Board of Building Standards

EDUCATION COMMITTEE MEETING
AGENDA (AMENDED JANUARY 18, 2023)

DATE:	JANUARY 19, 2023
TIME:	10:00 AM
LOCATION:	TRAINING ROOM 3, 6606 TUSSING ROAD, REYNOLDSBURG, OHIO
	Click here to join the meeting

Call to Order

Consent Agenda

Course Applications

ER-1 Conduit and Box Fill Calculations Based on the 2020 NEC (Master Electrical Contractors Association)
All certifications (5 hours)
Staff Notes: Recommend approval
ESIAC Recommendations: No consensus reached, Dewayne Jenkins abstaining.
Committee Recommendation:

ER-2 Electric Vehicle Power Transfer Systems and the 2020 NEC Part 1 (Matthews Electrical Services)
All certifications (4 hours)
Staff Notes: Matthews plans to present it at least once per quarter. It is not a multisession course. Recommend approval.
ESIAC Recommendation: No consensus reached.
Committee Recommendation:

Old Business

New Business

Adjourn

Ohio Board of Building Standards
6606 Tussing Road
Reynoldsburg, OH 43068-9009

Timothy Galvin, Chairman

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EDUCATION COMMITTEE MEETING
CONSENT AGENDA

Course Applications

EC-1 Chapter 1 Code Administration Round Table (Northwest Ohio Building Officials Association)
All certifications (two 1.5-hour sessions)
Code Administration course credit.

EC-2 Chapter 34 Existing Buildings Round Table (Northwest Ohio Building Officials Association)
All certifications (two 1.5-hour sessions)
Existing Building course credit.

EC-3 Code Consistency Round Table (Northwest Ohio Building Officials Association)
All certifications (twelve one-hour sessions)

EC-4 Ohio Portable Fire Extinguishers (Fire Tech Productions)
All certifications (6.5 hours)

EC-5 Understanding the National Electric Code Based on the 2017 NEC (Master Electrical Contractors Association)
All certifications (5 hours)

EC-6 Carbon Monoxide Alarm and Detection Requirements IBC/NFPA 720 (Fire Code Academy)
All certifications (1 hour)

EC-7 Emergency Responder Communication Enhancement Systems and the UL Certification Program (Fire Code Academy)
All certifications (1 hour)

EC-8 Fire Sprinkler Considerations for Tall Clear-Height Warehousing (Fire Code Academy)
All certifications (1 hour)

EC-9 Past, Current, and Future of the Alarm Transmission Ecosystem (Fire Code Academy)
All certifications (1 hour)

EC-10 The Five Specialty Sprinkler Types and Design Approaches (Fire Code Academy)
All certifications (1 hour)

File Attachments for Item:

ER-1 Conduit and Box Fill Calculations Based on the 2020 NEC (Master Electrical Contractors Association)

All certifications (5 hours)

Staff Notes: Recommend approval

ESIAC Recommendations: No consensus reached, Dewayne Jenkins abstaining.

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: Laura Bachman

Organization: Master Electrical Contractors Association

Address: 1555 Stanley Avenue Dayton Ohio 45404

E-mail: Laurameca@aol.com Telephone: 937-264-0418

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: Conduit and Box fill calculations Based on the 2020 NEC

Course instructor: D.Dewayne Jenkins and Robert Barnett

Course description: The purpose is to provide detailed instruction on conduit and box fill calculations

Instructional hours per session: five (5) Number of Sessions: ____

Course Date(s) and Location: March 18, 2023 Presidential Banquet Center 4548 Presidential way Dayton Ohio 45429

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

Daniel Dewayne Jenkins

Dewayne started his career in the electrical field in August of 1982 in Dayton, Ohio and has over 40 years' 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 the Senior Building Inspector and conducts electrical plans examinations, electrical safety inspections and building inspections for the past 23 years.

Dewayne is an adjunct lecturer II for Sinclair Community College in the electrical trades for the past 20 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 serves as President of the Southwest Division of IAEI, Ohio Chapter (2018-2022) and President of the Miami Valley Building Officials Council (2002 & 2003). He also serves on the Electrical Safety Inspector Advisory Committee for the Ohio Board of Building Standards.

Address: 3600 Shroyer Road, Kettering, OH 45429

Robert L. Barnett

10696 Wengerlawn Road
Brookville, OH 45309

937.510.0424
rbarnett@tricountyelectricalservices.com

Small Business Owner

Strategic Planning • Project Management • Construction • Team Leadership • Customer Service • Value Engineering • Project Coordination • Highly Detailed • Organizational Effectiveness • Design-Build • Quality Control • Materials Management • Educational Leadership

A multi-skilled professional with a solid career history in the electrical industry. Able to manage complex projects in various environments. Able to lead projects in under budget by managing and supervising an effective team in the installation of a quality product. Making a professional appearance to customers and other employees.

Technical Proficiencies

Microsoft Office	Excel	AutoCAD	Networks
Internet & Research	Word	Accounting Software	Citrix
Database Management	PowerPoint	ExamView	PDF Software

Professional Experience

Tri-County Electric, Brookville OH (License# EL48489) **2018-Present**

Owner (Since 2018)

- Creating and implementing business plans and strategies based on long term visions. Implement high-level planning to measure progress, gather insight and readjust plans and goals as necessary.
- Establish and maintain business banking accounts, payment processing systems, taxes, insurance and manage day-to-day costs and business expenses.
- Procuring business and contractor licensing for compliance with state and local licensing requirements.
- Establish solid marketing strategies and maintaining working relationships with clients to ensure outstanding customer service.
- Manage day-to-day business operations by overseeing employees and projects. Addressing various issues with staffing, project and technical issues.

Reliable Electric, Dayton OH **2006-2017**

Project Manager (3 years)

- Establish and manage cost, schedules, manpower and performance of large, highly complex projects. Fully accountable for complex/diverse projects with a high degree of business risk.
- Collaborate with general contractors, design professionals, sales representatives and business owners to accomplish project objectives. Identify and resolve project issues and manage project risk.
- ***Project Examples:***
    - Managed a $1.5M energy conservation project at Wright State University. Successfully supervised a team of 10 electricians in a complex energy retrofit on an active college university. Completed the project on time and under budget.
    - Completed a $4M urban development project in Downtown Cincinnati with a two-year scope.

Project Foreman (3 years)

- Perform business management duties such as maintaining records and files, preparing reports and ordering supplies and materials.
- Layout and installation of lighting, power, equipment and special systems wiring, based on construction documents and local codes.
- Assign work to other employees, prioritize the work of others and organize and coordinate the work of the project.
- Direct and train workers to install, maintain, or repair electrical wiring, equipment and fixtures.

Commercial Service Technician (2 years)

- Created and maintained business relationships with commercial and industrial clients.
- Troubleshoot malfunctions in circuitry, equipment, motor control circuits and special systems wiring using test equipment to correctly diagnose and repair problems.
- Use a variety of tools and equipment such as power construction equipment, measuring devices, power tools and testing equipment.

Field Electrician (3 years)

- Assist project foreman and journeyman on large commercial construction sites.
- Install, maintain and repair of electrical wiring, equipment and fixtures.
- Perform physical demanding tasks such as digging trenches to lay conduit and moving/lifting heavy objects.
- Fire alarm system installation and troubleshooting.

Sinclair Community College, Dayton OH **2013-2020**

Adjunct Instructor (7 years)

- First year instructor for the Independent Electrical Contractors (IEC) Apprenticeship Training Program, sponsored by the Master Electrical Contractors Association Training School (MECATS) Dayton Ohio
- Responsible for creating a positive learning environment for 10-12 entry level apprentice electricians.
- Develop lesson plans, quizzes and exams for student development and evaluation. Provide support and direction for students in and out of the classroom.
- Previously an active member of the MECATS A&T Committee.

Education

- **Electrical Engineering Technology/IEC Apprenticeship Program,** Sinclair Community College, Dayton OH, 2010 (GPA: 4.0)
  Ohio licensed Journeyman
  Ohio Fire Alarm licensed
- **Architectural /Engineering Technology,** Miami Valley Career Technology Center, Clayton OH, 2006 (GPA: 3.5)
- **Milton-Union High School,** West Milton OH, 2006 (GPA: 3.0)

WELCOME!

FROM THE MASTER ELECTRICAL CONTRACTORS ASSOCIATION

CONDUIT AND BOX FILL CALCULATIONS

Presented by: Dewayne Jenkins

Based on 2020 NEC

300.14 LENGTH OF FREE CONDUCTORS AT OUTLETS, JUNCTIONS, AND SWITCH POINTS

- At least 150 mm (6 in.) of free conductor, measured from the point in the box where it emerges from its raceway or cable sheath, shall be left at each outlet, junction, and switch point for splices or the connection of luminaires or devices.
- Where the opening to an outlet, junction, or switch point is less than 200 mm (8 in.) in any dimension, each conductor shall be long enough to extend at least 75 mm (3 in.) outside the opening.

300.14 - EXCEPTION

- *Exception: Conductors that are not spliced or terminated at the outlet, junction, or switch point shall not be required to comply with 300.14.*

300.14 - COMMENT

- For a conductor that loops through an outlet box and that is intended for connection to a receptacle, switch, lampholder, or other such device, 300.14 specifies the length of slack (free conductor) required for the box size, The intent is to ensure enough slack for the terminal connections to be made easily.
- The exception excludes conductors running through a box, which should have sufficient slack to prevent physical damage from the insertion of devices or from the use of luminaire studs, hickeys, or other luminaire supports within the box.

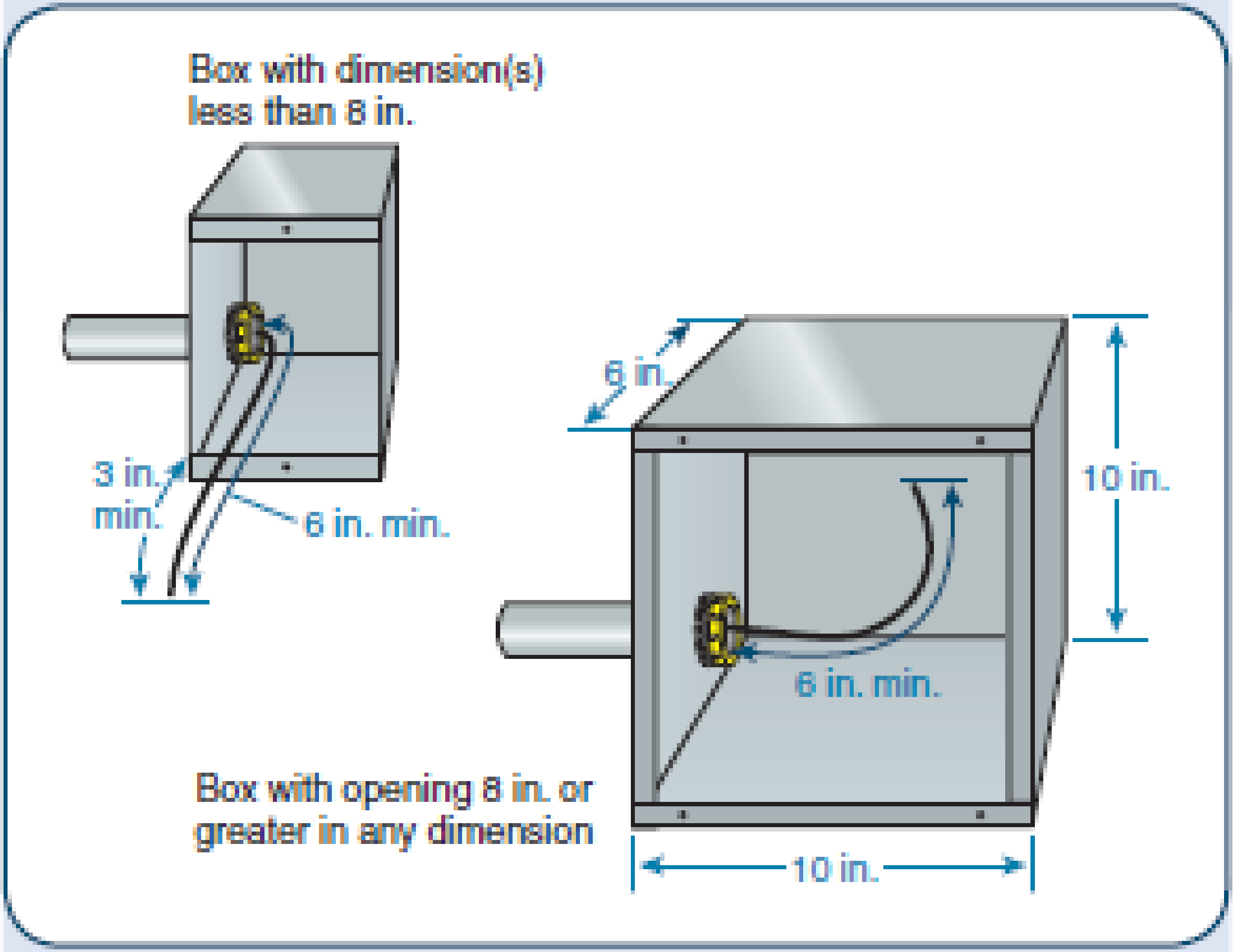


EXHIBIT 300.13 Two different boxes with free conductor lengths according to 300.14.

300.15 BOXES, CONDUIT BODIES, OR FITTINGS WHERE REQUIRED

- A box shall be installed at each outlet and switch point for concealed knob-and-tube wiring.
- Fittings and connectors shall be used only with the specific wiring methods for which they are designed and listed.
- Where the wiring method is conduit, tubing, Type AC cable, Type MC cable, Type MI cable, nonmetallic-sheathed cable, or other cables, a box or conduit body shall be installed at each conductor splice point, outlet point, switch point, junction point, termination point, or pull point, unless otherwise permitted in 300.15(A) through (L).

310.15 (A) WIRING METHODS WITH INTERIOR ACCESS.

- A box or conduit body shall not be required for each splice, junction, switch, pull, termination, or outlet points in wiring methods with removable covers, such as wireways, multioutlet assemblies, auxiliary gutters, and surface raceways.
- The covers shall be accessible after installation.

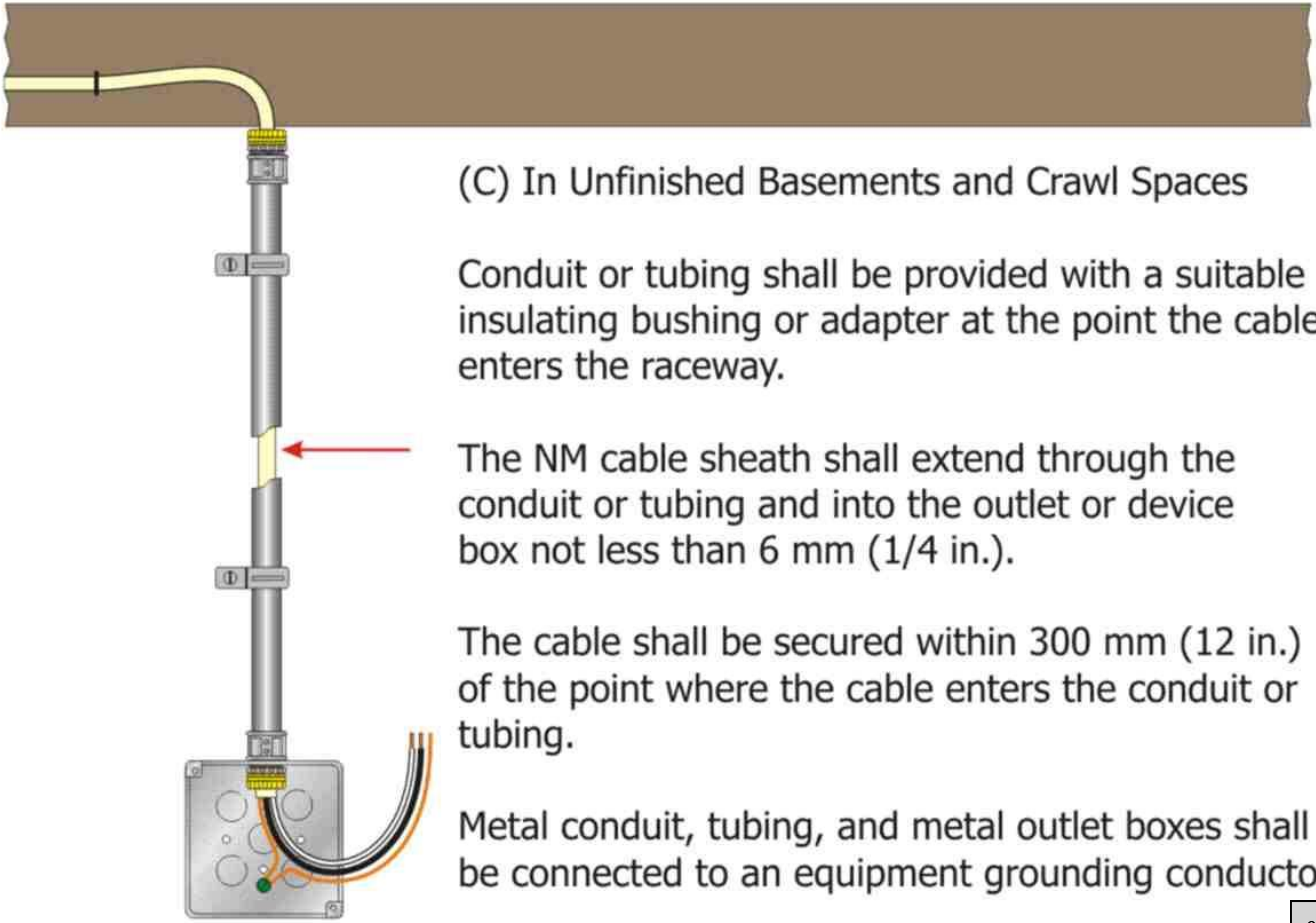
300.15 (B) - EQUIPMENT.

- An integral junction box or wiring compartment as part of approved equipment shall be permitted in lieu of a box.

300.15(C) - PROTECTION.

- A box or conduit body shall not be required where cables enter or exit from conduit or tubing that is used to provide cable support or protection against physical damage.
- A fitting shall be provided on the end(s) of the conduit or tubing to protect the cable from abrasion.

334.15 Exposed Work



(C) In Unfinished Basements and Crawl Spaces

Conduit or tubing shall be provided with a suitable insulating bushing or adapter at the point the cable enters the raceway.

The NM cable sheath shall extend through the conduit or tubing and into the outlet or device box not less than 6 mm (1/4 in.).

The cable shall be secured within 300 mm (12 in.) of the point where the cable enters the conduit or tubing.

Metal conduit, tubing, and metal outlet boxes shall be connected to an equipment grounding conductor.

314.1 SCOPE

- This article covers the installation and use of all boxes and conduit bodies used as outlet, device, junction, or pull boxes, depending on their use, and handhole enclosures.
- Cast, sheet metal, nonmetallic, and other boxes such as FS, FD, and larger boxes are not classified as conduit bodies.
- This article also includes installation requirements for fittings used to join raceways and to connect raceways and cables to boxes and conduit bodies.

