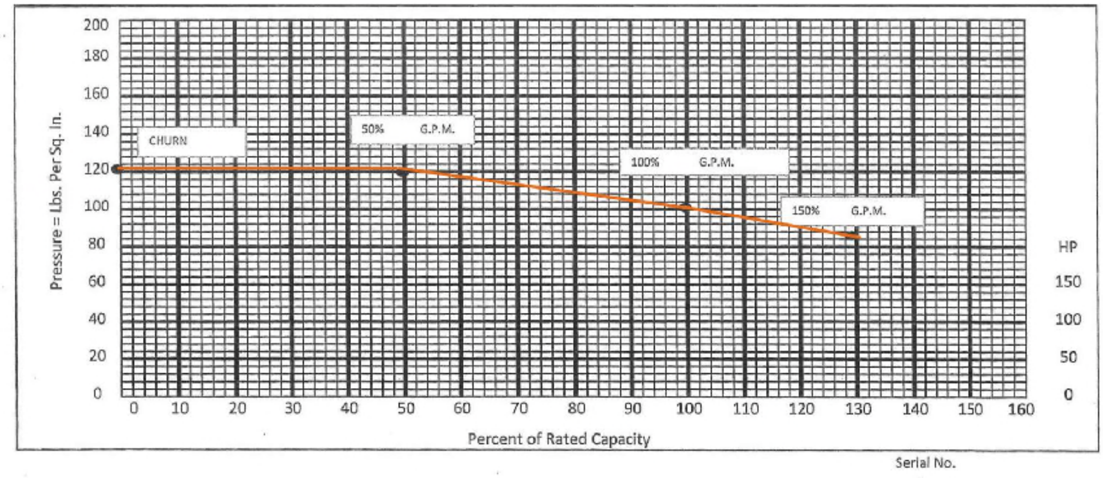
NFPA 20 2016, Sections 14.2.1 – 14.2.4

In this section, the standard requires that the pump manufacturer or a designated representative **be present for the acceptance test**. The AHJ must be **notified** of the time and place of the acceptance test.

In addition, a **copy of the manufacturer's pump test characteristic curve** must be available to compare with the acceptance test results. A **comparison of the test results with the certified pump curves** will provide an indication if the pump performance is acceptable.

The fire pump should **equal** the performance of the manufacturer's certified shop test curve at all flow conditions, within the accuracy limits of the test equipment.

The following is an example of a pump test characteristic curve that would be used for a field performance test.



ⓘ All electric wiring to the fire pump motor(s), are required to be completed and checked by the electrical contractor prior to the initial startup and acceptance test. This includes control interwiring for multiple pumps, normal power supply, alternate power supply where provided, and the jockey pump. (*NFPA* 20 2016, Section 14.2.3)

TEST EQUIPMENT

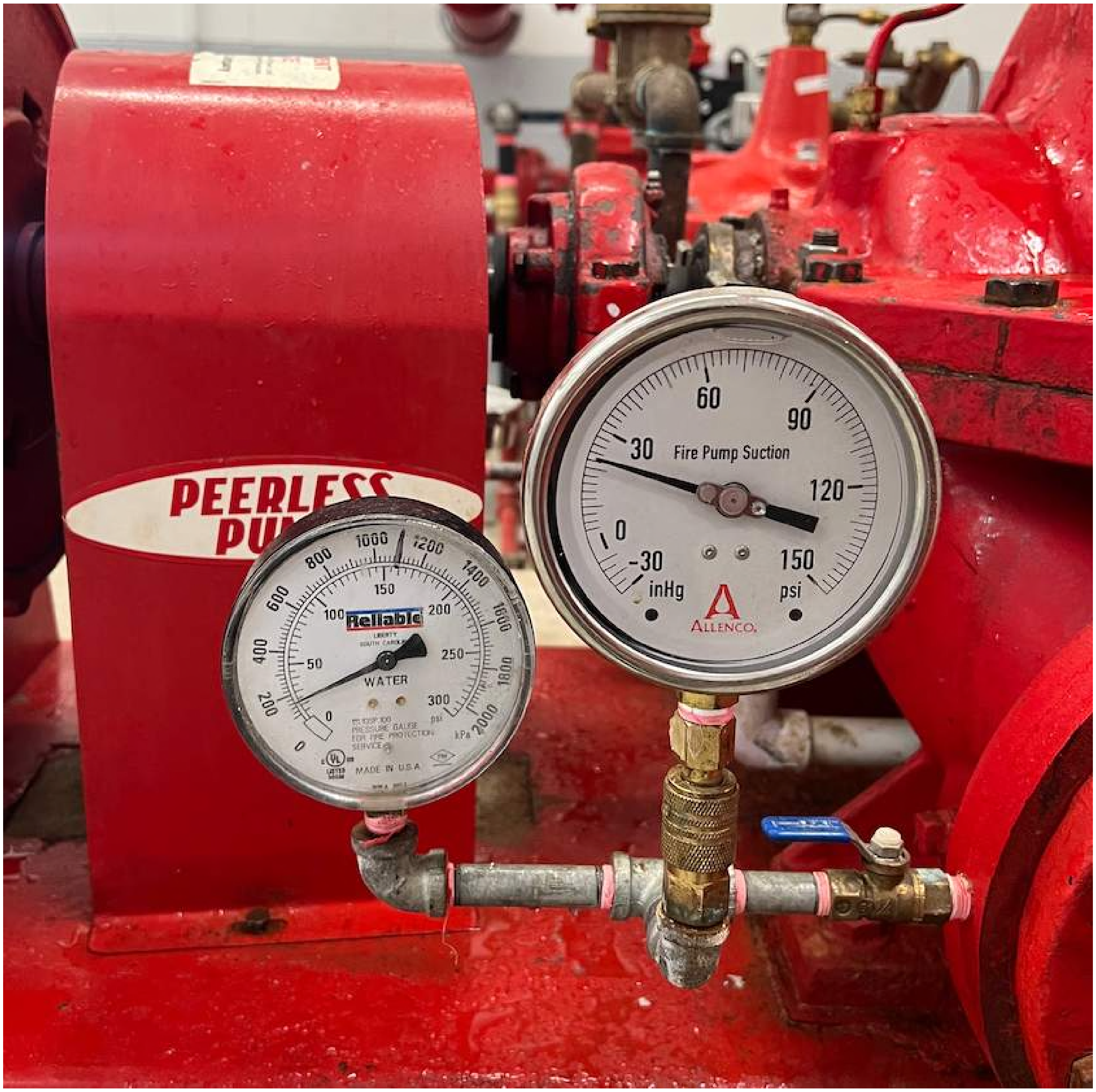
Test Equipment

NFPA 20 2016, Section 14.2.6

Progressing on in the standard, the next section discusses requirements for the availability of test equipment.

Calibrated test equipment is required to determine:

- Net pump pressures
- Rate of flow through the pump
- Volts and amperes for electric motor-driven pumps
- Speed



Calibrated test gauges are required, must be calibrated at a minimum on an **annual** basis bearing the latest date of calibration, and must be maintained at an **accuracy level of ± 1%**.

The minimum, rated, and peak loads of the fire pump are to be determined by controlling the amount of water discharged through the test devices.

CONTINUE

NFPA 20 2016, Section A.14.2.6

The Annex provides additional recommendations regarding test equipment.

The test equipment should be provided by either the **AHJ, the installing contractor, or the pump manufacturer**. The equipment should include at least the following:

Equipment for Use with Test Valve Header

50 ft. lengths of 2 ½ in. lined hose should be provided including Underwriters Laboratories' play pipe nozzles as needed to flow the required volume of water.
This may not be needed if a test meter is provided.

Instrumentation

- Clamp-on volt/ammeter
- Test gauges
- Tachometer

- Pitot tube with gauge (for use with hose and nozzle)

Instrumentation Calibration

All test instrumentation should be calibrated by an approved testing and calibration facility within the 12 months prior to the test.

Calibration documentation should be available for AHJ review.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

In a field acceptance test, the fire pump should ____ the performance of the manufacturer’s certified shop test curve at all flow conditions, within the accuracy limits of the test equipment.

○ be greater than

○ be less than

○ be equal to

SUBMIT

Who must be notified of the time and place of a pump's acceptance test?

Type your answer here

SUBMIT

How often are test gauges required to be calibrated, at minimum?

○ Weekly

○ Monthly

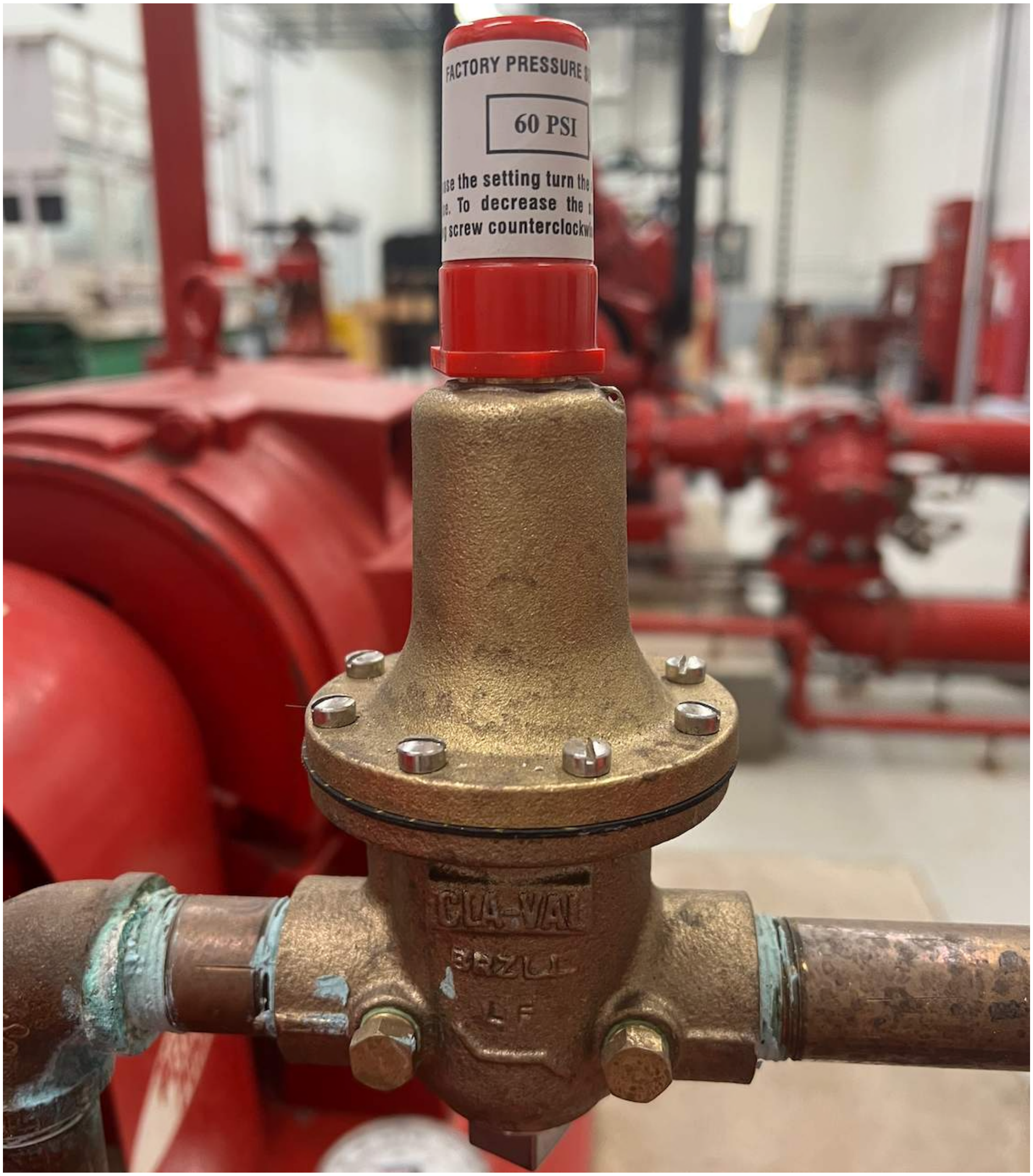
○ Annually

○ Whenever the accuracy level is over +5%

SUBMIT

Complete the knowledge checks above before moving on.

A **true churn condition (no flow)** is ideal during the test so that the results can be compared to the manufacturer’s pump characteristics curve. However, it is not always possible to achieve under all circumstances.



Pumps with circulation relief valves allow a small amount of water to discharge, even when there is no flow into the fire protection system, in order to **keep the pump from overheating**.

- Therefore, the minimum flow in a test occurs where **no water is flowing** to the fire protection system, with a small amount of flow through the circulation relief valve.

During a test on a pump with a **pressure relief valve**, the valve should **not open**.

- Overspeed conditions **should not** occur during the test, and the **pressure relief valve should remain closed**.

CONTINUE

When **pressure relief valves** are installed on systems to relieve pressure under normal operating conditions, and if a true churn condition is desired during the acceptance tests, the **system discharge**

valve can be closed and the **pressure relief valve can be adjusted** again to **allow flow and relief of pressure**.

This is considered to be a "**one-time test**," allowing the **net pressure to serve as the reference point** with the relief valve open. The relief valve can then **remain open** during subsequent **annual tests** allowing a comparison back to the reference residual net pressure rather than the manufacturer's curve.

The **quantity of water discharging** from the fire pump assembly must be **determined and stabilized**, immediately followed by measuring the operating conditions of the fire pump and driver.

CONTINUE

NFPA 20 2016, Section A.14.2.6(4)

Fire pump settings during acceptance testing include:

1. The jockey pump stop point should **equal** the pump churn pressure **plus** the minimum static supply pressure.
2. The jockey pump start point should be **at least 10 PSI less than** the jockey pump stop point.
3. The fire pump start point should be **5 PSI less than** the jockey pump start point. Use **10 PSI increments** for each additional pump.
4. Where minimum run times are provided, the pump will **continue to operate** after attaining these pressures. The final pressures should **not exceed** the pressure rating of the system.
5. If the operating differential of pressure switches does not permit these settings, the settings should be **as close as equipment will permit**. The settings should be established by pressures observed on test gauges.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

How do circulation relief valves keep pumps from overheating?

○ They remain closed as to not allow excess heat into the system.

○ They control the speed at which the pump runs.

○ They allow a small amount of water to discharge.

○ They produce ice when running.

SUBMIT

For a fire pump acceptance test, the jockey pump start point should be at least ____ PSI less than the jockey pump stop point.

Type your answer here

SUBMIT

Complete the knowledge checks above before moving on.

Controller Acceptance Tests

NFPA 20 2016, Sections 14.2.7 and 14.2.11

The fire pump controller acceptance test is expected to have **six automatic and six manual operations**, with the duration of each cycle **no less than five minutes**.

An electric-driven fire pump is to operate for **at least five minutes** at full speed during each of these operations.

Alternate power supplies must be tested, including the emergency generator and automatic transfer switch.

The total pump operating time during the required tests must be **no less than 1 hour**.

ALTERNATE POWER SUPPLY

Alternate Power Supply

NFPA 20 2016, Section 14.2.8

On installations with an alternate source of power and an automatic transfer switch, loss of primary source shall be **simulated**, and transfer shall occur while the pump is **operating at peak load**.

If the normal power source is **not reliable**, and the alternate power source provided is a **generator set**, then installation acceptance shall be in accordance with *NFPA* 110 – *Standard for Emergency and Standby Power Systems*.

In concluding this section, note that the total pump operating time during the required tests must be **no less than one hour**.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

The duration of each cycle for fire pump controller acceptance testing is to be no less than ___ minutes.

Type your answer here

SUBMIT

Installation acceptance of an alternate power supply must be in accordance with which standard?

○ *NFPA* 20

○ *NFPA* 25

○ *NFPA* 100

○ *NFPA* 110

SUBMIT

Complete the knowledge checks above before moving on.

Lesson 2 of 3

Measurement Procedures

Lesson Goal

By the end of this lesson, you will be able to do the following:

☐ Follow proper procedures to obtain appropriate measurements during fire pump testing.

Key References

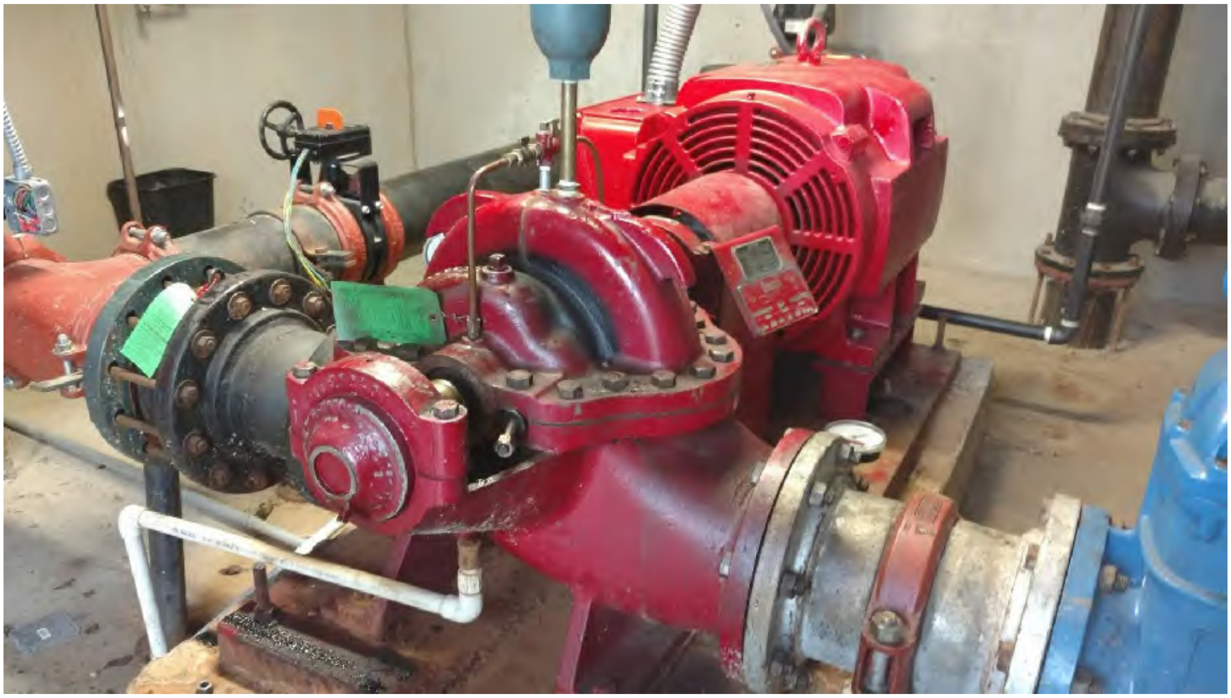
- *NFPA* 13 – *Standard for the Installation of Sprinkler Systems*, 2016
- *NFPA* 20 – *Standard for the Installation of Stationary Pumps for Fire Protection*, 2016
- *NFPA Fire Protection Handbook*, 2008

LET'S BEGIN

Measurement Procedures

NFPA 20 2016, Section 14.2.6.5

The **quantity of water discharging** from the fire pump assembly must be determined and stabilized, immediately followed by **measuring the operating conditions** of the fire pump and driver.



CONTINUE

NFPA 20 2016, Section A.14.2.6.5

Sample Procedure

Click the "Start" button below to view the detailed process as outlined in the Annex to obtain the measurements during the test procedure.

Step 1

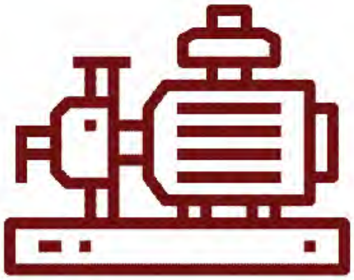
Check the Unit

Visually check the unit, verifying:

- The hose and nozzles are secured.
- The hose valves are closed.
- The valve on the discharge side of the meter is closed, if a test meter is used.

Step 2

Start Pump



Start the pump.

Step 3

Partially Open Valves

Partially open one or two hose valves, or slightly open the meter discharge valve.

Step 4

Check Unit Operation

Check the operation of the unit, adjust the packing glands, and watch for:

- Vibration
- Leaks
- Unusual noises
- General operation

Step 5

Measure Water Discharge

Measure the water discharge.

Specific steps to follow, as detailed in the Annex.

Step 6

Record Data

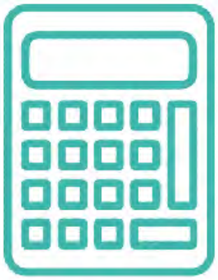
Record the data for each test point. **See Figure A.14.2.6.5(a).**

- Pump RPM
- Suction pressure
- Discharge pressure
- Number and size of hose nozzles:
    - Pitot pressure for each nozzle
    - Total GPM
    - For the test meter, record the GPM
- Amperes (for each phase for electric motor-driven pump)
- Volts (phase to phase for electric motor-driven pump)
- Engine back pressure (diesel engine drive pump)

- Oil pressure (diesel engine drive pump)
- Cooling loop pressure (diesel engine drive pump)
- Engine temperature (diesel engine drive pump)
- Steam pressure (steam drive pump)

Step 7

Calculate Test Results



Calculation of the test results include:

- **Discharge Flow and Pressure –** Confirm discharge pressure and flow will meet the fire protection system demand.
- Rated Speed – Determine the pump is operating at rated RPM.
- **Capacity –** For hose valve header, using a fire stream table, determine the GPM for each nozzle at each pitot reading.
    - As an example, 16 PSI pitot pressure with a 1 ¾ in. nozzle indicates 356 GPM. Add the GPM for each hose line to determine the total volume. For a test meter, the total GPM is read directly.
- **Total Head for Horizontal Pump**– Total head is the sum of the following:
    - Pressure measured by the discharge gauge at pump discharge flange
    - Velocity head difference, pump discharge and pump suction

  - Gauge elevation corrections to pump centerline (plus or minus)
  - Pressure measured by suction gauge at pump suction flange – negative value when pressure is above zero

- **Total Head for Vertical Pump**– Total head is the sum of the following:
  - Pressure measured by discharge gauge at pump discharge flange
  - Velocity head at the discharge
  - Distance to the supply water level
  - Discharge gauge elevation correction to centerline of discharge

- **Electrical Input** – Voltage and amperes read directly from volt/ammeter, and reading compared to motor nameplate full-load amperes.
- **Correction to Rated Speed***– Capacity, head, and power should be corrected from test values at test speed to the rated speed of the pump.
  - Corrections are made as follows:
    - **Capacity:** $Q_2 = (N_2 \div N_1) \times Q_1$
      - Q_1 = capacity at test speed in GPM
      - Q_2 = capacity at rated speed in GPM
      - N_1 = test speed in RPM
      - N_2 = rated speed in RPM

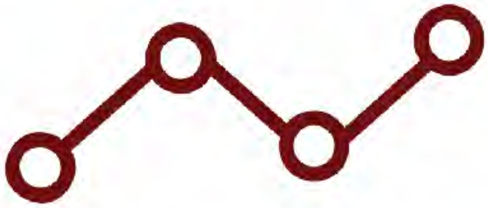
    - **Head:** $H_2 = (N_2 \div N_1)^2 \times H_1$
      - H_1 = head at test speed in ft.
      - H_2 = head at rated speed in ft.

    - **Horsepower:** $hp_2 = (N_2 \div N_1)^3 \times hp_1$

  - hp_1 = horsepower at test speed
  - hp_2 = horsepower at rated speed

Step 8

Plot Test Points



The final step in the test calculation is a plot of the test points.

A **head-capacity curve** is plotted, and an **ampere-capacity curve** is also plotted.

A study of these curves indicates the performance picture of the pump as it was tested.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Using the formula below, find the capacity at rated speed (Q_2) given the following information:

Capacity of test speed = 716 GPM

Test speed = 1700 RPM

Rated speed = 1780 RPM

$$Q_2 = \left(\frac{N_2}{N_1}\right)Q_1$$

○ 700

○ 716

○ 750

○ 800

SUBMIT

Before starting the pump, which of the following should be done? (Select all that apply)

☐ Check that the hose and nozzles are secured.

☐ Check that the hose valves are closed.

☐ Check for leakage.

☐ Partially open one or two hose valves.

☐ Slightly open the meter discharge valve.

☐ Close the valve on the discharge side of the meter, if a test meter is used

SUBMIT

Which of the following curves are plotted after the test calculations are made?

○ **A.** Head-capacity curve

○ **B.** Ampere-capacity curve

○ **C.** Discharge-pressure curve

○ **D.** Both A and B

○ **E.** Both B and C

SUBMIT

🔒 Complete the knowledge checks above before moving on.

Lesson 3 of 3

Inspection, Testing, and Maintenance of Fire Pumps

Lesson Goals

By the end of this lesson, you will be able to do the following:

- ☐ Employ the appropriate testing criteria when replacing fire pump components.
- ☐ Navigate the *NFPA Fire Protection Handbook* for additional resources on fire pump systems.

Key References

- *NFPA* 13 – *Standard for the Installation of Sprinkler Systems*, 2016
- *NFPA* 20 – *Standard for the Installation of Stationary Pumps for Fire Protection*, 2016
- *NFPA* 25 – *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2014
- *NFPA Fire Protection Handbook*, 2008

LET'S BEGIN

Inspection, Testing, and Maintenance

Fire pumps are required to be inspected, tested, and maintained in accordance with *NFPA* 25 - *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

Chapter 8 of *NFPA* 25 contains the majority of the fire pumps requirements. Review this portion of the standard, if you are not familiar with it already.

COMPONENT REPLACEMENT

Component Replacement

NFPA 20 2016, Section 14.5

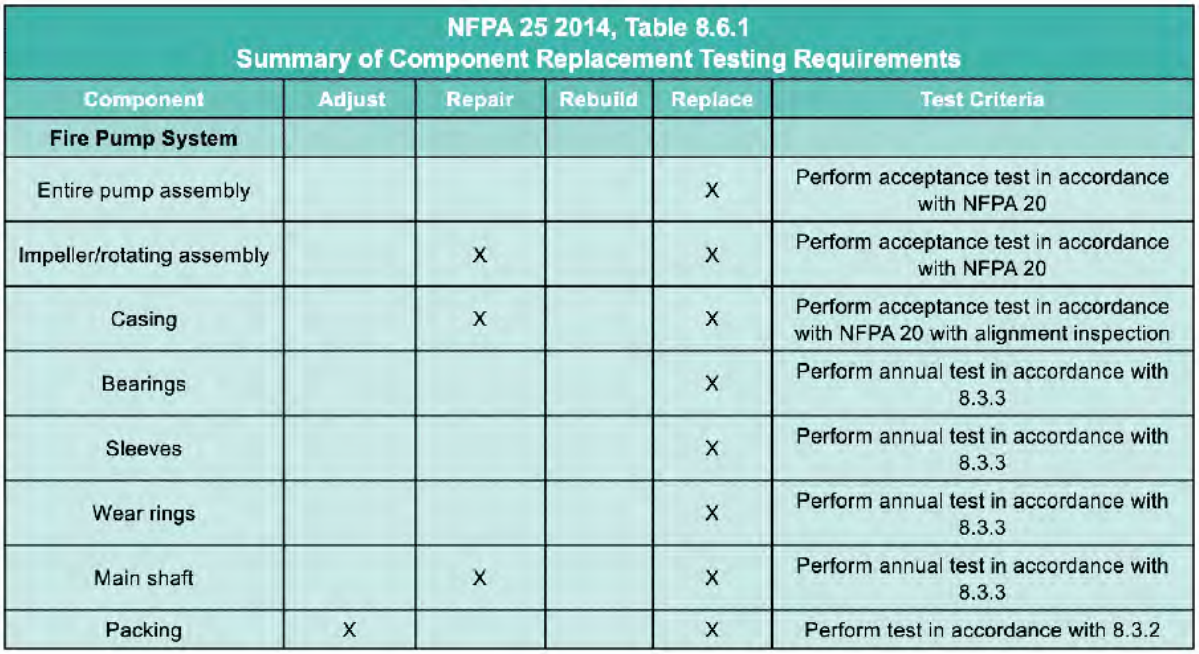
Critical path components include the following features of the pump equipment:

- Fire Pumps
    - Impeller, casing
    - Gear drives

- Fire pump controllers (electric or diesel): total replacement
- Electric motor, steam turbines, or diesel engine drivers

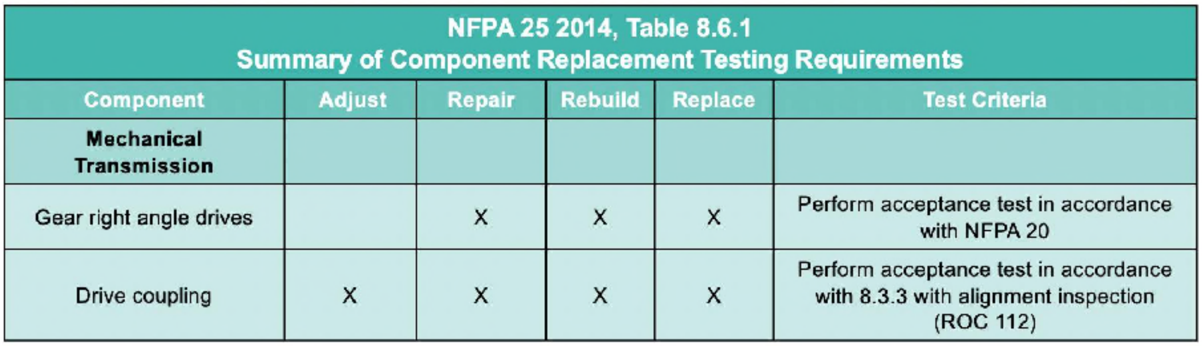
Another table for your reference is *NFPA* 25 2014, Table 8.6.1, which provides a summary of component replacement testing requirements, containing requirements found in *NFPA* 20 and *NFPA* 25.