314.16 NUMBER OF CONDUCTORS IN OUTLET, DEVICE, AND JUNCTION BOXES, AND CONDUIT BODIES

- Boxes and conduit bodies shall be of sufficient size to provide free space for all enclosed conductors. In no case shall the volume of the box, as calculated in 314.16(A), be less than the fill calculation as calculated in 314.16(B).
- The minimum volume for conduit bodies shall be as calculated in 314.16(C).
- The provisions of this section shall not apply to terminal housings supplied with motors or generators. See 430.12
- Boxes and conduit bodies enclosing conductors 4 AWG or larger shall also comply with the provisions of 314.28.

314.16 (A) - BOX VOLUME CALCULATIONS.

- The volume of a wiring enclosure (box) shall be the total volume of the assembled sections and, where used, the space provided by plaster rings, domed covers, extension rings, and so forth, that are marked with their volume or are made from boxes the dimensions of which are listed in Table 314.16(A).


RACO

314.16 (A) (1) STANDARD BOXES.

- The volumes of standard boxes that are not marked with their volume shall be as given in Table 314.16(A).

TABLE 314.16(A) Metal Boxes

Box Trade Size			Minimum Volume		Maximum Number of Conductors* (arranged by AWG size)						
mm	in.		cm³	in.³	18	16	14	12	10	8	6
100 × 32	(4 × 1¼)	round/octagonal	205	12.5	8	7	6	5	5	5	2
100 × 38	(4 × 1½)	round/octagonal	254	15.5	10	8	7	6	6	5	3
100 × 54	(4 × 2⅛)	round/octagonal	353	21.5	14	12	10	9	8	7	4
100 × 32	(4 × 1¼)	square	295	18.0	12	10	9	8	7	6	3
100 × 38	(4 × 1½)	square	344	21.0	14	12	10	9	8	7	4
100 × 54	(4 × 2⅛)	square	497	30.3	20	17	15	13	12	10	6
120 × 32	(4^11⁄16 × 1¼)	square	418	25.5	17	14	12	11	10	8	5
120 × 38	(4^11⁄16 × 1½)	square	484	29.5	19	16	14	13	11	9	5
120 × 54	(4^11⁄16 × 2⅛)	square	689	42.0	28	24	21	18	16	14	8
75 × 50 × 38	(3 × 2 × 1½)	device	123	7.5	5	4	3	3	3	2	1
75 × 50 × 50	(3 × 2 × 2)	device	164	10.0	6	5	5	4	4	3	2
753 50 × 57	(3 × 2 × 2¼)	device	172	10.5	7	6	5	4	4	3	2
75 × 50 × 65	(3 × 2 × 2½)	device	205	12.5	8	7	6	5	5	4	2
75 × 50 × 70	(3 × 2 × 2¾)	device	230	14.0	9	8	7	6	5	4	2
75 × 50 × 90	(3 × 2 × 3½)	device	295	18.0	12	10	9	8	7	6	3
100 × 54 × 38	(4 × 2⅛ × 1½)	device	169	10.3	6	5	5	4	4	3	2
100 × 54 × 48	(4 × 2⅛ × 1⅞)	device	213	13.0	8	7	6	5	5	4	2
100 × 54 × 54	(4 × 2⅛ × 2⅛)	device	238	14.5	9	8	7	6	5	4	2
95 × 50 × 65	(3¾ × 2 × 2½)	masonry box/gang	230	14.0	9	8	7	6	5	4	2
95 × 50 × 90	(3¾ × 2 × 3½)	masonry box/gang	344	21.0	14	12	10	9	8	7	4
min. 44.5 depth	FS — single cover/gang (1¾)		221	13.5	9	7	6	6	5	4	2
min. 60.3 depth	FD — single cover/gang (2⅜)		295	18.0	12	10	9	8	7	6	3
min. 44.5 depth	FS — multiple cover/gang (1¾)		295	18.0	12	10	9	8	7	6	3
min. 60.3 depth	FD — multiple cover/gang (2⅜)		395	24.0	16	13	12	10	9	8	[illegible]

*Where no volume allowances are required by 314.16(B)(2) through (B)(5).

TABLE 314.16(B) Volume Allowance Required per Conductor

Size of Conductor (AWG)	Free Space Within Box for Each Conductor	
	cm^3	$in.^3$
18	24.6	1.50
16	28.7	1.75
14	32.8	2.00
12	36.9	2.25
10	41.0	2.50
8	49.2	3.00
6	81.9	5.00

314.16 (A)(2) OTHER BOXES.

- Boxes 1650 cm3 (100 in.3) or less, other than those described in Table 314.16(A), and nonmetallic boxes shall be durably and legibly marked by the manufacturer with their volume.
- Boxes described in Table 314.16(A) that have a volume larger than is designated in the table shall be permitted to have their volume marked as required by this section.

314.16 (B) BOX FILL CALCULATIONS.

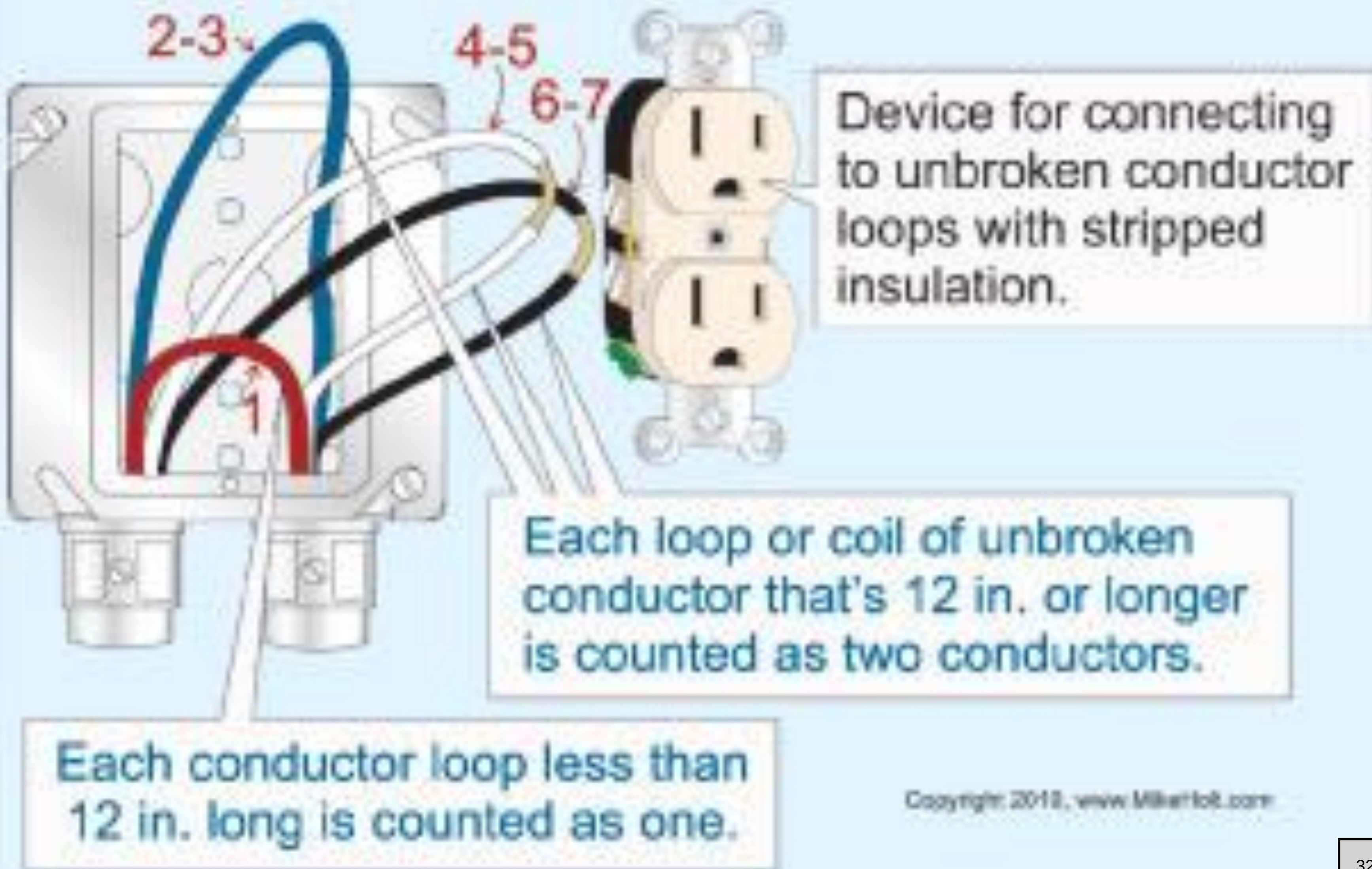
- The volumes in paragraphs 314.16(B)(1) through (B)(5), as applicable, shall be added together.
- No allowance shall be required for small fittings such as locknuts and bushings.

314.16 (B) (1) CONDUCTOR FILL.

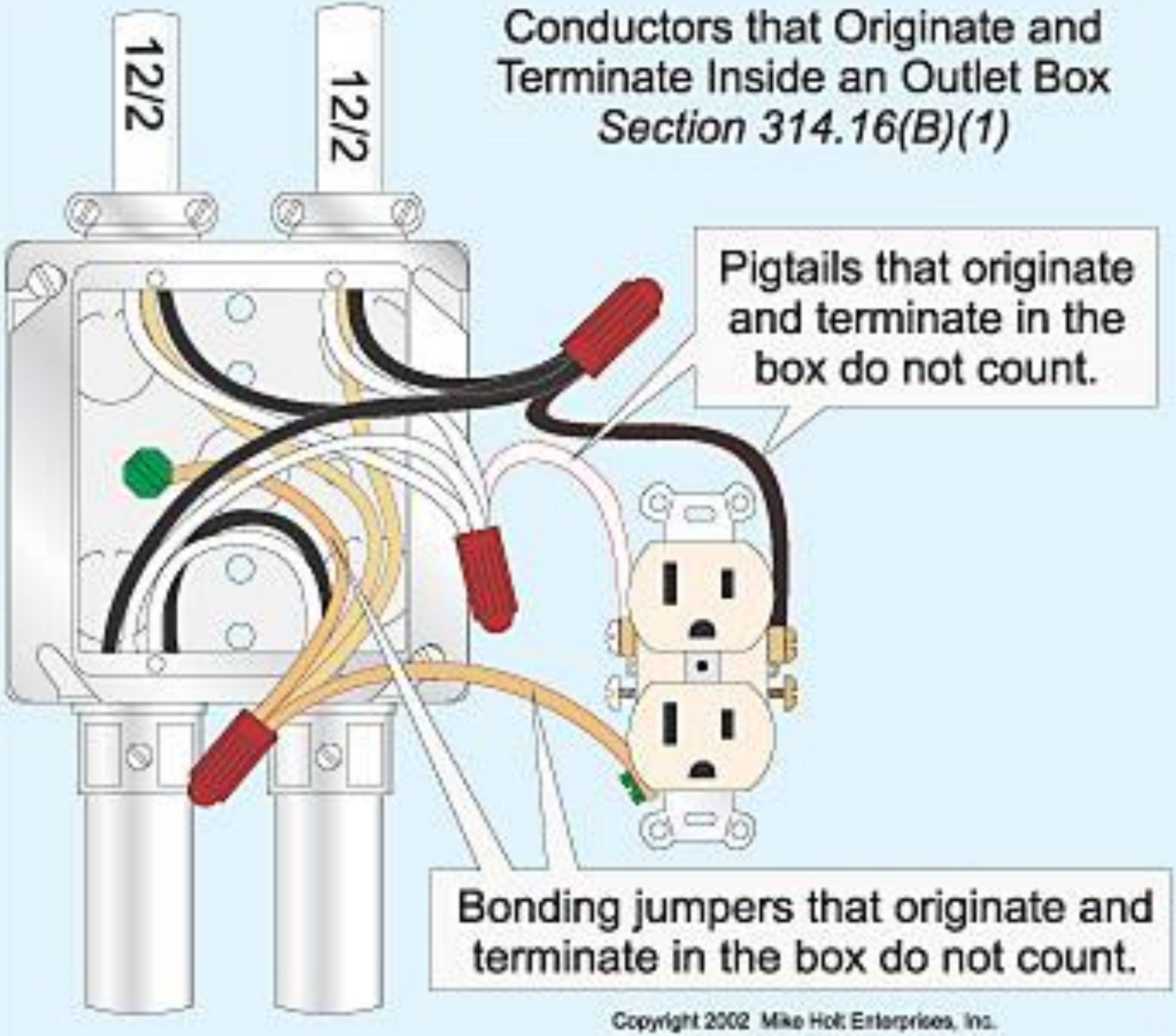
- Each conductor that originates outside the box and terminates or is spliced within the box shall be counted once, and each conductor that passes through the box without splice or termination shall be counted once.
- Each loop or coil of unbroken conductor not less than twice the minimum length required for free conductors in 300.14 shall be counted twice.
- The conductor fill shall be calculated using Table 314.16(B). A conductor, no part of which leaves the box, shall not be counted.

Box Fill Calculations - Conductor Volume

314.16(B)(1)



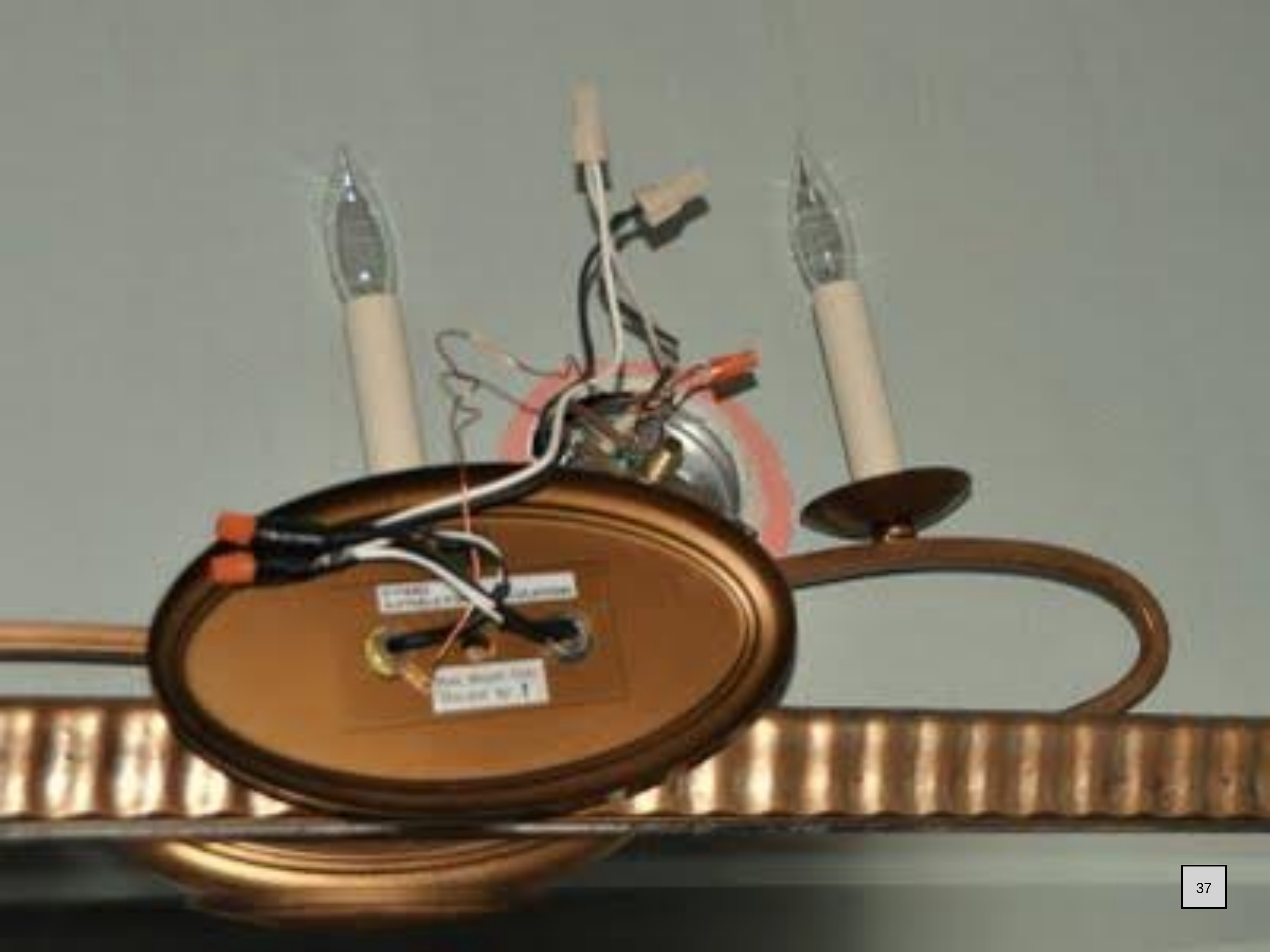
Conductors that Originate and Terminate Inside an Outlet Box
Section 314.16(B)(1)




OWER SUPPLY
DANGER
DANGE

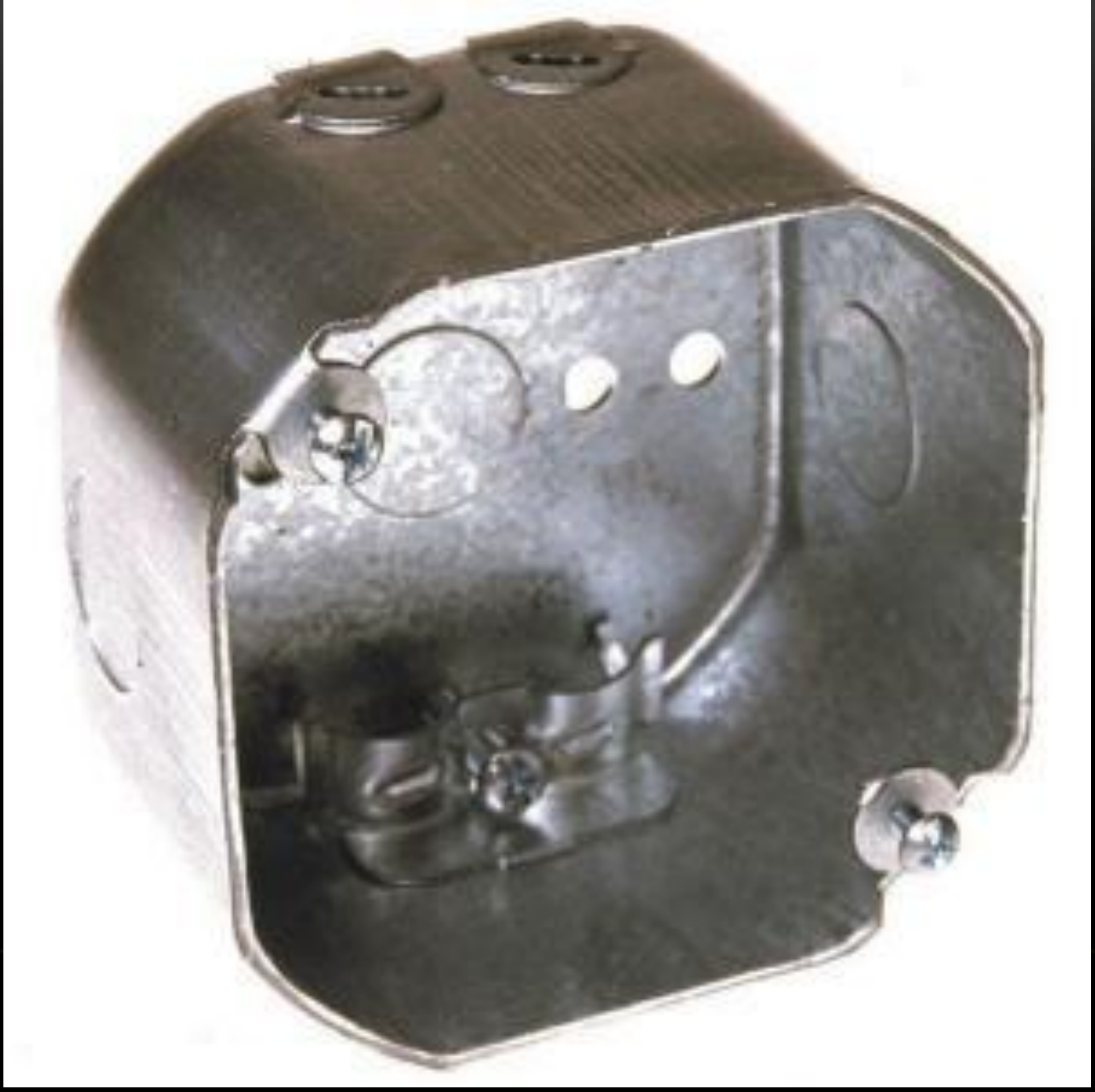
CONDUCTOR FILL EXCEPTION

- *Exception: An equipment grounding conductor or conductors or not over four fixture wires smaller than 14 AWG, or both, shall be permitted to be omitted from the calculations where they enter a box from a domed luminaire or similar canopy and terminate within that box.*



314.16 (B) (2) CLAMP FILL.

- Where one or more internal cable clamps, whether factory or field supplied, are present in the box, a single volume allowance in accordance with Table 314.16(B) shall be made based on the largest conductor present in the box.
- No allowance shall be required for a cable connector with its clamping mechanism outside the box.

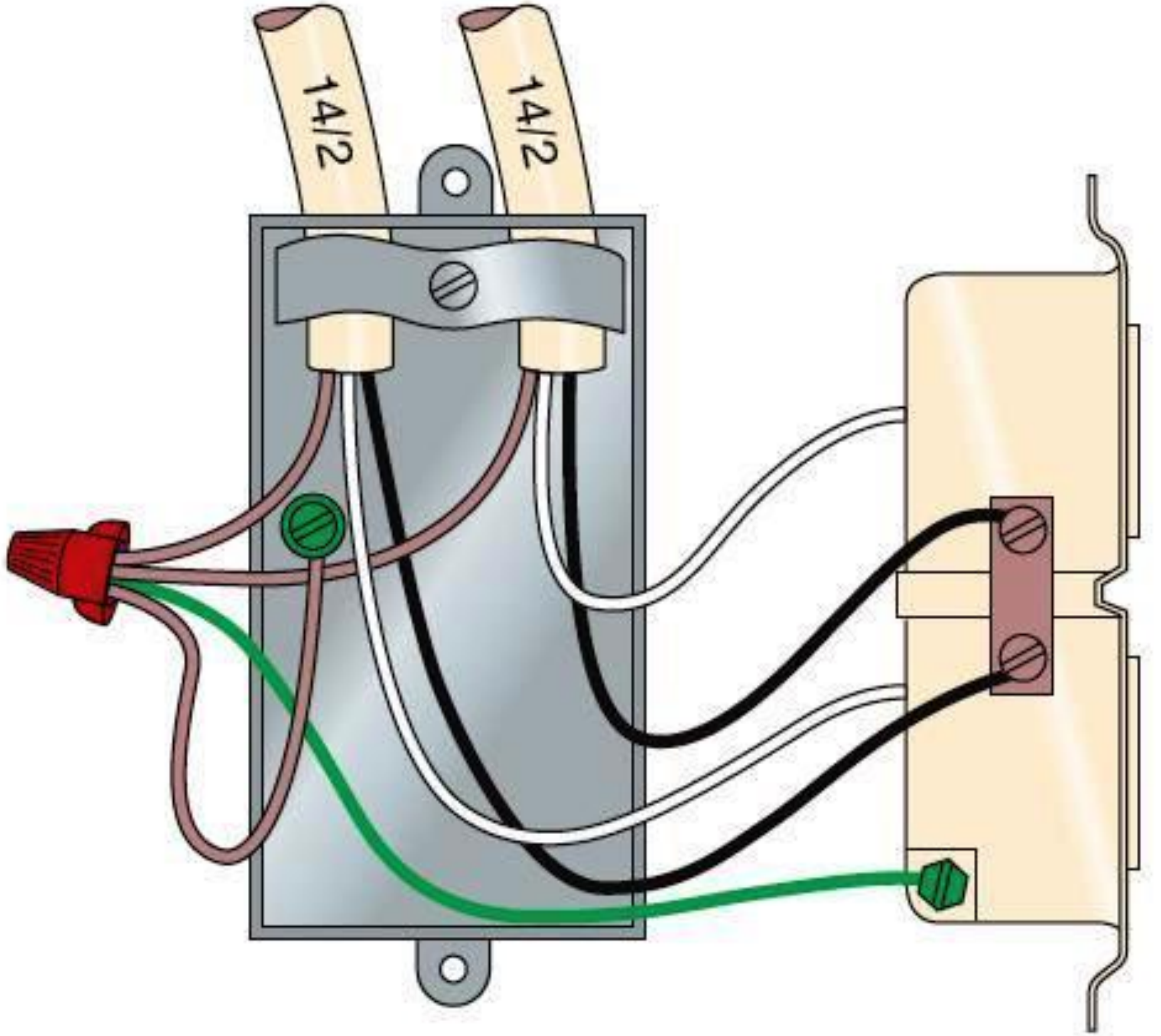


314.16 (B) (3) SUPPORT FITTINGS FILL.

- Where one or more luminaire studs or hickeys are present in the box, a single volume allowance in accordance with Table 314.16(B) shall be made for each type of fitting based on the largest conductor present in the box.

314.16 (B) (4) DEVICE OR EQUIPMENT FILL.

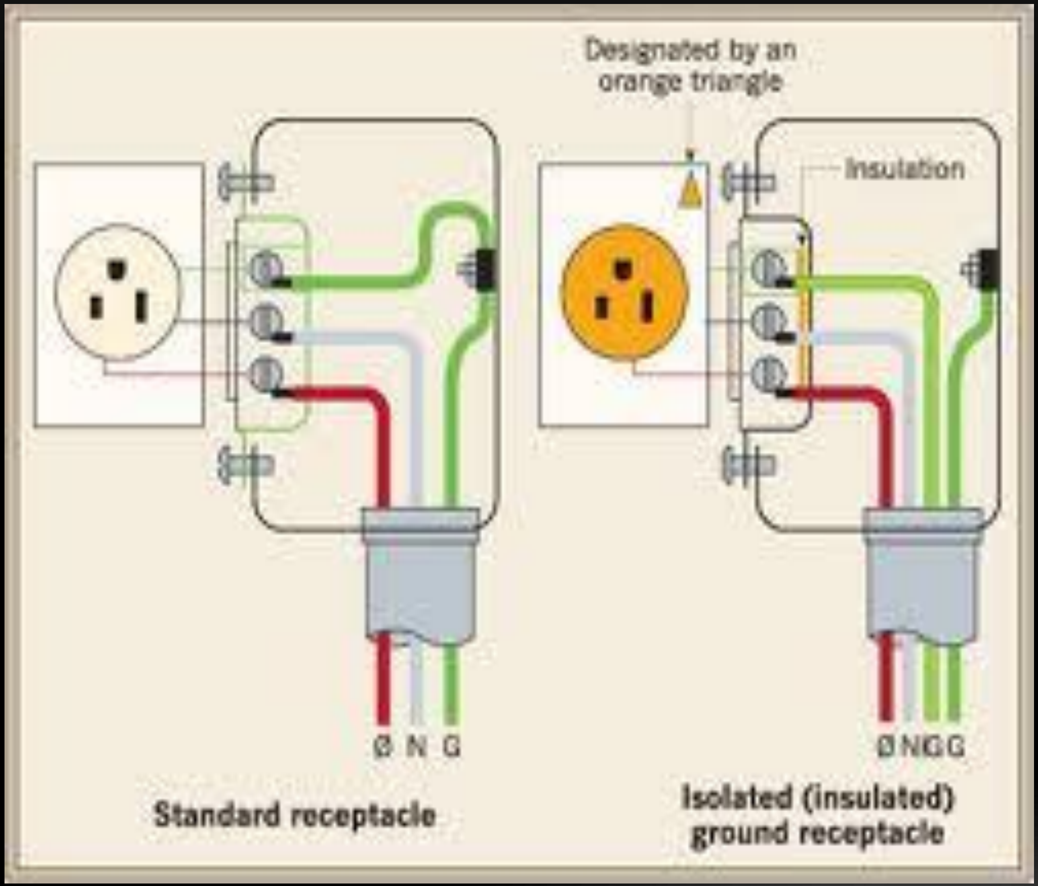
- For each yoke or strap containing one or more devices or equipment, a double volume allowance in accordance with Table 314.16(B) shall be made for each yoke or strap based on the largest conductor connected to a device(s) or equipment supported by that yoke or strap.
- A device or utilization equipment wider than a single 50 mm (2 in.) device box as described in Table 314.16(A) shall have double volume allowances provided for each gang required for mounting.



Standard 3 in. × 2 in. × 3½ in. device box (18 in.^{3})

314.16 (B) (5) EQUIPMENT GROUNDING CONDUCTOR FILL

- Where one or more equipment grounding conductors or equipment bonding jumpers enter a box, a single volume allowance in accordance with Table 314.16(B) shall be made based on the largest equipment grounding conductor or equipment bonding jumper present in the box.
- Where an additional set of equipment grounding conductors, as permitted by 250.146(D), is present in the box, an additional volume allowance shall be made based on the largest equipment grounding conductor in the additional set.

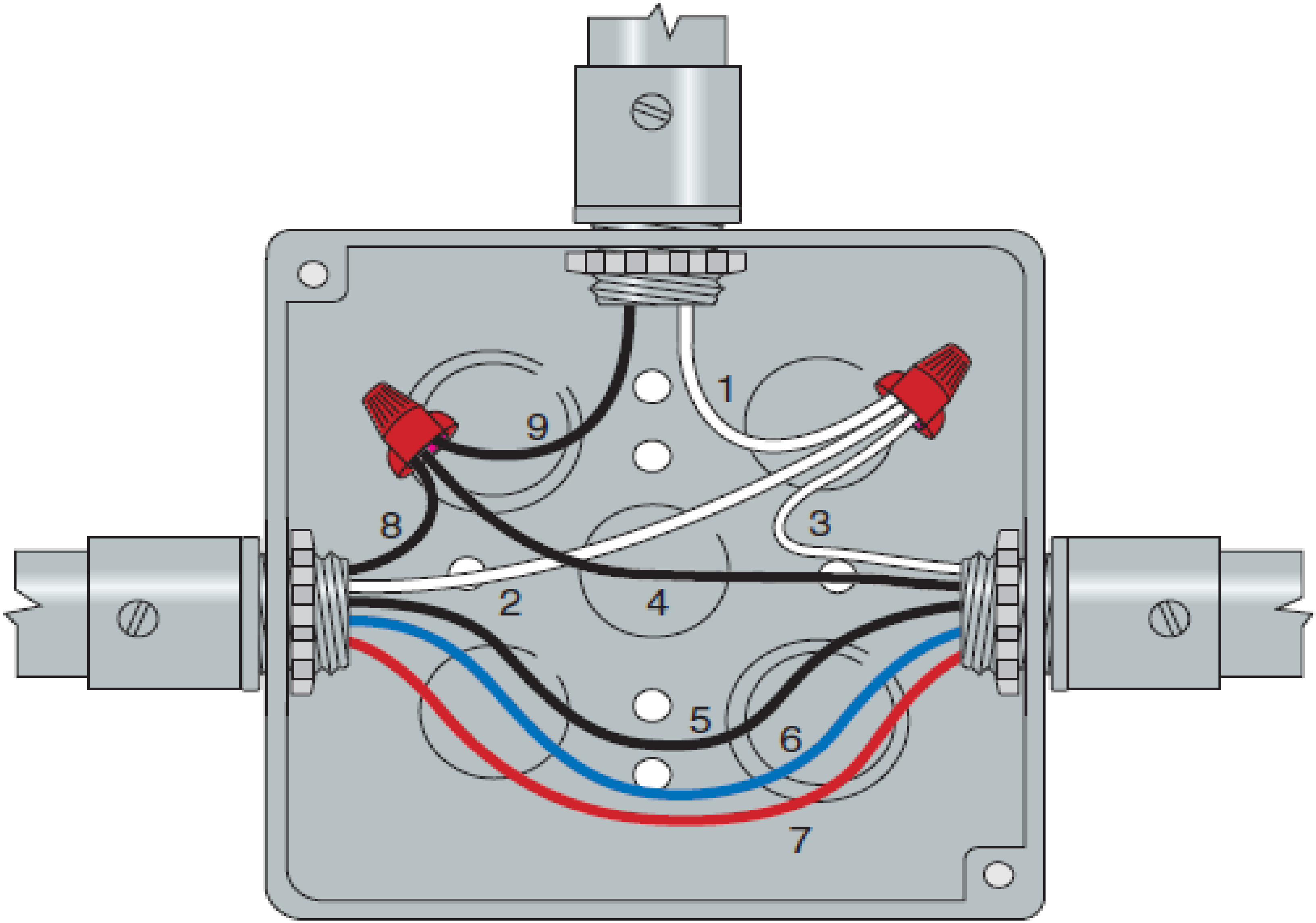


Designated by an
orange triangle
Insulation
Ø N G
Ø N G G
Standard receptacle
Isolated (insulated)
ground receptacle

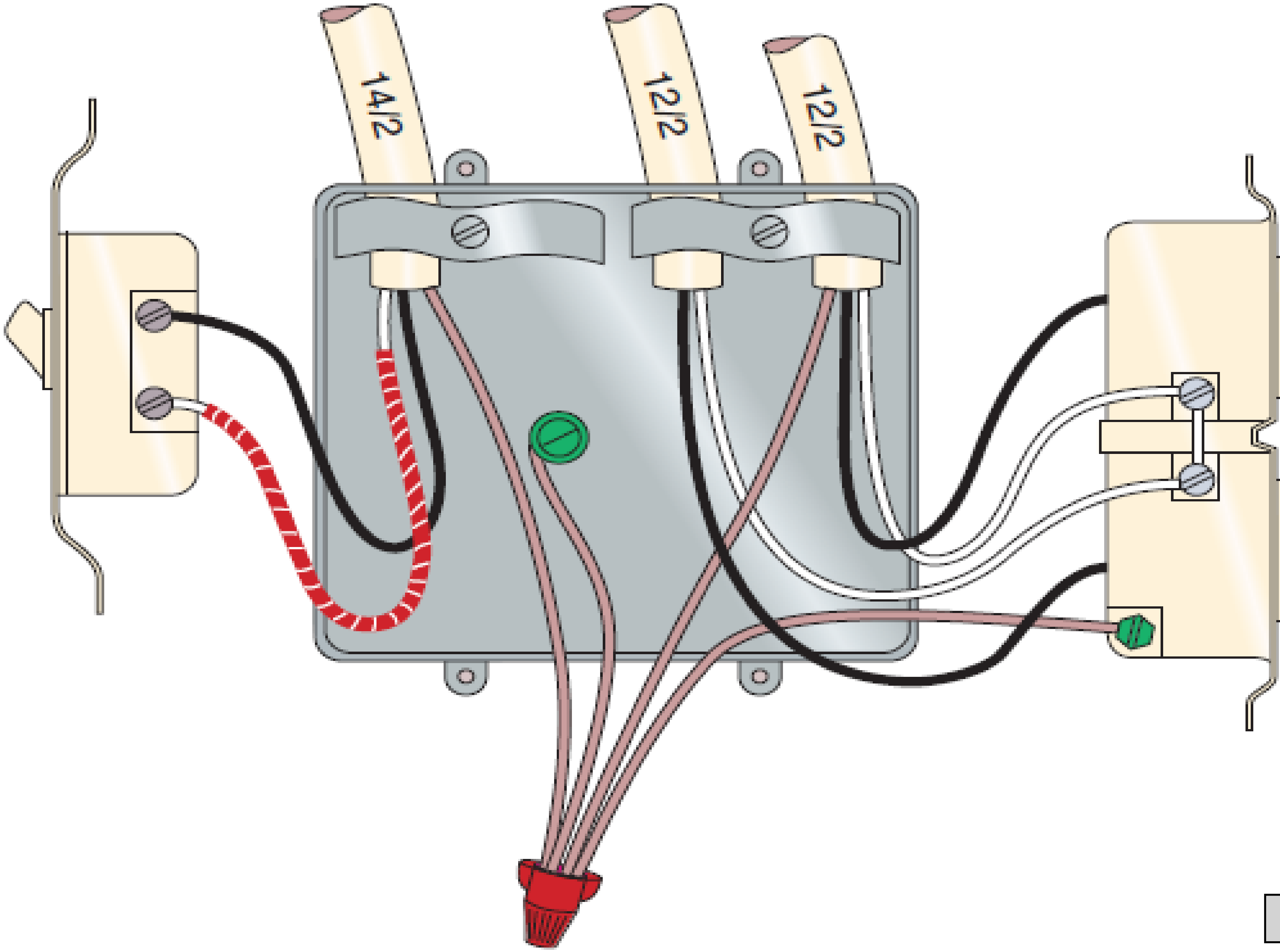
COMMENTARY TABLE 314.1 Summary of Items Contributing to Box Fill

Items Contained Within Box	Volume Allowance	Based on [see Table 314.16(B)]
Conductors that originate outside box	One for each conductor	Actual conductor size
Conductors that pass through box without splice or connection (less than 12 in. in total length)	One for each conductor	Actual conductor size
Conductors 12 in. or greater that are looped (or coiled) and unbroken (see 300.14 for exact measurement)	Two for a single (entire) unbroken conductor	Actual conductor size
Conductors that originate within box and do not leave box	None (these conductors not counted)	n.a.
Fixture wires [per 314.16(B)(1), Exception]	None (these conductors not counted)	n.a.
Internal cable clamps (one or more)	One only	Largest-sized conductor present
Support fittings (such as luminaire studs or hickeys)	One for each type of support fitting	Largest-sized conductor present
Devices (such as receptacles, switches) or utilization equipment (such as timers, dimmers, AFCI receptacles, GFCI receptacles, TVSS receptacles)	Two for each yoke or mounting strap	Largest-sized conductor connected to device or utilization equipment
Equipment grounding conductor (one or more)	One only	Largest equipment grounding conductor present
Isolated equipment grounding conductor (one or more) [see 250.146(D)]	One only	Largest isolated and insulated equipment grounding conductor present

n.a.= not applicable.

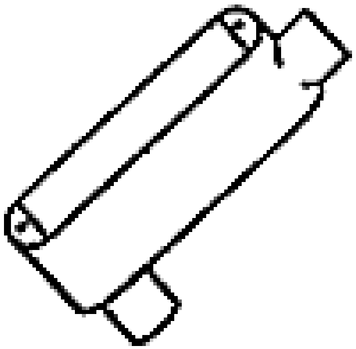


Standard 4 in. × 1½ in. square box (21.0 in.^{3})


14/2
12/2
12/2

314.16 (C) CONDUIT BODIES.