Click through the following component replacement testing requirements of Table 8.6.1



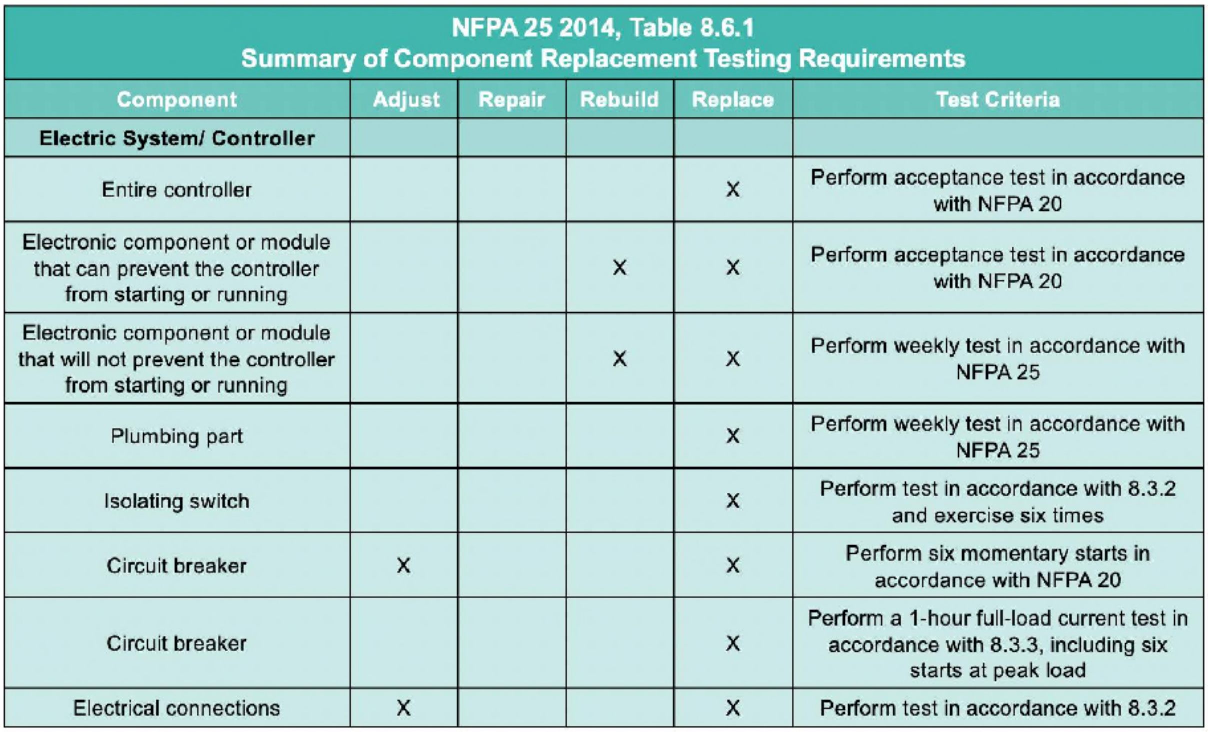
NFPA 25 2014, Table 8.6.1
Summary of Component Replacement Testing Requirements

Component	Adjust	Repair	Rebuild	Replace	Test Criteria
Fire Pump System					
Entire pump assembly				X	Perform acceptance test in accordance with NFPA 20
Impeller/rotating assembly		X		X	Perform acceptance test in accordance with NFPA 20
Casing		X		X	Perform acceptance test in accordance with NFPA 20 with alignment inspection
Bearings				X	Perform annual test in accordance with 8.3.3
Sleeves				X	Perform annual test in accordance with 8.3.3
Wear rings				X	Perform annual test in accordance with 8.3.3
Main shaft		X		X	Perform annual test in accordance with 8.3.3
Packing	X			X	Perform test in accordance with 8.3.2



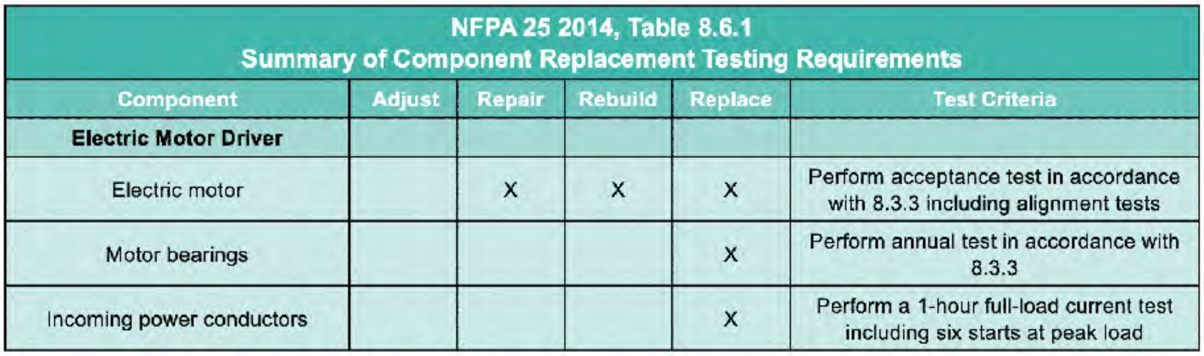
NFPA 25 2014, Table 8.6.1
Summary of Component Replacement Testing Requirements

Component	Adjust	Repair	Rebuild	Replace	Test Criteria
Mechanical Transmission					
Gear right angle drives		X	X	X	Perform acceptance test in accordance with NFPA 20
Drive coupling	X	X	X	X	Perform acceptance test in accordance with 8.3.3 with alignment inspection (ROC 112)



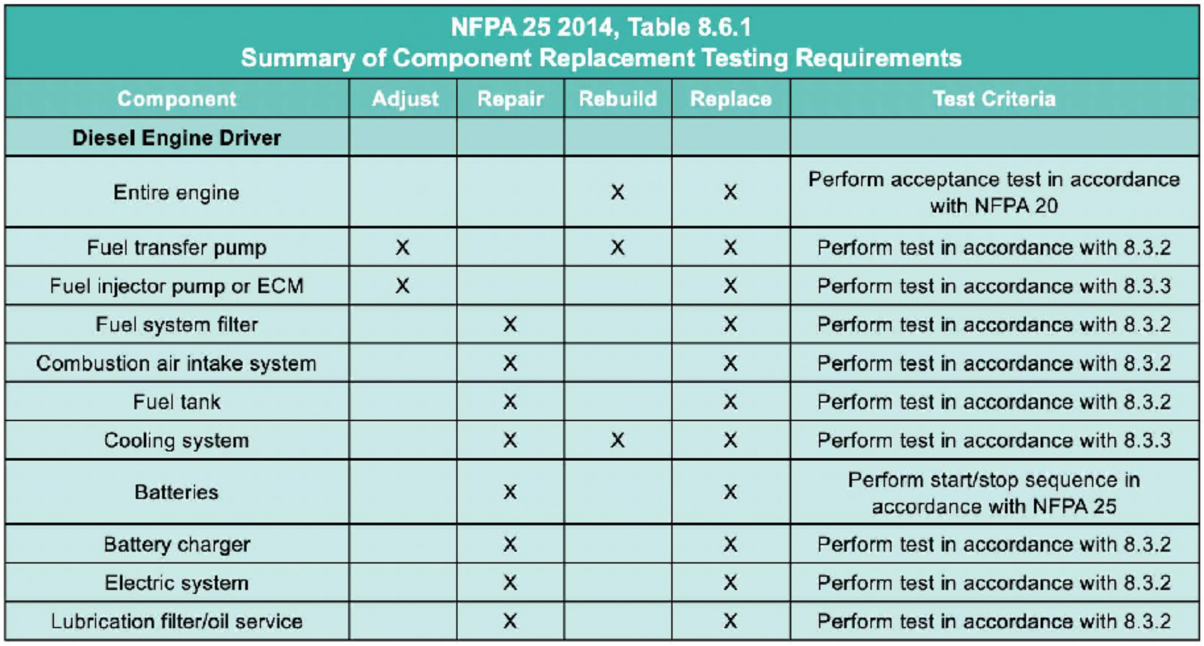
NFPA 25 2014, Table 8.6.1
Summary of Component Replacement Testing Requirements

Component	Adjust	Repair	Rebuild	Replace	Test Criteria
Electric System/ Controller					
Entire controller				X	Perform acceptance test in accordance with NFPA 20
Electronic component or module that can prevent the controller from starting or running			X	X	Perform acceptance test in accordance with NFPA 20
Electronic component or module that will not prevent the controller from starting or running			X	X	Perform weekly test in accordance with NFPA 25
Plumbing part				X	Perform weekly test in accordance with NFPA 25
Isolating switch				X	Perform test in accordance with 8.3.2 and exercise six times
Circuit breaker	X			X	Perform six momentary starts in accordance with NFPA 20
Circuit breaker				X	Perform a 1-hour full-load current test in accordance with 8.3.3, including six starts at peak load
Electrical connections	X			X	Perform test in accordance with 8.3.2



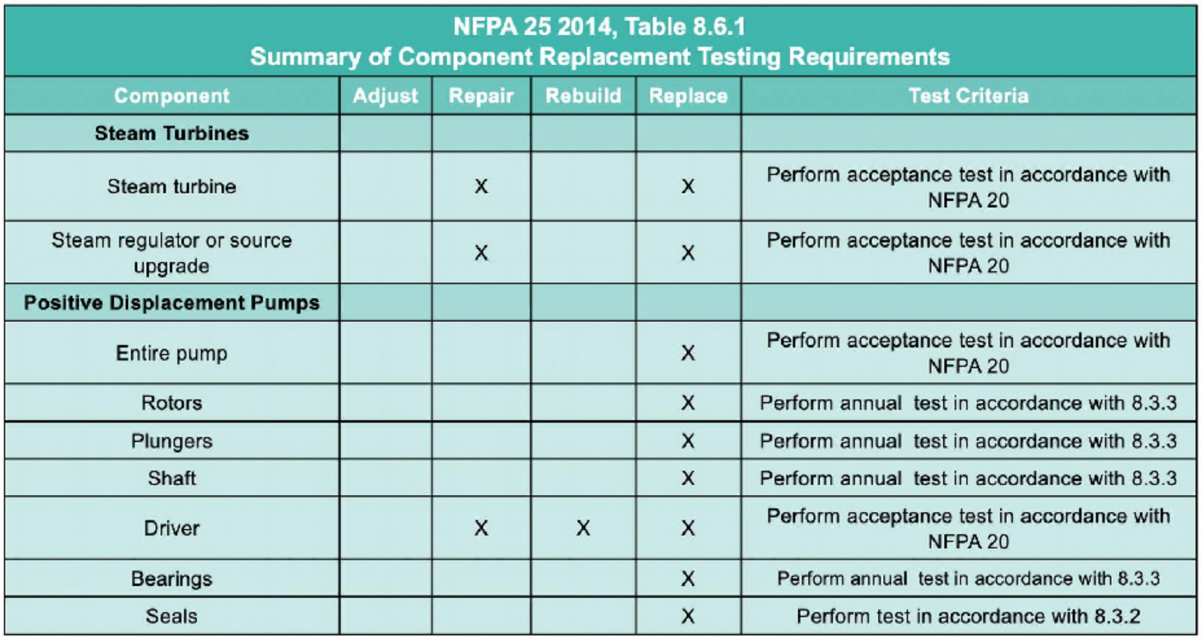
NFPA 25 2014, Table 8.6.1
Summary of Component Replacement Testing Requirements

Component	Adjust	Repair	Rebuild	Replace	Test Criteria
Electric Motor Driver					
Electric motor		X	X	X	Perform acceptance test in accordance with 8.3.3 including alignment tests
Motor bearings				X	Perform annual test in accordance with 8.3.3
Incoming power conductors				X	Perform a 1-hour full-load current test including six starts at peak load



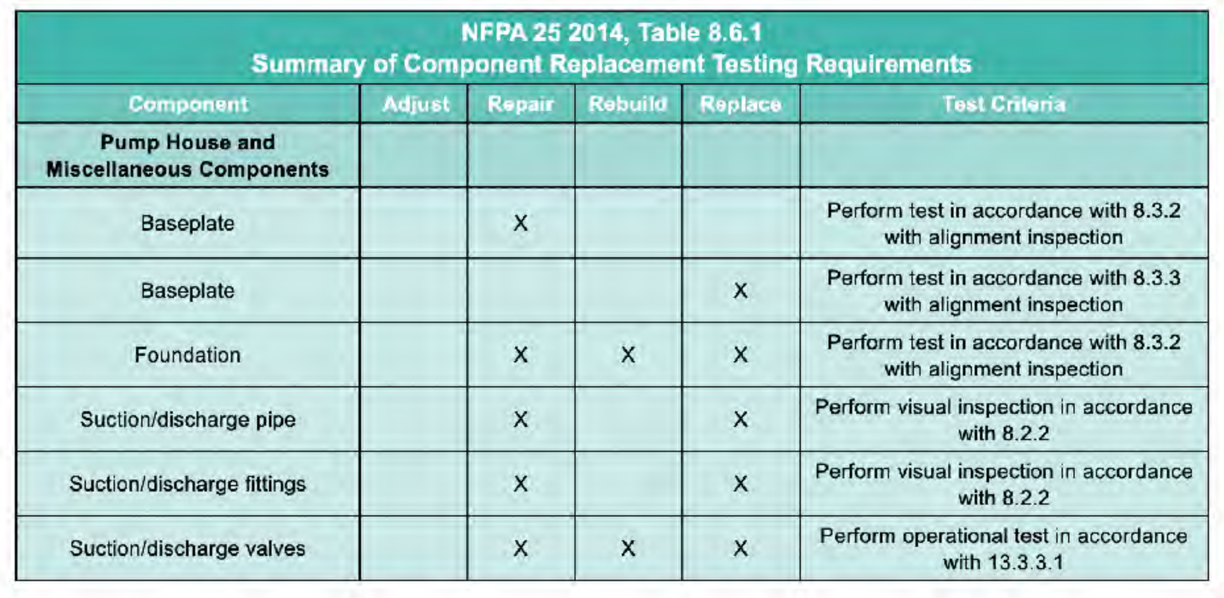
NFPA 25 2014, Table 8.6.1
Summary of Component Replacement Testing Requirements

Component	Adjust	Repair	Rebuild	Replace	Test Criteria
Diesel Engine Driver					
Entire engine			X	X	Perform acceptance test in accordance with NFPA 20
Fuel transfer pump	X		X	X	Perform test in accordance with 8.3.2
Fuel injector pump or ECM	X			X	Perform test in accordance with 8.3.3
Fuel system filter		X		X	Perform test in accordance with 8.3.2
Combustion air intake system		X		X	Perform test in accordance with 8.3.2
Fuel tank		X		X	Perform test in accordance with 8.3.2
Cooling system		X	X	X	Perform test in accordance with 8.3.3
Batteries		X		X	Perform start/stop sequence in accordance with NFPA 25
Battery charger		X		X	Perform test in accordance with 8.3.2
Electric system		X		X	Perform test in accordance with 8.3.2
Lubrication filter/oil service		X		X	Perform test in accordance with 8.3.2



NFPA 25 2014, Table 8.6.1
Summary of Component Replacement Testing Requirements

Component	Adjust	Repair	Rebuild	Replace	Test Criteria
Steam Turbines					
Steam turbine		X		X	Perform acceptance test in accordance with NFPA 20
Steam regulator or source upgrade		X		X	Perform acceptance test in accordance with NFPA 20
Positive Displacement Pumps					
Entire pump				X	Perform acceptance test in accordance with NFPA 20
Rotors				X	Perform annual test in accordance with 8.3.3
Plungers				X	Perform annual test in accordance with 8.3.3
Shaft				X	Perform annual test in accordance with 8.3.3
Driver		X	X	X	Perform acceptance test in accordance with NFPA 20
Bearings				X	Perform annual test in accordance with 8.3.3
Seals				X	Perform test in accordance with 8.3.2



NFPA 25 2014, Table 8.6.1
Summary of Component Replacement Testing Requirements

Component	Adjust	Repair	Rebuild	Replace	Test Criteria
Pump House and Miscellaneous Components					
Baseplate		X			Perform test in accordance with 8.3.2 with alignment inspection
Baseplate				X	Perform test in accordance with 8.3.3 with alignment inspection
Foundation		X	X	X	Perform test in accordance with 8.3.2 with alignment inspection
Suction/discharge pipe		X		X	Perform visual inspection in accordance with 8.2.2
Suction/discharge fittings		X		X	Perform visual inspection in accordance with 8.2.2
Suction/discharge valves		X	X	X	Perform operational test in accordance with 13.3.3.1

LET'S REVIEW

Let's do a quick check about what has been covered so far.

What is the test criteria for the suction and discharge valves of a pump house?

○ Perform operational test in accordance with 8.2.2

○ Perform visual inspection in accordance with 8.2.2

○ Perform operational test in accordance with 13.3.3.1

○ Perform test in accordance with 8.3.3 with alignment inspection

SUBMIT

The test criteria for steam turbines is in accordance with which standard?

○ *NFPA* 13

○ *NFPA* 20

○ *NFPA* 25

○ *NFPA* 110

SUBMIT

Complete the knowledge checks above before moving on.

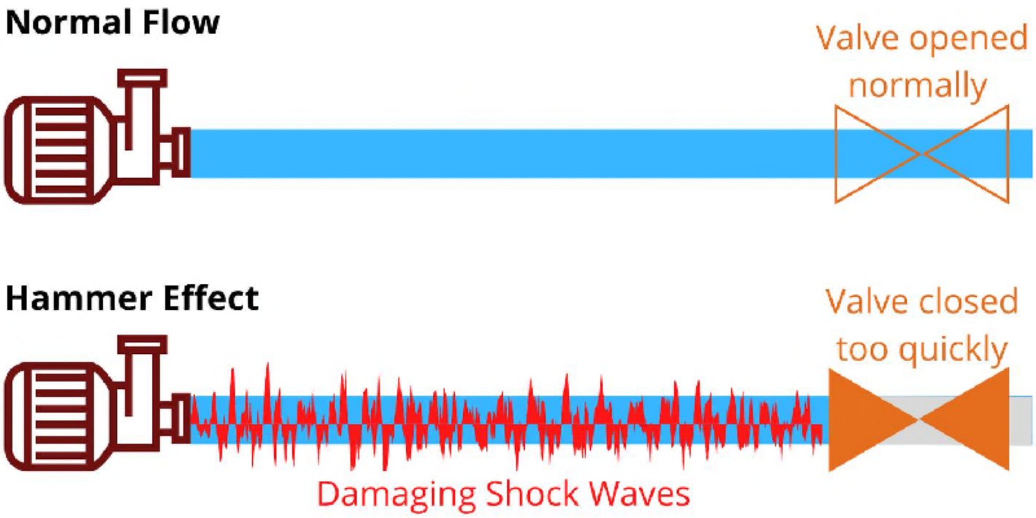
Additional Resources

The *NFPA Fire Protection Handbook* is an additional useful resource that discusses fire pump operations, the recommended practices for driving the pumps, field acceptance tests, and maintenance requirements to keep these pumps operating. Pump characteristics curves are also covered, total head calculations, and terms related to fire pump systems.

Cavitation

The handbook provides a thorough explanation of cavitation with respect to fire pumps and other hydraulic equipment:

> As water flows from the suction pipe, entering the eye of the impeller, the **velocity increases**, and the **pressure decreases**. If the pressure drop is enough to fall **below the vapor pressure** corresponding to the water temperature, then this can **cause pockets of vapor to form**.
>
> Once the vapor pockets reach an **area with higher pressure**, they can **collapse**. This can result in **increased noise and vibration**. In severe cases, the efficiency of the pump can be **compromised**, with pump failure occurring if this problem is allowed to continue.



Click on the image to enlarge.

Another condition to be aware of is **water hammer**, a pressure surge that occurs when there is an abrupt change in the system flow. Typically this can be caused by either **opening or closing a valve too quickly**, or by **starting and/or stopping a pump**. The change produces a **shock wave that can damage a system**.

CONTINUE

By now, you should have a better understanding of fire pumps: why they're important, how they work, and how they're tested.

If there is any section you'd like to go back and review, please feel free!

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.

Ohio Fire Pumps - Ohio Building Code & Ohio Fire Code

When you are ready to get started, click on the "**Begin**" button.

This module will provide information on SOME of the Ohio Building Code and Ohio Fire Code requirements for fire pumps.

It is not meant as a Building and Fire Code course, but to familiarize you with a few of the requirements.

Many of the requirements are the same or very similar to requirements from *NFPA* 20, *Standard for Installation of Stationary Pumps for Fire Protection*, 2016 edition.

In other instances, the Ohio Building Code and the Ohio Fire Code will refer you back to *NFPA* 20 2016 and *NFPA* 25 2014 for the necessary requirements, inspection, testing, and maintenance of fire pumps.

You can reference the Ohio Building Code at:
https://codes.iccsafe.org/content/OHBCU2017/cover

You can reference the Ohio Fire Code at: http://codes.ohio.gov/oac/1301:7-7-09.

Key References for this module:

- Ohio Building Code - Fire Protection Systems

  - https://codes.iccsafe.org/content/OHBCU2017/chapter-9-fire-protection-systems

- Ohio Fire Code - Fire Protection Systems
  - https://codes.iccsafe.org/content/OHFCJAN2019E/ohio-administrative-code-1301-7-7-09-fire-protection-systems

Section 901 Fire Protection Systems

Ohio Building Code and Ohio Fire Code

Lesson 1 of 2

Section 901 Fire Protection Systems

Goals for this lesson:

- Gain a working knowledge of the Ohio Building Code and Ohio Fire Code general requirements for fire protection.
- Identify NFPA standards associated with different types of fire protection systems.
- Recognize acceptance testing and related documentation requirements.
- Follow the correct procedures for all system impairments.

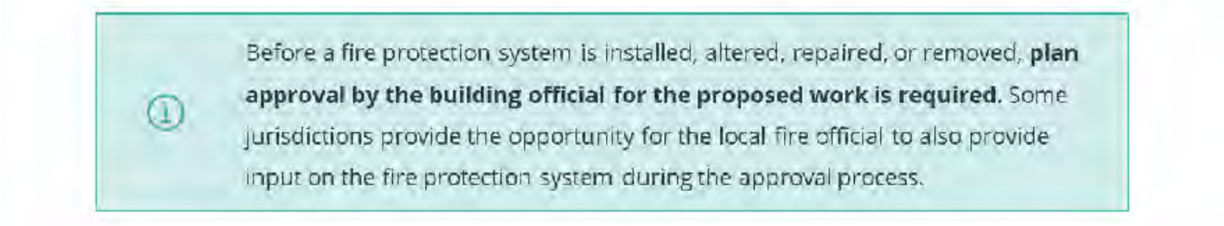
LET'S GET STARTED

Section 901

Fire Protection Systems

The Ohio Building Code and the Ohio Fire Code provide numerous requirements pertaining to fire protection systems. While the **majority of the requirements are found in Chapter 9** of the Ohio Building Code and Section 7-7-09 of the Ohio Fire Code, **Chapter 4 of the Ohio Building Code also contains special requirements to use for fire protection-related systems**, including high-rise buildings, malls, and atriums. We encourage you to be familiar with the requirements in both of these Codes.

Chapter 9 of the Ohio Building Code and **Section 901 of the Ohio Fire Code** apply to the **design**, **installation**, and **operation** of fire protection systems. These systems are to be **installed, repaired, operated, and maintained** per the Ohio Building Code and the Ohio Fire Code requirements.



Before a fire protection system is installed, altered, repaired, or removed, **plan approval by the building official for the proposed work is required.** Some jurisdictions provide the opportunity for the local fire official to also provide input on the fire protection system during the approval process.

ACCEPTANCE TESTING

Acceptance Testing

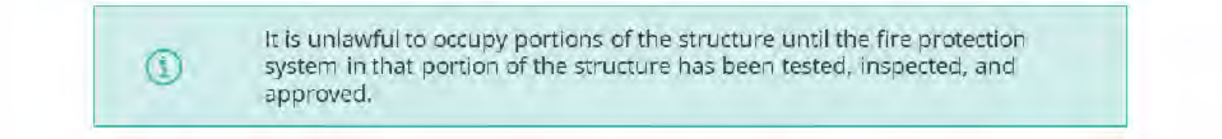
Advanced coordination for all acceptance testing is to be provided to the building official, in the event the building official or the fire official requires a certified building inspector or certified fire protection system inspector to be present to witness these tests.

Note: The Ohio Fire Code requires at least 48 hours advanced notification of the test schedule to be provided to the fire official.

- Acceptance tests are to **follow Ohio Building Code and Fire Code requirements**, as well as the **applicable NFPA standards** for the portion of the fire protection system undergoing acceptance testing.
- All tests are to be **conducted at the owner's expense**, in the presence of either those who installed the equipment or their company's representative.

- The test **results are to be documented** and completed certificates are submitted to the building official and the fire official.

- Copies of the test **records are to be maintained on-site** and readily available to the inspector during the final inspection.



It is unlawful to occupy portions of the structure until the fire protection system in that portion of the structure has been tested, inspected, and approved.

Neither modification to nor removal of the fire protection system is permitted without advanced consent of the building official with input from the fire official.

CONTINUE

The Ohio Fire Code requires fire protection systems to be inspected, tested, and maintained per the requirements of their associated NFPA standard, as shown in **Table 901.6.1**.

Ohio Fire Code Table 901.6.1
Fire Protection Systems Maintenance Standards

System	Standard (As Listed in Rule 1301:7-7-80 of the Administrative Code)
Portable fire extinguishers	NFPA 10

Ohio Fire Code Table 901.6.1
Fire Protection Systems Maintenance Standards

Carbon dioxide fire-extinguishing systems	NFPA 12
Halon 1301 fire-extinguishing systems	NFPA 12A
Dry-chemical extinguishing systems	NFPA 17
Wet-chemical extinguishing systems	NFPA 17A
Water-based fire protection systems	NFPA 25
Fire alarm systems	NFPA 72
Smoke and heat vents	NFPA 204
Water-mist systems	NFPA 750
Clean-agent extinguishing systems	NFPA 2001

ACCEPTANCE TESTING RECORDS

Acceptance Testing Records

Maintain records of all system inspections, tests, and maintenance tasks. Initial records shall be maintained for the life of the installation and include the following:

☑ Installation contractor ________

☑ Component manufacturers ________

☑ Location & number of components installed per floor ________

☑ Manufacturer's operation & maintenance instruction manuals

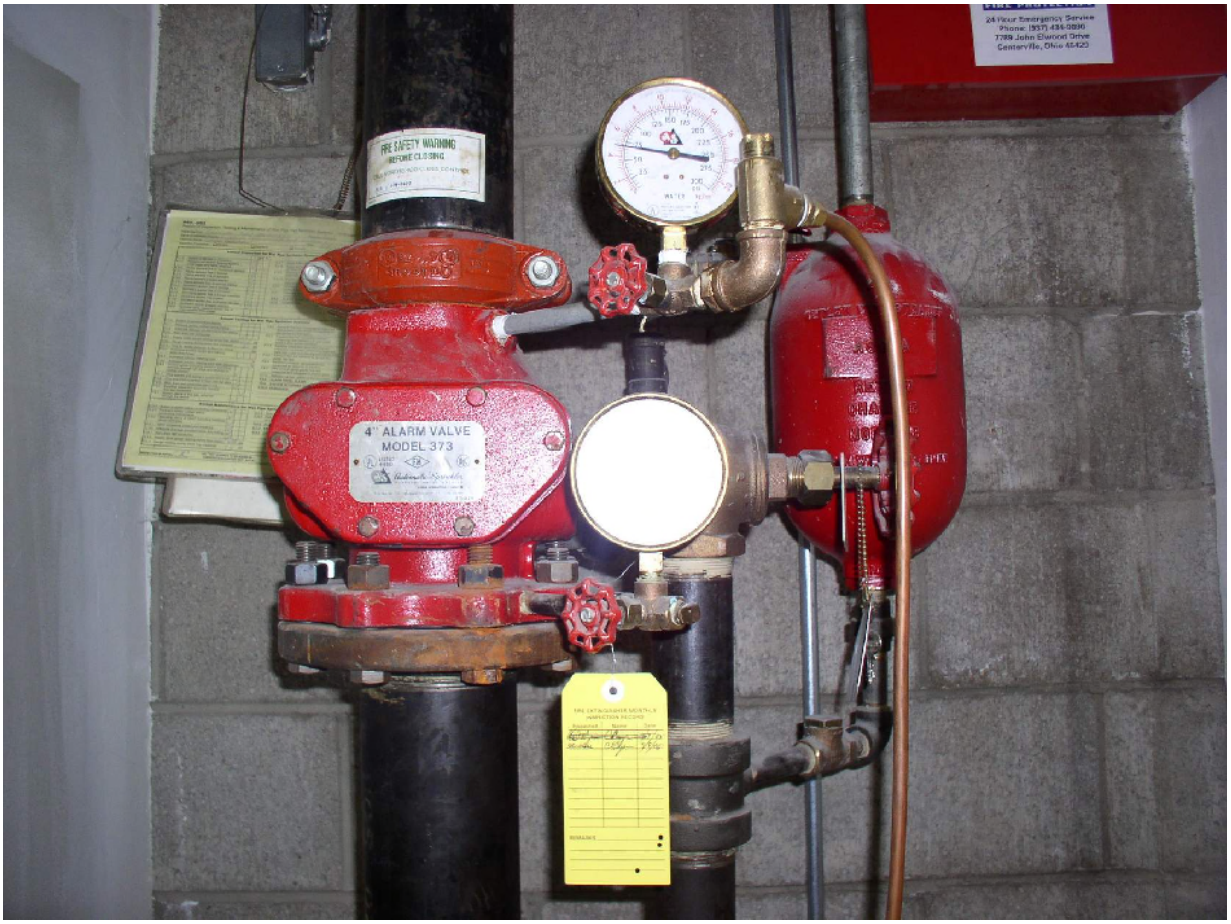
- Name of the installation contractor
- Component manufacturers
- Location and number of components installed per floor
- Manufacturer’s operation and maintenance instruction manuals

Acceptance testing records are required to be retained for the life of the system.

CONTINUE

The Ohio Fire Code additionally requires inspection tags to be attached to each fire protection system near the main control valve, main panel, or other appropriate visible locations as determined by the fire official. The annual inspection tag contains the following:

- The individual performing the work and the state fire marshal installer certification number(s) (if applicable)
- Date of test
- Results of inspection and test
- Deficiencies or impairments noted (yes or no)
- For sprinkler or standpipe systems, this tag requirement includes an impairment tag per NFPA 25


FIRE SAFETY WARNING
BEFORE CLOSING
4" ALARM VALVE
MODEL 373
24 Hour Emergency Service
John Elwood Drive
Centerville, Ohio

When a fire protection system is out of service, the fire department and fire official are to be notified immediately, and the building evacuated or an approved fire watch provided, per the discretion of the fire official, until the fire protection system is returned to service.

An impairment coordinator is to be assigned to the building and a tag is posted at each fire department connection, system control valve, fire alarm control unit, fire alarm annunciator, and fire command center indicating that the system (or portion thereof) has been removed from service. The fire official shall determine tag placement.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

It is acceptable to occupy the structure prior to approval by the fire code official as long as the acceptance test is complete.