- **(1) General.** Conduit bodies enclosing 6 AWG conductors or smaller, other than short-radius conduit bodies as described in 314.16(C)(3), shall have a cross-sectional area not less than twice the cross-sectional area of the largest conduit or tubing to which they can be attached.
- The maximum number of conductors permitted shall be the maximum number permitted by Table 1 of Chapter 9 for the conduit or tubing to which it is attached.



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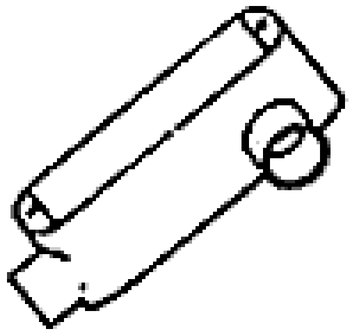

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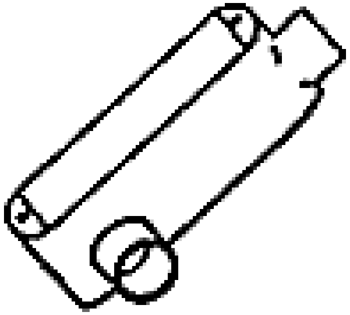

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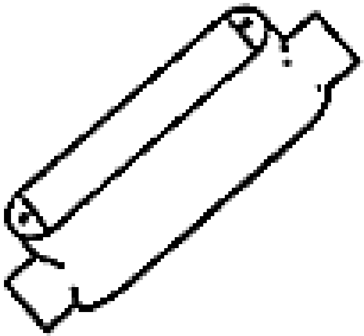

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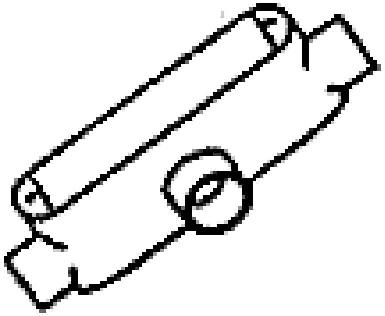


T

SLB

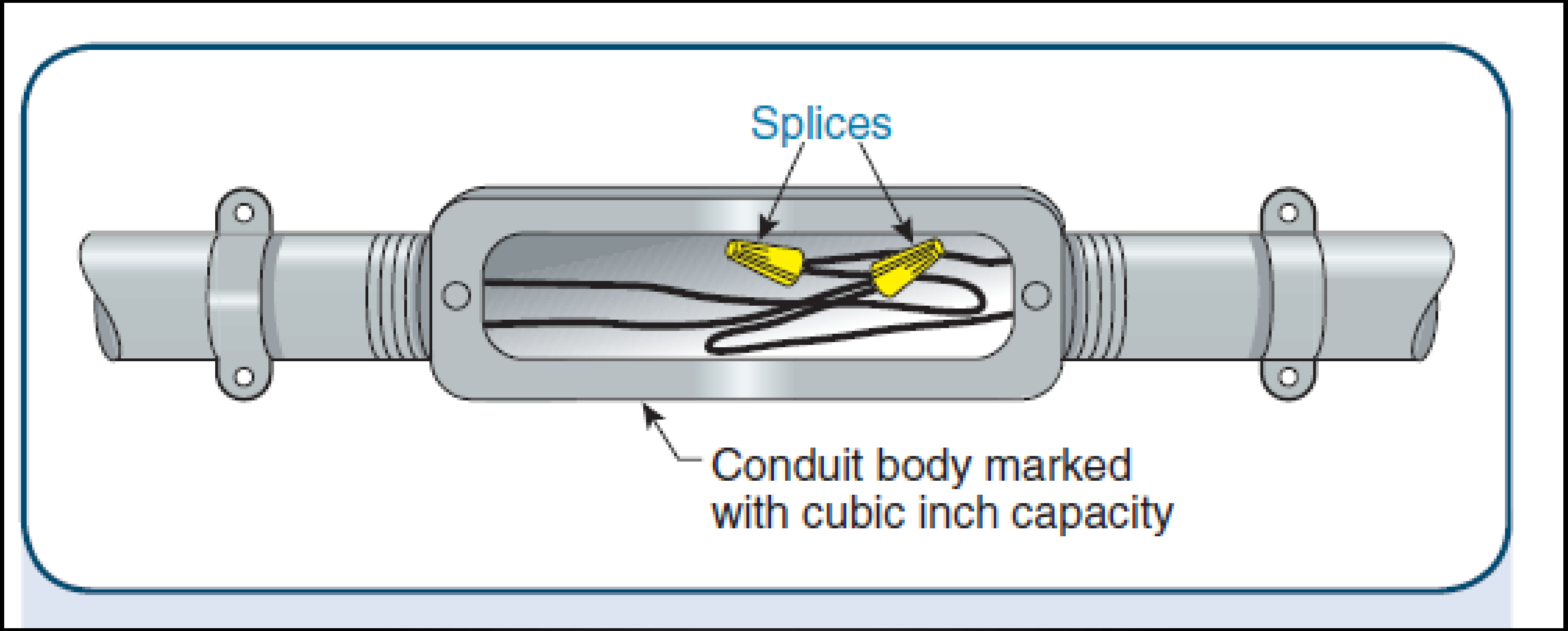
314.16 (C) (2) WITH SPLICES, TAPS, OR DEVICES.

- Only those conduit bodies that are durably and legibly marked by the manufacturer with their volume shall be permitted to contain splices, taps, or devices.
- The maximum number of conductors shall be calculated in accordance with 314.16(B).
- Conduit bodies shall be supported in a rigid and secure manner.

314.16 (C) (3) SHORT RADIUS CONDUIT BODIES.

- Conduit bodies such as capped elbows and service-entrance elbows that enclose conductors 6 AWG or smaller, and are only intended to enable the installation of the raceway and the contained conductors, shall not contain splices, taps, or devices and shall be of sufficient size to provide free space for all conductors enclosed in the conduit body.

CONDUIT BODY



314.28 PULL AND JUNCTION BOXES AND CONDUIT BODIES

- Boxes and conduit bodies used as pull or junction boxes shall comply with 314.28(A) through (E).
- *Exception: Terminal housings supplied with motors shall comply with the provisions of 430.12.*

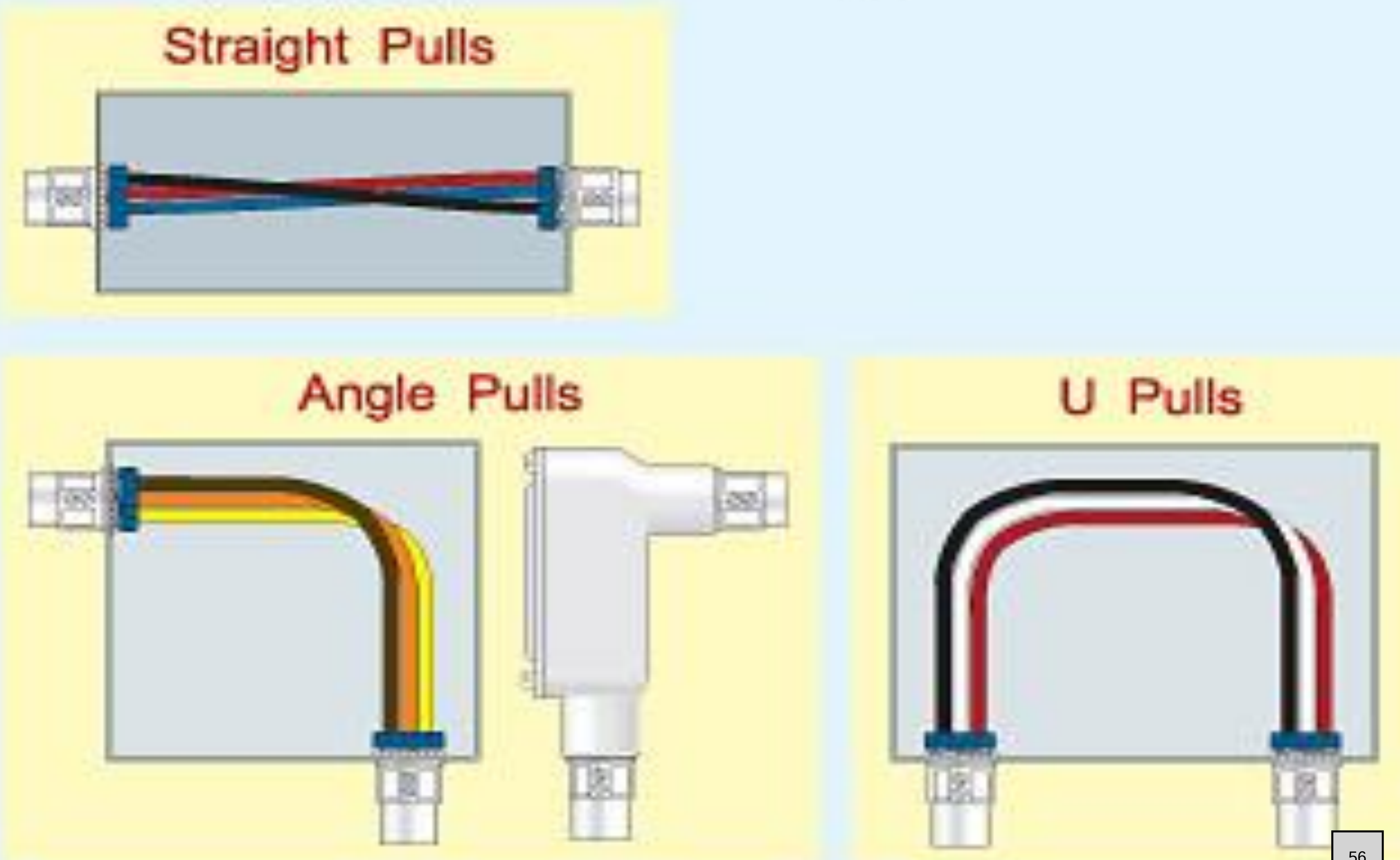
314.28 (A)

- A) Minimum Size. For raceways containing conductors of 4 AWG or larger that are required to be insulated, and for cables containing conductors of 4 AWG or larger, the minimum dimensions of pull or junction boxes installed in a raceway or cable run shall comply with (A)(1) through (A)(3).
- Where an enclosure dimension is to be calculated based on the diameter of entering raceways, the diameter shall be the metric designator (trade size) expressed in the units of measurement employed.

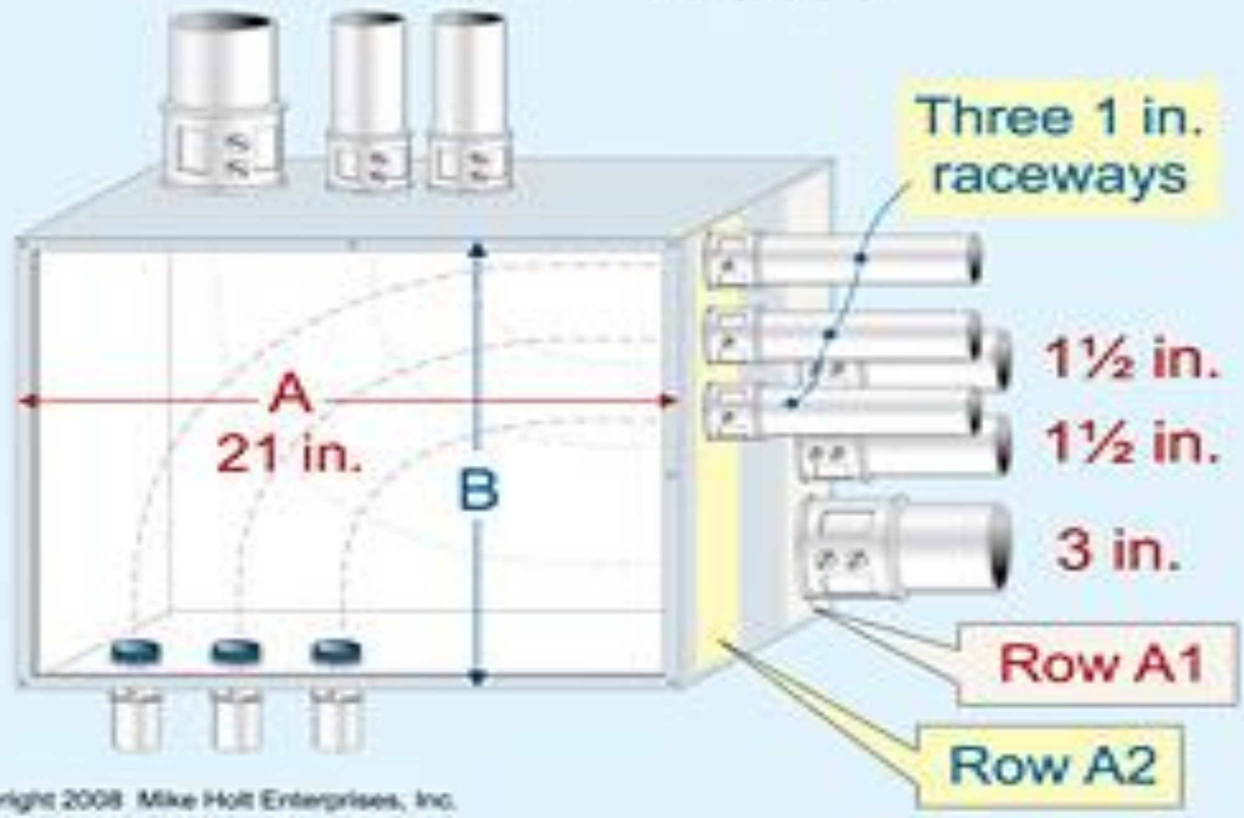
314.28 (A) (1) & (2)

- **(1) Straight Pulls.** In straight pulls, the length of the box or conduit body shall not be less than eight times the metric designator (trade size) of the largest raceway.
- **(2) Angle or U Pulls, or Splices.** Where splices or where angle or U pulls are made, the distance between each raceway entry inside the box or conduit body and the opposite wall of the box or conduit body shall not be less than six times the metric designator (trade size) of the largest raceway in a row.
- This distance shall be increased for additional entries by the amount of the sum of the diameters of all other raceway entries in the same row on the same wall of the box.
- Each row shall be calculated individually, and the single row that provides the maximum distance shall be used.

Pull and Junction Boxes - 4 AWG and Larger
Section 314.28(A)

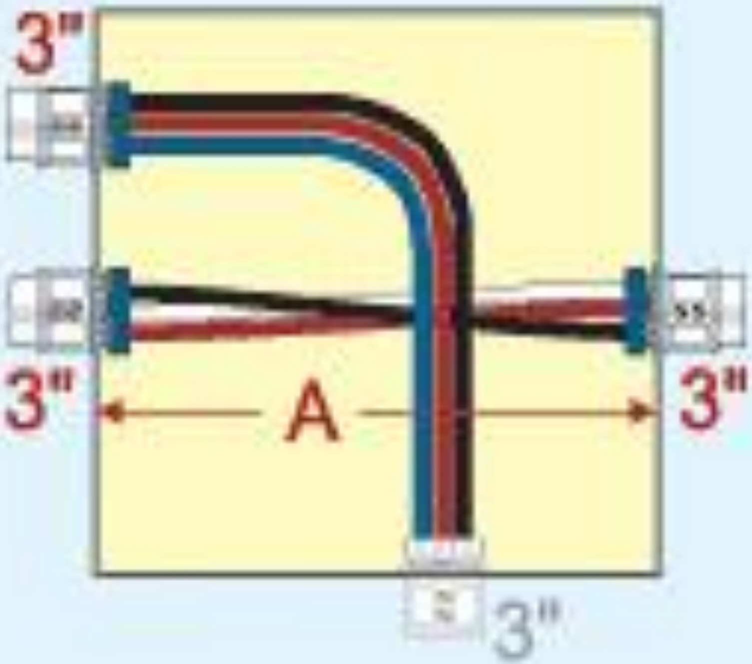


Sizing Junction/Pull Boxes for Angle Conductor Pulls
Determining Largest Row
Section 314.28(A)(2)



Row A1 = (6 x 3 in.) + 1½ + 1½ = 21 in.
Row A2 = (6 x 1 in.) + 1 in. + 1 in. = 8 in. (omit)
Dimension A = 21 in.

Pull (Junction) Box Sizing
4 AWG and Larger
Section 314.28(A)



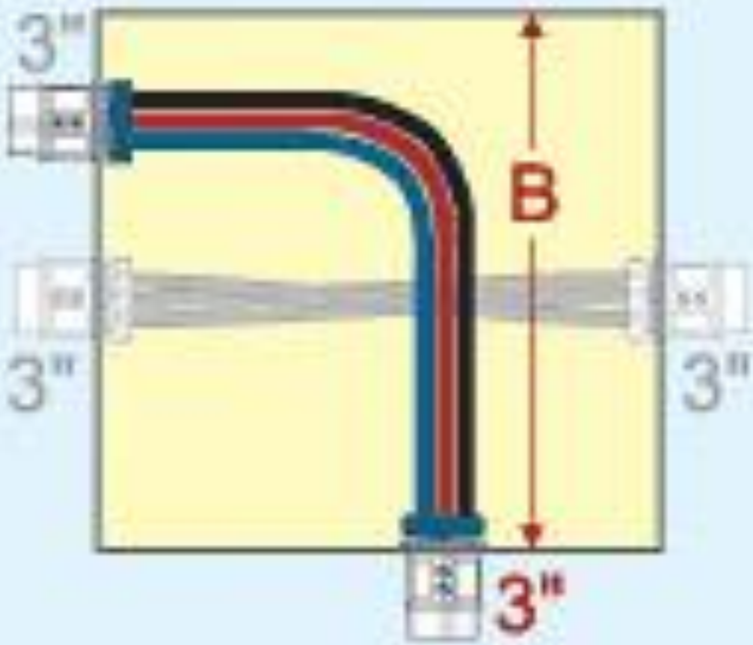
Horizontal Dimension A

Straight Pull:
Left to Right: 8 x 3 in. = 24 in.
Right to Left: 8 x 3 in. = 24 in.

Angle Pull:
Left to Right: (6 x 3 in.) + 3 in. = 21 in.
Right to Left: No Calculation

Largest Calculation = 24 in.

Pull (Junction) Box Sizing
4 AWG and Larger
Section 314.28(A)



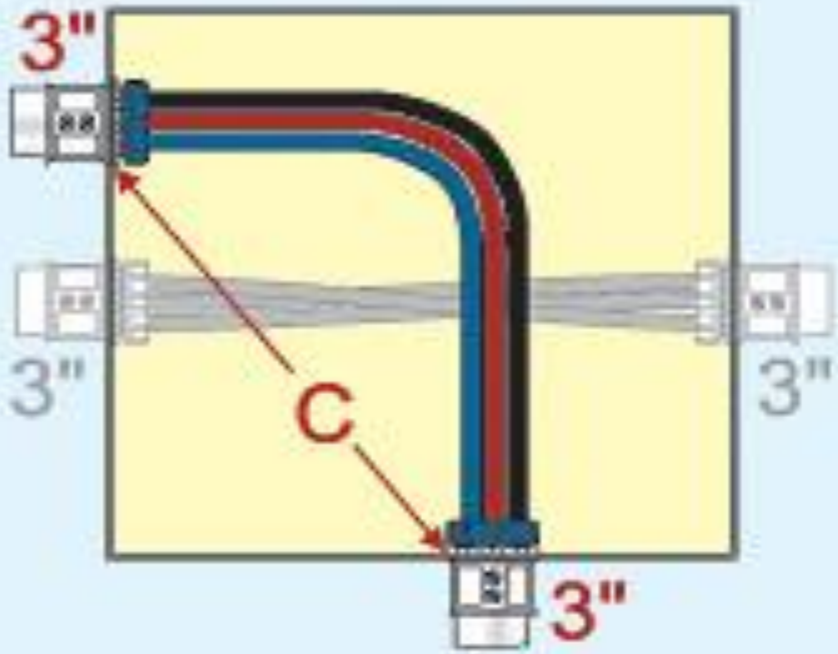
Vertical Dimension B

Straight Pull:
Top to Bottom: No Calculation
Bottom to Top: No Calculation

Angle Pull:
Top to Bottom: (No Calculation)
Bottom to Top: 6 x 3 in. = 18 in.