○ True

○ False

SUBMIT

Initial records shall be maintained for the life of the installation and include the following:

☐ Component manufacturers

☐ Manufacturer’s operation and maintenance instruction manuals

☐ Name of the installation contractor

☐ Name and identification number of the AHJ

☐ Location and number of components installed per floor

SUBMIT

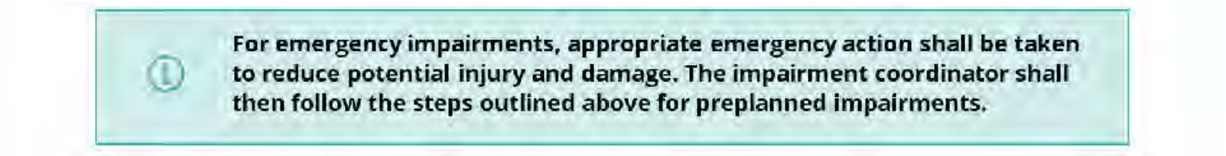
PREPLANNED IMPAIRMENTS

Preplanned Impairments

Preplanned impairments require prior authorization by the impairment coordinator. Prior to approval, the following procedures shall be implemented and verified:

- **Determine the extent** and expected duration of the impairment

- **Inspect the areas** of the building involved to assess the increased risks
- **Submit recommendations** to management or the building owner
- **Notify** the fire department, the insurance carrier, the alarm company, the building owner, and other appropriate AHJs
- **Notify any supervisors** in the affected areas
- **Implement** a tag impairment system
- **Confirm** all needed tools and materials are on-site



For emergency impairments, appropriate emergency action shall be taken to reduce potential injury and damage. The impairment coordinator shall then follow the steps outlined above for preplanned impairments.

CONTINUE

Once the impaired equipment is ready to be restored to normal operations, the impairment coordinator needs to confirm the following procedures have been implemented:

- **Verify** by inspection and test that the affected systems are operational
- **Notify** supervisors that the system has been restored
- **Notify** the fire department, building owner, insurance carrier, alarm company and other appropriate parties that the system has been restored

- **Remove** the impairment tag

Note that it is unlawful to remove, tamper with, or disturb any of the following, except when extinguishing a fire, during training, or when recharging/repairing a system:

Fire hydrant

Fire detection and alarm system

Fire suppression system

Other fire appliances

When supervisory services are terminated, the fire official is required to be notified within 24 hours.

FIRE PUMPS

Fire Pumps

Section 901.8 – Pump and Riser Room Ohio Building Code and Section 901.4.6 Ohio Fire Code

Automatic sprinkler system riser rooms and fire pump rooms are required to have sufficient room for all needed equipment, allowing ample working space around the stationary equipment. Clearance around the equipment needs to be adequate to permit inspection, service, repair, or replacement to successfully occur without having to remove or disassemble portions of the systems. These rooms are required to have doors and a large enough unobstructed passageway to allow the removal of the largest piece of equipment.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Once the impaired equipment is ready to be restored to normal operations, the impairment coordinator needs to confirm the following have been notified:

- ☐ Supervisors
- ☐ Fire Department
- ☐ Building owner

☐ Insurance carrier

SUBMIT

Preplanned impairments require prior authorization by the impairment coordinator.

○ True

○ False

SUBMIT

CONTINUE TO NEXT LESSON: OHIO BUILDING CODE AND OHIO FIRE CODE

Lesson 2 of 2

Ohio Building Code and Ohio Fire Code

Lesson Goal

By the end of this lesson, you will be able to do the following:

☐ Gain a working knowledge of the Ohio Building Code and Ohio Fire Code requirements for fire pumps.

INTRODUCTION

Introduction

This module will provide information on **some** of the Ohio Building Code and Ohio Fire Code requirements for fire pumps.

It is **not** meant as a Building and Fire Code course, but to **familiarize** you with a few of the requirements.

Many of the requirements are the **same or very similar** to requirements from *NFPA* 20, Installation of Stationary Pumps for Fire Protection, 2016 edition.

In other instances, the Ohio Codes will refer you back to *NFPA* 25 2014 for the necessary requirements, inspection, testing, and maintenance of fire pumps.

Fire Protection Systems portion

You can reference the Ohio Building Code and use this button to take you to the fire protection systems portion of the Building Code.

CLICK HERE

Fire Protection Systems portion

You can reference the Ohio Fire Code and use this button to take you to the fire protection systems portion of the Fire Code

CLICK HERE

CONTINUE

The **Ohio Building Code** lists all of the sections that deal with fire pumps in **Chapter 35**, Referenced Standards. Similarly, the **Ohio Fire Code** lists these sections in **Section 1301:7-7-80.**

Referenced Standards Table

You can take a look at the table by clicking on this button.
The information we are looking for is on the NFPA table under the "Standard Reference Number" column and titled "20-16."

CLICK HERE

Per the NFPA table, the sections of the building code covering fire pumps are:

- Section 913.1
- Section 913.2

- Section 913.5.1

We will not cover every section listed above but will provide information so that you **get a feel for what both the Ohio Building Code and the Ohio Fire Code entail**.

SECTION 913

Ohio Building Code and Ohio Fire Code, Section 913

As listed above, Section 913 contains fire pump requirements. Fire pumps are to be installed per *NFPA* 20 2016 requirements.

Ohio Environmental Protection Agency

The Ohio Environmental Protection Agency requires one of the following be installed to ensure a **minimum 10 PSI is maintained in the suction line** when the pump is running:

- Low pressure cut-off
- Low suction throttling valve
- Variable speed suction line

NFPA 20 2016

Per *NFPA* 20 2016, the fire pump, driver, and fire pump controller are required to be **protected against the possible interruption** of service that could be caused by the following:

- Explosion
- Fire, flood, or earthquake
- Rodents or insects
- Windstorms or freezing
- Vandalism or other adverse conditions

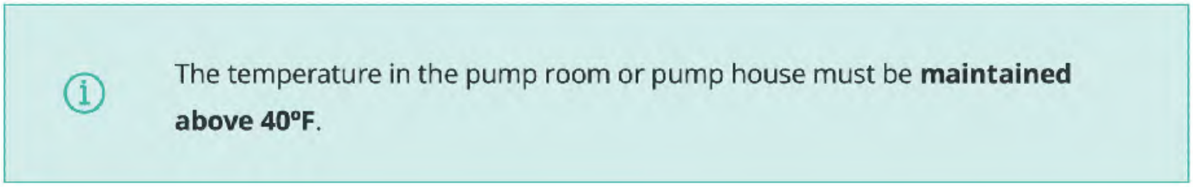
CONTINUE

Fire Pump Location

Fire pumps are to be located in rooms separated from all other areas of the building by a **2-hour barrier** as defined in Section 707, **2-hour assemblies** constructed per Section 711, or both.

There are exceptions for non-high-rise buildings, which requires a **1-hour fire barrier or horizontal assembly (or both)** in buildings that are protected by an automatic sprinkler system.

Cables used for circuit survivability are required to be listed **per UL 2196**.



ⓘ The temperature in the pump room or pump house must be **maintained above 40ºF**.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

The Ohio Environmental Protection Agency requires which of the following be installed to ensure a minimum 10 PSI is maintained in the suction line when the pump is running? (Select all that apply)

☐ Backflow preventer

☐ Low pressure cut-off

☐ Low suction throttling valve

☐ Fire barrier

☐ Variable speed suction line

SUBMIT

As defined by Section 707, a ___-hour barrier is required to separate the fire pumps from all other areas of the building.

Type your answer here

SUBMIT

Complete the knowledge checks above before moving on.

Backflow Prevention

Fire pump suction, discharge and bypass valves, and isolation valves on a backflow prevention device or assembly are required to be **supervised by one of the following**:

- Central station, proprietary, or remote-station signaling service
- Local signaling service that will sound an audible signal at a constantly attended location
- Locking valves open
- Sealing of valves and approved weekly recorded inspection where valves are located within fenced enclosures under the control of the owner

Fire pump test outlet valves are required to be **supervised, sealed, or locked in the closed position**.

Backflow prevention

CONTINUE

Acceptance Testing

All acceptance testing is required to follow ***NFPA* 20 2016 requirements and Section 901.5 of the Ohio Building Code (OBC)**. Section 901.5 requires acceptance tests to be conducted in accordance with the requirements of the following at the expense of the owner or the owner's representative:

- The OBC
- The OH Fire Code
- The applicable referenced standards

Additionally, the building official may require acceptance tests be conducted in the **presence of a certified building inspector or certified fire protection system inspector**.

The Ohio Fire Code, Section 901.5 provides additional requirements:

1. The fire code official shall be notified by the responsible person of any scheduled acceptance testing of a fire protection system **not less than 48 hours prior to the start of the test**.
2. When required by the fire code official, all acceptance testing shall be **conducted in the presence of the fire code official**.
3. When required by the fire code official, all acceptance testing shall be **conducted in the presence of the person who installed the equipment** or, if it is not possible for the actual installer to be present, the acceptance testing shall be conducted in the presence of another qualified representative of the company that installed the equipment.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Fire pump test outlet valves are required to be supervised, sealed, or locked in the _____ position.

○ open

○ closed

SUBMIT

If required by the building official, acceptance tests are to be conducted in the presence of whom?

○ **A.** A certified building inspector

○ **B.** A certified fire protection system inspector

○ **C.** Both A and B

○ **D.** Either A or B

SUBMIT

🔒 Complete the knowledge checks above before moving on.

After completing this module, you should now have a better understanding of the Ohio Building Code and the Ohio Fire Code for fire pumps.

Please press the button to proceed.

Fire Pumps - Glossary

Click on a letter below to see each term and its definition.

- A
- C
- D
- E
- F
- H
- I
- L
- N
- P

R

S

V

W

Lesson 1 of 14

A

Additive Pump

A pump that is used to inject additives into the water stream. (*NFPA* 20 2016, Section 3.3.44.1)

Approved

Acceptable to the authority having jurisdiction. (*NFPA* 20 2016, Section 3.2.1)

Authority Having Jurisdiction (AHJ)

An organization, office, or individual responsible for enforcing requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure. (*NFPA* 20 2016, Section 3.2.2)

Lesson 2 of 14

C

Cavitation

A complex phenomenon related to pumps which results from suction pressure falling below the vapor pressure corresponding to the water temperature.

Centrifugal Pump

A pump in which the pressure is developed principally by the action of centrifugal force. (*NFPA 20* 2016, Section 3.3.44.3)

Circulation Relief Valve

A valve used to cool a pump by discharging a small quantity of water. This valve is separate from and independent of the main relief valve. (*NFPA* 20 2016, Section 3.3.67.5.1)

D

Diesel Engine

An internal combustion engine in which the fuel is ignited entirely by the heat resulting from the compression of the air supplied for combustion. (*NFPA* 20 2016, Section 3.3.15.1)

Dump Valve

An automatic valve installed on the discharge side of a positive displacement pump to relieve pressure prior to the pump driver reaching operating speed. (*NFPA* 20 2016, Section 3.3.67.1)

E

Electric Motor

A motor that is classified according to mechanical protection and methods of cooling. (*NFPA* 20 2016, Section 3.3.35.4)

End Suction Pump

A single suction pump having its suction nozzle on the opposite side of the casing from the stuffing box and having the face of the suction nozzle perpendicular to the longitudinal axis of the shaft. (*NFPA* 20 2016, Section 3.3.44.4)

Lesson 5 of 14

F

Fire Pump

A pump that is a provider of liquid flow and pressure dedicated to fire protection. (*NFPA* 20 2016, Section 3.3.44.5)

Fire Pump Controller

A group of devices that serve to govern, in some predetermined manner, the starting and stopping of the fire pump driver and to monitor and signal the status and condition of the fire pump unit. (*NFPA* 20 2016, Section 3.3.19)

Lesson 6 of 14

H

Head

A quantity used to express a form (or combination of forms) of the energy content of water per unit weight of the water referred to any arbitrary datum. (*NFPA* 20 2016, Section 3.3.25)

High-Rise Building

A building where the floor of an occupiable story is greater than 75 ft. above the lowest level of fire department vehicle access. (*NFPA* 20 2016, Section 3.3.26)

Horizontal Pump

A pump with the shaft normally in a horizontal position. (*NFPA* 20 2016, Section 3.3.44.8)

Horizontal Split-Case Pump

A centrifugal pump characterized by a housing that is split parallel to the shaft. (*NFPA* 20 2016, Section 3.3.44.9)

I

In-Line Pump

A centrifugal pump whose drive unit is supported by the pump having its suction and discharge flanges on approximately the same centerline. (*NFPA* 20 2016, Section 3.3.44.10)

L

Listed

Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose. (*NFPA* 20 2016, Section 3.2.3)

N

No Flow (Churn, Shutoff)

The condition of zero flow when the fire pump is running but the only water passing through the pump is a small flow that is discharged through the pump circulation relief valve or supplies the cooling for a diesel engine driver. (*NFPA* 20 2016, Section 3.3.38)

P

Positive Displacement Pump

A pump that is characterized by a method of producing flow by capturing a specific volume of fluid per pump revolution and reducing the fluid void by a mechanical means to displace the pumping fluid. (*NFPA* 20 2016, Section 3.3.44.14)

Pressure Maintenance (Jockey or Make-Up) Pump

A pump designed to maintain the pressure on the fire protection system(s) between preset limits when the system is not flowing water. (*NFPA* 20 2016, Section 3.3.44.15)

Pressure-Reducing Valve

A valve designed for the purpose of reducing the downstream water pressure under both flowing (residual) and non-flowing (static) conditions. (*NFPA* 20 2016, Section 3.3.67.4)

R

Rated Speed

The speed for which the fire pump is listed and that appears on the fire pump nameplate. (*NFPA* 20 2016, Section 3.3.57.3)

Relief Valve

A device that allows the diversion of liquid to limit excess pressure in a system. (*NFPA* 20 2016, Section 3.3.67.5)

S

Shall

Indicates a mandatory requirement. (*NFPA* 20 2016, Section 3.2.4)

Should

Indicates a recommendation or that which is advised but not required. (*NFPA* 20 2016, Section 3.2.5)

Sprinkler System

A system that consists of an integrated network of piping designed in accordance with fire protection engineering standards that includes a water supply source, a water control valve, a waterflow alarm, and a drain. The portion of the sprinkler system above ground is a network of specifically sized or hydraulically designed piping installed in a building, structure, or area, generally overhead, and to which sprinklers are attached in a systematic pattern. The system is commonly activated by heat from a fire and discharges water over the area. (*NFPA* 13 2016, Section 3.3.23)

Standard

An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides. (*NFPA* 20 2016, Section 3.2.6)

V

Velocity Head

The kinetic energy of a unit weight of fluid moving with velocity (v) determined at the point of the gauge connection. (*NFPA* 20 2016, Section 3.3.25.6)

Vertical Lineshaft Turbine Pump

A vertical shaft centrifugal pump with rotating impeller or impellers and with discharge from the pumping element coaxial with the shaft. The pumping element is suspended by the conductor system, which encloses a system of vertical shafting used to transmit power to the impellers, the prime mover being external to the flow stream. (*NFPA* 20 2016, Section 3.3.44.18)

Lesson 14 of 14

W

Wet Pit

A timber, concrete, or masonry enclosure having a screened inlet kept partially filled with water by an open body of water such as a pond, lake, or stream. (*NFPA* 20 2016, Section 3.3.71)

File Attachments for Item:

EC-7 Ohio Household Fire Warning Equipment (Fire Tech Productions)

All certifications (5 hours)

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

APPLICATION FOR CONTINUING EDUCATION APPROVAL
COURSE CONDITIONS AND GUIDELINES

The Ohio Board of Building Standards is committed to the ongoing education and professional development of board-certified personnel through the delivery of high-quality, accurate and engaging professional continuing education content. To this end, the Board reviews and approves Continuing Education Courses for building department personnel.

Board approval is granted for course instruction on current codes and standards, including the OBC, OMC, OPC, and RCO, and any other content areas directly related to the responsibilities of the certification for which credit is being requested.

Promotion: Any person or organization promoting an approved course is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, categories 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 may not falsely state BBS approval before approval is granted. Course providers may state that BBS approval is pending.

Application Submission: All Applications and associated materials shall be submitted by email in .pdf format. Instructions for completing the application are attached.

Certificate of Completion: Course providers shall 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.

Any person or organization administering an approved course shall return a completed BBS Course Attendance form by email.

Participants: Participants must attend the complete course as presented by the instructor to receive credit hours approved by the Board. The organization or instructor of online courses shall plan and execute methods to verify the individual's attendance and completion of the course. No partial credit will be given to any participant who failed to complete the entire course as approved.

Board approval: All courses are approved for the calendar year in which application is made. Courses may be renewed so long as the referenced code is in effect, and the CEUs, certification and content remain unchanged. When the referenced code is updated, courses must be updated, and new approvals obtained.

Facility/training area: BBS Course may be delivered in person or online, or both, at the sponsor's option.
Course facilities shall include the following:

In Person Classes:	**Online Classes:**
Sufficient seating capacity	Web-accessible
ADA accessible facilities	ADA accessible delivery
Appropriate Audio/Visual devices for delivery	Tech support available
Writing surfaces for participants	Live and recorded courses permitted

In-person facilities shall comfortably and safely seat at least the number of attendees present in the room and shall be climate controlled, non-smoking, and sound controlled so that outside noise will not interfere with the training.

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Julie Miller

Organization: Fire Tech Productions

Address: 7976 Clyo Rd., Centerville, OH 45459

E-mail: julie@firetech.com Telephone: 937.434.3473

Website: firetech.com

Conference Sponsor (if applicable)________ Conference Email:________

Check here if Course Renewal:______ Prior course number ________ (*i.e. BBS2018-429*)

Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: Ohio Household Fire Warning Equipment - NFPA 72 2016 - FAOH 103 2016

Course instructor: Bill Ford

Course description: Understand basic requirements of Household Fire Warning Equipment, per NFPA 72 2016.
This course provides the knowledge to:
Recognize detection requirements for smoke alarm systems
Compare various types of equipment performance
Identify proper installation of fire alarm systems
Determine detector location and spacing

Instructional hours per session: 5.0 Number of Sessions:________

Course Date(s) and Location:________

Special Content:

Code Administration:______ Conference Course:________
Existing Buildings:______ Conference Name:________
Electrical Instruction:______ Conference location:________
Plumbing Instruction:______

Course to be offered online? X **On Demand** X **Webinar**______

Course Website: firetech.com

Detail online course participation confirmation method (*i.e. test, quizlets, participant activity confirmation*):
100% completion/review of all lessons/knowledge checks and 70% passing on all quizzes/exams

Course applicable for the following certifications

Residential Certifications Only: ______ Commercial Certifications: X
Administrative Course, All Certifications: ______

Application materials included:

______ Course Outline or Course Learning Objectives
______ Presentation Materials/Slides (not required for roundtable courses)
______ Assessment Materials (for online courses)
______ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or **BBS@com.ohio.gov**

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Instructions for new Continuing Education Approval form

Provider Information

1. Please include all contact information.
2. If course is not part of a conference, leave conference sponsor and email blank.

Course Renewal

1. Indicate if the course is being submitted for renewal. Include prior approval letter and write in prior course number.
2. Certification approval for courses has now changed: all existing courses being renewed will be approved within the new classification system.
   a. Courses previously approved for only residential certifications will be approved for all residential certifications.
   b. Courses previously approved for at least on commercial certification will now be approved for all commercial certifications and all residential certifications.
   c. Courses on required instruction topics, Ohio Ethics, Code Administration and Existing Buildings, will be noted as Administrative Courses and be approved for all certifications.
3. Courses being renewed should skip the New Course information section and are not required to submit outline, agenda, slides or other instructional materials for review. Skip to Special Content, and mark any item that applies to the course.

New Course Information

1. Enter course title, name of instructor, and a brief description of the course content. Learning objectives may be substituted for course description, if desired.
2. Number of instructional hours per session is the length of instructional time.
3. Number of sessions: can be 1 or the number of sessions planned.
4. Course date(s) and location: not necessary at this time, enter if known.

Special Content

1. Indicate if the course will meet instructional time in Code Administration or Existing Buildings.
2. Indicate if the course is a plumbing or electrical course, for ESIAC review and trainee course tracking.
3. If the course is associated with a conference, indicate the conference name and location, as this will allow BBS to coordinate approvals with the conference provider.
4. If the course will be offered online, specify whether it will be on demand or offered as a virtual webinar, or both. Include website where the course will be provided.

Ohio Board of Building Standards
6606 Tussing Road
Reynoldsburg, OH 43068-9009

Timothy Galvin, Chair

614-644-2613
Fax 614 -644-3147
TTY/TDD 800-750-0
com.ohio.gov/dico

An Equal Opportunity Employer and Service Provider

Course applicable for the following certifications

This section represents a major change from previous BBS course approval forms.

1. If the course is only for residential certifications, check 'Residential Certifications Only'. The course, if approved, will be approved for all residential certifications.
2. If the course is appropriate for any commercial certifications, check Commercial Certifications. The course, if approved, will be approved for all commercial certification **AND** all residential certifications.
3. If the course is intended to meet required instruction in Code Administration (Chapter 1) or Existing Buildings (commercial or residential) check 'Administrative Course, All Certifications'.

Application Materials Included

This is a checklist for the course submitter's use, to be sure all materials necessary for review are included with the application. All materials should be submitted in .pdf format, along with the application, via email to Michael.Lane@com.ohio.gov or BBS@com.ohio.gov

Ohio Course Submission

Included in this document: Course Outline, Instructor resume(s)

Course: Ohio Fire Alarms and Detection Equipment - NFPA 72 2016 - FAOH 102

Course Outline:

- **01.**

Course Navigation Video (Optional)
  - Course Navigation Video (Optional)

- **02.**

Ohio Fire Alarms and Detection Equipment - NFPA 72 2016
  - Introduction
  - Fire Alarm Basics and Wiring
  - Detection Devices
  - Location and Spacing
  - Notification Appliances
  - Household Fire Alarm Systems
  - Inspection, Testing, and Maintenance
  - Emergency Control Functions and Interfaces
  - Ohio Building Code and Ohio Fire Code

- **03.**

Practice Exam
  - Practice Exam

Instructor Resume:

Charles William Ford

OBJECTIVE

To utilize my strong administrative and people skills in combination with my technical background, to eliminate or reduce the incidence of unfriendly fire and the resulting losses through motivation, education, behavior modification and engineering principles where applicable.

EDUCATION

EASTERN KENTUCKY UNIVERSITY, Richmond, Kentucky,
B. S. Degree in Fire Prevention and Control, 1982.
Minor Studies Law Enforcement

EXPERIENCE

KETTERING HEALTH NETWORK (2021-Present)

Operation Coordinator

- Manage seven technicians who hold sprinkler technician, fire alarm technician and portable extinguisher certifications
- Responsible for the inspection/testing of fire protection systems owned and operated by Kettering Health

KETTERING FIRE DEPARTMENT (2008-2021)

Fire Marshal

- Manage the fire investigation program
- Conduct plan reviews and field fire protection system acceptance tests for the Kettering Building Department
- Conduct fire safety code enforcement inspections

HUBER HEIGHTS FIRE DIVISON (2002- 2008)

Fire Chief

- Managed 51 person paid fire department with paramedic service with two stations
- Administered a 7.4 million dollar budget
- Developed City Emergency Operations Plan
- NIMS Compliance Coordinator
- Served as acting City Manager in the absence of the manager
- Authored FEMA Fire Act Grant for City Traffic Signal Pre-emption System

DAYTON AIRPORT FIRE DEPARTMENT (2000-2002)

Airport Fire Chief

- Managed 30 person paid fire department with paramedic service
- Responsible for budgeting, planning and policy development
- Administered 3 million dollar budget, including capital equipment
- Responsible for airport disaster planning and functional exercises
- Responded to aircraft emergencies, EMS calls, and structural alarms serving as incident command

CITY OF DAYTON FIRE DEPARTMENT (1982-2000)

Fire Protection Engineer/Fire Marshal

- Bureau head of Fire Prevention Bureau – responsible for planning, organizing and evaluation of fire prevention and hazard abatement programs and activities
- Responsible for budgeting and supervisory activities for 13 employees

- Served as acting Assistant Chief of Administration
- Sector commander at scene of major incidents
- Fire Investigator Regional Fire Investigation Unit
- Instructor - Dayton Fire Training Center and Dayton Police Academy
- Qualified fire investigation expert, Montgomery County Common Pleas Court

CITY OF DAYTON FIRE DEPARMENT (1979-1982)

Firefighter/EMT-A

- Graduate of Dayton Fire Academy, assigned to Operations Division and Fire Prevention Bureau
- Engaged in fire suppression activities and staffed ambulances serving as an EMT-A
- Conducted fire safety inspections and served as plans examiner

SINCLAIR COMMUNITY COLLEGE, (1989-2014)

Instructor – Lecturer II

- Instruct courses in Fire Science Technology Program, Department of Engineering Technologies

MONTGOMERY COUNTY SHERRIFF'S OFFICE, (1990-2015)

Commissioned Law Enforcement Officer (Deputy)

- Assigned commission as Fire Marshal for City of Dayton

SPECIAL INFORMATION

- Graduate Dayton Fire Academy, certified by the Ohio Division of Public Safety, 1979
- Graduate Dayton Police Academy, certified by the Ohio Peace Officers' Training Council, 1990
- State of Ohio Level II certified firefighter
- State of Ohio Fire Safety Inspector
- State of Ohio Fire Safety Inspector Instructor, Fire Fighter Instructor
- Hazardous Materials Operations certified
- Basic and Advanced Aircraft Rescue Firefighter certification, - American Association of Airport Executives
- Certified Fire Service and Fire Safety Inspector Instructor, State of Ohio
- Ohio Board of Building Standards, Fire Protection Inspector, Interim Fire Protection Plans Examiner certifications.
- National Fire Academy attendee
    - ✓ Strategic Analysis of Community Risk Reduction
    - ✓ Codes and Ordinances
    - ✓ Fire Prevention Specialist II
    - ✓ Microcomputers for Arson Squad Managers

PROFESSIONAL AFFILIATIONS

- Southwest Fire Safety Council
- International Code Council

Household Fire Warning Equipment - Introduction

Welcome to the Introduction for the Household Fire Warning Equipment course.

This introduction provides a brief overview of what will be covered in the course.

You can come back to this module and reference this information anytime in your menu.

Topics that are covered in this introduction are as follows:

- State of Ohio Important References
- Preparing for the Exam
- Study Tips
- Ohio Codes
- NFPA Codes
- *NFPA* 72 2016 Definitions

When you are ready to begin, click on the button above to start the course.

Overview

Glossary

Overview

Welcome

Please review this introduction before getting started on the course.

We will look at key references and study tips. In addition, we will highlight key vocabulary terms in the glossary.

REFERENCES

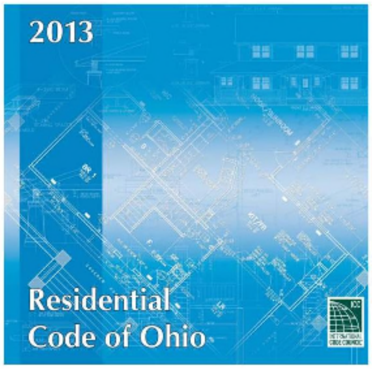
Key References

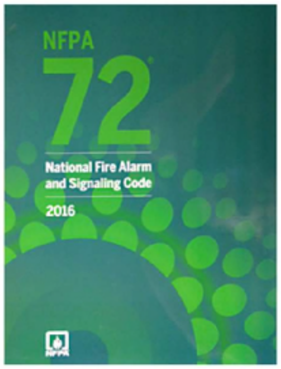
You will want to really focus on the following:

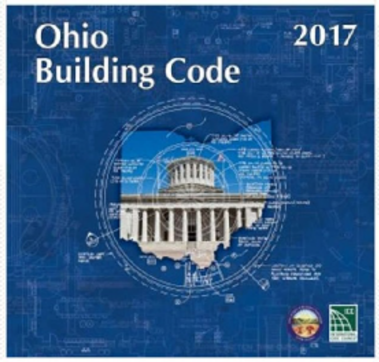
☐ *The Residential Code of Ohio*, 2013

☐ *NFPA* 72 – *National Fire Alarm and Signaling Code*, 2016 (Chapter 29)

☐ *Ohio Building Code*, 2017







References

The exam is prepared from the following:

- Ohio Administrative Code Section 1301:7-7-09 (Ohio Fire Code), 2013 edition Chapter 3: https://codes.iccsafe.org/content/OHRC2013U0118/chapter-3-building-planning

- *NFPA* 72, 2016 edition

- Ohio Building Code, 2017 edition

CONTINUE

Additional Resources

Below is additional information and resources for the Ohio exam.

Ohio Department of Commerce – Division of State Fire Marshal:

Ohio Department of Commerce

To access the Ohio Department of Commerce – Division of State Fire Marshal, click on this "Click Here" button.

CLICK HERE

Ohio Department of Commerce phone: **(614) 752-7126**

The following downloadable PDF is for the Fire Protection Exam Application through the Ohio Department of Commerce:

PDF **FireProtectionExamApplication.pdf**
548.9 KB

PSI Candidate Information Bulletin

A very important source of information is the PSI Candidate Information Bulletin from PSI Services LLC. Take time to read it below in its **ENTIRETY**.

PDF **OhioCertificationExaminationBulletin.pdf**
230.9 KB

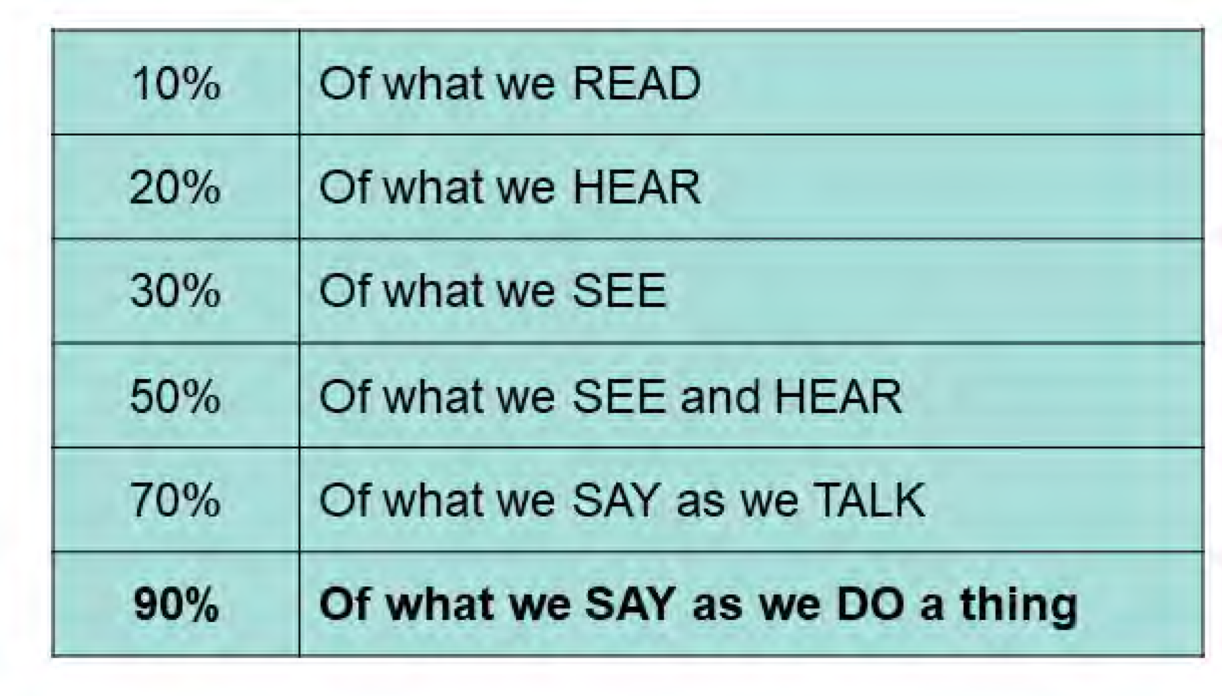
PSI Online Exams

To check for the most updated information on PSI Services, visit their website by clicking on this "Click Here" button.