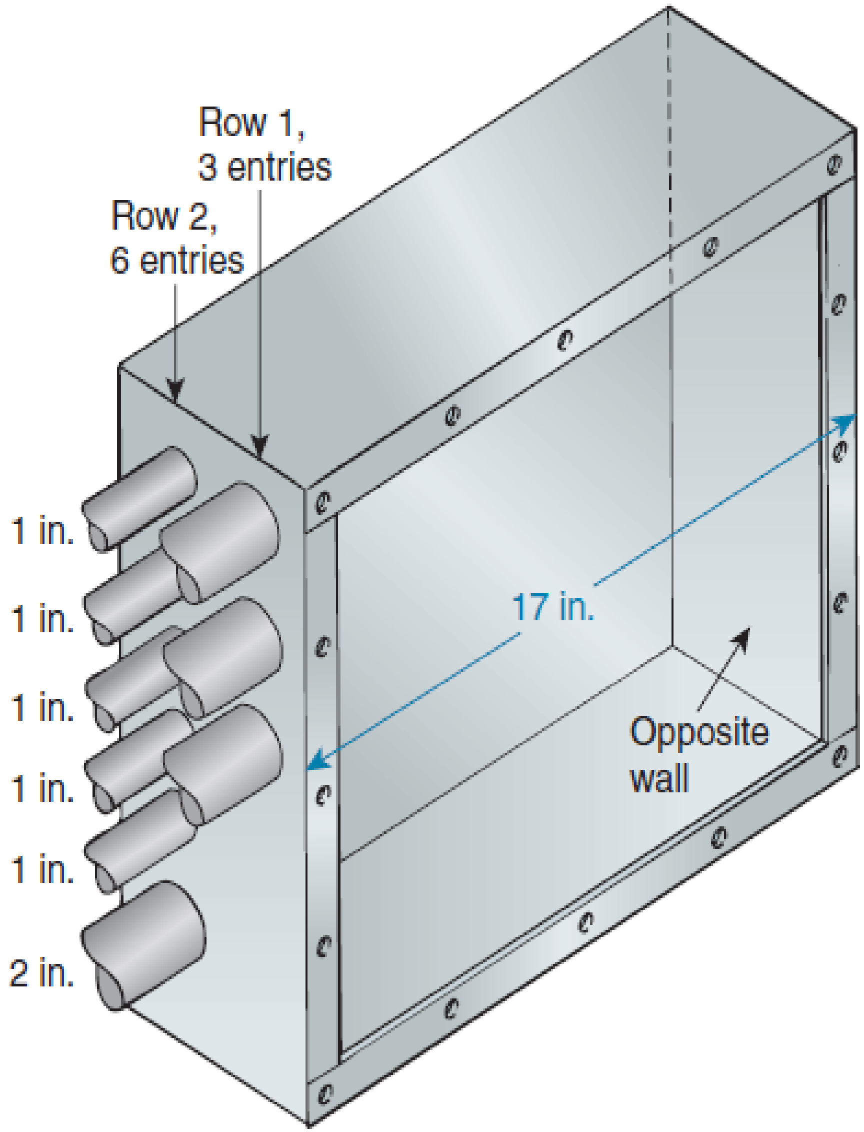
Largest Calculation = 18 in.

Pull (Junction) Box Sizing
4 AWG and Larger
Section 314.28(A)(2)

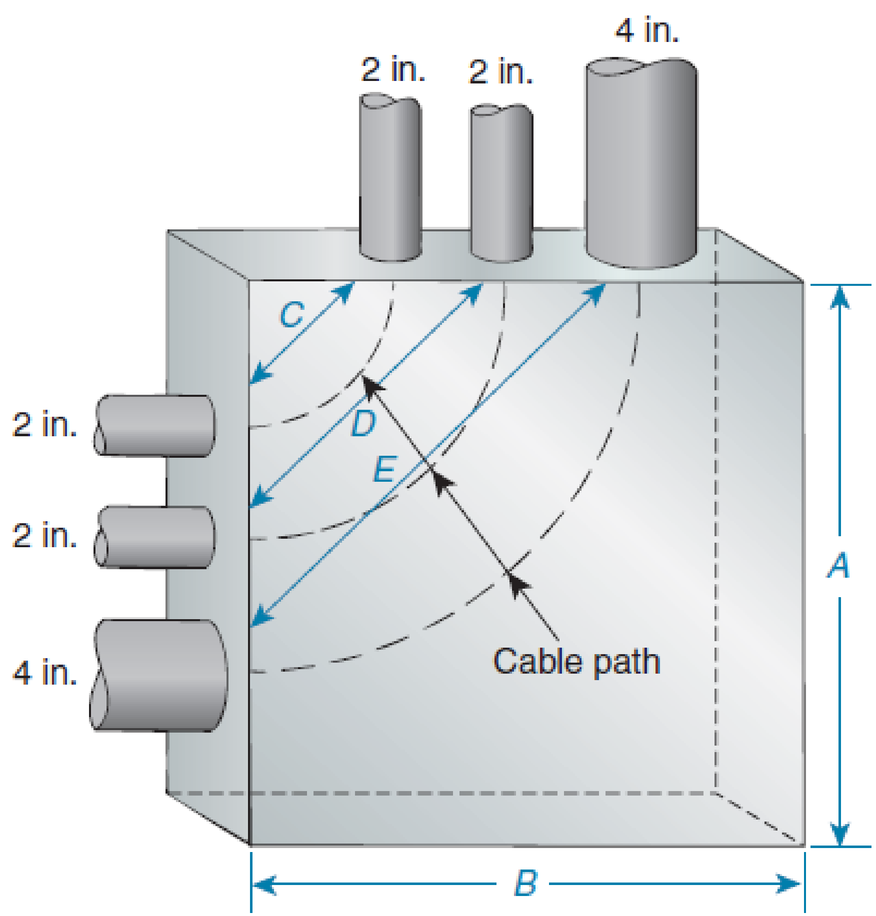


Distance Between Raceways - "C"

(Containing the same conductor)
Angle Pull is the only application
6 x 3 in. = 18 in.



6 × 2 in. (trade diameter of largest raceway) = 12 in.
12 in. + 5 in. (sum of diameters of other entries, row 2 only)
= 17 in. (min. required from each entry to opposite wall)



$A = (6 \times 4 \text{ in.}) + 2 \text{ in.} + 2 \text{ in.} = 28 \text{ in. min.}$

$B = (6 \times 4 \text{ in.}) + 2 \text{ in.} + 2 \text{ in.} = 28 \text{ in. min.}$

$C = 6 \times 2$ in. = 12 in. min. required between raceways enclosing the same conductor

$D = 6 \times 2$ in. = 12 in. min. required between raceways enclosing the same conductor

$E = 6 \times 4$ in. = 24 in. min. required between raceways enclosing the same conductor

314.28 (A)(2) EXCEPTION

- *Exception: Where a raceway or cable entry is in the wall of a box or conduit body opposite a removable cover, the distance from that wall to the cover shall be permitted to comply with the distance required for one wire per terminal in Table 312.6(A).*
- TABLE 312.6(A) Minimum Wire-Bending Space at Terminals and Minimum Width of Wiring Gutters

314.28 (A)(2)

- The distance between raceway entries enclosing the same conductor shall not be less than six times the metric designator (trade size) of the larger raceway.
- When transposing cable size into raceway size in 314.28(A)(1) and (A)(2), the minimum metric designator (trade size) raceway required for the number and size of conductors in the cable shall be used.

314.28 (A) (3) SMALLER DIMENSIONS.

- Boxes or conduit bodies of dimensions less than those required in 314.28(A)(1) and (A)(2) shall be permitted for installations of combinations of conductors that are less than the maximum conduit or tubing fill (of conduits or tubing being used) permitted by Table 1 of Chapter 9, provided the box or conduit body has been listed for, and is permanently marked with, the maximum number and maximum size of conductors permitted.

314.28 (B), (C) & (D)

- **(B) Conductors in Pull or Junction Boxes.** In pull boxes or junction boxes having any dimension over 1.8 m (6 ft), all conductors shall be cabled or racked up in an approved manner.
- **(C) Covers.** All pull boxes, junction boxes, and conduit bodies shall be provided with covers compatible with the box or conduit body construction and suitable for the conditions of use. Where used, metal covers shall comply with the grounding requirements of 250.110.
- **(D) Permanent Barriers.** Where permanent barriers are installed in a box, each section shall be considered as a separate box.

314.28 (E)

- **(E) Power Distribution Blocks.** Power distribution blocks shall be permitted in pull and junction boxes over 1650 cm3 (100 in.3) for connections of conductors where installed in boxes and where the installation complies with (1) through (5).
- *Exception: Equipment grounding terminal bars shall be permitted in smaller enclosures.*
- **(1) Installation**. Power distribution blocks installed in boxes shall be listed.

POWER DISTRIBUTION BLOCKS

314.28 (E) 2 & 3

- **(2) Size.** In addition to the overall size requirement in the first sentence of 314.28(A)(2), the power distribution block shall be installed in a box with dimensions not smaller than specified in the installation instructions of the power distribution block.
- **(3) Wire Bending Space.** Wire bending space at the terminals of power distribution blocks shall comply with 312.6.

314.28 (E) 4 & 5

- **(4) Live Parts.** Power distribution blocks shall not have uninsulated live parts exposed within a box, whether or not the box cover is installed.
- **(5) Through Conductors.** Where the pull or junction boxes are used for conductors that do not terminate on the power distribution block(s), the through conductors shall be arranged so the power distribution block terminals are unobstructed following installation.

CALCULATIONS

- A metal device box with internal cable clamp contains a 3-way switch and one 14/3 with ground romex.
- How many conductors will this installation have?
- Wires – 3 (one for each conductor)
- Clamps – 1
- Ground – 1
- Device – 2 (double volume)
- Total – 7 wires
- 7 @ 2.0 cu. In. = 14 cubic Inches box minimum

CALCULATIONS

- A 18 cubic inch plastic device box has (3) 12/2 with ground nm cables with a GFI receptacle.
- Permitted or not permitted?
- Wires – 6
- Grounds – 1
- Devices – 2
- Total = 9
- @ 2.25 cubic inches = 20.25 cu in. min.
- Not Permitted! 22 cu. or 4" square w/ring

CALCULATIONS

- What is the minimum size metal box needed for (2) 12/2 w/ground and (2) 14/2 w/ground nm-cables with internal clamps?
- The receptacle is connected to a 20 amp circuit, while a switch is connected to a 15 amp circuit

CALCULATIONS CONTINUED

- (4) # 12 AWG wires @ 2.25 Cu. inches
- (4) # 14 AWG wires @ 2.0 Cu. inches
- Grounds @ 2.25 Cu. inches
- Internal clamp @ 2.25 Cu. Inches
- Receptacle @ 2 x 2.25 (double volume)
- Switch @ 2 x 2.0
- 9 + 8 + 2.25 + 2.25 + 4.5 + 4 = 30 cubic in.
- What size box? See Table 314.16 (A)
- 4” sq. box by 2-1/8” deep = 30.3 cubic in.

QUESTION 1

- A 10” x 10” x 4” deep box would only require 6” of free conductor measured from the point in the box where the conductors enter the enclosure. The 3” outside the box rule does or does not apply?
- Does Not! - 300.14 States boxes larger than 8” in any dimension does not require the 3” requirement.

QUESTION 2

- FS, FD, and larger cast or sheet metal boxes are or are not classified as conduit bodies?

- Are not! – 314.1

QUESTION 3

- Each yoke or strap containing one or more devices or equipment in a device box counts as ______ conductor (s)?
- A) one
- B) two
- C) three
- D) four

- B) two – 314.16 (B)(4)

QUESTION 4

- A 6 AWG copper conductor requires _____ cubic inches of free space within a box?
- A) 3”
- B) 4”
- C) 5”
- D) 6”

- 5” - Table 314.16 (B)

QUESTION 5

- All of the following shall be counted when calculating box conductor fill, except for _____?
- A) conductors that pass through the box without splice or termination.
- B) fixtures, hickeys, and clamps.
- C) looped or unbroken conductors
- D) four fixture wires smaller than 14 AWG

- D) - 314.16 (B) (1) exception

QUESTION 6

- A raised plaster ring is permitted to increase the maximum number of conductors permitted in an outlet box when it is_____?
- A) listed as a box extension
- B) by the same manufacturer as the box
- C) marked with its cubic inches
- D) metallic and capable of being grounded

- C) marked with its cubic inches 314.16 (A)

CONDUIT FILL

- 300.17 – The number and size of conductors in any raceway shall not be more than will permit dissipation of the heat and ready installation or withdrawal of the conductors without damage to the conductors or to their insulation.

ANNEX C

- Conduit and Tubing Fill for Conductors and Fixture Wires of the same size.
- Tables C.1 through C.12
- This table not part of the requirements of the NEC but is included for informational purposes only.

CHAPTER 9 – TABLE 1

- Percent of Cross Section of Conduit and Tubing for Conductors

- One Conductor = 53%
- Two Conductors = 31%
- Over 2 Conductors = 40%
- Based on common conditions of proper cabling, alignment of conductors, length of pull and number of bends.

INFORMATIONAL NOTE NO. 2

- When pulling three conductors or cables into a raceway, if the ratio of the raceway (inside diameter) to the conductor or cable (outside diameter) is between 2.8 and 3.2 jamming can occur.
- The probability of four or more conductors or cables jamming in a raceway is very low.

NOTES TO TABLES

- 1.) See Annex C for the maximum number of conductors and fixture wires, all of the same size permitted in raceways or tubing of a specific size.
- 2.) Table one only applies to complete conduit or tubing systems and does not apply to sections of raceways or tubing used for physical protection.
- 3.) Equipment grounding or bonding conductors must be included when calculating conduit or tubing fill.

NOTES TO TABLES

- 4.) Where conduit or tubing nipples are 24” or less and installed between boxes, cabinets and similar enclosures the wire fill is permitted to be increased to 60% and adjustment factors do not apply to this condition.
- 5.) Conductors not included in Chapter 9, the actual dimension shall be used.

NOTES TO TABLES

- 6.) For combinations of conductors of different sizes, use Table 5 & 5A for conductor dimensions and Table 4 for conduit or tubing dimensions.
- 7.) When calculating the maximum number of conductors in a conduit or tubing, all of the same size (CSA including insulation) the next higher whole number may be used to determine the maximum conductors permitted when the calculation results in a decimal of 0.8 or larger.

NOTES TO TABLES

- 8.) Where the bare conductors are permitted by other sections of this code. The dimension for bare conductors in Table 8 shall be permitted.
- 9.) A multiconductor cable of two or more conductors shall be treated as a single conductor for calculating percentage conduit fill area. For cables having elliptical cross sections, the cross-sectional area shall be based on the major diameter of the ellipse as the circle diameter.

EXAMPLES

- How many 10 AWG THHN copper conductors can fit into an 1-1/4" EMT conduit? See Table C.1 - 28 # 10 AWG
- RMC? Table C.8 - 29 # 10 AWG
- PVC Conduit SCH-80 T. C.9 - 23 # 10 AWG

MIXED WIRE SIZE EXAMPLE

- What is the minimum size EMT conduit needed for (3) 6 AWG, (4) 10 AWG & (3) 12 AWG THHN copper conductors? (See Table 5)
- 6 AWG is 0.0507 x 3 = .15 in sq area
- 10 AWG is 0.0211 x 4 = .08 in sq area
- 12 AWG is 0.0133 x 3 = .0399 in sq area
- Total of all conductors is 0.2699 in sq area
- (See Table 4) EMT – 1" is 0.346 @ 40%

TABLE 5 *continued*

Type	Size (AWG or kcmil)	Approximate Diameter mm	Approximate Diameter in.	Approximate Area mm²	Approximate Area in.²
Type: RHH*, RHW*, RHW-2*, THHN, THHW, THW, THW-2, TFN, TFFN, THWN, THWN-2, XF, XFF					
RHH,* RHW,* RHW-2,* XF, XFF	10	5.232	0.206	21.48	0.0333
RHH*, RHW*, RHW-2*	8	6.756	0.266	35.87	0.0556
TW, THW, THHW, THW-2, RHH*, RHW*, RHW-2*	6	7.722	0.304	46.84	0.0726
	4	8.941	0.352	62.77	0.0973
	3	9.652	0.380	73.16	0.1134
	2	10.46	0.412	86.00	0.1333
	1	12.50	0.492	122.6	0.1901
	1/0	13.51	0.532	143.4	0.2223
	2/0	14.68	0.578	169.3	0.2624
	3/0	16.00	0.630	201.1	0.3117
	4/0	17.48	0.688	239.9	0.3718
	250	19.43	0.765	296.5	0.4596
	300	20.83	0.820	340.7	0.5281
	350	22.12	0.871	384.4	0.5958
	400	23.32	0.918	427.0	0.6619
	500	25.48	1.003	509.7	0.7901
	600	28.27	1.113	627.7	0.9729
	700	30.07	1.184	710.3	1.1010
	750	30.94	1.218	751.7	1.1652
	800	31.75	1.250	791.7	1.2272
	900	33.38	1.314	874.9	1.3561
	1000	34.85	1.372	953.8	1.4784
	1250	39.09	1.539	1200	1.8602
	1500	42.21	1.662	1400	2.1695
	1750	45.11	1.776	1598	2.4773
	2000	47.80	1.882	1795	2.7818
TFN, TFFN	18	2.134	0.084	3.548	0.0055
	16	2.438	0.096	4.645	0.0072
THHN, THWN, THWN-2	14	2.819	0.111	6.258	0.0097
	12	3.302	0.130	8.581	0.0133
	10	4.166	0.164	13.61	0.0211
	8	5.486	0.216	23.61	0.0366
	6	6.452	0.254	32.71	0.0507
	4	8.230	0.324	53.16	0.0824
	3	8.941	0.352	62.77	0.0973
	2	9.754	0.384	74.71	0.1158
	1	11.33	0.446	100.8	0.1562
	1/0	12.34	0.486	119.7	0.1855
	2/0	13.51	0.532	143.4	0.2223
	3/0	14.83	0.584	172.8	0.2679
	4/0	16.31	0.642	208.8	0.3237
	250	18.06	0.711	256.1	0.3970
	300	19.46	0.766	297.3	0.4608

DERATING

- Adjustments – More than 3 current-carrying conductors in a conduit or tubing or bundling of cable assemblies longer than 24” without maintaining spacing.
- See 310.15 (B)(3)(a) for percentage of deration.
- Remember 334.80 for 2 or more NM Cables that are ran through holes that will be fire or draft-stopped also requires consideration of 310.15 (B)(3)(a)

TABLE 310.15(B)(3)(a) Adjustment Factors for More Than Three Current-Carrying Conductors in a Raceway or Cable

Number of Conductors[1]	Percent of Values in Table 310.15(B)(16) through Table 310.15(B)(19) as Adjusted for Ambient Temperature if Necessary
4–6	80
7–9	70
10–20	50
21–30	45
31–40	40
41 and above	35

[1]Number of conductors is the total number of conductors in the raceway or cable adjusted in accordance with 310.15(B)(5) and (6).