CLICK HERE

HOW WE LEARN

Thinking About How We Learn



10%	Of what we READ
20%	Of what we HEAR
30%	Of what we SEE
50%	Of what we SEE and HEAR
70%	Of what we SAY as we TALK
90%	**Of what we SAY as we DO a thing**

Source: ***Skill With People*** by Les Giblin

Different people learn in different ways.

It is important to discover what works **best for you** and use your strengths to ensure you retain the material.

OHIO CODES

Ohio Codes

The Ohio Building Code has a lot of information in it. However, only a relatively small portion of the code pertains to fire alarm systems. It ***does*** give the State Fire Marshal the responsibility for promulgating and enforcing the Ohio Codes, testing and training, and licensing and certification support services.

The Ohio Fire Code states that fire protection systems shall be installed, inspected, tested, and maintained per *NFPA* 72 2016 and *NFPA* 70 2017 (NEC). The code also defines specific rules for Ohio as well as reinforces some of the *NFPA* 72 2016 requirements.

- One of these requirements is to be certified and licensed by the state of Ohio.
- The only exception is for a provisional person in an approved formal apprenticeship program. They are permitted to work under the constant supervision of a certified person. The certified person is only allowed to supervise one provisional person.

NFPA 72 2016

NFPA 72 2016

NFPA 72 2016 is the *National Fire Alarm and Signaling Code*

- **Chapter 1** (Administration) – Defines the scope, purpose, and administration of *NFPA* 72 2016.

- **Chapter 2** (Referenced Publications) – Lists all referenced NFPA and ANSI specifications and codes.

- **Chapter 3** (Definitions) – Has a brief explanation of almost every fire alarm term.

- **Chapter 10** (Fundamentals of Fire Alarm Systems) – This large chapter includes power supplies, installation, equipment, and documentation.

- **Chapter 12** (Circuits and Pathways) – This relatively small chapter includes information on capabilities of types of circuits or system pathways.

- **Chapter 14** (Inspection, Testing and Maintenance) – Covers the requirements for the inspection, testing, and maintenance for all devices and systems.

- **Chapter 17** (Initiating Devices) – Contains all of the requirements for signaling devices, such as smoke and heat detectors.

- **Chapter 18** (Notification Appliances) – Covers the requirements for alarm bells, sirens, lights, and any device that indicates an alarm.

- **Chapter 21** (Emergency Control Functions and Interfaces) – Covers the requirements for emergency control function interfaces.
- **Chapter 23** (Protected Premises Fire Alarm Systems) – Covers system performance and integrity requirements.
- **Chapter 24** (Emergency Communications Systems (ECS)) – Covers the requirements of communications and mass notification systems.
- **Chapter 26** (Supervising Station Fire Alarm Systems) – Covers the requirements between a continuously attended supervising station and the protected premises.
- **Chapter 27** (Public Reporting Fire Alarm Systems) – Covers the requirements for municipal fire alarm systems.
- **Chapter 29** (Single- and Multiple-Station Alarms and Household Fire Alarm Systems) – Covers requirements for dwellings, hotels, day care, and nursing facilities.

ⓘ ***NFPA* 72 2016 also contains several Annexes and supplements that have very valuable examples and information. It is recommended you study this material as well. However, the focus of this course is Chapter 29.**

TRAINING MODULES

Training Modules

Be prepared to **refer to your copy of the referenced NFPA standards constantly** throughout these modules. Be comfortable with the technical material.

Each **training module** is carefully planned and designed to **highlight areas of the standards that you need to know in order to increase your chances of success on the exam**. The goal of these training modules is to help you become knowledgeable of important areas of the standards and to gain a working understanding of how to apply these requirements.

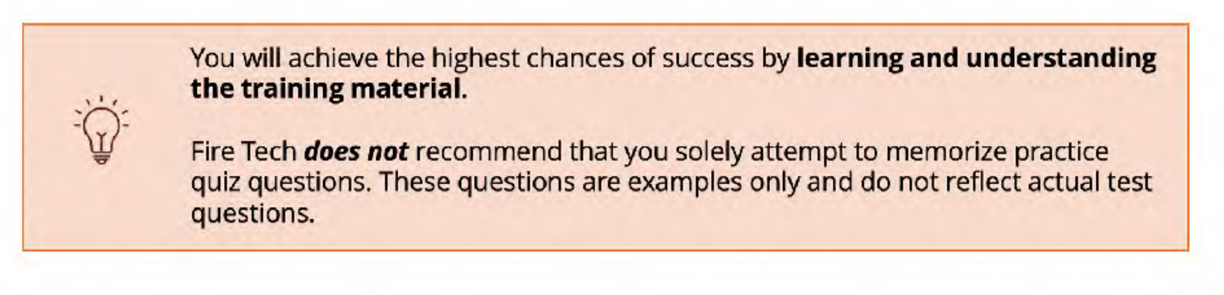
Take notes as you are studying, and **highlight** areas of the standards that are important to know.

The more familiar you are with the requirements, tables, and figures, the better your chances of success on the exam.

QUIZZES

The Quizzes

Fire Tech provides a practice quiz associated with each training module, which should be taken following completion of the module. As you take each practice quiz, use your copy of the referenced *NFPA* standards to **look up every answer to each quiz question**. This will assist you in **becoming more familiar with the requirements and where they are located** in each of the codes and standards.

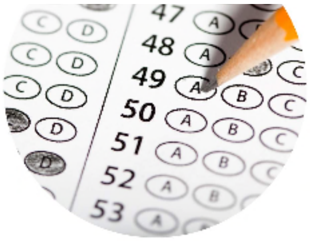


You will achieve the highest chances of success by **learning and understanding the training material.**

Fire Tech ***does not*** recommend that you solely attempt to memorize practice quiz questions. These questions are examples only and do not reflect actual test questions.

Additionally, **read each question carefully**. Sift through what is pertinent to the question and what is irrelevant information that may be included as a distractor.

You will achieve the highest chances of success by learning and understanding the training material. Fire Tech does **not** recommend that you solely attempt to memorize practice quiz questions.



KNOWLEDGE CHECKS

Knowledge Checks

To help you apply course material and prepare for the quizzes, **knowledge checks** are sprinkled throughout each course.

Completing these knowledge checks is **required** to proceed further in the lesson. If you're stuck on a question, refer to previous lesson material and use your NFPA standard to find the answer.

Knowledge checks will help you apply course material and prepare for course quizzes.

○ True

○ False

SUBMIT

Complete the knowledge check above before moving on.

Practice Exams

Once you have read all of the lessons in this course and passed all of the quizzes, you will be ready to take the **Practice Exam**.

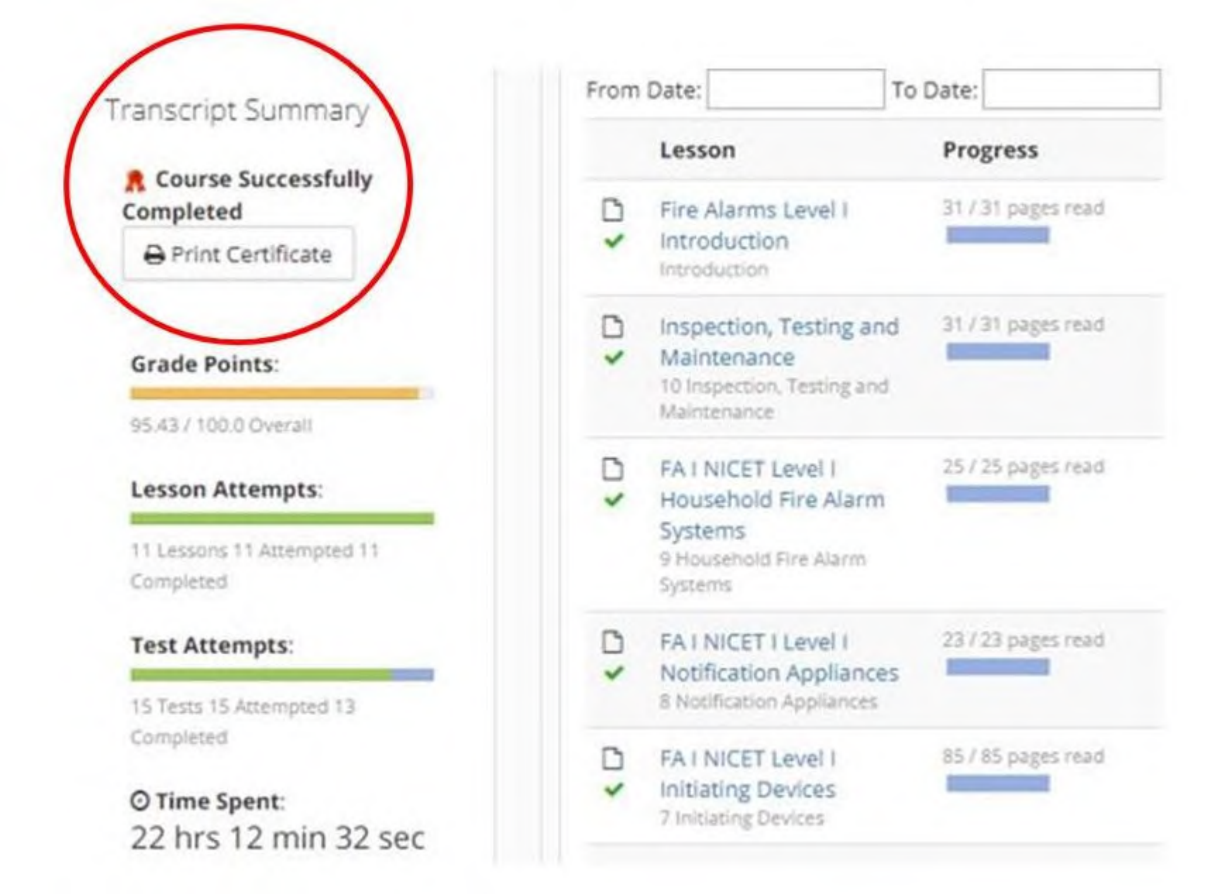
The Practice Exam consists of questions from the quizzes and are presented in a randomized manner. Fire Tech highly recommends that you take each of these practice exams.

Three practice exams are offered:

- Exam #1 is **required** to pass the course
- Exams #2 and #3 are **optional** and are not required to pass the course.

CONTINUE

Course Completion



Transcript Summary

Course Successfully Completed

Grade Points:

95.43 / 100.0 Overall

Lesson Attempts:

11 Lessons 11 Attempted 11 Completed

Test Attempts:

15 Tests 15 Attempted 13 Completed

Time Spent:

22 hrs 12 min 32 sec

From Date: To Date:

	Lesson	Progress
✓	Fire Alarms Level I Introduction Introduction	31 / 31 pages read
✓	Inspection, Testing and Maintenance 10 Inspection, Testing and Maintenance	31 / 31 pages read
✓	FA I NICET Level I Household Fire Alarm Systems 9 Household Fire Alarm Systems	25 / 25 pages read
✓	FA I NICET I Level I Notification Appliances 8 Notification Appliances	23 / 23 pages read
✓	FA I NICET Level I Initiating Devices 7 Initiating Devices	85 / 85 pages read

Upon successful completion of the Practice Exam #1, you can download your course completion certificate, as shown in the transcript summary.

CONTINUE TO THE NEXT LESSON: GLOSSARY

Lesson 2 of 2

Glossary

COMMON ACRONYMS

Common Acronyms

Every industry has its own unique terms and acronyms. Here are some common acronyms related to fire alarm systems that you will see throughout this course. Click on each "**+**" sign below to learn more about common acronyms you will see in this module and in the field. For now, take a moment to become familiar with them, and see what the letters stand for.

AHJ –

Authority Having Jurisdiction

CFPS —

Certified Fire Protection Specialist

FACU —

Fire Alarm Control Unit (also called a Fire Alarm Control Panel (FACP)

FAS —

Fire Alarm System

IBC —

International Building Code

IDC —

Initiating Device Circuit

IFC —

International Fire Code

NAC —

Notification Appliance Circuit

NEC —

National Electrical Code

NFPA —

National Fire Protection Association

NICET —

National Institute for Certification in Engineering Technologies

SLC –

Signaling Line Circuit

GLOSSARY

Glossary

Click on each "**+**" symbol to see the definition for each word below. These words are also linked throughout the course. Remember **all** of the definitions that may be on the exam are in *NFPA* 72 2016, Chapter 3.

Alarm Signal –

A signal that results from the manual or automatic detection of an alarm condition. (*NFPA* 72 2016, Section 3.3.253.1)

Authority Having Jurisdiction (AHJ) –

An organization, office, or individual responsible for enforcing requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure. (*NFPA* 72 2016, Section 3.2.2)

Combination System

A fire alarm system in which components are used, in whole or in part, in common with a non-fire signaling system. Examples of non-fire systems are security, card access control, closed circuit television, sound reinforcement, background music, paging, sound masking, building automation, time, and attendance. (*NFPA* 72 2016, Section 3.3.103.1)

Control Unit (Fire Alarm Control Unit-FACU)

A component of the fire alarm system, provided with primary and secondary power sources, which receives signals from initiating devices or other fire alarm control units, and processes these signals to determine part or all of the required fire alarm system output function(s). (*NFPA* 72 2016, Section 3.3.100)

Also known as the **Fire Alarm Control Panel** (FACP), **control panel**, or **control unit**.

Detector

A device suitable for connection to a circuit that has a sensor that responds to a physical stimulus such as heat or smoke. (*NFPA* 72 2016, Section 3.3.66)

Dwelling Unit

A single unit, providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation. (*NFPA* 72 2016, Section 3.3.79)

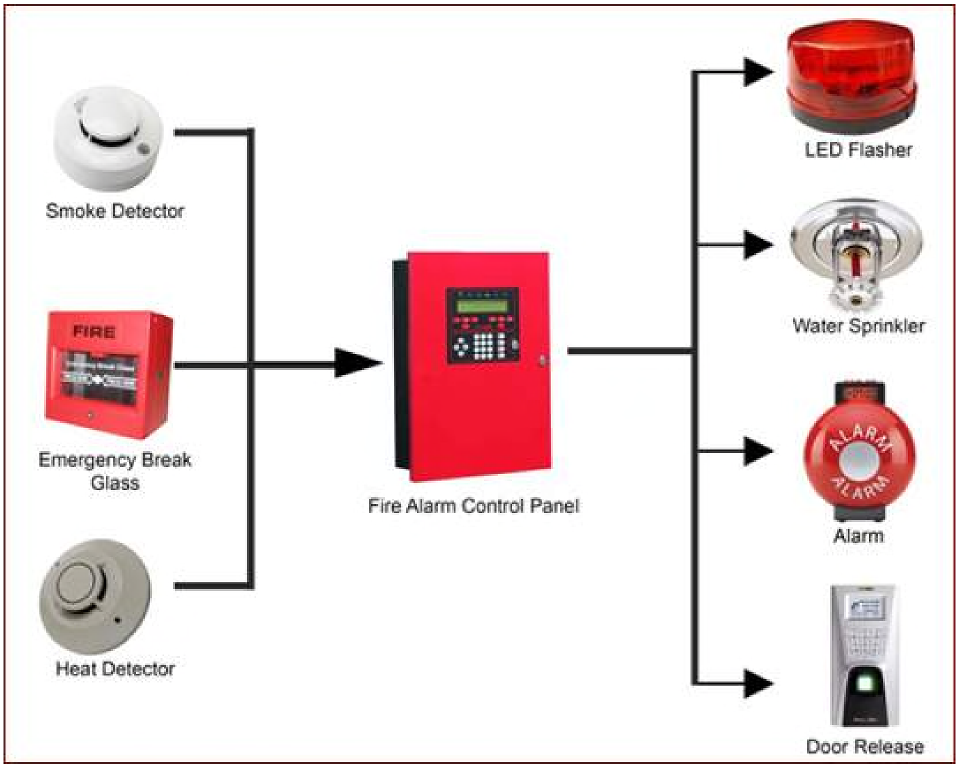
Fire Alarm Control Unit (FACU)

A component of the fire alarm system, provided with primary and secondary power sources, which receives signals from initiating devices or other fire alarm control units, and processes these signals to determine part or all of the required fire alarm system output function(s). (*NFPA* 72 2016, Section 3.3.100)

Also known as the **Fire Alarm Control Panel** (FACP), **control panel**, or **control unit**.

Fire Alarm System

A system or portion of a combination system that consists of components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal-initiating devices and to initiate the appropriate response to those signals.) (*NFPA* 72 2016, Section 3.3.103)



Household Fire Alarm System –

A system of devices that uses a fire alarm control unit (panel) to produce an alarm signal in the household for the purpose of notifying the occupants of the presence of a fire so that they will evacuate the premises. (*NFPA* 72 2016, Section 3.3.103.2)

Initiating Device –

A system component that originates transmission of a change-of-state condition, such as in a smoke detector, manual fire alarm box, or supervisory switch. (*NFPA* 72 2016, Section 3.3.131)

Multiple-Station Alarm Device –

Two or more single station alarm devices that can be interconnected so that actuation of one causes all integral or separate audible alarms to operate; or one single station alarm device having connections to other detectors or to a manual fire alarm box. (*NFPA* 72 2016, Section 3.3.161)

Notification Appliance —

A fire alarm system component such as a bell, horn, speaker, light, or text display that provides audible, tactile, or visible outputs, or any combination thereof. (*NFPA* 72 2016, Section 3.3.172)

Notification Appliance Circuit (NAC) —

A circuit or path directly connected to a notification appliance(s). (*NFPA* 72 2016, Section 3.3.173)

Shall —

Indicates a mandatory requirement. (*NFPA* 72 2016, Section 3.2.6)

Single-Station Alarm Device —

An assembly that incorporates the detector, the control equipment, and the alarm-sounding device in one unit operated from a power supply either in the unit or obtained at the point of installation. (*NFPA* 72 2016, Section 3.3.260)

Sloping Ceiling

A ceiling that has a slope of more than 1 in 8. (*NFPA* 72 2016, Section 3.3.36.2)

Smoke Alarm

A single or multiple-station alarm responsive to smoke. (*NFPA* 72 2016, Section 3.3.265)

Smoke Detector

A device that detects visible or invisible particles of combustion. (*NFPA* 72 2016, Section 3.3.66.20)

Smooth Ceiling

A ceiling surface uninterrupted by continuous projections, such as solid joists, beams, or ducts, extending more than 4 in. (100 mm) below the ceiling surface. (*NFPA* 72 2016, Section 3.3.38.3)

Trouble Signal –

A signal that results from the detection of a trouble condition. (*NFPA* 72 2016, Section 3.3.253.10)

CONTINUE

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.

Household Fire Warning Equipment - Basic Requirements and Smoke Alarms

FIRE TECH
PRODUCTIONS

Welcome to the Basic Requirements and Smoke Alarms module of the Household Fire Warning Equipment Course.

By the end of this module, you will be able to do the following:

- Identify basic requirements for Chapter 29 in *NFPA* 72 2016.
- Recognize detection requirements for smoke alarms.
- Describe required occupant notification.

Key Reference for this module:

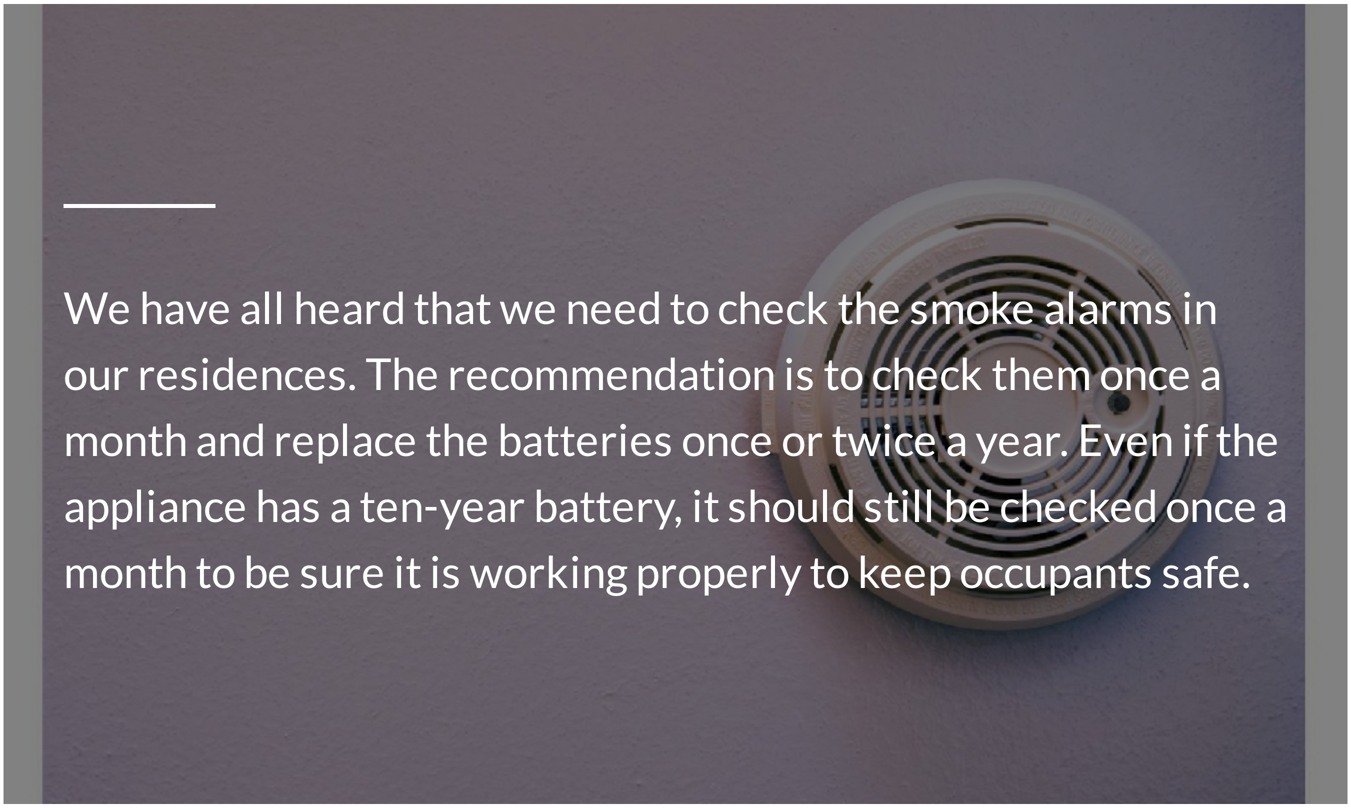
- *NFPA* 72 – *The National Fire Alarm and Signaling Code*, Chapter 29, 2016

When you are ready to begin, click on the button above to start the course.

Basic Requirements and Smoke Alarms

Lesson 1 of 1

Basic Requirements and Smoke Alarms



We have all heard that we need to check the smoke alarms in our residences. The recommendation is to check them once a month and replace the batteries once or twice a year. Even if the appliance has a ten-year battery, it should still be checked once a month to be sure it is working properly to keep occupants safe.

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Identify basic requirements for Chapter 29 in *NFPA* 72 2016.
2. Recognize detection requirements for smoke alarms.

3. Describe required occupant notification.

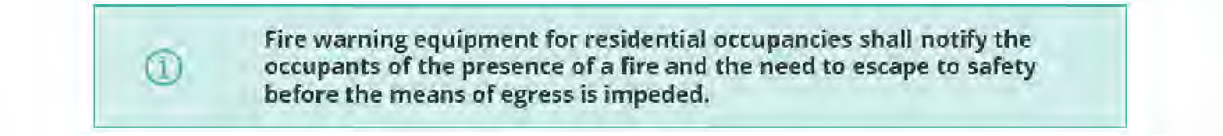
LET'S GET STARTED

ⓘ ***NFPA* 72 2016** defines a **Household Fire Alarm System** as a system of devices that uses a **fire alarm control unit** **to produce an** **alarm signal** in the household for the purpose of **notifying the occupants** of the presence of a fire so that **they will evacuate** the premises.

NFPA 72 2016, Chapter 29 covers the requirements for:

1. One- and two-family dwelling units
2. Sleeping rooms of lodging and rooming houses
3. Individual dwelling units of apartment buildings
4. Guest rooms, sleeping rooms, and living areas within guest suites of hotels and dormitories
5. Day-care homes
6. Residential board and care facilities

7 Other locations where applicable laws, codes, or standards specify a requirement for the installation of smoke alarms


ⓘ Fire warning equipment for residential occupancies shall notify the occupants of the presence of a fire and the need to escape to safety before the means of egress is impeded.

ⓘ **The requirements in Chapter 29 apply to the life safety of occupants and not the protection of property. Additionally, these requirements do not apply to manufactured homes.**

CONTINUE

A multiple-station alarm device is an interconnection of two or more single-station alarm devices which, when one alarms, will alarm all integral or separate alarm devices.

- If one of your alarms goes off, its connection to the others will give you a chorus of alarms. But, the multiple-station concept does create a situation where a single alarm will alert many people to the presence of smoke, heat, or whatever happens to be the response mode of that particular detector.

A **single-station alarm device** is simply a **unit containing the detection, control, and alarm units**. Power can be either internal or wired at the point of attachment. This could be the type of detector which we can buy at the hardware store. It's the typical smoke detector installed in many older homes.

Remember:

- **Smoke ALARMS** are **single- or multiple-station alarm devices *not normally connected* to a fire alarm system**, that are capable of detecting a fire condition and alerting the occupants**.**

- **Smoke DETECTORS** are **connected to a fire alarm system and *send a signal* to the fire alarm control unit**. The fire alarm control unit then activates the notification appliances to alert the occupants**.**

BASIC REQUIREMENTS

NFPA 72 2016, Section 29.3

Any and all devices and equipment to be installed in conformity with Chapter 29 shall be approved or listed for the purposes for which they are intended.

Fire-warning equipment shall be installed in accordance with the listing and manufacturer's published instructions.

The installation of smoke alarms or fire alarm systems, or combinations of these, shall comply with the requirements of this chapter and shall satisfy the minimum requirements for number and location of smoke alarms or smoke detectors by one of the following:

① The required minimum number and location of smoke detection devices shall be satisfied (independently) through the installation of smoke alarms. The installation of additional smoke alarms shall be permitted.

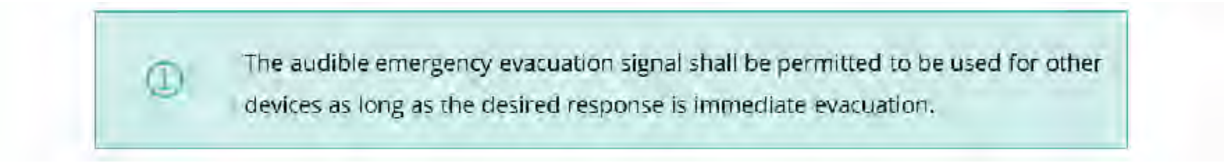
② The required minimum number and location of smoke detection devices shall be satisfied (independently) through the installation of system smoke detectors.

Additional smoke alarms or detectors are permitted to be installed.

CONTINUE

Fire-warning equipment to be installed in residential occupancies shall produce the audible emergency evacuation signal described in **ANSI S3.41**, American National Standard Emergency Evacuation Signal, whenever the intended response is to evacuate the building.

Exception: Where mechanically powered single-station heat alarms are used as supplementary devices, unless required by applicable laws, codes, or standards, such devices shall not be required to produce the emergency evacuation signal described in ANSI S3.41.


The audible emergency evacuation signal shall be permitted to be used for other devices as long as the desired response is immediate evacuation.

CONTINUE

Let's do a quick check about what has been covered so far.

Match the words to their definitions.

Smoke Alarm

single- or multiple-station alarm device not normally connected to a fire alarm system

Smoke Detector

connected to a fire alarm system and sends a signal to the fire alarm control unit

SUBMIT

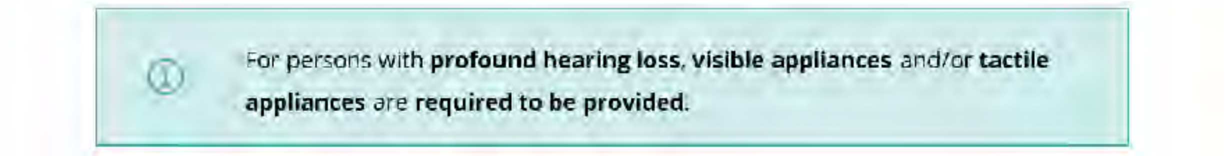
Complete the knowledge check above before moving on.

Audible fire alarm signals shall meet the performance requirements of Sections 18.4.3, 18.4.5.1, 18.4.5.2, and 29.3.8.

Individuals with Hearing Loss

Visible appliances shall meet the requirements of Section 18.5. If the occupants of the residence have hearing deficits, it is the responsibility of the party with the hearing loss to inform the installer of the hearing deficit.

Where required by governing laws, codes, or standards, **low frequency 520 Hz (+/- 10%) square wave audible appliances** are to be provided for those persons with **mild to severe hearing loss**.