QUESTION

- If there are 7 current carrying conductors in a conduit, the adjustment factor to be used to determine the ampacity of the conductors is:
- A.) 80%
- B.) 70%
- C.) 50%
- D.) 45%
- B.) 70%

QUESTION

- I have a ¾” EMT conduit with (9) 12 AWG copper Type THHN conductors installed. What is the allowable ampacity rating of the 12 AWG conductors?
- T. 310.16 - 12 AWG THHN is 30 Amps
- T. 310.15(B)(3)(a) indicates 70%
- 30 x .70 = 21 Amps
- See T.310.15(B)16 * 12 AWG , refer to 240.4(D)
- Select 20 Amp OCD.

QUESTION

- I have dual listed copper wire like THHN/THWN, what temperature can I use when determining the allowable ampacity?
- THHN = 90 degree C. in dry locations
- THWN = 75 degree C. in wet locations

ADJUSTMENT FACTOR FIXES

- Lower OCD to adjusted allowable ampacity.
- Separate the amount of current carrying conductors in one raceway.
- Increase wire size to allow greater adjusted ampacity.
- Separate bundled cable assemblies
- Nipples 24” or less do not apply.
- Increase distance above roof.

DERATING

- Correction Factors – When conductors are ran through areas where an ambient temperature is greater than 30 degree C. or 86 degree F.
- Correction Table T. 310.15(B)(2)(a)

TABLE 310.15(B)(2)(A) Ambient Temperature Correction Factors Based on 30°C (86°F)

For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities specified in the ampacity tables by the appropriate correction factor shown below.

Ambient Temperature (°C)	Temperature Rating of Conductor			Ambient Temperature (°F)
	60°C	75°C	90°C	
10 or less	1.29	1.20	1.15	50 or less
11–15	1.22	1.15	1.12	51–59
16–20	1.15	1.11	1.08	60–68
21–25	1.08	1.05	1.04	69–77
26–30	1.00	1.00	1.00	78–86
31–35	0.91	0.94	0.96	87–95
36–40	0.82	0.88	0.91	96–104
41–45	0.71	0.82	0.87	105–113
46–50	0.58	0.75	0.82	114–122
51–55	0.41	0.67	0.76	123–131
56–60	—	0.58	0.71	132–140
61–65	—	0.47	0.65	141–149
66–70	—	0.33	0.58	150–158
71–75	—	—	0.50	159–167
76–80	—	—	0.41	168–176
81–85	—	—	0.29	177–185

QUESTION

- A size 2 AWG copper, Type THHN conductors is run through a room with an ambient temperature of 110 degree F. (43.3 degree C.) and there are no conductor termination in this area. The ampacity of the conductor is:
- T. 310.16 – 2 AWG = 130 Amps at 90 degree C.
- 130 x 0.87 = 113 Amps

ADJUSTMENT & CORRECTION

- A raceway contains two 3-phase circuits that supply a 38 amp continuous load. The circuit will be supplied by THHN copper conductors and circuit terminations are 75 degree C. In route to supply the load, the circuits run through a boiler room with the design temperature of 120 degree F. The minimum size conductors is:

QUESTION CONTINUED

- 38 Amp continuous load x 125% = 47.5 A.
- 6 – current carrying conductors x 80%
- 120 degree F. ambient temperature of THHN wires terminated @ 75 Degree C. = 82%
- 4 AWG @ 75 degree C = 85 Amps
- 85 x .80 x .82 = 55.76 Amps

THANK YOU!

- From the Master Electrical Contractors Association!

File Attachments for Item:

ER-2 Electric Vehicle Power Transfer Systems and the 2020 NEC Part 1 (Matthews Electrical Services)

All certifications (4 hours)

Staff Notes: Matthews plans to present it at least once per quarter. It is not a multisession course. Recommend approval.

ESIAC Recommendation: No consensus reached.

Committee Recommendation:

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.

Application for Continuing Education Course Approval

Provider Information:

Name: Henry P. Matthews

Organization: Matthews Electrical Services

Address: 1203 McKinley Place; Fostoria, Ohio 4830

E-mail: hpmatthews@matthewselectrical.net Telephone: 419-575-3488

Website: www.matthewselectrical.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: Electric Vehicle Power Transfer Systems and the NEC Part 1

Course instructor: Henry P. Matthews

Course description: This course will cover article 625 in the NEC for electric vehicle power transfer systems. This course will also cover the history of electric vehicles and discuss projected growth and the electrical infrastructure requirements. This course will focus on installations for one and two family dwelling units and the other relevant NEC sections required for a code-compliant electric vehicle installation.

Instructional hours per session: 4 Number of Sessions: at least one per quarter

Course Date(s) and Location: January 7, 2023 via Zoom. Registration at www.matthewselectrical.net

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: www.matthewselectrical.net

Detail online course participation confirmation method (*i.e. test, quizlets, participant activity confirmation*):
Surveys, polls, and roll call after each break will be conducted.

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

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

BIOGRAPHY

Henry P. Matthews PE, CPE, CESCP, PVA

Henry has over 31 years of experience in the electrical design, construction, engineering and safety fields. He has a passion for teaching and mentoring.

Henry obtained his Bachelor of Science degree in Electrical Engineering from Penn State University in 1989.

He also earned a Master of Business Administration from Bowling Green State University in 2003.

In addition, Henry earned several certificates including:

- Plumbing and Electrician from Penn Foster Career School
- Welding from Owens Community College in Findlay, Ohio
- Residential Solar PV Systems from Solar Engineering International

Henry currently holds the following licenses, and memberships:

- Licensed Electrical Contractor in Ohio
- Licensed Training Agency in Ohio
- Licensed Professional Engineer in Ohio, Michigan, Kentucky, Indiana, Illinois, Wisconsin
- Certified Plant Engineer (CPE)
- Certified Building Operator (CBO)
- Certified Electrical Compliance Safety Professional (CESCP) by NFPA
- Solar PV Associate by the North American Board of Certified Energy Practitioners
- Electric Vehicle Infrastructure Training Program (EVITP) certification
- Senior Member of the Institute of Electrical and Electronic Engineers (IEEE)
- Member of the International Association of Electrical Inspectors (IAEI)
- Member of the National Fire Protection Association (NFPA)

Henry is currently employed as an Advanced Senior Engineer for Marathon Petroleum Company in Findlay, Ohio. During his 16 years at Marathon, Henry has worked as an Electrical Design Engineer, Project Engineer, Engineering Supervisor and currently as a Reliability Engineer.

Henry is also the owner of Matthews Electrical Services, a small, but full-service electrical contractor company.

Prior to this, he worked 13 years as an Electrical Engineer and a Plant Engineering Manager in at Cooper Standard Automotive, a major automotive parts supplier in Bowling Green, Ohio

Henry is the past co-chair of American Petroleum Institute Recommended Practice 545 Lightning Protection for Above Ground Storage Tanks.

He was also past president of the Fostoria Toastmaster club.

Electrical Vehicle Power Transfer Equipment and the NEC
Outline

Relevant NEC Chapters and Articles (Based on the 2020 NEC)

- Article 625 Electric Vehicle Power Transfer Systems
- Article 100 Key Definitions
- Article 110 Requirements for Electrical Installations
- Article 210 Branch Feeders
- Article 215 Feeders
- Article 220 Branch-circuit, Feeder and Service Load Calculations
- Article 230 Services
- Article 240 Overcurrent Protection
- Article 242 Overvoltage Protection
- Article 250 Grounding and Bonding
- Chapter 3 Wiring Methods and Materials
- Article 685 Integrated Electrical Systems
- Article 690 Solar Photovoltaic Systems
- Article 702 Optional Standby Systems
- Article 705 Interconnected Electric Power Production
- Article 706 Energy Storage Systems
- Chapter 9 Tables

Other Resources:

- NFPA 70E (2021) Electrical Safety in the Workplace
- NECA 413 Standard for Installing and Maintaining Electrical Vehicle Supply Equipment (EVSE)
- OSHA 1910 Subpart S Electrical Safety

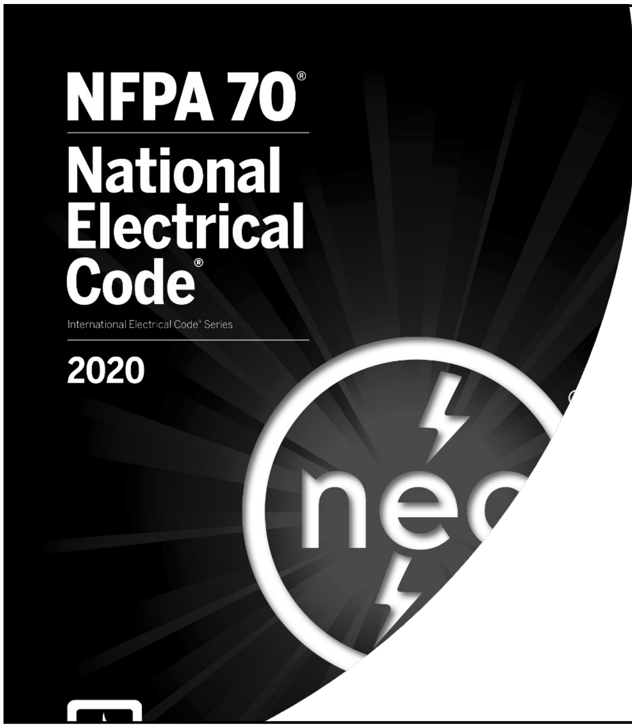
Referenced Websites:

- www.NFPA.org
- NREL – National Renewable Energy Laboratories
- www.IAEI.org (International Association of Electrical Inspectors)
- www.mikeholt.com
- www.esfi.org Electrical Safety Foundation International)
- Multiple automobile and Class 2/DC Fast charger manufacturer websites

Course Content:

- History of Electric Vehicles
- Electrical Safety review with emphasis on DC systems
- NEC definitions
- Charger site evaluation and considerations
- Types of charger connectors and their functions

- Other requirements
    - Grounding and bonding
    - GFCI and ground fault protection
    - Overcurrent protection’
    - Bi-directional current flow considerations
        - Article 705 Interconnected Electric Power Production
    - EVPE considerations
        - Article 702 optional standby systems
        - Article 705
- Types of EV chargers: Class I, Class 2 and DC Fast chargers
- Types of chargers: connected and wireless (induction)
- Installation requirements
- Electrical calculations for charger installation



1

Electric Vehicles
NEC Article: 625

OCILB Course # 4871434

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1

Notice!

This course is based on the 2020 NEC.

The 2020 NEC has not been adopted in Ohio

Presented for
INFORMATIONAL PURPOSES ONLY.

The 2020 NEC has not been adopted in Ohio. PRESENTED FOR INFORMATIONAL PURPOSES ONLY

2

2

Webinar Rules

- Attendee must be present the entire time (except breaks)
- Mute microphone at all times
  - Prevents distraction during webinar
  - Instructor may activate participant microphone if verbal response is needed

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3

Webinar Rules (Continued)

- 5 minute breaks every hour
  - Return promptly after breaks
  - The instructor will check attendance after each break
- Emergencies
- Contingency Plans: Ohio Weather
- Unexpected interruption
  - Re-joining webinar
  - Problems:
    - send me a text message: 419-575-3488
    - Or email: hpmatthews66@att.net

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4

4

WELCOME!

- Goals
  - Promote learning
  - Make session engaging
    - Discussion
    - Videos
    - Case Studies
    - Polls
  - Make 4 hours as productive as possible!

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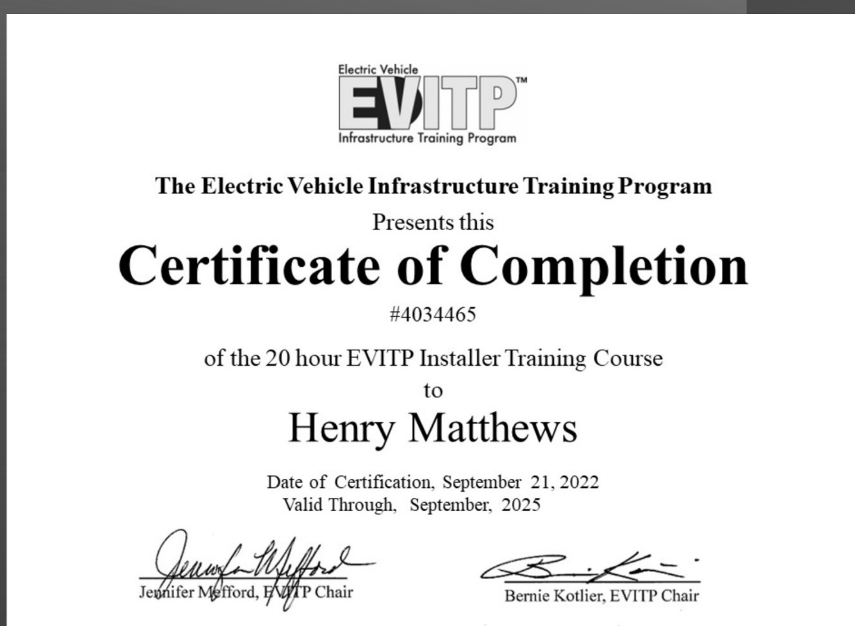

Electric Vehicle EVITP™ Infrastructure Training Program

The Electric Vehicle Infrastructure Training Program

Presents this

Certificate of Completion

#4034465

of the 20 hour EVITP Installer Training Course

to

Henry Matthews

Date of Certification, September 21, 2022

Valid Through, September, 2025

Jennifer Mefford, EVITP Chair

Bernie Kotlier, EVITP Chair

6

Roll Call!

Turn on your cameras!

7

7

Agenda

- Relevant EV NEC Articles and other sources of information
- History of Electric Vehicles
- Electrical Safety review with emphasis on DC systems
- NEC definitions
- Charger site evaluation and considerations
- Types of charger connectors and their functions

8

Relevant NEC Chapters and Articles (Based on the 2020 NEC)

- Article 625 Electric Vehicle Power Transfer Systems
- Article 100 Key Definitions
- Article 110 Requirements for Electrical Installations
- Article 210 Branch Feeders
- Article 215 Feeders
- Article 220 Branch-circuit, Feeder and Service Load Calculations
- Article 230 Services

9

Relevant NEC Chapters and Articles (Based on the 2020 NEC)

- Article 240 Overcurrent Protection
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- Article 250 Grounding and Bonding
- Chapter 3 Wiring Methods and Materials
- Article 685 Integrated Electrical Systems
- Article 690 Solar Photovoltaic Systems

10

Relevant NEC Chapters and Articles (Based on the 2020 NEC)

- Article 702 Optional Standby Systems
- Article 705 Interconnected Electric Power Production
- Article 706 Energy Storage Systems
- Chapter 9 Tables

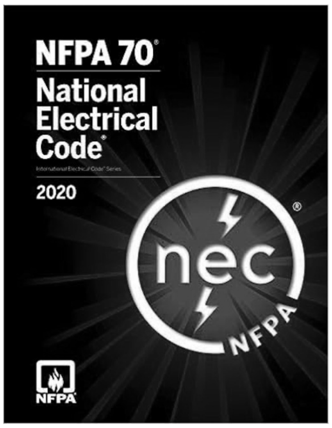
11

Other Resources

- NFPA 70E (2021) Electrical Safety in the Workplace
- NECA 413 Standard for Installing and Maintaining Electrical Vehicle Supply Equipment (EVSE)
- OSHA 1910 Subpart S Electrical Safety

12

Resources



13

Websites

- www.NFPA.org
- www.evassociation.org   Electric Vehicle Charging Association
- www.chargedevs.com. Charged Electric Vehicles Magazine
- www.IAEI.org (International Association of Electrical Inspectors)
- www.mikeholt.com
- www.esfi.org Electrical Safety Foundation International)
- NREL – National Renewable Energy Laboratories
- Multiple automobile and Class 2/DC Fast charger manufacturer websites

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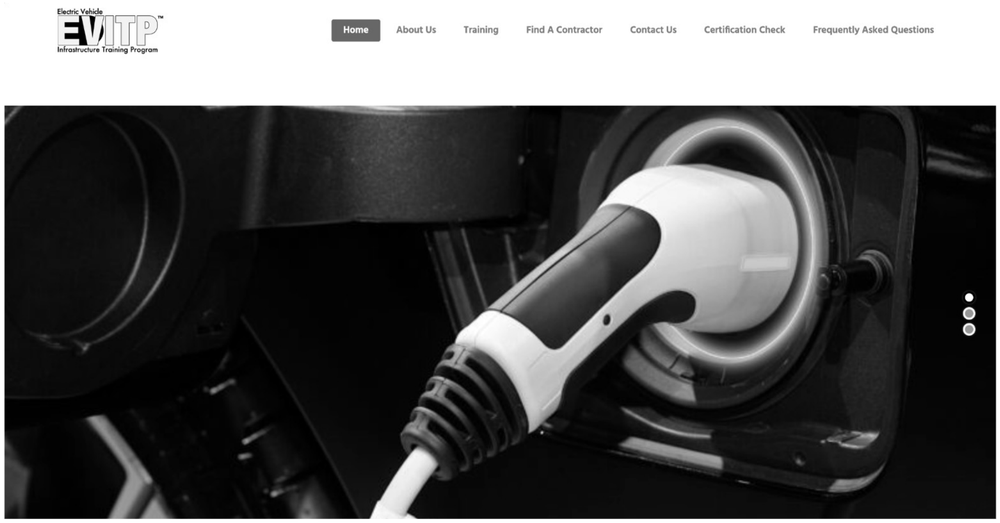
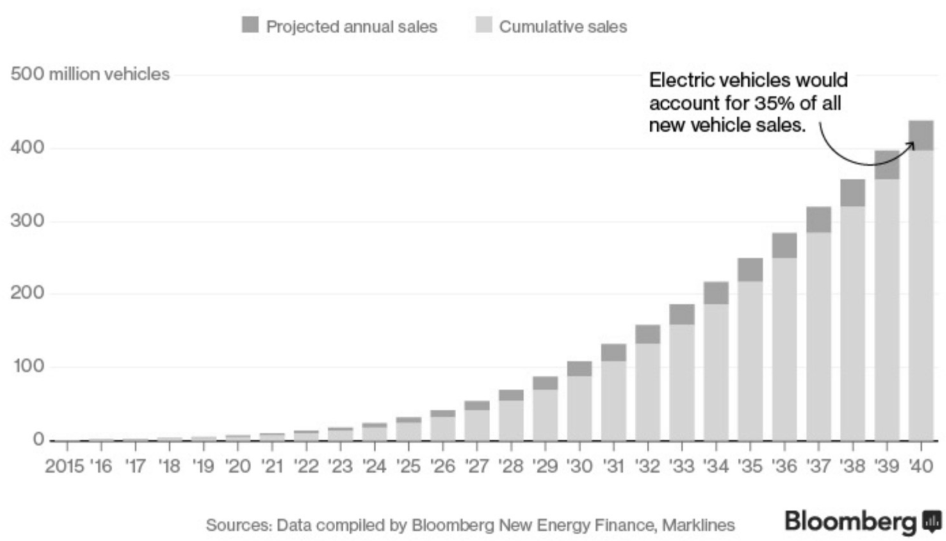


https://evitp.org/

15

The Rise of Electric Cars

By 2022 electric vehicles will cost the same as their internal-combustion counterparts. That's the point of liftoff for sales.