For persons with **profound hearing loss, visible appliances** and/or **tactile appliances** are **required to be provided.**

REQUIRED DETECTION

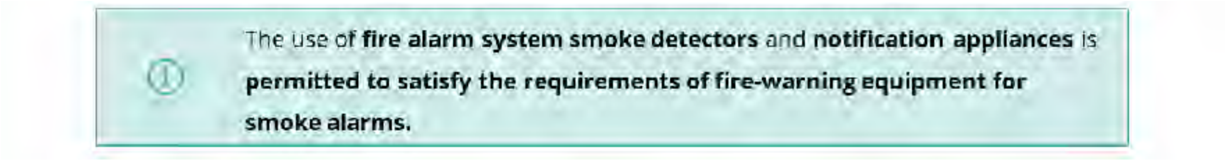
Required Detection

NFPA 72 2016, Section 29.5.1

This section defines the detection requirements for smoke alarms in these applications:

1. In all sleeping rooms and guest rooms
2. Outside of each separate dwelling unit sleeping area, within 21 ft. of any door to a sleeping room, with the distance measured along a path of travel
3. On every level of a dwelling unit, including basements
4. On every level of a residential board and care occupancy (small facility), including basements and excluding crawl spaces and unfinished attics
5. In the living area(s) of a guest suite

6 In the living area(s) of a residential board and care occupancy (small facility)



The use of **fire alarm system smoke detectors** and **notification appliances** is **permitted to satisfy the requirements of fire-warning equipment for smoke alarms.**

CONTINUE

If the area outside the sleeping rooms is separated from the adjacent living areas by a door, a smoke alarm shall be installed in the area between the door and the sleeping rooms, and additional alarms shall be installed on the living area side of the door.

If the interior floor area for a given level of a dwelling unit, excluding garage areas, is greater than 1,000 ft^2, smoke alarms shall be installed per the following:

- All points on the ceiling shall have a smoke alarm within a 30 ft. travel distance or shall have an equivalent of one smoke alarm per 500 ft^2 of floor area. One smoke alarm per 500 ft^2 is calculated by dividing the total interior square footage of floor area per level by 500 ft^2.

- Where dwelling units include great rooms or vaulted/cathedral ceilings extending over multiple floors, smoke alarms located on the upper floor that are intended to protect the great room(s) are permitted to be considered as part of the lower floor(s) protection scheme used to meet the requirements of the statement above.

CONTINUE

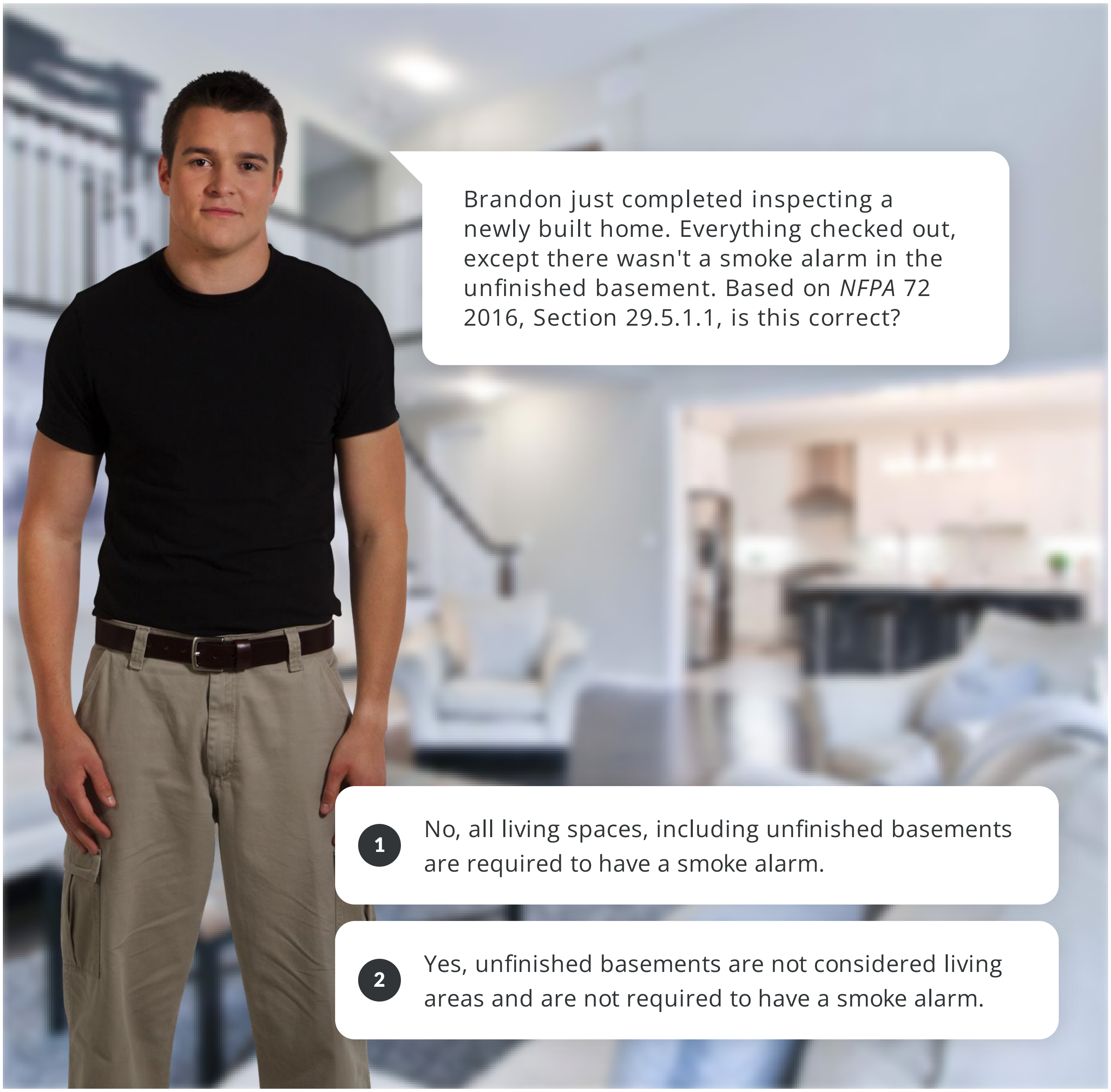
Try the following scenario to see how you would do in this situation.

NFPA 72 2016, Section 29.5.1

Required detection in a dwelling unit.

Scene 1 Slide 1

Continue → Next Slide



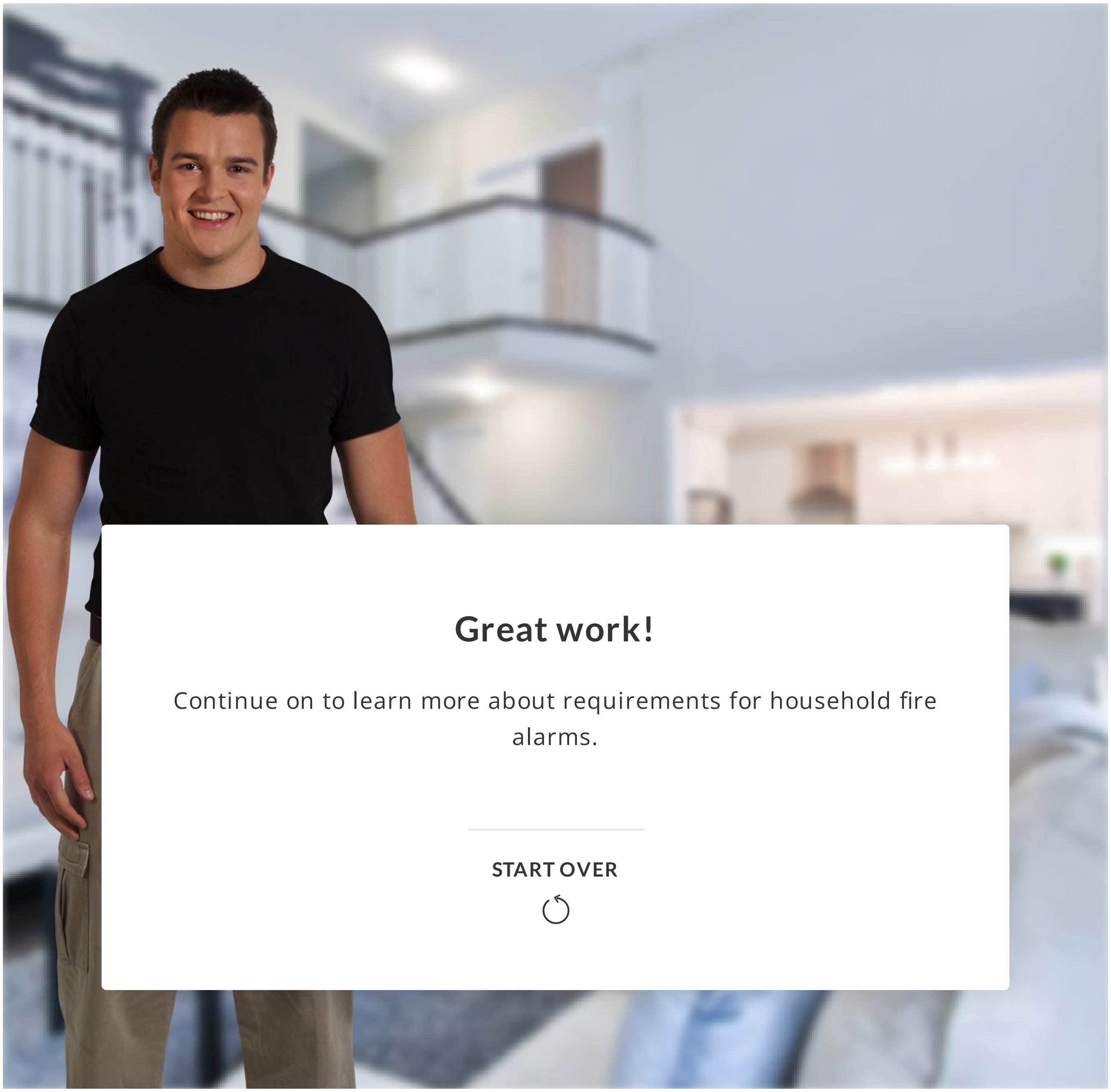
Brandon just completed inspecting a newly built home. Everything checked out, except there wasn't a smoke alarm in the unfinished basement. Based on *NFPA* 72 2016, Section 29.5.1.1, is this correct?

1. No, all living spaces, including unfinished basements are required to have a smoke alarm.
2. Yes, unfinished basements are not considered living areas and are not required to have a smoke alarm.

Scene 1 Slide 2

0 → Next Slide

1 → Next Slide



Great work!

Continue on to learn more about requirements for household fire alarms.

START OVER

Scene 1 Slide 3

Continue → End of Scenario

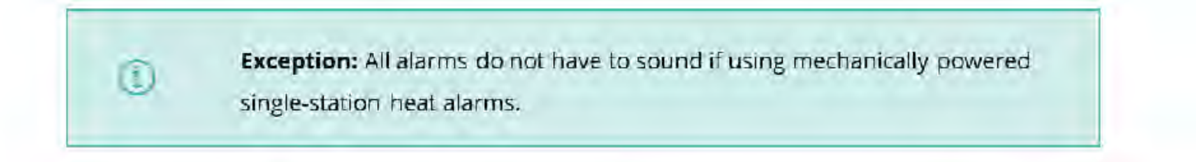
Complete the scenario above before moving on.

Required Occupant Notification

NFPA 72 2016, Section 29.5.2

Fire-warning equipment used to provide required or optional detection shall produce audible fire alarm signals.

Unless exempted by applicable laws, codes, or standards, smoke or heat alarms in a dwelling unit must be installed so that if one smoke or heat alarm sounds, all smoke or heat alarms within a dwelling unit, suite of rooms, or similar area, sound to notify the occupants.



Exception: All alarms do not have to sound if using mechanically powered single-station heat alarms.

Unless otherwise permitted by the authority having jurisdiction (AHJ), audible fire alarm signals shall sound only in an individual dwelling unit, suite of rooms, or similar area and shall not be arranged to operate fire-warning equipment or fire alarm systems outside these locations. Remote annunciation shall be permitted.

CONTINUE

By now, you should have a better understanding of basic requirements for household fire alarm systems and smoke alarms.

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.

Household Fire Warning Equipment - Power Supplies and Equipment Performance

Welcome to the Power Supplies and Equipment module of the Household Fire Warning Equipment Course.

By the end of this module, you will be able to do the following:

- Compare various types of equipment performance.
- Recognize operational characteristics of combination systems.

Key Reference for this module:

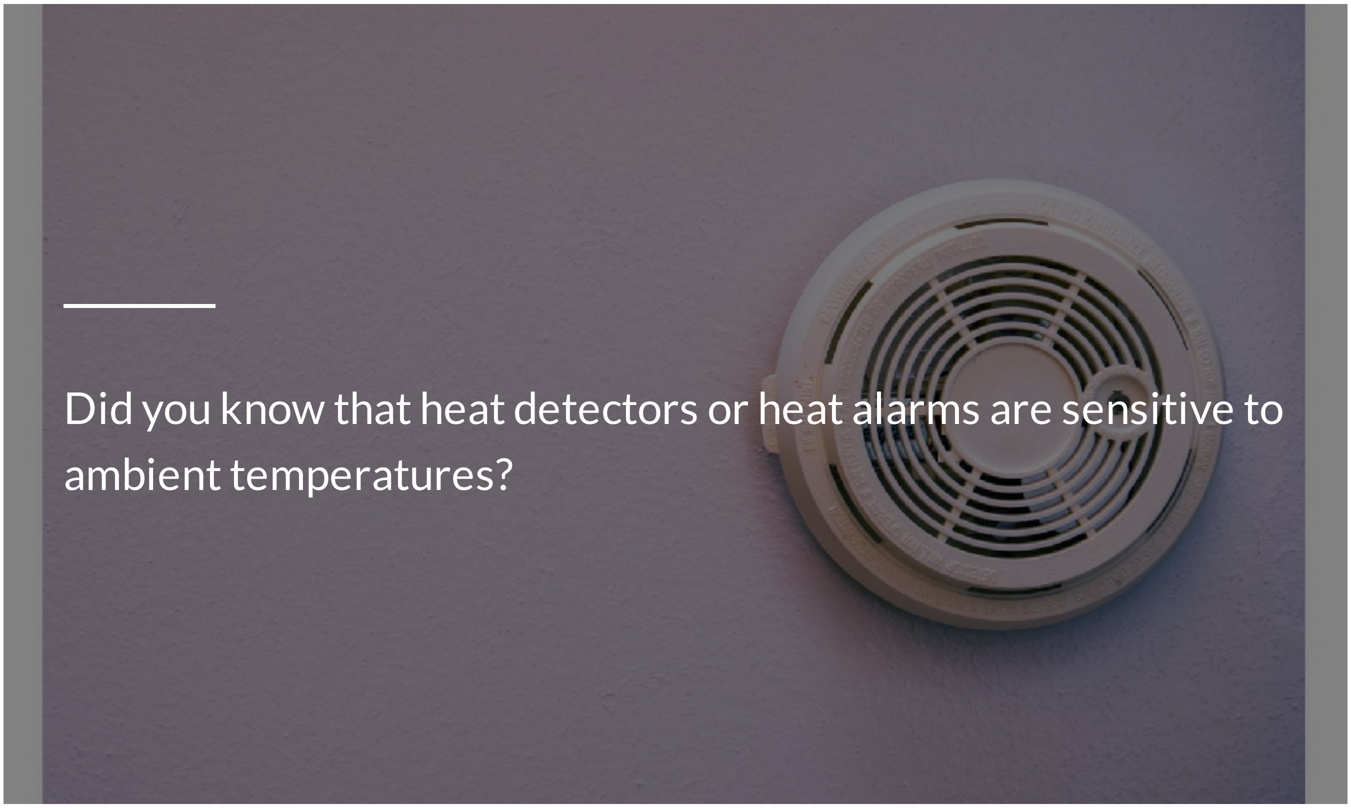
- *NFPA 72 – The National Fire Alarm and Signaling Code*, Chapter 29, 2016

When you are ready to begin, click on the button above to start the course.

≡ **Power Supplies and Equipment Performance**

Lesson 1 of 1

Power Supplies and Equipment Performance


Did you know that heat detectors or heat alarms are sensitive to ambient temperatures?

Goals for this Lesson

By the end of this lesson, you will be able to do the following:

1. Compare various types of equipment performance.
2. Recognize operational characteristics of combination systems.

LET'S GET STARTED

NFPA 72 2016, Section 29.6.1

Smoke and Heat Alarms Power Supplies

The power supply requirements for smoke and heat alarms are as follows...

Requirement 1

A commercial light and power source along with a secondary power source that is capable of operating the device for at least **7 days in the normal condition**, followed by **4 minutes of alarm**.

Note the 4-minute requirement vs. the normal 5-minute requirement for system power supplies.

Requirement 2

If a commercial light and power source is not normally available, a noncommercial AC power source along with a secondary power source capable of supplying the device for at least **7 days in normal condition** and **4 minutes in alarm**.

Requirement 3

A nonrechargeable, nonreplaceable battery capable of operating the device for **10 years in normal condition**, followed by **4 minutes in alarm**, followed by **7 days in a** ***trouble condition***.

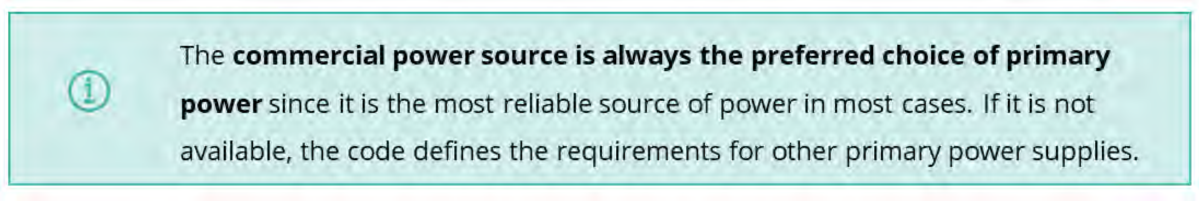
Requirement 4

If a battery primary power supply is specifically permitted, a battery meeting the requirements of **Section 29.6.6 (nonrechargeable primary battery)** or the requirements of **Section 29.6.7 (rechargeable primary battery)** is permitted.

Requirement 5

A suitable spring-wound mechanism for the nonelectrical portion of a listed single-station alarm with a visible indication to show that sufficient operating power is **not** available.

Summary



The **commercial power source is always the preferred choice of primary power** since it is the most reliable source of power in most cases. If it is not available, the code defines the requirements for other primary power supplies.

POWER SUPPLY REQUIREMENTS

Power Supply Requirements

NFPA 72 2016, Section 29.6.2

The power supply requirements for household fire alarm systems are:

1. Two independent power sources are required. Both a commercial light and power source along with a secondary rechargeable battery power source.

2. The rechargeable battery must be capable of operating the device for at least **24 hours** in the normal condition, followed by **4 minutes** of alarm.

3. The secondary power source must be supervised and cause a distinctive audible and visible trouble signal upon removal or disconnection of a battery, or a low-battery condition.

The rechargeable battery used as a secondary power source shall:

1. Be automatically recharged by an AC circuit of the commercial power source.
2. Be recharged **within 48 hours**.
3. Provide a distinctive audible trouble signal before the battery is incapable of operating the device(s) for alarm purposes.

Low-power wireless systems must comply with the criteria of **Section 23.16**.

SECONDARY POWER SOURCE

Secondary Power Source

NFPA 72 2016, Section 29.6.4

If household fire alarms include a battery for a secondary power source, the following are required:

1. The secondary power source shall be supervised and cause a distinct audible or visible trouble signal when the battery is removed or disconnected or a low-battery condition occurs.
2. Acceptable replacement batteries shall be labeled with the manufacturer's name and model number on the unit near the battery compartment.

3

If the battery is rechargeable, the battery shall: (Use the arrow to click through the slides below to learn more)

Rechargeable Battery Rule 1

Automatically recharge by the primary power source.

Rechargeable Battery Rule 2

Recharge within **4 hours** if power is provided from a circuit that can be switched on or off by means other than a circuit breaker.

Rechargeable Battery Rule 3

Recharge within **48 hours** if power is provided from a circuit that cannot be switched on or off by means other than a circuit breaker

Rechargeable Battery Rule 4

Provide a distinct audible trouble signal **before** the battery can no longer operate the device(s) for alarm purposes

Rechargeable Battery Rule 5

At a battery condition at which a trouble signal is obtained, be capable of producing an alarm signal for at least **4 minutes**, followed by **at least 7 days** of trouble signal operation

Rechargeable Battery Rule 6

Produce an audible trouble signal **at least once every minute** for 7 consecutive days

ⓘ **If a visible notification appliance is used along with a smoke or heat alarm application, the notification appliance is not required to have a secondary power source according to *NFPA* 72 2016, Section 29.6.5.**

Primary Power Source (Non-rechargeable Battery)

NFPA 72 2016, Section 29.6.6

For smoke alarms powered by a primary battery, the battery is required to be monitored for the following conditions:

- All power requirements are met for **at least 1 year of battery life**, including weekly testing
- A **distinct audible trouble signal** before the battery cannot operate the devices(s) for alarm purposes
- If the unit has a lock-in alarm feature, the **automatic transfer is provided from alarm to a trouble condition**
- At the battery voltage at which a trouble signal is obtained, the unit can produce an **alarm signal for at least 4 minutes**, followed by **at least 7 days of trouble signal operation**
- The **audible trouble signal is produced at least once every minute for 7 consecutive days**
- Replacement batteries are **clearly identified with the manufacturer's name and model number** on the unit near the battery compartment
- A noticeable, **visible indication is displayed** when a primary battery is removed from the unit

Primary Power Supply (Rechargeable Battery)

NFPA 72 2016, Section 29.6.7

For smoke alarms powered by a rechargeable battery, the battery shall:

Rechargeable Battery 1

Be able to power the alarm for **1 year** (properly charged)

Rechargeable Battery 2

Be automatically recharged by a commercial light and power source circuit

Rechargeable Battery 3

Recharge within **4 hours** if power is provided from a circuit that can be switched on or off by means other than a circuit breaker

Rechargeable Battery 4

Recharge within **48 hours** if power is provided from a circuit that cannot be switched on or off by means other than a circuit breaker

Rechargeable Battery 5

Provide a distinct audible trouble signal before the battery can no longer operate the device(s) for alarm purposes

Rechargeable Battery 6

At a battery condition at which a trouble signal is obtained, be capable of producing an alarm signal for **at least 4 minutes**, followed by **at least 7 days** of trouble signal operation

Rechargeable Battery 7

Produce an audible trouble signal **at least once every minute** for **7 consecutive days**

SECONDARY (STANDBY) NON-BATTERY POWER SOURCE

Secondary (Standby) Non-Battery Power Source

NFPA 72 2016, Section 29.6.8

When alarms include a secondary non-battery power source, the following apply:

- The secondary power source shall be supervised and **produce a distinct audible or visible trouble signal upon depletion or failure.**
- Provide a **distinct audible trouble signal before the power source is incapable of operating the device(s)** for alarm purposes.
- At the power source condition at which a trouble signal is obtained, the power source **can produce an alarm signal for at least 4 minutes, followed by at least 7 days of trouble signal operation**.
- The audible trouble signal is **produced at least once every minute for 7 consecutive days.**
- A rechargeable secondary power source shall be:

Automatically recharged

Recharge within 4 hours if power is provided from a circuit that can be switched on or off by means other than a circuit breaker

Recharge within 48 hours if power is provided from a circuit that cannot be switched on or off by means other than a circuit breaker

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Based on *NFPA* 72 2016, Section 29.6.2, the power supply requirements for household fire alarm systems are: (Select all that apply)

☐ The rechargeable battery must be capable of operating the device for at least 24 hours in the normal condition, followed by 4 minutes of alarm.

☐ The secondary power source must be supervised and cause a distinctive audible and visible trouble signal upon removal or disconnection of a battery, or a low-battery condition.

☐ Two independent power sources are required. Both a commercial light and power source along with a secondary rechargeable battery power source.

☐ Provide a distinctive audible trouble signal before the battery is incapable of operating the device(s) for alarm purposes.

SUBMIT

Based on *NFPA* 72 2016, Section 29.6.7 For smoke alarms powered by a rechargeable battery, the battery shall recharge within _____ if power is provided from a circuit that cannot be switched on or off by means other than a circuit breaker.

○ 4 hours

○ 24 hours

○ 48 hours

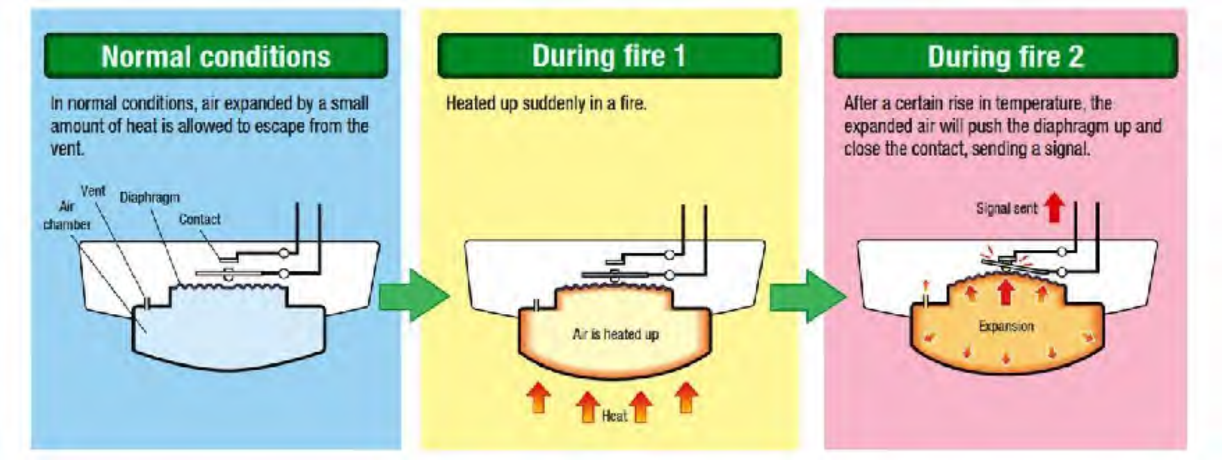
SUBMIT

EQUIPMENT PERFORMANCE

Equipment Performance

NFPA 72 2016, Section 29.7

Any failure of any nonreliable or short-life component that renders the detector inoperable shall result in a trouble signal or otherwise be apparent to the occupant of the living unit without the need for test.



Rate of Rise Detector (Click to enlarge image)

Heat detectors and heat alarms, including heat detectors or alarms combined with smoke detectors or smoke alarms may be fixed-temperature or rate-of-rise and shall be **listed for no less than 50 ft. spacing**.

Fixed temperature heat detectors or heat alarms must have a **temperature rating at least 25°F above the normal ambient temperature** and shall **not be rated less than 50°F higher than the maximum expected ambient temperature** in the area where it is installed.

All single-station alarm devices and multiple-station alarm devices must have a convenient means of testing its operability by the occupant, owner, or other responsible party.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

As per the power supply requirements for smoke and heat alarms, a non-rechargeable, non-replaceable battery capable of operating the device for 10 years in normal condition, followed by 4 minutes in alarm, followed by 7 days in a(n) _____ condition.

○ Alarm

○ Supervisory

○ Trouble

SUBMIT

Complete the knowledge check above before moving on.

System Control Equipment

NFPA 72 2016, Section 29.7.6

If a fire alarm system is used for household fire-warning equipment, the control equipment shall be automatically restoring upon restoration of electrical power.

The system control equipment must be of a type that “locks in” (latch) on an alarm condition. Smoke detection circuits are not required to lock in.

If a reset switch is provided, it must be a self-restoring (momentary operation) type.

A means for silencing the trouble notification appliance(s) is permitted only if the following conditions are met:

1. The means is key-operated or located within a locked enclosure, or arranged to provide protection against unauthorized use.
2. The means transfers the trouble indication to an identified lamp or other acceptable visible indicator, such as an LED, and the visible indication stays lit until the trouble condition has been corrected.

A means for turning off activated alarm notification appliances is permitted only if the following conditions are met:

1. The means is key-operated or located within a locked cabinet, or arranged to provide protection against unauthorized use.

2 The means includes the provision of a visible alarm silence indication.

Household fire alarm system smoke detectors, initiating devices, and notification appliances shall be monitored for integrity so that the occurrence of a single open or single ground fault in the interconnection, which prevents normal operation of the interconnected devices, is indicated by a distinctive trouble signal.

This is the **same requirement** as a **protected premises fire alarm system**...because basically it **is** a protected premises system.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Smoke detection circuits are not required to lock in.

○ True

○ False

SUBMIT

🔒 Complete the knowledge check above before moving on.

Combination System

NFPA 72 2016, Section 29.7.6

Combination systems are **permitted as long as the fire alarm signals take precedence over non-fire alarm signals**, even if the other signals are activated first.

Fire alarm signals must be distinctive from non-fire alarm signals so occupants can distinguish them from other signals that may require them to respond differently.

Faults in other systems or components cannot affect the operation of the fire alarm portion of the system.

Installations that include connecting a single-station alarm device or multiple-station alarm device with other input or output devices shall be permitted. An open, ground fault or short circuit of the wiring connecting input or output devices to the single- or multiple-station alarms shall not prevent the operation of each individual alarm.

A sprinkler waterflow alarm initiating device shall be permitted to be connected to the multiple-station alarms or household fire alarm system to activate the alarm signal.

WIRELESS DEVICES

Wireless Devices

NFPA 72 2016, Section 29.7.7

Household fire alarm systems utilizing low-power wireless transmission of signals within the protected dwelling unit shall comply with the requirements of **Section 23.16**.

To ensure adequate transmission and reception capability, nonsupervised, low-power wireless alarms shall be capable of reliably communicating at a distance of 100 ft. indoors.

ⓘ ****There's much more to this requirement that involves formulas. Check *NFPA* 72 2016, page 170 and 171****

Fire alarm signals have priority over all other signals.

The maximum allowable response delay from activation of an initiating device to receipt and alarm/display by the receiver or control unit is 20 seconds.

Wireless interconnected smoke alarms, in the receive mode, shall remain in alarm as long as the originating unit (transmitter) remains in alarm.

A **single fault** that disables a transceiver **shall not prevent** other transceivers in the system from operating.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

To ensure adequate transmission and reception capability, nonsupervised, low-power wireless alarms shall be capable of reliably communicating at a distance of _____ indoors.

○ 50 ft.

○ 100 ft.

○ 150 ft.

SUBMIT

Wireless interconnected smoke alarms shall remain in alarm in the _____ mode as long as the originating unit (transmitter) remains in alarm.