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Electric Vehicle Growth Challenges

- Existing infrastructure
- Cost of electric vehicles
- Range Anxiety
- Availability of resources, battery materials for example
- Contractor skill level: AC to DC adaptability
- Lithium-Ion battery safety
- Comfort level with new technology

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Origins of the Electric Vehicle (EV)

- Inventor of the first EV is not known
- 1829, Anyos Jedlik (Hungary) developed small-scale model car powered by an electric motor
- 1834, the first American built battery-electric car by Thomas Davenport, a blacksmith from Vermont. Batteries were not rechargeable
  - Davenport was also the inventor of the first American-build DC electric motor
- 1886, Karl Benz (Germany) applied for patent for his gas-powered vehicle
- 1893, Charles and Frank Duryeas, (Springfield, Mass), credited with first America gas-powered vehicle

18

Origins of the Electric Vehicles

- Designs improved, but distance limited by batteries. Most were not rechargeable
- Gaston Plante (France) invented a better rechargeable lead-acid battery in 1859
- Electric vehicles gained popularity due to easier starting, less vibration, less odor, less noise and easier to change gears
- From 1899 to 1900, EVs outsold gasoline cars 10 to 1

19

Origins of the Electric Vehicles

- By 1900, there were gas, steam and electric powered vehicles available
- Mix was about even with 33% gas, 33% steam and 33% electric
- The best roads were in cities and towns, which was ideal for the limited range of electric vehicles

20

The Decline of Electric Vehicles

- By 1910, the popularity of EVs started to decline:
- Improved roads increased demand for longer range vehicles
- Discovery of Texas crude oil made gas more affordable
- Invention of the electric starter by Charles Kettering in 1912 made it easier to start gas power cars vs the traditional hand crank
- Mass production of Internal Combustion Engine (ICE) cars by Henry Ford made gas cars more affordable to consumer
- Electric vehicles virtually disappeared by 1935

21

Reappearance of Electric Vehicles

- Began to see rebirth in 1960s and 1970s due to concerns about air pollution and the OPEC Oil Embargo
- A few car makers resumed production of EVs in limited quantities
- Spearheaded by California's Zero Emission Vehicle (ZEV) mandate
  - Required 2% of vehicles to be ZEV by 1998 and 10% by 2003
- The global economic recession in late 2000s led to more interest in alternative fueled vehicles.
- Tesla (California), led by Elon Musk, launched the Tesla Roadster in 2008
  - First highway capable all-electric vehicle in serial production in 2008

22

Reappearance of Electric Vehicles

- 1995, GM announced prototype EV called Impact, later renamed EV-1

23

Reappearance of Electric Vehicles

- Tesla Roadster, 2008

24

Types of Electric Vehicles

There are several types of Electric Vehicles:

- Hybrid Electric Vehicles (HEV)
- Plug-In Hybrid (PHEV)
- Plug-In Electric Vehicle (PEV)
- Battery Electric Vehicle (BEV)

25

Hybrid Electric Vehicle (HEV)

- Combines traditional ICE with and electric propulsion system
- First popular electric vehicle, ex. Toyota Prius
- Utilizes regenerative braking which converts vehicle's kinetic (moving) energy into electric energy to charge the batter
- The internal combustion engine can generate electricity by turning an electrical generator
- Does not rely on external AC or DC charging. Regenerative charging or charging by ICE engine keeps battery charged

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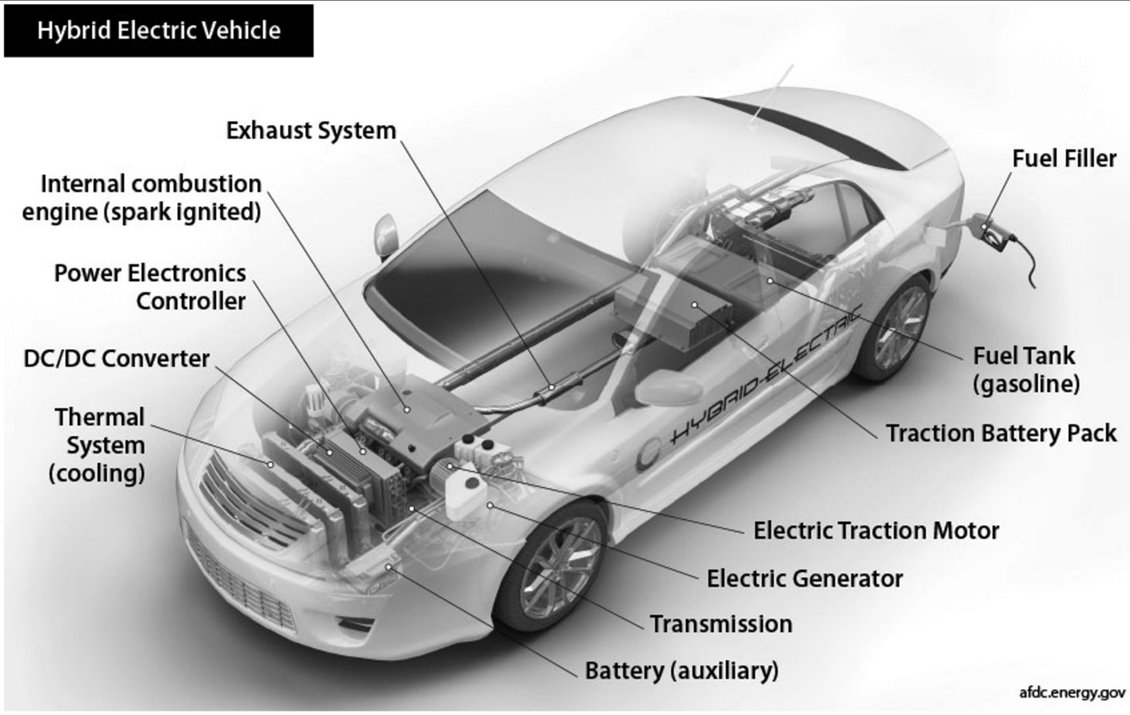

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Plug-In Hybrid (PHEV)

- Has internal rechargeable batteries
- Also has internal combustion engine similar to pure Hybrid EV
- Batteries recharged by external power source
- Combination of external charging and ICE eases "range anxiety" of running out of gas or power while going long distances
- ICE can power car if batteries are depleted

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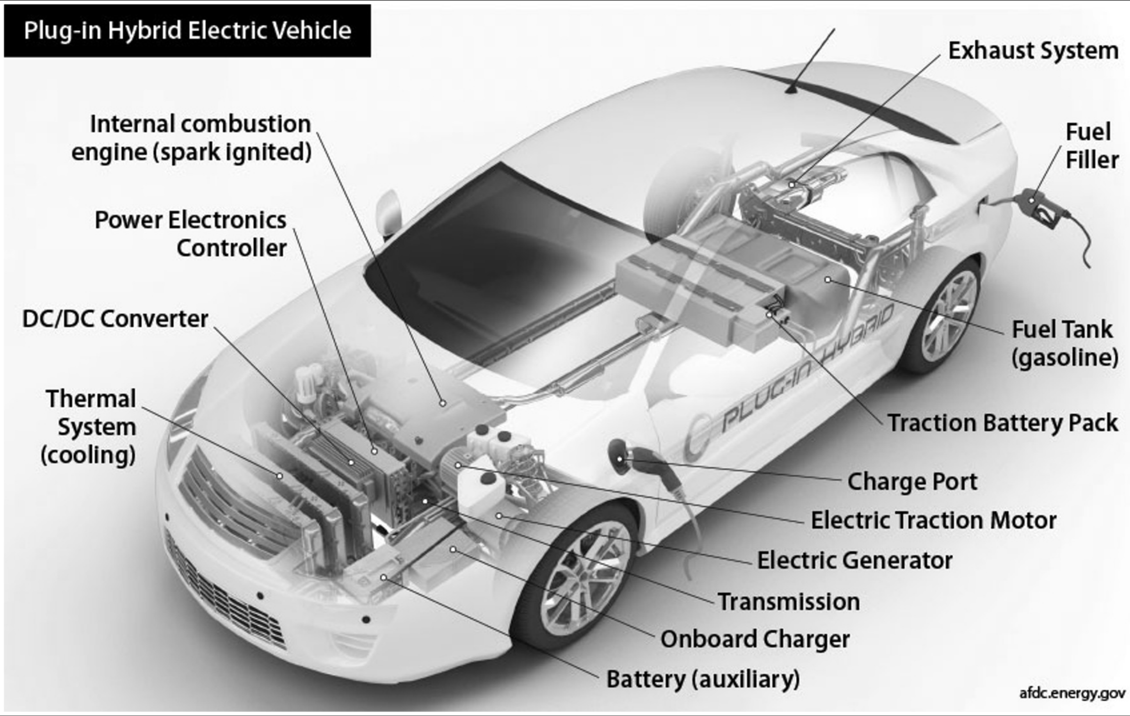

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Plug-In Electric Vehicle (PEV)

- A superset of the electric vehicles that includes:
  - Battery Electric Vehicles
  - Plug-in Hybrid Vehicles (PHEVs)
- Slower to adopt than hybrid versions for several reasons
  - Cost
  - Battery range
  - Lack of charging infrastructure leading to range anxiety (running out of charge)

30

Battery Electric Vehicle (BEV)

- Also known as an All-Electric Vehicle
- Has internal batteries that can only be recharged from an external power source of electricity
- Does not have an internal combustion engine to help recharge batteries

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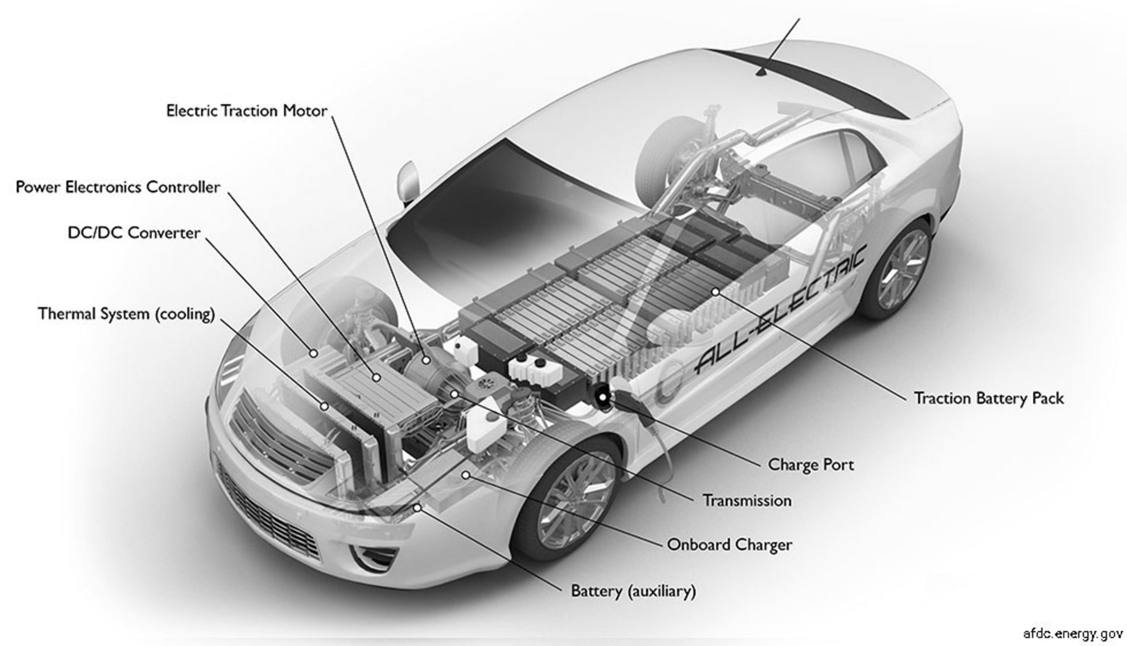
All-Electric Vehicle



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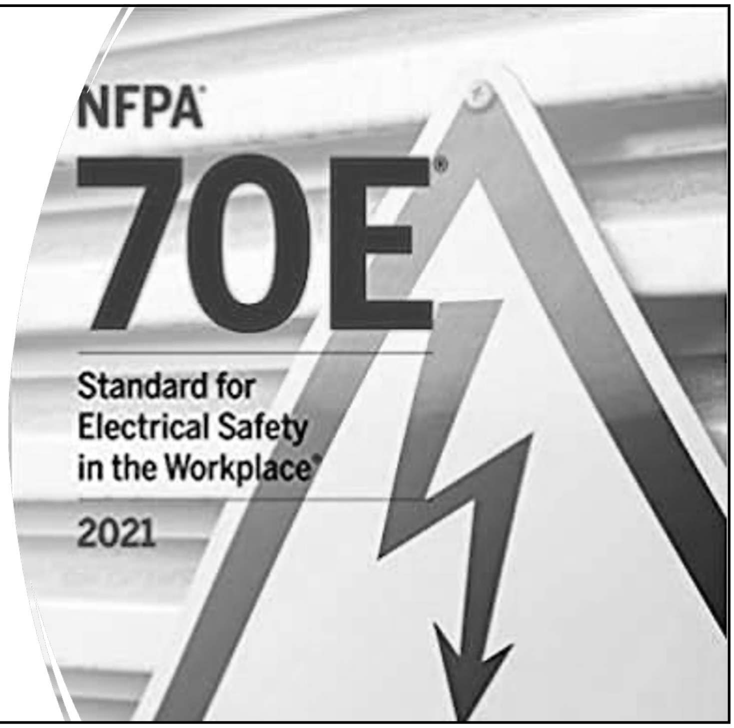
Safety Considerations

- NFPA 70E
- Battery Safety
- Lithium-Ion batteries: thermal run-away and other issues
- AC and DC electrical work
- Bi-directional flow of electricity
- Proper PPE



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Electric Vehicle Supply Equipment

- Three types:

- Level 1
- Level 2
- DC Fast Charging (several levels)

34

Connector Handshake

- Plug not powered until plugged into and commanded by vehicle
- Electric Vehicle Supply Equipment (EVSE) signals presence of AC input power
- Vehicle detects plug via proximity circuit (prevents drive away while connected)

35

Level 1 Chargers

- Usually come with the Plug-In Electric Vehicle
- Inexpensive
- Portable
- Usually plugs into standard 120V AC outlet
- Operates at 1.4 kW, 12 amps: requires 15A circuit breaker or
- Operates at 1.9 kW, 16 amps: requires 20A circuit breaker
- Long charge times, usually overnight in garage (12 - 16 hours)
- Supply AC power to the EV's on-board battery charger

36

Level 2 Chargers

- Higher capacity chargers
- Usually not portable, fixed installation
- Installed in garages, shopping parking lots, businesses (fleet charging)
- Operates at 208 or 240V AC, single-phase or 3-phase
- Higher power usually requires 3-phase circuit
- Commercial charges range from 6.6 to 19.2 kW

37

Level 2 Chargers

- Requires 30 to 60 amp circuit breaker depending on power requirements and electrical system (single phase or 3-phrase)
- Dramatically reduces time to charge batteries
- Charges batteries between 3 and 8 hours
- Delivers AC power to the EV onboard charger, same as Level 1 chargers

38

DC Fast Chargers

- Three competing technologies
- SAE J1772 Combo
- CHAdeMO
- Tesla proprietary
- Bypasses EV charging system (AC)
- Provides DC power directly to vehicle battery management system
- Some charging stations have all three technologies for efficiency

39

DC Fast Chargers

- Provide fastest way to charge batteries
- Can provide charge in 15 to 60 minutes
- Require more power, 3-phase power
- Outputs of 15kW to over 350kW
- Usually connected to a network requirement some form of payment
- Common networks: Blink, ChargePoint, Electrify America, Greenlots SKY, NRG eVgo, SemaConnect and more

40

30 kW	87 miles/hour
50 kW	145 miles/hour
100 kW	289 miles/hour
120 kW	347 miles/hour
150 kW	434 miles/hour
180 kW	520 miles/hour
250 kW	723 miles/hour
350 kW	1012 miles/hour

41

SAE J1772 Combo

- Has two extra large pins for DC Fast charging
- Used by GM, Ford, Chrysler, Audi, Daimler, Porsche, Volkswagen and BMW

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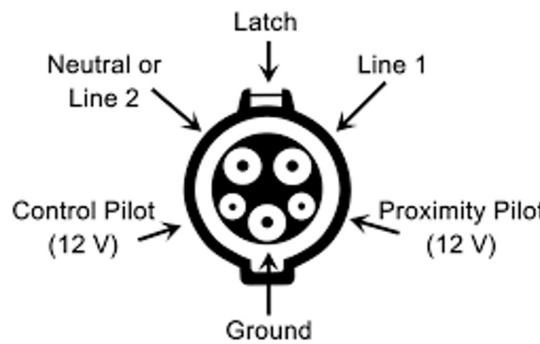
SAE J1772 Connector for Level 1 and Level 2 Chargers



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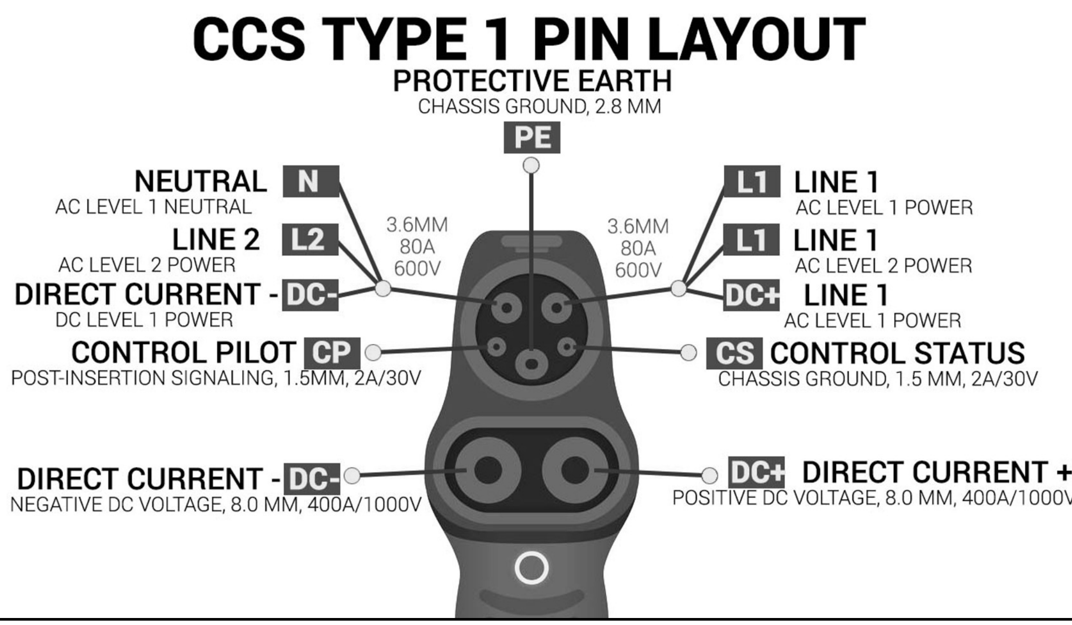
SAE J1772 Combo for Fast Chargers