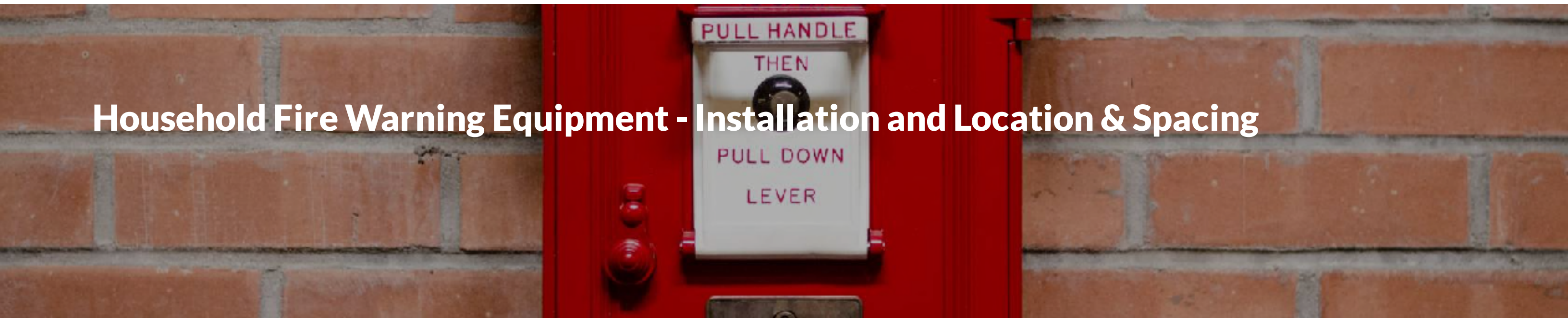
Type your answer here

SUBMIT

Complete the knowledge check above before moving on.

By now, you should have a better understanding of the types of power supplies and equipment performance needed for household fire alarm systems.

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.



Household Fire Warning Equipment - Installation and Location & Spacing

FIRETECH
PRODUCTIONS

Welcome to the Installation and Location & Spacing module of the Household Fire Warning Equipment Course.

By the end of this module, you will be able to do the following:

- Identify proper installation of fire alarm systems.
- Identify requirements for detector location and spacing.
- Identify requirements for audible alarms.
- Recognize markings and instructions for various components of fire warning systems.

Key Reference for this module:

- *NFPA* 72 – *The National Fire Alarm and Signaling Code*, Chapter 29, 2016

When you are ready to begin, click on the button above to start the course.

☰ **Installation and Location & Spacing**

Lesson 1 of 1

Installation and Location & Spacing

Smoke alarms and heat alarms are point of use devices. They need to be installed in the correct location in order to do their job. If they are tucked away because they do not fit the aesthetic feel of a room, it defeats their purpose.

Goals of this Lesson

By the end of this lesson, you will be able to do the following:

1. Identify proper installation of fire alarm systems.
2. Identify requirements for detector location and spacing.
3. Identify requirements for audible alarms.
4. Recognize markings and instructions for various components of fire warning systems.

INSTALLATION

Installation

NFPA** **72 2016, Section 29.8

The installation of household fire alarm systems has to be done in a manner where they are immune to vibration or jarring following the manufacturer's published instructions.

The detectors and components must be mounted independently of their wiring, and they have to be restored promptly after any alarm or test.

The supplier or installing contractor shall provide the owner or other responsible parties with the following:

1. An instruction booklet illustrating typical installation layouts
2. Instruction charts describing the operation, method, and frequency of testing and maintenance of fire-warning equipment
3. Printed information for establishing an emergency evacuation plan
4. Printed information to inform owners of repair or replacement services and how to find replacements for parts within **2 weeks**
5. Information noting both of the following:

   a. Unless manufacturers recommend otherwise, smoke alarms shall be replaced when they fail to respond to tests

   b. Smoke alarms installed in one- and two-family dwellings shall not remain in service longer than **10 years** from the date of manufacture

INTERCONNECTION OF DETECTORS OR MULTIPLE STATION ALARMS

Interconnection of Detectors or Multiple Station Alarms

NFPA 72 2016, Section 29.8.2

The interconnection of smoke or heat alarms must comply with the following:

1. Smoke or heat alarms may not be interconnected in numbers that exceed the manufacturer’s published instructions.
2. If the interconnecting means is not supervised, **no more than 18 initiating devices** may be interconnected (of which **12** can be smoke alarms).
3. If the interconnecting means is supervised, **no more than 64 initiating devices** may be interconnected (of which **42** can be smoke alarms).

4 Smoke or heat alarms shall not be interconnected with alarms from other manufacturers unless listed as being compatible with the specific model.

5 When alarms of different types are interconnected, all interconnected alarms shall produce the appropriate audible response for the phenomena being detected, or remain silent.

A single fault on the interconnecting means between multiple-station alarm devices shall not prevent the single-station alarm device operation of any of the interconnected alarms.

Remote notification appliance circuits of multiple-station alarms shall be capable of being tested for integrity by activation of the test feature on any interconnected alarm.

Activation of the test feature shall result in the operation of all interconnected notification appliances.

DETECTOR LOCATION AND SPACING

Smoke Alarms and Smoke Detectors

***NFPA* 72 2016, Section 29.8.3**

Smoke alarms or smoke detectors mounted on a **peaked ceiling shall be located within 36 in. horizontally of the peak, but not closer than 4 in. vertically to the peak**.

Smoke alarms or smoke detectors mounted on a **sloping ceiling having a rise greater than 1 ft. in 8 ft. horizontally shall be located within 36 in. of the high side of the ceiling**, but **not closer than 4 in. from the adjoining wall** surface.

Wall-mounted smoke alarms or detectors shall be **mounted no more than 12 in. from the ceiling.**

Smoke alarms and smoke detectors **shall not be located in unfinished attics or garages where temperatures may be below 40°F or over 100°F** unless they are rated for the environment.

- If the outside wall could be considerably warmer or cooler than the room temperature, the smoke detection devices shall be mounted on an inside wall.
- Smoke alarms or detectors **shall not be mounted within 10 ft. radial** from a stationary or fixed **cooking appliance**. There are **exceptions to this requirement in Section 29.8.3.4**.

SPECIFIC LOCATIONS REQUIREMENTS

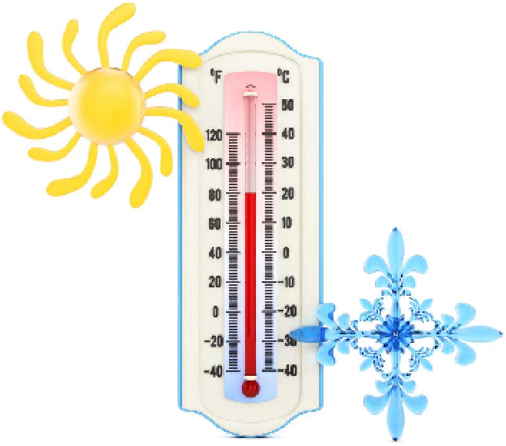
Click the "Start" button below to learn more about Specific Locations Requirements.

Specific Locations Requirements

***NFPA* 72 2016, Section 29.8.3.4**

Section 29.8.3.4 provides specific location requirements for smoke alarms and smoke detectors. **We encourage you to review this section in its entirety**. Highlights include the following:

Specific Location Requirement 1



Smoke alarms and detectors **shall** be located within the **humidity and temperature limits** defined by the manufacturer.

Specific Location Requirement 2

Smoke alarms and detectors **shall not** be located within **unfinished attics or garages**, or in spaces where temperatures are outside a range of 40 – 100°F.

Specific Location Requirement 3

In places where the mounting surface is significantly warmer or cooler than the room, the **alarms and detectors are permitted to be mounted on an inside wall**. Examples include poorly insulated ceilings below an unfinished attic or an exterior wall.

Specific Location Requirement 4

Smoke alarms and detectors are **not** permitted within an area of exclusion consisting of a 10 ft. radial distance along a horizontal path from a **stationary or fixed cooking appliance unless specifically listed**. Smoke alarms and smoke detectors installed between 10 ft. and 20 ft. along a horizontal flow path from a stationary or fixed cooking appliance shall either have a **means of silencing the alarm** or use **photoelectric detection**.

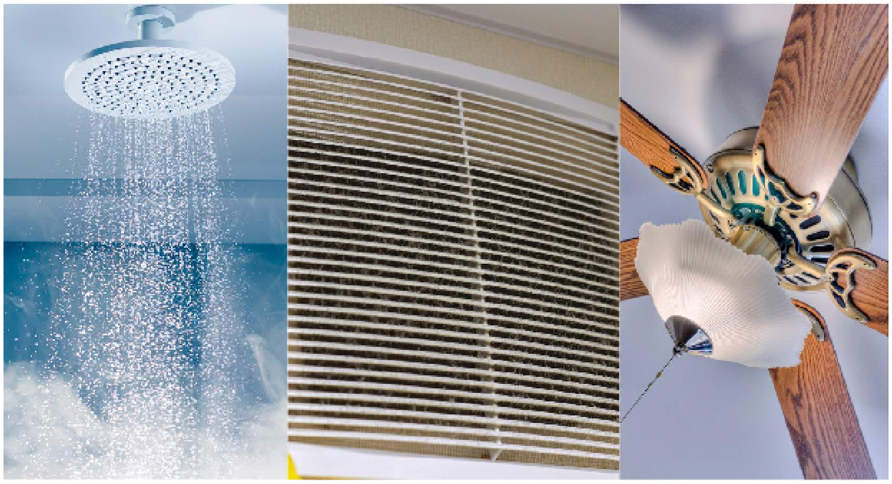
Note the exception: Smoke alarms or smoke detectors that use photoelectric detection are permitted to be installed at a radial distance greater than 6 ft. from any stationary or fixed cooking appliance, if:

- The kitchen or cooking area and adjacent spaces have no clear interior partitions or headers and
- The 10 ft. area of exclusion prohibits the placement of a smoke alarm or smoke detector required by other sections of *NFPA* 72 2016

Specific Location Requirement 5

Smoke alarms and smoke detectors used in household fire alarm systems installed between 6 ft. and 20 ft. along a horizontal flow path from a stationary or fixed cooking appliance are **required to be listed for resistance to common nuisance sources from cooking**.

Specific Location Requirement 6



Smoke alarms and smoke detectors **shall not** be installed within a 36 in. horizontal path from the following:

- A **door to a bathroom containing a shower or tub** unless listed otherwise
- The **supply registers** of forced-air heating or cooling systems
- The **horizontal path from the tip of the blade** of a ceiling-suspended fan

Specific Location Requirement 7

For stairs leading to occupiable levels, a smoke alarm or smoke detector shall be located so that **rising smoke is not blocked by doors or obstructions** and can reach the smoke alarm or detector.

Specific Location Requirement 8

Stairways leading from a basement are required to have smoke alarms or smoke detectors located on the **basement ceiling near the entry to the stairs**.

Specific Location Requirement 9

Smoke alarms and smoke detectors shall be installed on the **highest portion of a tray-shaped ceiling** or on the **sloped portion of the ceiling** within 12 in. vertically down from the highest point.

Specific Location Requirement 10

For rooms with joists or beams:

- Refer to **Section 17.7.3.2.4** for requirements for smoke alarms and detectors
- Refer to **Section 17.6.3** for requirements for heat alarms and detectors

CONTINUE

Let's do a quick check about what has been covered so far.

According to *NFPA* 72, Section 29.8.2, if the interconnecting means is not supervised, no more than ____initiating devices may be interconnected (of which ___ can be smoke alarms).

○ 18 (12)

○ 20 (14)

○ 22 (16)

○ 24 (18)

SUBMIT

According to *NFPA* 72, Section 29.8.2, If the interconnecting means is supervised, no more than ____ initiating devices may be interconnected (of which ____ can be smoke alarms).

○ 60 (40)

○ 62 (41)

○ 64 (42)

○ 66 (43)

SUBMIT

Smoke alarms and smoke detectors shall not be located in unfinished attics or garages where temperatures may be below ____ or over 100°F unless they are rated for the environment.

○ 32°F

○ 36°F

○ 40°F

SUBMIT

Complete the knowledge check above before moving on.

Heat Detectors and Alarms

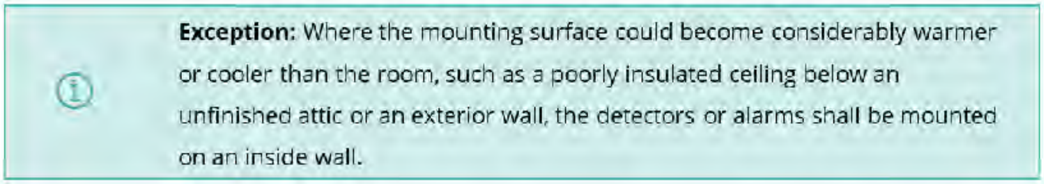
NFPA **72 2016, Section 29.8.4**

On smooth ceilings, heat detectors and heat alarms shall be installed within the strict limitations of their listed spacing.

For **sloping ceilings** having a **rise greater than 1 ft. in 8 ft. horizontally**, the detector or alarm **shall be located within 36 in. of the peak.** The spacing of additional detectors or alarms, if any, shall be based on a horizontal distance measurement, not on a measurement along the slope of the ceiling.

CONTINUE

Heat detectors or alarms shall be mounted on the ceiling at least 4 in. from a wall or on a wall with the top of the detector or alarm not less than 4 in., nor more than 12 in. below the ceiling.



Exception: Where the mounting surface could become considerably warmer or cooler than the room, such as a poorly insulated ceiling below an unfinished attic or an exterior wall, the detectors or alarms shall be mounted on an inside wall.

In rooms with **open joists or beams, all ceiling-mounted detectors or alarms shall be located on the bottom of such joists or beams.**

Detectors or alarms installed on an **open-joisted ceiling shall have their smooth ceiling spacing reduced** where this spacing is measured at right angles to solid joists; **in the case of heat detectors or heat alarms, this spacing shall not exceed one-half of the listed spacing.**

ADDITIONAL CONSIDERATIONS

Additional Considerations

Per Section 29.3.6, fire-warning audible alarms must meet the requirements of Sections 18.4.3 and 18.4.5. They must **be at least 15 dBA above the average ambient sound level**, or 5 dBA above the maximum sound level.

In the **sleeping areas**, the **sound level must be a minimum of 75 dbA** measured at the **pillow level**. The code specifies requirements for notification appliances in sleeping and guest rooms for people with hearing loss in **Section 29.3.8.**

As previously stated, for **mild to severe hearing loss**, the audible appliance must also **produce a low frequency alarm signal with a fundamental frequency of 520 Hz +/- 10%**.

If the **hearing loss is profound**, **visible appliances must be provided**. In the applications that apply to Chapter 29, synchronization of visible appliances in the same field of view is not required.

When we have devices such as smoke alarms and heat alarms, we must realize that they respond only to smoke or heat in their immediate location. **They are point-of-use devices.** If we tuck the alarms away somewhere because we don't like their appearance or their color, we are defeating the purpose of the alarm itself.

A **basement alarm must be close to the connecting stairway.** As the smoke rises, it will approach the stairway and go up to where there are sleeping occupants of the building. **We want to detect the smoke when it gets close to these connecting stairways going up.**

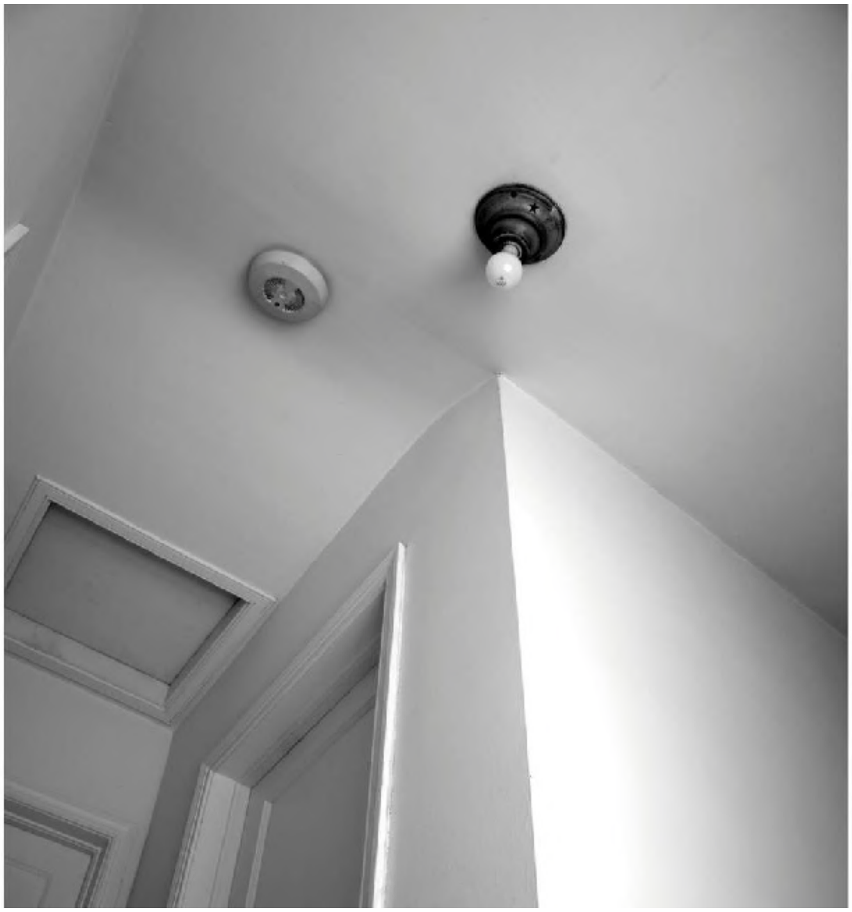
This requirement also holds for other non-sleeping floors. If we have a downstairs living area only, we must mount our alarms close to any stairway leading up to the sleeping areas.

This helps to catch the smoke at the very earliest possible time.

Smoke alarms protecting a sleeping area must be installed close to, but *outside* of, bedrooms.

An alarm installed inside of a bedroom would be a little late in terms of alarming the occupants of other bedrooms, especially if the doors were closed. **Smoke alarms should alert occupants prior to smoke getting inside the bedroom.**

To **avoid dead air space**, it is **required** that **heat alarms be mounted at least 4 in. from a wall, *or* on a wall between 4 and 12 in. from the ceiling.**



Do not place smoke or heat alarms in kitchens, garages, or other areas where the temperature can exceed 100°F or fall below 32°F.

Heat alarms must be installed within their listed spacing. There are many mounting conditions. **Review the requirements in Chapter 17.**

Heat alarms must be installed at or near the ceiling, and at or within 3 ft. of the peak of a sloping ceiling.

WIRING AND MAINTENANCE

Wiring and Maintenance

System wiring must comply with *NFPA* 70, National Electrical Code, and with Article 760, which contains the *NFPA* 70 wiring requirements for protective signaling systems (fire alarms).

Maintenance and testing must be done in accordance with the **manufacturer's instructions and Chapter 14.**

This is a very common requirement throughout most of the NFPA standards.

Single-station alarm devices and multiple-station alarm devices must have this done monthly.

MARKINGS AND INSTRUCTIONS

Markings and Instructions

***NFPA* 72 2016, Section 29.11**

Our last reference involves the required markings and instructions. This is a list of the required markings and instructions which must appear on the various components and systems comprising these fire warning systems for dwelling units. Be sure to take the time to review this section.

Extra Notes:

- Read the *NFPA* 72 2016 Annex material, if for no other reason than your own safety.
- Review what you have in your own home.
- Review what you have in your own shop.

- Make certain that you, your family, and your fellow employees are in a situation where you're as well protected and as safe as you can possibly be.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

In the sleeping areas, the sound level must be a minimum of _____ measured at the pillow level.

○ 75 dbA

○ 85 dbA

○ 95 dbA

SUBMIT

Smoke alarms protecting a sleeping area must be installed inside of bedrooms.

○ True

○ False

SUBMIT

Heat alarms must be installed within their listed spacing. There are many mounting conditions. Review the requirements in Chapter ____.

Type your answer here

SUBMIT

🔒 Complete the knowledge check above before moving on.

- This completes the Household Fire Warning Equipment course.
- There are many more requirements than we have the time to review in this module.
- Take time to familiarize yourself with the requirements since some of the requirements are unique to household fire-warning systems and components.

***Remember that Chapter 29 does occasionally refer you to other chapters of the code**.

CONTINUE

After completing this module, you should now have a better understanding of the installation, and location and spacing of different types of household fire alarm systems.

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.

Household Fire Warning Equipment - 2019 Residential Code of Ohio

Welcome to the 2019 Residential Code of Ohio module of the Household Fire Warning Equipment Course.

When you are ready to begin, click on the "**Begin**" button to start.

By the end of this module, you will be able to do the following:

- Recognize requirements found in the 2019 Residential Code of Ohio.
- Distinguish requirements for household fire alarm systems.
- Identify carbon monoxide alarm requirements.

Key Reference for this module:

- 2019 *Residential Code of Ohio*
- *NFPA* 72 – *The National Fire Alarm and Signaling Code*, 2016

Lesson 1 of 1

2019 Residential Code of Ohio

Goals for this Lesson:

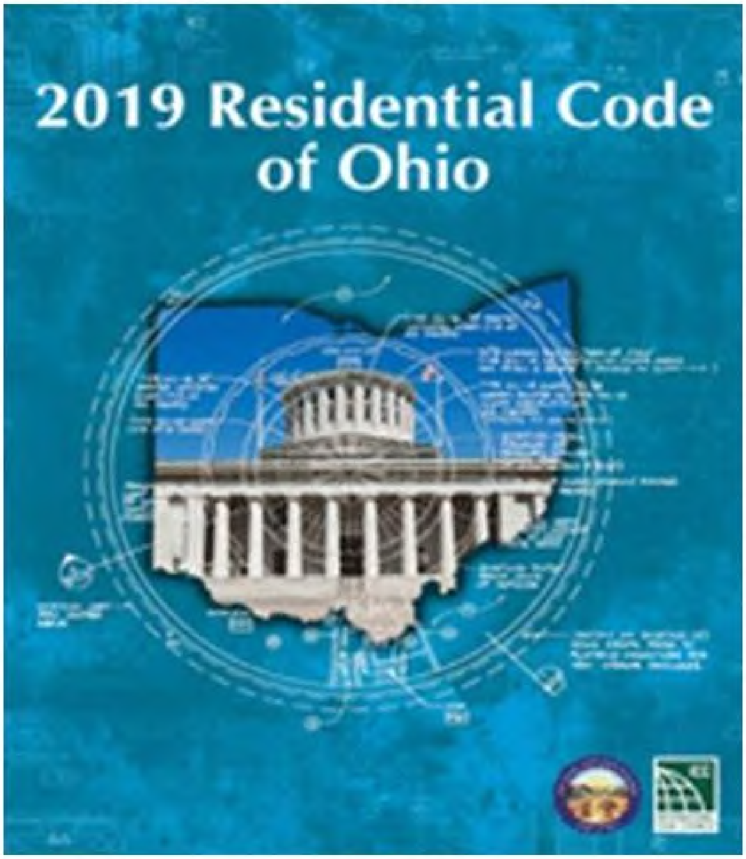
- Recognize requirements found in the 2019 Residential Code of Ohio.
- Distinguish requirements for household fire alarm systems.
- Identify carbon monoxide alarm requirements.

LET'S GET STARTED

Ohio Building Code and 2019 Residential Code of Ohio

Ohio Building Code – Section 101.2, Scope

The requirements in the Ohio Building Code apply to the construction, alteration, replacement, repair, and maintenance of every building or structure and/or appurtenances connected or attached to these buildings or structures.



2019 Residential Code of Ohio

While an owner may exceed Ohio Building Code requirements, keep in mind that this code directs the following to comply with the 2019 Residential Code of Ohio, as defined in **Section 310**:

1. Detached one- two- and three-family dwellings and their accessory structures
2. Single-family dwellings with five or fewer people receiving care in a supervised environment but capable of self-preservation with or without limited verbal or physical assistance

> ⓘ **This is reiterated in Section 310.1 which states the 2019 Residential Code of Ohio shall apply to structures comprised exclusively of one-,**

two-, or three-family dwellings (having independent exits) and their accessory structures, or single-family dwellings as described above.

2019 RESIDENTIAL CODE OF OHIO

2019 Residential Code of Ohio

Section 314

Section 314 defines requirements for smoke alarms. All smoke alarms are to be listed per **UL 217** and installed in accordance with the 2019 Residential Code of Ohio and the household fire warning equipment requirements found in *NFPA* 72 2016.

Smoke alarms (photoelectric and ionization) are required to be installed on each level within each dwelling unit. Separate or dual-sensing smoke alarms are permitted.

Systems that satisfy **Section 314.7** requirements are not required to include both technologies.

Smoke Detection Systems

Section 314.2

Smoke alarms are required in new dwelling units as defined in **Section 314.3**. When dwelling units are altered, repaired, or have additions added to them (that require approval), **smoke alarms are required to be installed in the impacted areas as follows**:

- If alterations or repairs are made to spaces such as **sleeping rooms or outside the sleeping area**, these spaces are required to have smoke alarms installed.
- If one or more sleeping rooms are added to or created in existing dwelling units, these **new sleeping rooms and the immediate vicinity outside each of the rooms** are required to have smoke alarms installed.

This **excludes** work on the **exterior** of the dwelling, such as:

- roof or siding replacement
- door or window replacement
- addition of a deck or porch
- installation, alteration, or repairs to mechanical or plumbing systems

LOCATION

Location

Section 314.3

Install smoke alarms in the following locations:

1. In each sleeping room
2. Outside each separate sleeping area, such as in the corridors in the immediate vicinity of the sleeping rooms
3. On each additional story of the dwelling
4. Outside of bathrooms that contain a shower or bathtub, **no less than 3 ft. horizontally from the door or opening of the bathroom**, unless this prevents smoke alarm placement

This includes basements and habitable attics.

This excludes crawl spaces and uninhabitable attics.

For dwellings or dwelling units with split levels and no intervening door between adjacent levels, a smoke alarm installed on the upper level is permitted to suffice for the adjacent lower level if the lower level is less than one full story below the upper level.

When smoke alarm installation is near cooking appliances, they are required to be installed at the following horizontal distances away from permanently installed cooking appliances:

- **Ionization smoke alarms**: At least **20 ft.** horizontally from the cooking appliances
- **Ionization smoke alarms with an alarm-silencing switch**: At least **10 ft.** from the cooking appliances
- **Photoelectric smoke alarms**: At least **6 ft.** from the cooking appliances

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Smoke alarms (photoelectric and ionization) are required to be installed on _____ level within each dwelling unit.

Type your answer here

SUBMIT

Install smoke alarms in the following locations: (Select all that apply)

- ☐ Crawl spaces and uninhabitable attics
- ☐ In each sleeping room

☐ On each additional story of the dwelling

☐ Outside each separate sleeping area, such as in the corridors in the immediate vicinity of the sleeping rooms

SUBMIT

Photoelectric smoke alarms are required to be installed at least _____ from the cooking appliances.

○ 6 ft.

○ 10 ft.

○ 12 ft.

○ 20 ft.

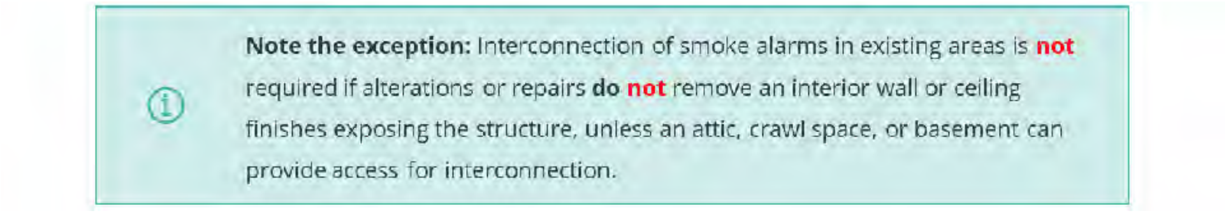
SUBMIT

INTERCONNECTION

Interconnection

Section 314.4

If **more than one smoke alarm device** is required within a dwelling unit, the devices are **required to be interconnected** so that one alarm activates all the alarms in the dwelling unit. **Wireless alarms** are **not required** to be **physically interconnected** if all alarms sound when one alarm activates.


Note the exception: Interconnection of smoke alarms in existing areas is **not** required if alterations or repairs **do not** remove an interior wall or ceiling finishes exposing the structure, unless an attic, crawl space, or basement can provide access for interconnection.

COMBINATION ALARMS

Combination Alarms

Section 314.5

Combination smoke and carbon monoxide alarms are permitted to be used instead of smoke alarms.

POWER SOURCE

Power Source

Section 314.6

Primary power for smoke alarms shall come from the building wiring when wiring is served from a commercial source for the following:

- New dwelling units

- Existing dwelling units with an attic, crawl space, or basement available which could provide access for hard wiring
- Existing dwelling units where the existing interior finishes have been removed and the structure exposed

Note the exceptions:

- For **buildings with no commercial power**, smoke alarms may be **battery operated.**
- Smoke alarms are **not required to be hard-wired in existing areas** if the alterations or repairs do **not** remove interior wall or ceiling finishes exposing the structure unless an attic, crawl space, or basement can provide hard-wiring access without removing interior finishes.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

For buildings with no commercial power, smoke alarms must be connected to a generator.

○ True

○ False

SUBMIT

FIRE ALARM SYSTEMS

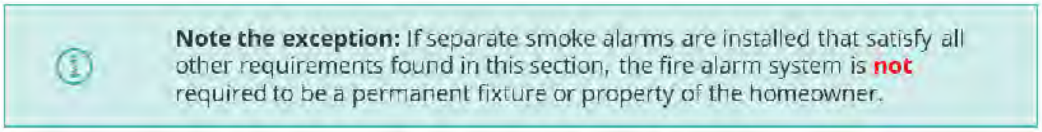
Fire Alarm Systems

Section 314.7

Fire alarm systems are permitted to be used instead of smoke alarms. The following requirements apply:

1. Fire alarm systems are to comply with ***NFPA* 72 2016** household fire alarm wiring equipment provisions.
2. Smoke detectors shall be listed per **UL 268** requirements.
3. Smoke detector installation shall comply with **Section 314.3** requirements found in this code.

Installation of a household fire alarm system makes it a permanent fixture of the occupancy and is therefore property of the homeowner.



Note the exception: If separate smoke alarms are installed that satisfy all other requirements found in this section, the fire alarm system is **not** required to be a permanent fixture or property of the homeowner.

Combination smoke and carbon monoxide detectors are permitted to be installed in fire alarm systems instead of smoke alarms but are required to be listed per **UL 268** and **UL 2075**.

CARBON MONOXIDE ALARMS

Carbon Monoxide Alarms

Section 315

Carbon monoxide (CO) alarms are required to be installed per the manufacturer's instructions and be listed and labeled per UL 2034. Combination carbon monoxide and smoke alarms are required to be **listed and labeled per both UL 2034 and UL 217**.

WHERE REQUIRED

Where Required

Section 315.2

Carbon monoxide alarms in dwelling units are required for both new construction and for existing units that undergo alterations, repairs, or additions (requiring a permit). The conditions differ depending on the situation.

In new construction, carbon monoxide alarms are required for **either or both** of the following:

1. The dwelling unit contains a fuel-fired appliance
2. The dwelling unit has an attached garage

In existing dwelling units that have fuel-fired appliances or an attached garage that are undergoing alterations, repairs, or additions that require a permit, carbon monoxide alarms are required for any of the following areas or systems within the dwelling unit:

1. A sleeping room is added or newly created to the dwelling unit.
2. A sleeping room is altered.
3. The immediate vicinity outside the sleeping room is altered.
4. An attached garage is added or altered.
5. A fuel-fired appliance is added, altered, repaired, or replaced.

LOCATION

Location

Section 315.3

Carbon monoxide alarms are required outside of each separate sleeping area in the immediate vicinity of the bedrooms. A carbon monoxide alarm is required to be installed in a bedroom if a fuel-burning appliance is located within the bedroom or its attached bathroom.

COMBINATION ALARMS

Combination Alarms

Section 315.4

Combination carbon monoxide and smoke alarms are permitted to be used instead of carbon monoxide alarms.

CARBON MONOXIDE DETECTION SYSTEMS

Carbon Monoxide Detection Systems

Section 315.7

Household carbon monoxide detection systems are required to meet NFPA 720 requirements, with the carbon monoxide detectors being **listed and labeled per UL 2075**. Carbon monoxide detectors are to be installed per **Section 315.3** requirements of this Code. Be aware that these locations supersede those specified by NFPA 720.

When a household carbon monoxide detection system is installed, it becomes a permanent fixture of the occupancy and is owned by the homeowner. However, if separate carbon monoxide alarms are provided that satisfy all requirements in this section, the carbon monoxide detection system is **not** required to be a permanent fixture of the occupancy or be owned by the homeowner.

Combination carbon monoxide and smoke detectors installed in carbon monoxide detection systems in place of carbon monoxide detectors are **required to be listed and labeled per UL 2075** and **UL 268**.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

According to Section 315, regarding existing dwelling units – If the work requires a permit, CO alarms are to be installed in the following locations: (Select all that apply)

☐ A fuel-fired appliance is added, altered, repaired, or replaced

☐ An addition or alteration to a detached garage

☐ A sleeping room is added or newly created to the dwelling unit

☐ A sleeping room is altered

☐ An alteration is done to the immediate vicinity outside of a sleeping room

SUBMIT

Combination carbon monoxide and smoke alarms are permitted to be used instead of carbon monoxide alarms.

○ True

○ False

SUBMIT

CONTINUE

After completing this module, you should now have a better understanding of smoke and carbon monoxide requirements found in the 2019 Residential Code of Ohio.

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.

Glossary: Household Fire Warning Equipment

This is the glossary for the Household Fire Warning Equipment course. Click on a letter below to see each term and its definition.

- A
- C
- D
- F
- H
- I
- M
- N
- S
- T

Lesson 1 of 10

A

Alarm Signal

A signal that results from the manual or automatic detection of an alarm condition. (*NFPA* 72 2016, Section 3.3.253.1)

Authority Having Jurisdiction (AHJ)

An organization, office, or individual responsible for enforcing requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure. (*NFPA* 72 2016, Section 3.2.2)

C

Combination System

A fire alarm system in which components are used, in whole or in part, in common with a non-fire signaling system. Examples of non-fire systems are security, card access control, closed circuit television, sound reinforcement, background music, paging, sound masking, building automation, time, and attendance. (*NFPA* 72, 2016, Section 3.3.103.1)

Control Unit (Fire Alarm Control Unit-FACU)

A component of the fire alarm system, provided with primary and secondary power sources, which receives signals from initiating devices or other fire alarm control units, and processes these signals to determine part or all of the required fire alarm system output function(s). (*NFPA* 72 2016, Section 3.3.100)

Also known as the **Fire Alarm Control Panel** (FACP), **control panel**, or **control unit**.

D

Detector

A device suitable for connection to a circuit that has a sensor that responds to a physical stimulus such as heat or smoke. (*NFPA* 72 2016, Section 3.3.66)

Dwelling Unit

A single unit, providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation. (*NFPA* 72 2016, Section 3.3.79)

F

Fire Alarm Control Unit

A component of the fire alarm system, provided with primary and secondary power sources, which receives signals from initiating devices or other fire alarm control units, and processes these signals to determine part or all of the required fire alarm system output function(s). (*NFPA* 72 2016, Section 3.3.100)

Also known as the **Fire Alarm Control Panel** (FACP), **control panel**, or **control unit**.

Fire Alarm System

A system or portion of a combination system that consists of components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal-initiating devices and to initiate the appropriate response to those signals. (*NFPA* 72 2016, Section 3.3.103)

Lesson 5 of 10

H

Household Fire Alarm System

A system of devices that uses a fire alarm control unit (panel) to produce an alarm signal in the household for the purpose of notifying the occupants of the presence of a fire so that they will evacuate the premises. (*NFPA* 72 2016, Section 3.3.103.2)

Initiating Device

A system component that originates transmission of a change-of-state condition, such as in a smoke detector, manual fire alarm box, or supervisory switch. (*NFPA* 72 2016, Section 3.3.131)

M

Multiple-Station Alarm Device

Two or more single station alarm devices that can be interconnected so that actuation of one causes all integral or separate audible alarms to operate; or one single station alarm device having connections to other detectors or to a manual fire alarm box. (*NFPA* 72 2016, Section 3.3.161)

N

Notification Appliance

A fire alarm system component such as a bell, horn, loudspeaker, visual notification appliance, or text display that provides audible, tactile, or visual outputs, or any combination thereof. (*NFPA* 72 2016, Section 3.3.172)

Notification Appliance Circuit (NAC)

A circuit or path directly connected to a notification appliance(s). (*NFPA* 72 2016, Section 3.3.173)

Lesson 9 of 10

S

Shall

Indicates a mandatory requirement. (*NFPA* 72 2016, Section 3.2.6)

Single-Station Alarm Device

An assembly that incorporates the detector, the control equipment, and the alarm-sounding device in one unit operated from a power supply either in the unit or obtained at the point of installation. (*NFPA* 72 2016, Section 3.3.260)

Sloping Ceiling

A ceiling that has a slope of more than 1 in 8. (*NFPA* 72 2016, Section 3.3.36.2)

Smoke Alarm

A single or multiple-station alarm responsive to smoke. (*NFPA* 72 2016, Section 3.3.265)

Smoke Detector

A device that detects visible or invisible particles of combustion. (*NFPA* 72 2016, Section 3.3.66.20)

Smooth Ceiling

A ceiling surface uninterrupted by continuous projections, such as solid joists, beams, or ducts, extending more than 4 in. (100 mm) below the ceiling surface. (*NFPA* 72 2016, Section 3.3.38.3)

Lesson 10 of 10

T

Trouble Signal

A signal that results from the detection of a trouble condition. (*NFPA* 72 2016, Section 3.3.253.10)

File Attachments for Item:

EC-8 Ohio Plumbing Code Chapter 9: Vents and Venting Principles (Franklin County Public Health)

All certifications (7 hours)

Ohio | **Department of Commerce**

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Brien L Bellous

Organization: Franklin County Public Health

Address: 280 E. Broad St., 2nd Floor

E-mail: brienbellous@franklincountyohio.gov Telephone: 614-525-5333

Website: myfcph.org (no class content listed on this site)

Conference Sponsor (if applicable)________ Conference Email:________

Check here if Course Renewal:________ Prior course number ________ (*i.e. BBS2018-429*)

Renewals will only be granted for identical content and certifications, within the current code cycle. Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: Ohio Plumbing Code Chapter 9. Vents and Venting Principles.

Course instructor: Brien L Bellous

Course description: Offer an in-depth review of basic venting principles in the Ohio Plumbing Code with an emphasis on venting alternatives and their root in the ICC creation. Using the International Plumbing Code Commentary as a guide, highlight specialized OPC principles of sump venting, vent stack sizing, air admittance valves and flow of air within multi story stack configurations. Will also review each of the OPC venting alternatives listed in OPC 910 through OPC 918. Students will learn through use of visual aids and code text.

Instructional hours per session: 7 (see attached class schedule) Number of Sessions: 1

Course Date(s) and Location: January 25, 2023 to be held at 280 E Broad St., Columbus, Ohio 43215

Special Content:

Code Administration:______
Existing Buildings:______
Electrical Instruction:______
Plumbing Instruction: X

Conference Course:________
Conference Name:________
Conference location:________

Course to be offered online? No **On Demand**_____ **Webinar**_______

Course Website:________

Detail online course participation confirmation method (*i.e. test, quizlets, participant activity confirmation*):

____

Course applicable for the following certifications

Residential Certifications Only:________ Commercial Certifications: X

Administrative Course, All Certifications:________

Application materials included:

x Course Outline or Course Learning Objectives
x Presentation Materials/Slides (not required for roundtable courses)
NA Assessment Materials (for online courses)
x Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or **BBS@com.ohio.gov**

Course Overview: OPC Chapter 9: Vents and Venting Principles

Offer an in-depth review of basic venting principles in the Ohio Plumbing Code with an emphasis on venting alternatives and their root in the ICC creation. Using the International Plumbing Code Commentary as a guide, highlight specialized OPC principles of sump venting, vent stack sizing, air admittance valves and flow of air within multi story stack configurations. Will also review each of the OPC venting alternatives listed in OPC 910 through OPC 918. Students will learn through use of visual aids and code text.

Class Schedule for OPC Chapter 9-Vents and Venting Principles

Class date will be Wednesday, January 25, 2023 and as requested.

8:00 am: Morning Class Start

10:00 am: 15 minute break

Lunch: 11:30am – 12:00pm

12:00 pm: Afternoon Class Start

2:00 pm: 15 minute break

5:00 pm: Class Ends

BRIEN BELLOUS

2785 Beal Dr., Columbus, Ohio 43232 · (614) 381-9410
bbellous@gmail.com

Objective: To provide approved Ohio Board of Building Standard continuing credit hours for appropriate certification hours.

Professional Certifications

All certifications are current and issued by the Ohio Boards of Building Standards. All Ohio certifications require a combination of experience and an ICC passing test in specialty.

- Commercial Plumbing Inspector
- Commercial Plumbing Plans Examination
- Commercial Mechanical Inspector
- ASSE 6020 Medical Gas Inspector
- Residential Building Inspector
- Residential Building Official

EXPERIENCE

APRIL 5, 2021 – PRESENT

PLUMBING, MEDICAL GAS INSPECTOR, PLUMBING PLANS EXAMINER FRANKLIN COUNTY PUBLIC HEALTH

Inspect commercial and residential plumbing and medical gas systems in accordance with approved plans and Ohio codes. Review commercial and residential plumbing drawings. Work with internal and external customers to enforce the minimum provisions of the Ohio Plumbing Code and NFPA 99.

MARCH, 2018 – APRIL 1, 2021

PLUMBING, MECHANICAL AND BUILDING INSPECTOR, PICKAWAY COUNTY, OHIO

Inspect commercial and residential plumbing and mechanical systems in accordance with approved plans and Ohio codes. Review commercial plumbing drawings when appropriate. Inspect residential building to approved plans and Ohio Residential Code. Function as Residential Building Official when necessary.

DECEMBER, 2014 – MARCH, 2018

PLUMBING ESTIMATOR/PROJECT MANAGER, WATERWORKS PLUMBING CO.

Responsible for generating plumbing estimates based on client needs, managing plumbing jobs and crews and performing plumbing work in field as needed.

Sabbatical from work to care for elderly parent with dementia. January, 2013 to December, 2014

APRIL, 1997 – JANUARY, 2013

PLUMBING INSPECTOR FIELD SUPERVISOR, CITY OF COLUMBUS, OHIO

Perform commercial, industrial and residential plumbing inspections per approved plans and local ordinances. Plumbing plan review when needed. Medical gas inspections when required. Manage 5 plumbing inspectors and liaison between industry and Department. Appointed to point team implementing new “Acella Automation” inspection software for City of Columbus.

EDUCATION

JUNE, 1993

JOURNEYMAN PLUMBING APPRENTICE, APHC COLUMBUS OHIO

Successfully completed Federal apprenticeship program. GPA was first in class.

JUNE 1983

HIGH SCHOOL GRADUATE, IRVINE HIGH SCHOOL, IRVINE CALIFORNIA

High school graduation.

PROFESSIONAL ACCOMPLISHMENTS

- Board Trustee for the Ohio Association of Plumbing Inspectors 2003-2008
- Committee member for ICC Plumbing and Mechanical Code Committee 2001-2008
- Committee Chair for ICC Plumbing Committee 2006-2007
- APHC apprenticeship teacher 2002-2006
- Industry CEU instructor Central Ohio region
- Appointed to technology point team for implementation of Accela Automation software for City of Columbus. Largest Building Department software implementation in State of Ohio.

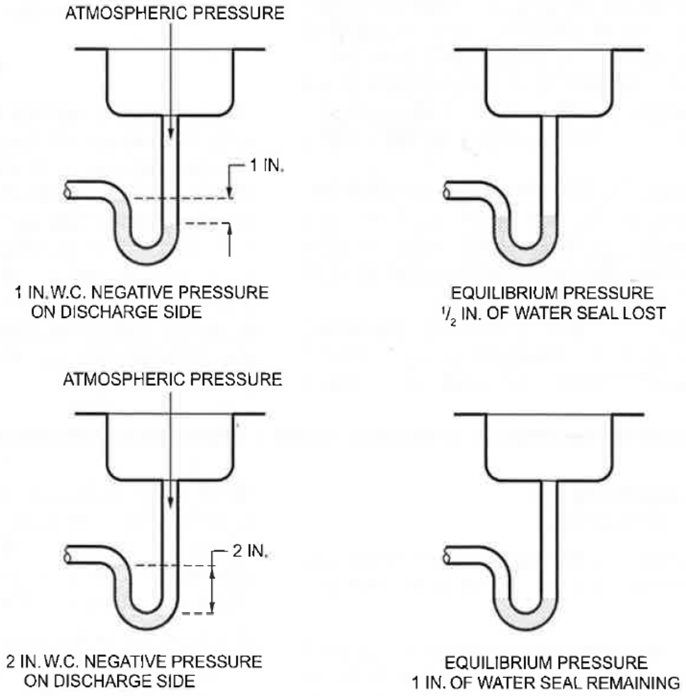
ACTIVITIES

I like to be involved with industry groups and professional conferences. I continue to enjoy learning new technology and serving trade groups when needed. Faith, family and community are all very important to me.

Ohio Plumbing Code Chapter 9 – Vents and Venting Prinicples

OPC 901.2 Trap seal protection: Protection of the trap seal means that during the normal operation of the plumbing system, the water seal remains in the trap. Each trap has a minimum 2-inch trap seal depth translating to a hydro-static pressure equal to a 2-inch water column. If exposed to a 1-inch water column pressure differential, a 1-inch water seal remains in the trap. The vent methods identified in this chapter are intended to limit the air pressure differential at trap seals to 1-inch of water column or less.

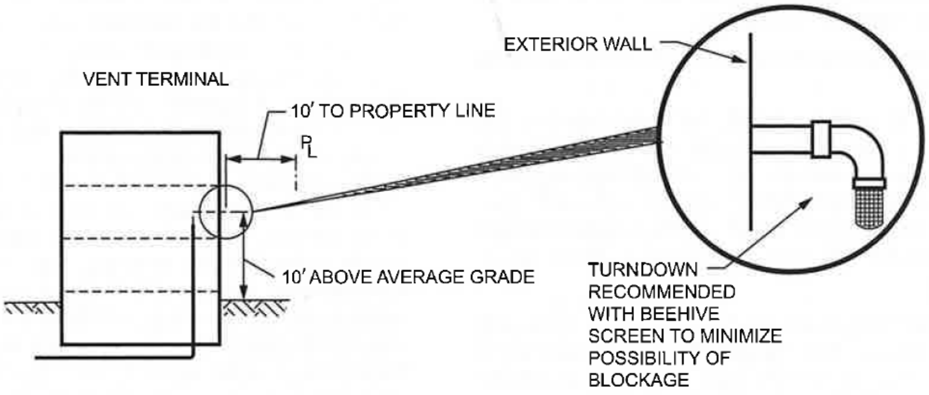
OPC 901.2.1 Venting required: This section establishes that traps and trap fixtures must be vented. This section also indicates that the method of venting can be any one of the applicable methods described in chapter nine. The proper application of these venting options can substantially reduce the amount of pipe and fittings while still providing proper venting. Inspectors and plumbers often overlook the opportunities afforded by the different venting methods. For example, a particular installation might not be in compliance with the code for a certain type of vent, however, that same installation might comply if it was considered as a different type of vent system or slightly modified to comply with the rules of a different type of venting system.



For SI: 1 inch = 25.4 mm.

OPC 901.3 Chemical waste vent systems: Must be separate. Where a chemical waste system is installed, the drainage system must be separate from the sanitary system. The vent system is also required to be separate. The flues and vapors in a chemical event system may adversely affect a sanitary vent system. In accordance with section 702.6, vent materials must be resistant to corrosion and degradation from the chemical waste and vapors involved.

OPC 903.1 Vent Terminals – Roof and Wall extensions: Open vent pipes that extend through a roof shall be terminated not less than 12 inches above the roof. The vent terminal through the roof must be designed to tolerate movement resulting from expansion and contraction of the piping material. Sidewall vent terminations are an alternative to roof penetrations that may result in significant cost savings and a more aesthetically pleasing installation. For example, a side wall vent may be preferred to penetrating membrane, slate or tile roofs. Vent terminals extending through the sidewall shall terminate at a point not less than 10 feet from a lot line and not less than 10 feet above average ground level. Where a side wall vent is installed the vent opening must be protected with a screen or louver to prevent birds from building a nest in the pipe. Such vents must not terminate where the emissions from the vent can either cause structural damage or enter the building envelope through soffit vents.



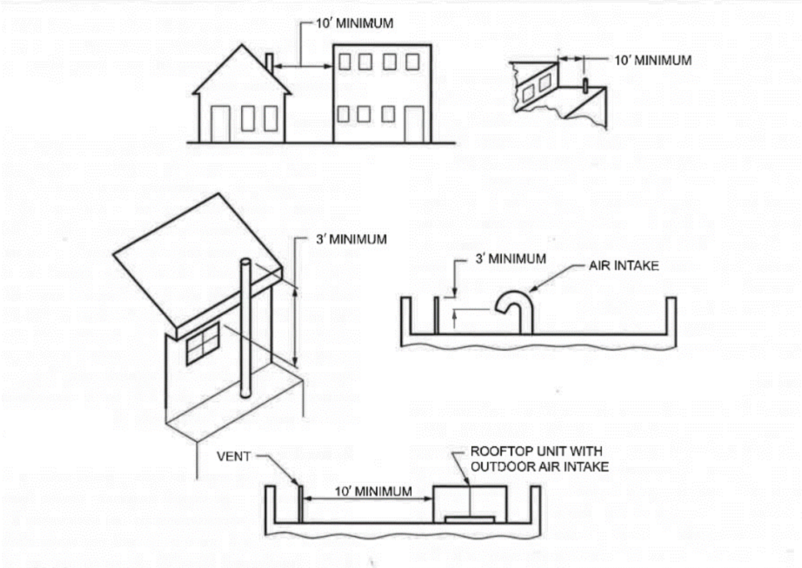
For SI: 1 foot = 304.8 mm.

Commentary Figure 903.6
SIDEWALL VENT

OPC 904.1 Required vent extension: this section of the code is intended to make sure that the building drain is vented to the outdoors. The required vent connecting to the outdoors can be satisfied in a number of ways including using a soil stack vent, a waste stack vent, an individual fixture vent, a common vent, event stack or a relief vent.

OPC 904.2 Vent stack required: A vent stack shall be required for every drainage stack that has five branch intervals or more.

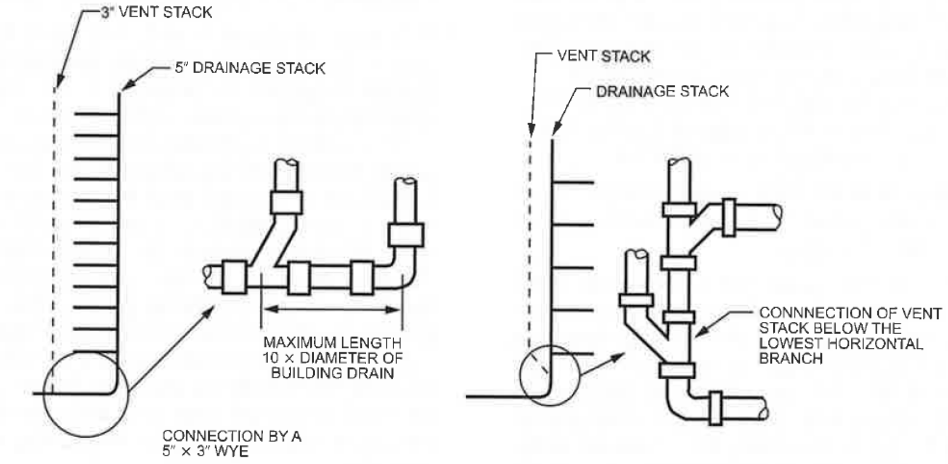
OPC 904.3 Vent termination: Vent stacks or stack vents shall terminate outdoors to the open air or to a stack type air admittance valve in accordance with section 918.



ot = 304.8 mm.

Commentary Figure 903.5
SEPARATION OF VENT TERMINAL

OPC 904.4 Vent connection at base: A drainage stack of five or more branch intervals must be vented at or below the lowest branch connection to relieve the positive pressure developed in the stack. The connection can be to the stack or to the building drain downstream of the stack and within a distance of 10 times the drainage stack diameter.

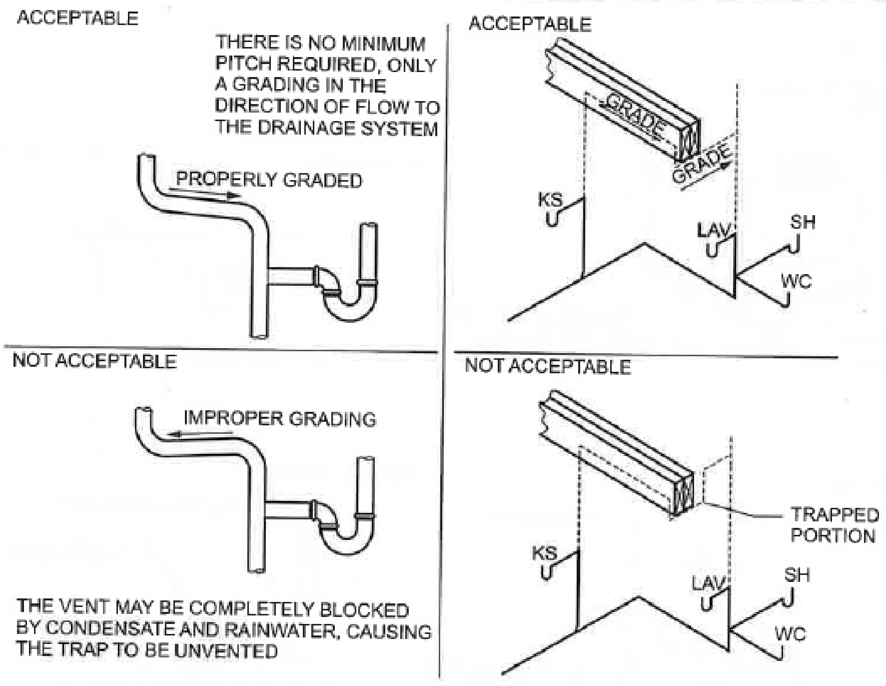


For SI: 1 inch = 25.4 mm.

Commentary Figure 904.4
VENT CONNECTION AT BASE OF STACK

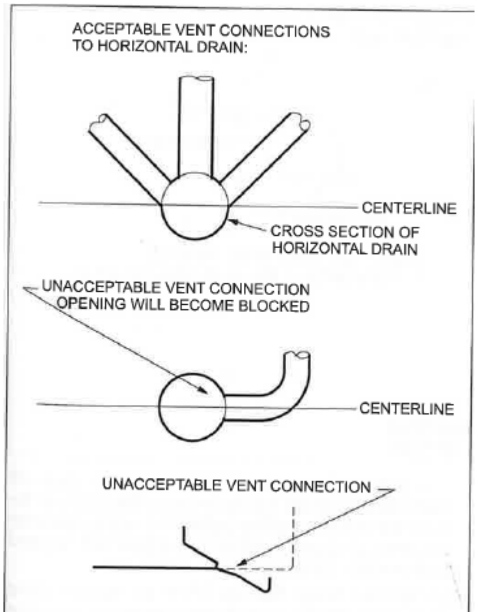
OPC 905 Vent connections and grade: Individual, branch and circuit vents shall connect to a vent stack, stack vent, air admittance valve or extend to the open air.

OPC 905.2 Grade: Vent and branch vent pipes shall be so graded and connected as to drain back to the drainage pipe by gravity.



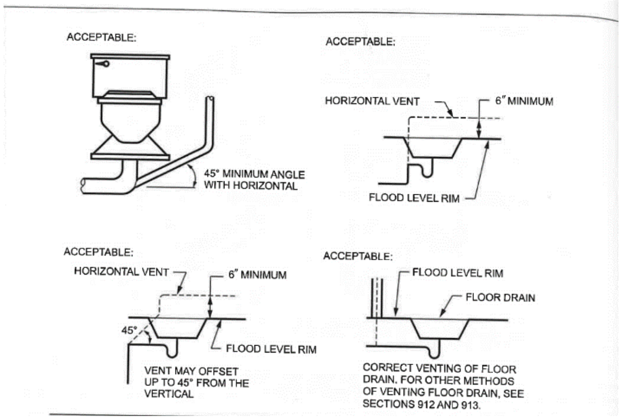
Commentary Figure 905.2
GRADE OF VENTS

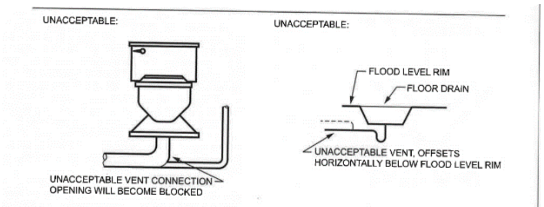
OPC905.3 Vent connection to drainage system: Every dry vent connecting to a horizontal drain shall connect above the centerline of the horizontal drain pipe.



Commentary Figure 905.3
VENT CONNECTIONS

OPC905.4 Vertical rise of vent: Every dry vent shall rise vertically to a point not less than 6 inches above the flood level rim of the highest trap or trapped fixture being vented.



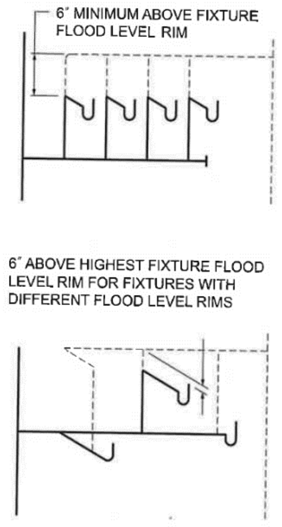


r SI: 1 inch = 25.4 mm, 1 degree = 0.0175 rad.

Commentary Figure 905.4
VERTICAL RISE OF VENT

ave settled out of the waste liquids. Additionally indi-

OPC905.5 Height above fixtures: A connection between a vent pipe and a vent stack or stack vent shall be made at not less than 6 inches above the flood level rim of:



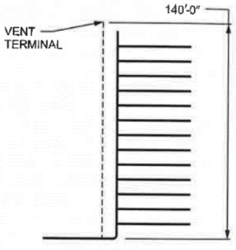
For SI: 1 inch = 25.4 mm.

Commentary Figure 905.5(3)
HORIZONTAL BRANCH VENT ELEVATION

OPC 905.6 Vent for future fixtures: Where the drainage piping has been roughed in for future fixtures, a rough in connection for a vent shall be installed. The vent size shall be not less than one half the diameter of the drain served.

OPC 906.1 Size of stack vents or vent stacks: The minimum required diameter of stack vents and vent stacks shall be determined from the developed length and the total drainage fixture units connected thereto in accordance with Table 906.1 but in no case shall the diameter be less than one half the diameter of the drain served.

EXAMPLE 1: TO DETERMINE THE MINIMUM VENT STACK SIZE FROM TABLE 906.1, USE THE ROW FOR A 4-INCH SOIL OR WASTE STACK AND A FIXTURE UNIT LOAD OF 540:

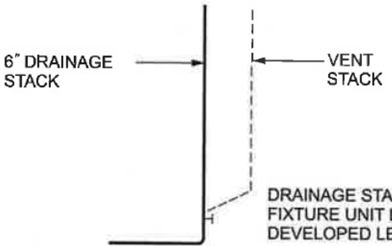


DRAINAGE STACK = 4"
FIXTURE UNIT LOAD/BRANCH = 35 DFU
FIXTURE UNIT LOAD = 455 DFU
DEVELOPED LENGTH = 140'
MINIMUM VENT DIAMETER = 3"

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

Commentary Figure 906.1(1)
VENT STACK SIZING

EXAMPLE 2: TO DETERMINE THE MINIMUM VENT STACK SIZE FROM TABLE 906.1, USE THE ROW FOR A 6-INCH SOIL OR WASTE STACK AND A FIXTURE UNIT LOAD OF 1,100:

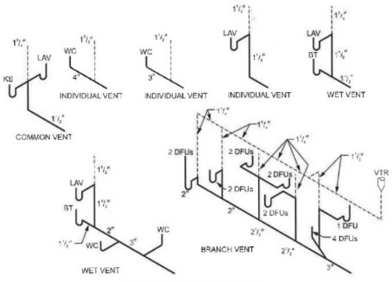


DRAINAGE STACK = 6"
FIXTURE UNIT LOAD = 750 DFU
DEVELOPED LENGTH = 280'
MIN. VENT DIAMETER = 5"

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

Commentary Figure 906.1(2)
VENT STACK SIZING

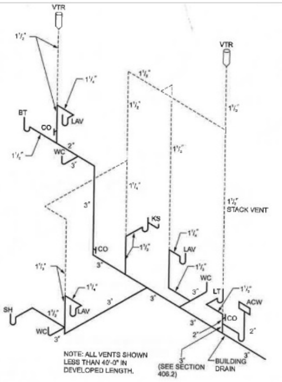
OPC 906.2: Vents other than stack vents or vent stacks: The diameter of individual vents, branch vents, circuit vents, and relief vents shall be not less than one half the required diameter of the drain served. The required drain served shall be determined in accordance with Table 710.1 (2). Vents exceeding 40 feet in developed length shall be increased by one nominal pipe size for the entire developed length of the vent pipe.



NOTE: ALL VENTS SHOWN LESS THAN 40'-0" IN DEVELOPED LENGTH

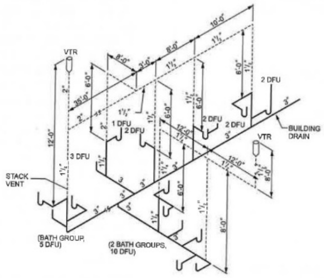
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

Commentary Figure 906.2(1)
VENT SIZING



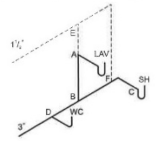
NOTE: ALL VENTS SHOWN LESS THAN 40'-0" IN DEVELOPED LENGTH.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.



For SI: 1 inch = 25.4, 1 foot = 304.8 mm.

Commentary Figure 906.2(4)
VENT SIZING

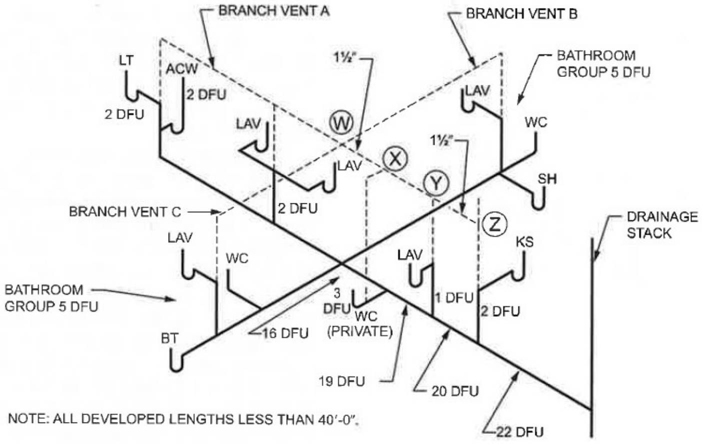


NOTE: ALL VENTS SHOWN LESS THAN 40'-0" IN DEVELOPED LENGTH

SECTION	LAV SOURCE OF WET VENT	SHOWER SOURCE OF WET VENT
A-B	1½"	1¼"
B-D	2"	2"
C-F	1½"	1½"
B-F	1½"	2"
A-E	1½"	1¼"
E-F	1¼"	1½"

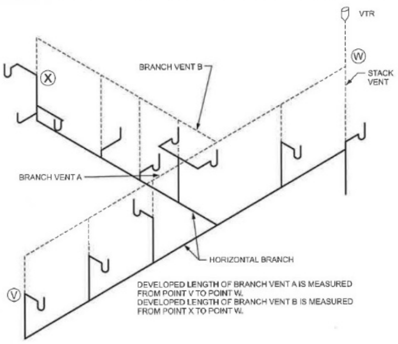
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

Commentary Figure 906.2(2)
VENT SIZING



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

Commentary Figure 906.4
COMMON BRANCH VENT



DEVELOPED LENGTH OF BRANCH VENT A IS MEASURED FROM POINT V TO POINT W.
DEVELOPED LENGTH OF BRANCH VENT B IS MEASURED FROM POINT X TO POINT W.

Commentary Figure 906.3(2)
DEVELOPED LENGTH OF VENTS

OPC 909.1 Distance of trap to vent: each fixture trap shall have a protecting vent located so that the slope and the developed length in the fixture drain from the trap weir to the vent fitting are within the requirements set forth in table 909.1

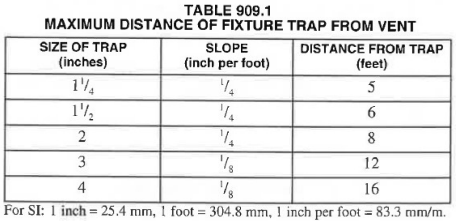
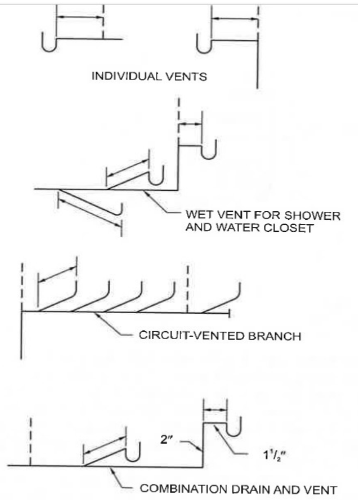


TABLE 909.1
MAXIMUM DISTANCE OF FIXTURE TRAP FROM VENT

SIZE OF TRAP (inches)	SLOPE (inch per foot)	DISTANCE FROM TRAP (feet)
$1^1/_4$	$^1/_4$	5
$1^1/_2$	$^1/_4$	6
2	$^1/_4$	8
3	$^1/_8$	12
4	$^1/_8$	16

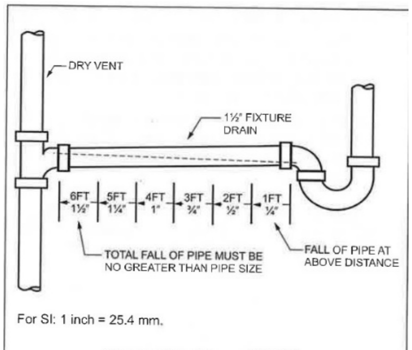
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 inch per foot = 83.3 mm/m.



For SI: 1 inch = 25.4 mm.

Commentary Figure 909.1(1)
DISTANCE FROM TRAP TO VENT

OPC 909.2 Venting of fixture drains: The total fall in a fixture drain due to pipe slope shall not exceed the diameter of the fixture drain, nor shall the vent connection to a fixture drain, except for water closets, be below the weir of the trap.



For SI: 1 inch = 25.4 mm.

Commentary Figure 909.1(2)
MAXIMUM FALL OF FIXTURE DRAIN BETWEEN TRAP AND VENT AND VENT

OPC 911.2 and 911.3 Common Vents: where the fixture drains being common vented connect at the same level, the vent connection shall be at the interconnection of the fixture drains or downstream of the interconnection. Where the fixture drains connect at different levels, the vent shall connect as a vertical extension of the vertical drain. The vertical drain pipe connecting the two fixture drains shall be considered the vent for the lower fixture drain, and shall be sized in accordance with table 911.3. The upper fixture shall not be a water closet.

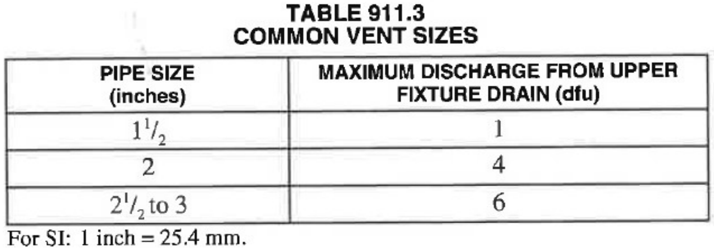
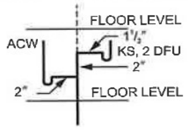
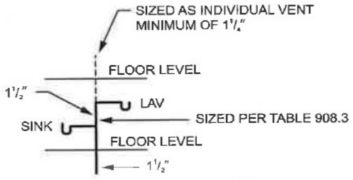


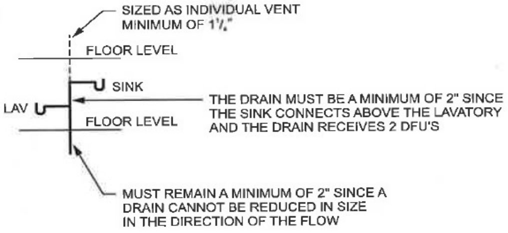
TABLE 911.3
COMMON VENT SIZES

PIPE SIZE (inches)	MAXIMUM DISCHARGE FROM UPPER FIXTURE DRAIN (dfu)
1½	1
2	4
2½ to 3	6

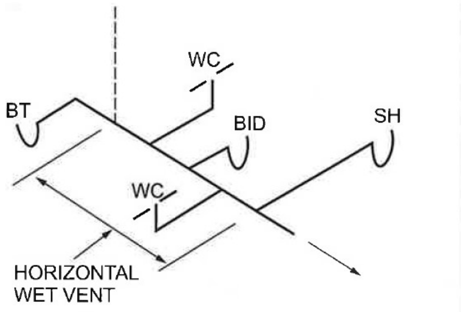
For SI: 1 inch = 25.4 mm.



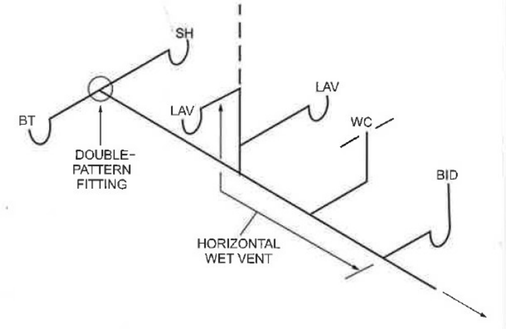




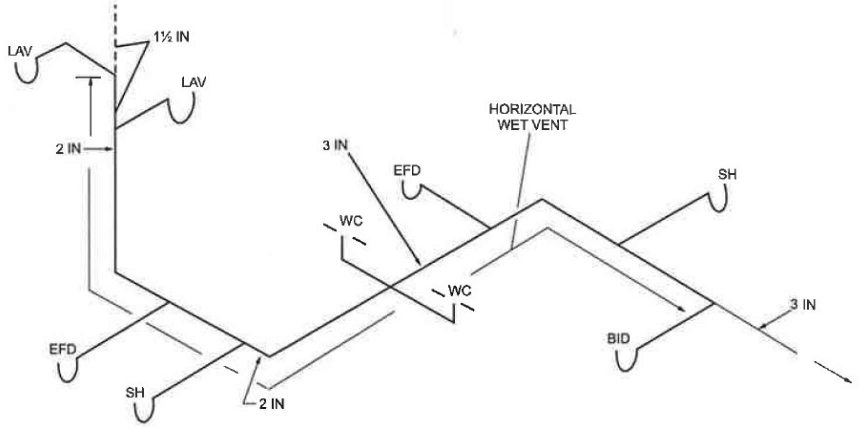
OPC 912 Wet Venting: any combination of fixtures within two bathroom groups located on the same floor level is permitted to be vented by a horizontal wet vent. The wet vent shall be considered to be the vent for the fixtures and shall extend from the connection of the dry vent along the direction of the flow in the drain pipe to the most downstream fixture drain connecting to the horizontal branch drain. Each wet vented fixtures drain shall connect independently to the horizontal wet vent. Only the fixtures within the bathroom groups shall connect to the wet vent of horizontal branch drain. Any additional fixtures cell discharge downstream of the horizontal wet vent.



Commentary Figure 912.1(2)
HORIZONTAL WET VENT WITH INDIVIDUAL VENT



Commentary Figure 912.1(4)
PROHIBITED CONNECTION OF TWO FIXTURES
UPSTREAM OF DRY-VENT CONNECTION

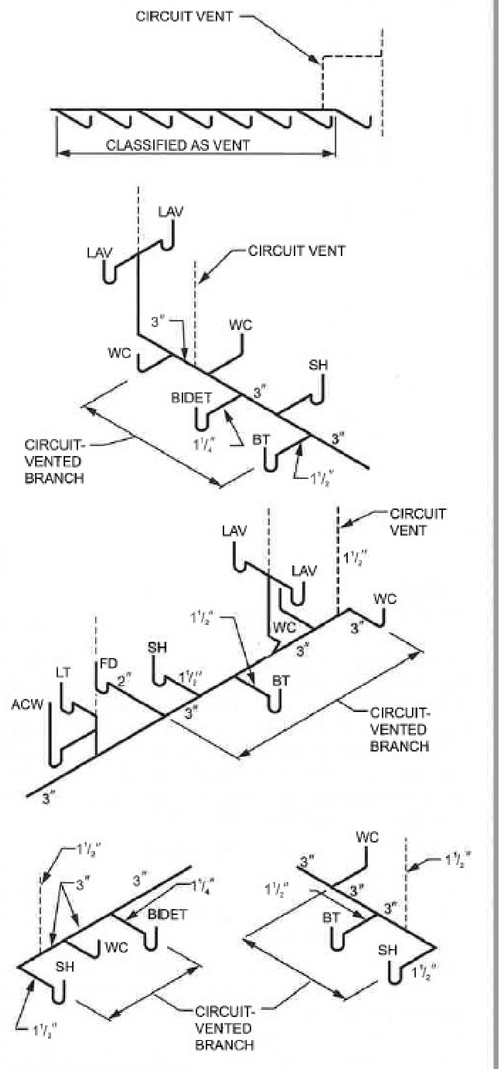


For SI: 1 inch = 25.4 mm.

Commentary Figure 912.1(8)
HORIZONTAL WET VENT SIZING (PRIVATE BATH GROUP)

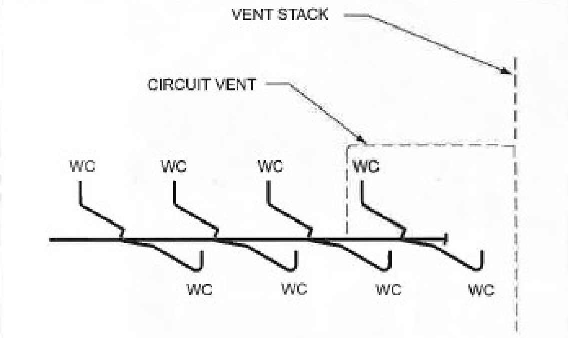
OPC 913 Waste Stack Vent: A waste stack uses the waste stack as a vent for all of the fixtures other than urinals and water closets. Because the drainage stack serves as event there are certain limitations on the design to prevent pressures in the system from exceeding plus or minus one inch of water column. The system is identified as a waste stack vent because it prohibits the connection of water closets and urinals. Only waste may discharge to the stack. Two preserve the desirable annular flow in the stack offsets are prohibited and the stack must be vertical from the lowest fixture connection to the highest fixture connection. Each fixture must connect independently through a single or double sanitary team stack. A stack vent shall be provided for the waste stack. the size of the stack then shall not be less than the size of the waste stack.

OPC 914 Circuit Vent: circuit venting in bonds up to 8 fixtures at a single vent. A dry vent connects between the two most upstream fixtures on the horizontal branch. The horizontal branch serves as the wet vent for the battery of fixtures. The principle of circuit venting is that the flow of drainage never exceeds 1/2 full flow condition. The air for venting the fixtures circulates in the top half of the horizontal branch drainpipe. The flow velocity in the horizontal branch is slow and non-turbulent, thereby preventing pressure differentials from affecting the connected fixtures. The circuit vented fixtures must connect to the circuit vented branch in the horizontal plane to limit the amount of turbulence created by fixture discharge.

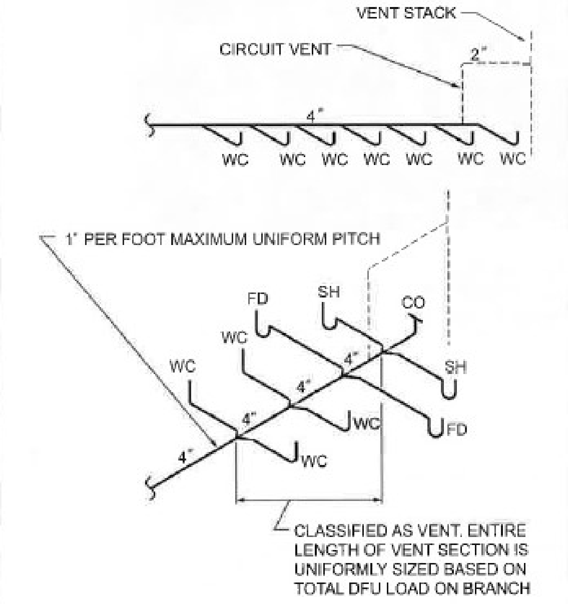


For SI: 1 inch = 25.4 mm.

Commentary Figure 914.1(1)
CIRCUIT VENTING



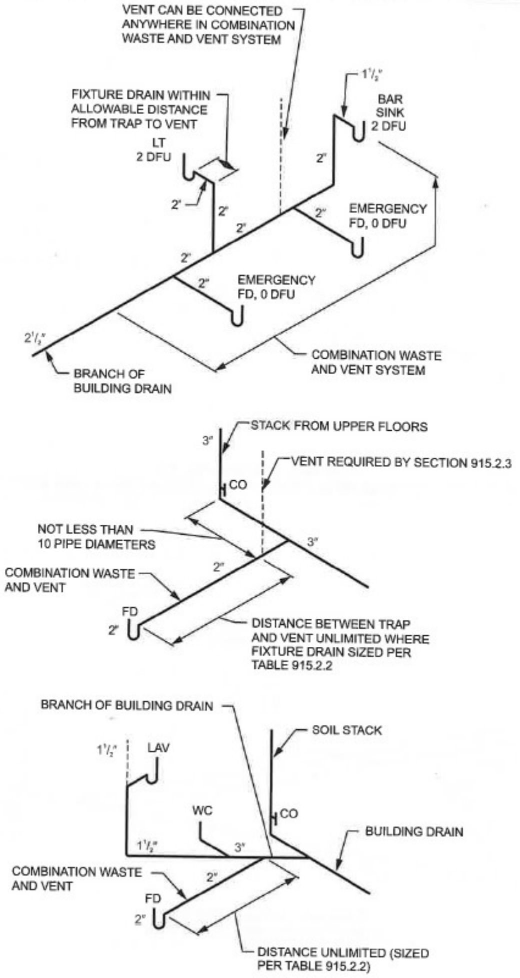
Commentary Figure 914.2
BACK-TO-BACK WATER CLOSETS CIRCUIT VENTED



For SI: 1 inch = 25.4 mm.

Commentary Figure 914.3
SIZING A CIRCUIT-VENT SYSTEM

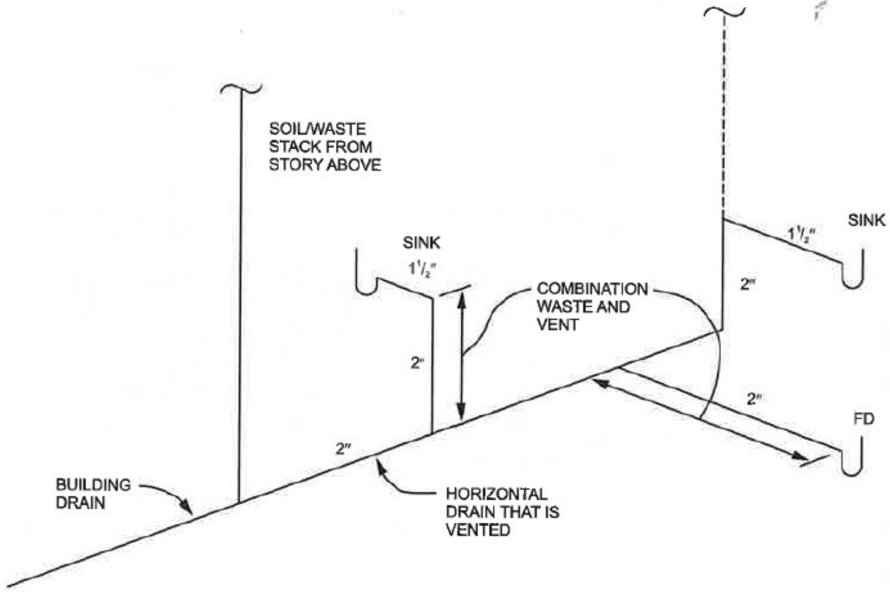
OPC 915 Combination Waste and Vent System: this section contains requirements for venting methods serving floor drains, sinks, lavatories and drinking fountains. Like wet vents and circuit vents, a combination waste and vent system is another variation of wet venting. Although the specific requirements for each are unique, all of the wet venting systems (circuit, wet and combination) utilize the same basic principle of oversized drains with ample space for air flow above the waste flow. To prevent blockages, combination drain and vent systems are intended to receive only clear and greywater wastes. Because of the low flow velocities and volumes that occur in these systems, any solids introduced would accumulate, causing blockages and reduction of the internal cross-sectional area of the piping. In a combination waste and vent system, the drain serves as the vent for the fixture. The system is intended to be a horizontal piping system, with the only vertical piping being the vertical portion of a fixture drain located above the level of the combination waste and vent system. Each fixture drained connected to a combination waste and vent system is sized in accordance with chapter seven. Depending on the method by which it is sized, the fixture drain may or may not be considered as a portion of the combination waste and vent system. Where the fixture drain is sized as a combination waste and vent in accordance with table 915 point 2.2 the trap to vent distances listed in table 909.1 do not apply because the drain is also event for its entire length.



For SI: 1 inch = 25.4 mm.

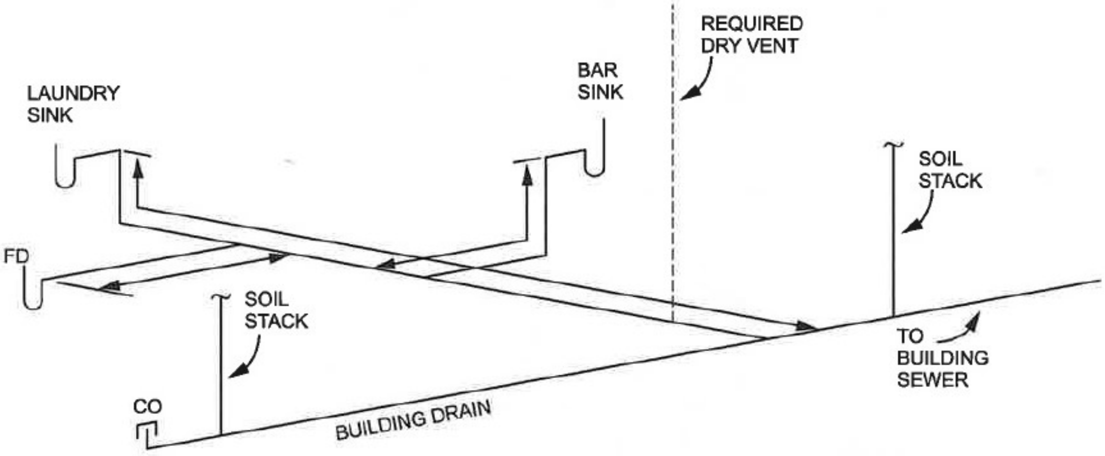
Commentary Figure 915.2(4)
COMBINATION WASTE AND VENT

OPC 915 Combination Drain and Vent System



For SI: 1 inch = 25.4 mm.

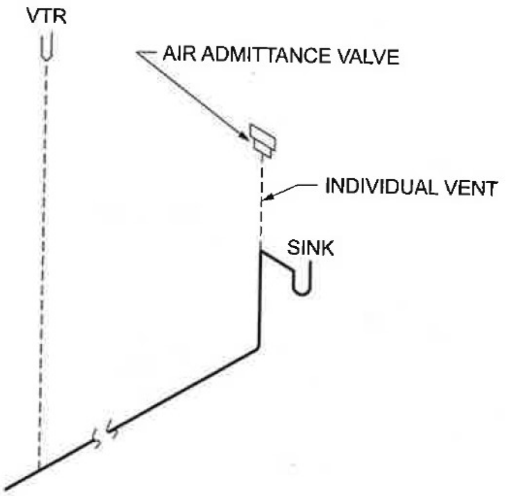
Commentary Figure 915.2.3(2)
COMBINATION WASTE AND VENT



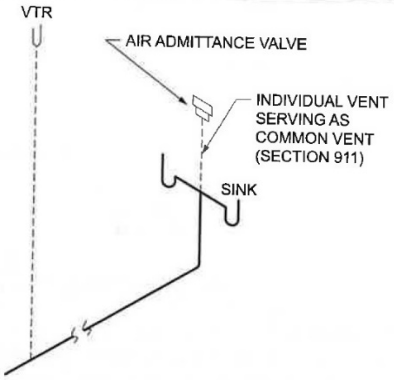
Commentary Figure 915.2.3(1)
COMBINATION WASTE AND VENT

This section contains requirements for a venting method serving floor drains, sinks, lavatories and drinking fountains. Like wet vents and circuit vents, a combination waste and vent system is another variation of wet venting. Although the specific requirements for each are unique, all of the wet venting means utilize the same basic principle of oversized drains with ample space for air flow above the waste flow. To prevent blockages, such systems are intended to receive only clear and Gray water wastes. Because of the low flow velocities and volumes that occur in these systems, any solids introduced would accumulate causing blockages the reduction of the internal cross-sectional area of the piping. In a combination waste and vent system, the drain serves as the vent for the fixture. The system is intended to be a horizontal piping system, with the only vertical piping limited to 8 feet in height being the vertical portion of a fixture drain located above the level of the combination waste and vent.

OPC 918 Air Admittance Valves

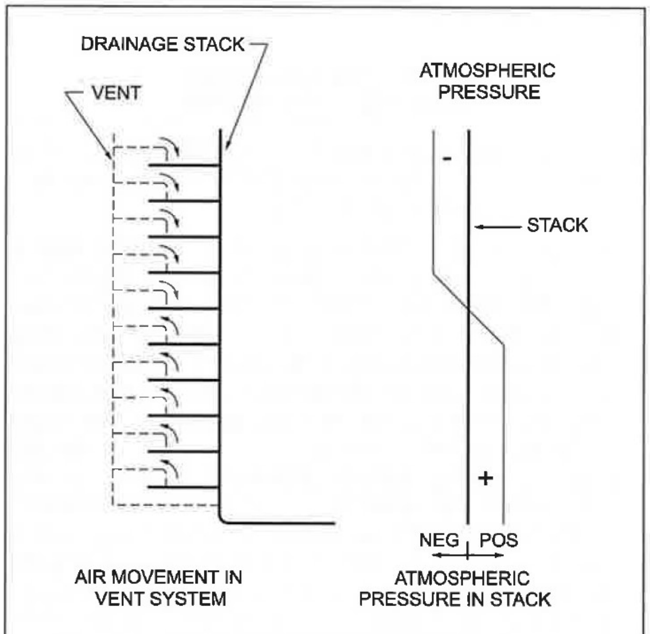


Commentary Figure 918.3.1(1)
AIR ADMITTANCE—INDIVIDUAL VENT



Commentary Figure 918.3.1(2)
COMMON VENT

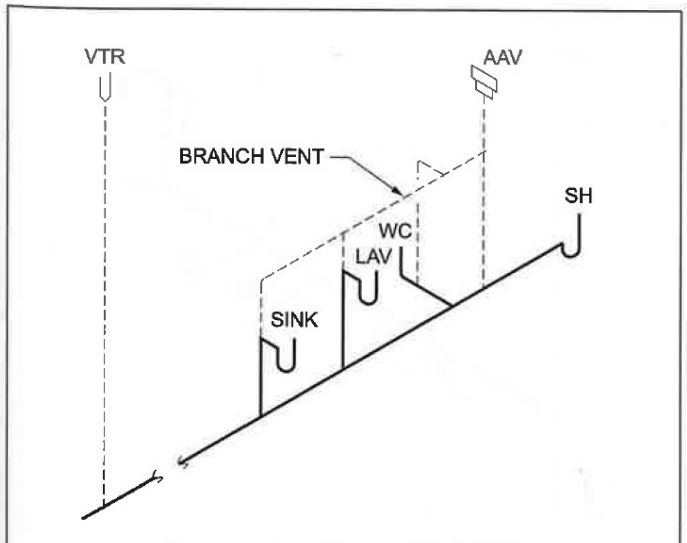
The installation of air admittance valves must conform to the requirements of section 918.3 through 918.8 and the manufacturer's instructions. Where differences occur between the provisions of the code and the manufacturer's instructions, the most restrictive provision must be applied.



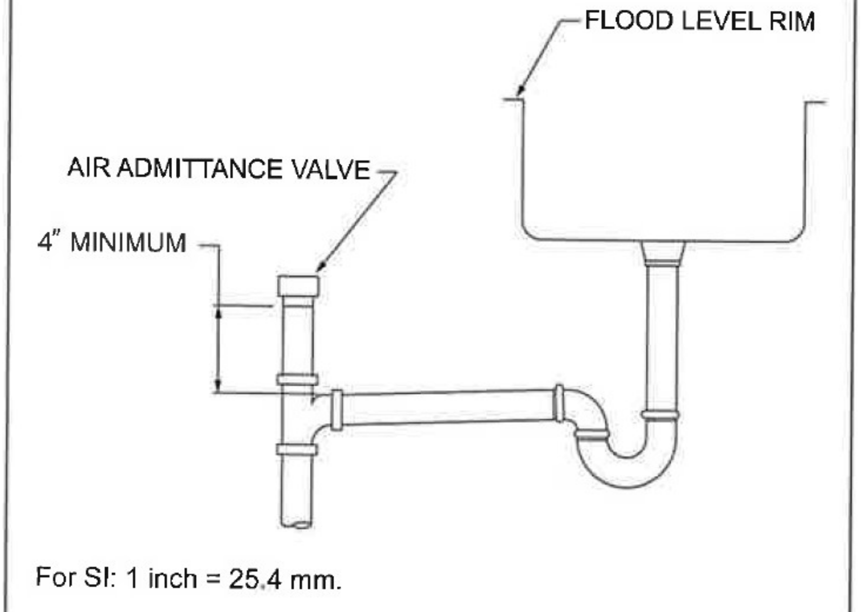
Commentary Figure 918.3.2
PRESSURE IN DRAINAGE STACK

As drainage flows down a stack, it tends to draw air downward with it. Air located in the drainage stack ahead of the flow also tends to be pushed downward by the flowing drainage- like the action of a piston in a cylinder. Measurements of the air pressure at various elevations in a stack with many branch intervals will indicate that flow creates negative pressures in the upper part of the stack and positive pressures in the lower part of the stack.

A horizontal branch drain served by an air admittance valve must be located within the top four branch intervals of the stack where pressure differentials would be tolerable. Otherwise, a method of relieving pressure is required because of the greater pressure differentials expected in the lower portions of the stack.



Commentary Figure 918.3.1(5)
BRANCH VENT



Commentary Figure 918.4
DISTANCE ABOVE DRAIN

In In the event of a drain stoppage, the seal may become inoperable or operate improperly if waste is permitted to rise into the air admittance valve assembly. Note that the Arab mittens valve need not extend above the flood level rim of the fixture served because in the event of a drain blockage such device will trap air between it and the rising waste, thereby protecting the device from contamination.

918.8 Prohibited installations.

because of the deleterious nature of the material and vapors associated with corrosive wastes comma standard construction eric mittens valves are prohibited for use with such systems. Air admittance valves are not permitted in spaces where pressure conditions adversely affect the valves operation. And finally Eric mittens valves must not be used to vent sumps or tanks as there is positive pressure created when the tank or sump is filling. Because here admittance valves cannot relieve positive pressures within the sump or tank, the positive pressure might be relieved through the traps of the fixtures connected to the sump or tank.