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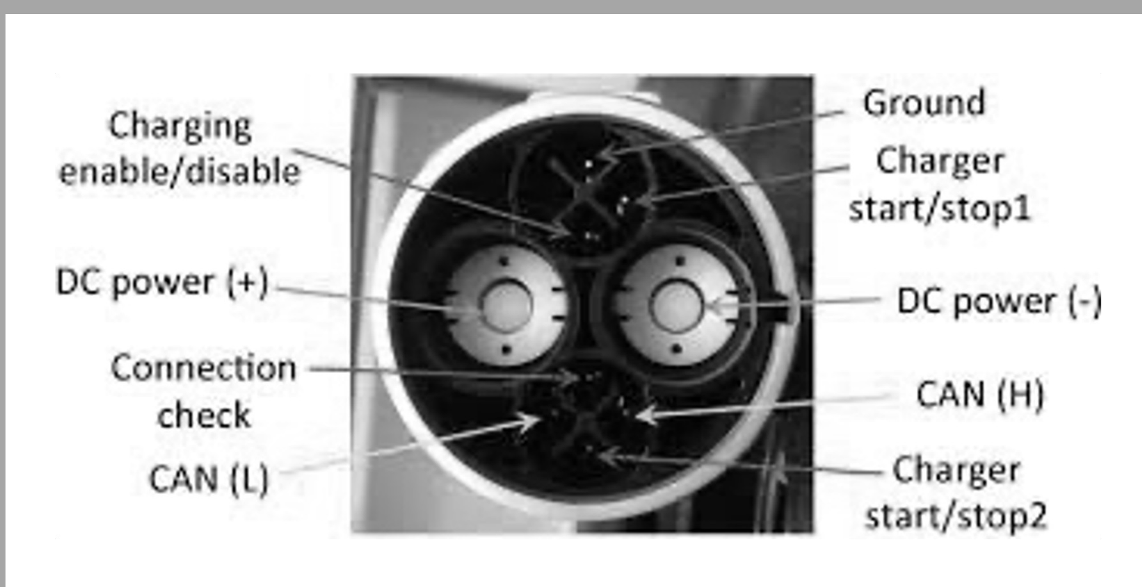
CHAdeMO Connector for DC Fast Charging

- Developed by the Tokyo Electric Power Company in Japan
- Used by Nissan, Mitsubishi, Toyota
- Abbreviatedfor **CHArge de Move**
- Meaning “Let's have a cup of tea while charging” in Japanese

45



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Contractor Basic Steps

- Electrical contractor must perform a site assessment for EVSE installation
- Obtain electrical wiring permit(s) and coordination of the inspection and approval processes.
- Coordinate with local utility company for time-of-use (TOU) meters, off- peak metering, etc.)
- Facilitate the installation of the EVSE and associated branch circuit wiring
- Inspection, startup, and commissioning completed EVSE installation

47

EVSE Installation Considerations

- Use EVSE nameplate data to calculate the full load current of equipment.
- EVSE is considered to be a continuous load
- Size ampacity of conductors and overcurrent protective devices at not less than 125% of the calculated load current.
- Verify the conductor material and size of the existing service conductors (copper vs. aluminum)

48

Scope: Section 625.1

- This article covers the electrical conductors and equipment connecting an electric vehicle to the premises wiring for the purposes of charging, power export or bidirectional current flow.

49

Scope: Section 625.1

- Informational notes:

1. NFPA 505-2018 Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance and Operations

2. UL 2594-2013, Standard for Electric Vehicle Supply Equipment
   UL 2202-2009, Standard for Electric Vehicle Charging System Equipment

50

Definitions: Section 625.2

- Cable Management System
- An apparatus designed to control and organize the output cable to the electric vehicle or to the primary pad

51

Definitions: Section 625.2

- Charger Power Converter
- The device used to convert energy from the power grid to a high-frequency output for wireless power transfer

52

Definitions: Section 625.2

- Electric Vehicle Connector (2020)

- A device that, when electrically coupled to an electric vehicle inlet, establishes and electrical connection to the electric vehicle for the purpose of power transfer and information exchange.

53

Definitions: Section 625.2

- Electric Vehicle Power Export Equipment, EVPE (New for 2020)

- The equipment, including the outlet on the vehicle, that is used to provide electrical power at voltages greater than or equal to 30 VAC or 60 VDC to loads external to the vehicle, using the vehicle as the source of supply

54

Definitions: Section 625.2

- Electric Vehicle Power Export Equipment, EVPE (New for 2020)

Informational note: EVPE and EVSE are sometimes contained in one piece of equipment, sometimes referred to as bidirectional EVSE

55

Definitions: Section 625.2

- Electric Vehicle Supply Equipment, EVSE (Revised for 2020)

- The conductors including the ungrounded, grounded, and equipment grounding conductors, and the EV connectors, attachment plugs, personnel protection system, and all other fittings, devices, power outlets, or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the electric vehicle

56

WARNING!

- Pay close attention to definitions for:
  - **FASTENED IN PLACE**
  - **FIXED IN PLACE**
  - **PORTABLE**

Specific requirements for each, including GFCI requirements!

57

Definitions: Section 625.2

- Fastened in Place (Revised for 2020)

- Mounting means of equipment in which the fastening means are specifically designed to permit periodic removal, without the use of a tool, for relocation interchangeability, maintenance or repair.

58

Definitions: Section 625.2

- Fixed in Place

- Mounting means of an EVSE attached to a wall or surface with fasteners that require a tool to be removed.

59

Definitions: Section 625.2

- Output Cable to the Electric Vehicle

- An assembly consisting of a length of flexible EV cable and an electric vehicle connector (supplying power to the electric vehicle).

60

Definitions: Section 625.2

- Output Cable to the Primary Pad

- A multi-conductor, shielded cable assembly consisting of conductors to carry the high-frequency energy and any status signals between the charger power converter and the primary pad.

61

Definitions: Section 625.2

- Personnel Protection System

- A system of personnel protection devices and constructional features that when used together provide protection against electric shock of personnel

62

Definitions: Section 625.2

- Power Supply Cord

- As assembly consisting of an attachment plug and length of flexible cord that connects equipment to a receptacle.

63

Definitions: Section 625.2

- Primary Pad (revised for 2020)

- A device external to the EV that transfers power via the contactless coupling as part of a wireless power transfer system

64

Definitions: Section 625.2

- Wireless Power Transfer (WPT)

- The transfer of electrical energy from a power source to an external load via electric and magnetic fields or waves by a contactless inductive means between a primary and secondary device.

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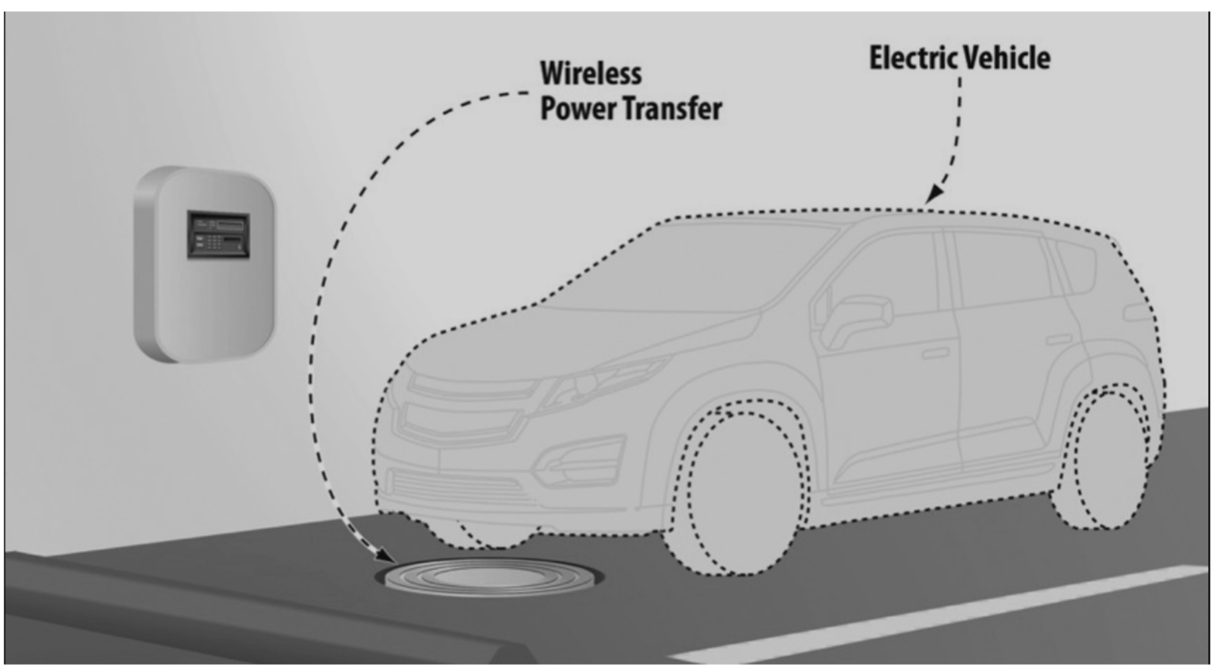

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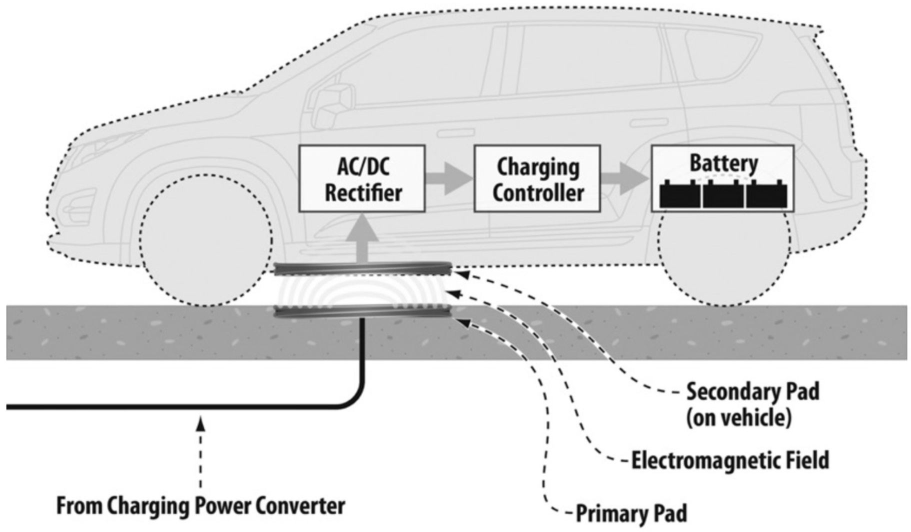

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Definitions: Section 625.2

- 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 the enclosure

68

625.4 Voltages

- Unless other voltages are specified, the nominal AC system voltages used to supply equipment in Article 625 are…
- 120
- 120/240
- 208Y/120
- 240
- 480Y/277
- 480
- 600Y/347
- 600 and
- 1000 volts
- and DC system voltages of up to 1000

69

625.5 Listed

- All equipment covered by the scope of this article shall be listed

70

625.17 Cords and Cables

- Shall be Listed Type EV, EVJ, EVE, EVJE, EVT, or EVJT flexible cable or
- An integral part of listed electric vehicle supply equipment
- Overall cord length shall not exceed 25 feet in length unless it is equipped with a cable management system that is part of a listed electric vehicle supply equipment
- Note: damage to cables are one of the biggest maintenance issues with EV power supply equipment. A cable management system may help keep cables neat, orderly and off of the ground

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SPEC 70859

Southwire Electric Vehicle EVE/EVJE and EV/EVJ Cables

90° or 105°C Dry/60°C Wet. 300, 600/1000 Volts. Class K, Bare Copper Conductors. TPE or EPDM Insulation and TPE or CPE oil, sunlight and flame resistant jacket.

Image not to scale & for reference only. See Table 1 for Dimensions

CONSTRUCTION:

Conductors: Class K, Flexible stranded bare copper per ASTM B3 and ASTM B174
Insulation: Thermoplastic Elastomer (TPE) with Optional Nylon Covering or Ethylene Propylene Diene Monomer (EPDM)
Filler: Paper or Polypropylene filler
Separator: Paper or Talc
Jacket: Black; Thermoplastic Elastomer (TPE) or Thermoset Chlorinated Polyethylene (CPE)

APPLICATIONS:

EV Charging Cables, designed for residential or commercial charging applications. Flexible construction, cabled with fillers, with wet rated, oil resistant, crush and impact resistant, low temperature materials. These cables meet Underwriters Laboratories and the Canadian Standard Association requirements as well as the National Electrical Code articles 400 (Flexible Cords & Flexible Cables) and 625 (Electric Vehicle Power Transfer System).

72

SPECIFICATIONS:
- ASTM B3 and ASTM B174
- UL 62 - Type EVE/EVJE or EV/EVJ
- CSA C22.2 No. 49 - Type EVT(TPE)/EVJE(TPE) or EV/EVJ
- NFPA 70, NEC Articles: 400, 625
- RoHS-3 – The CE Marking has been applied solely to express the conformance to the material restrictions identified in the European Directive (EU) 2015/863

SAMPLE PRINT LEGEND: (Marker Tape)
SOUTHWIRE® 3/C XX AWG (X.XXmm2) & 1/C XX AWG (X.XXmm2) EVE E312819 c(UL)us 1000V 105C DRY 60C WET -- EVT(TPE) 1000V 105C DRY 60C WET FT2 WATER RESISTANT -- FOR USE WITH ELECTRIC VEHICLES

PROPERTIES:
Voltage: 300V EVJE, EVJ; 600V or 1000V EVE or EV.
Temperature Range: -40°C to 105°C Dry, 60°C Wet

Other EV Offerings:

Custom EV Cable Design/Engineered Solutions
- DC Fast Charging Cable
- DC Fast Liquid-Cooled Charging Cable
- Coiled EV Cable
- Portable Charger, Charging Cable
- Custom Designs & 3 Phase Cables are Available
- Shielded Options
- Sizes up to 500 kcmil for listed products

EV Infrastructure
- Utility, Transmission & Distribution Cables
- Cable in Conduit (CIC)
- Armorlite Type MC Cable
- SimPull THHN/XHHW
- SimPull Medium Voltage Cable
- Low Smoke/Zero-Halogen Cable for confined space installations
- DLO Cable

73

625.22 Personnel Protection System

- The equipment shall have a listed system of protection against electric shock of personnel.
- A personnel protection system shall not be required for supplies less than 60 volts dc.

74

625.40 EV Branch Circuit

- Each outlet installed for the purpose of charging electric vehicles shall be supplied by an individual branch circuit. Each circuit shall have no other outlets.

75

625.41 Overcurrent Protection

- Overcurrent protection for EVSE and WPTE equipment shall be sized for continuous duty (125%)
- Shall have a rating of not less than 125% of the maximum load of the equipment.
- Use nameplate data to determine maximum rating
- Where noncontinuous loads are supplied from the same feeder, the overcurrent device shall have a rating of not less than the sum of the noncontinuous loads plus 125 percent of the continuous loads.

76

625.43 Disconnecting Means

- Disconnecting means required for equipment rated more than 60 amps or more than 150V to ground

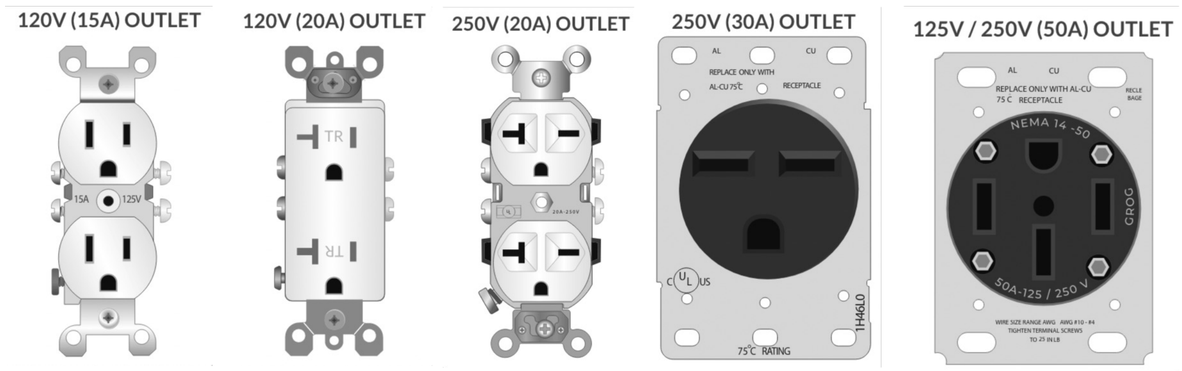
- Shall be lockable in the open position

77

78

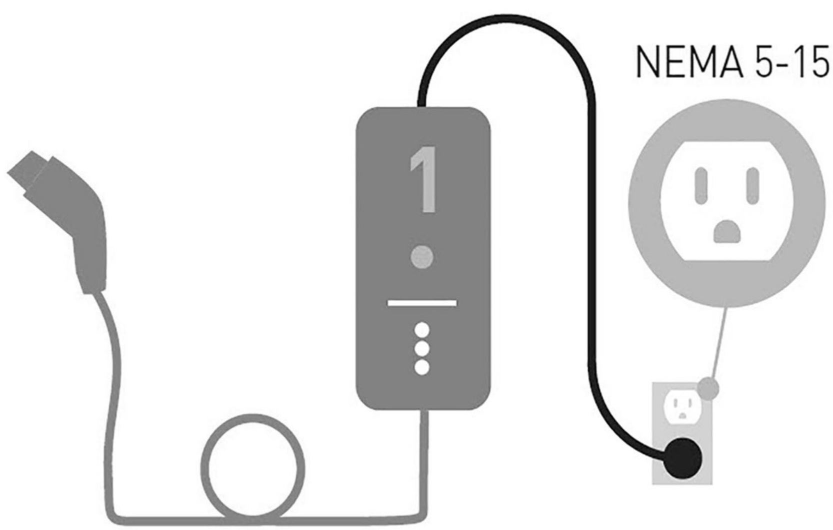
625.43(A) Portable Equipment

- Portable equipment shall be connected to the premises wiring by one or more of the following methods:



79

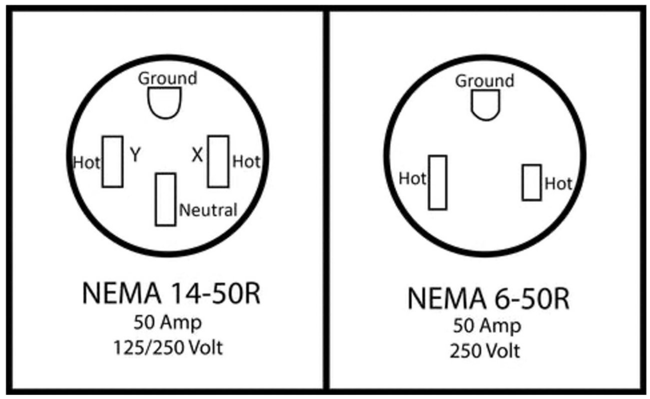
Level 1: 110V



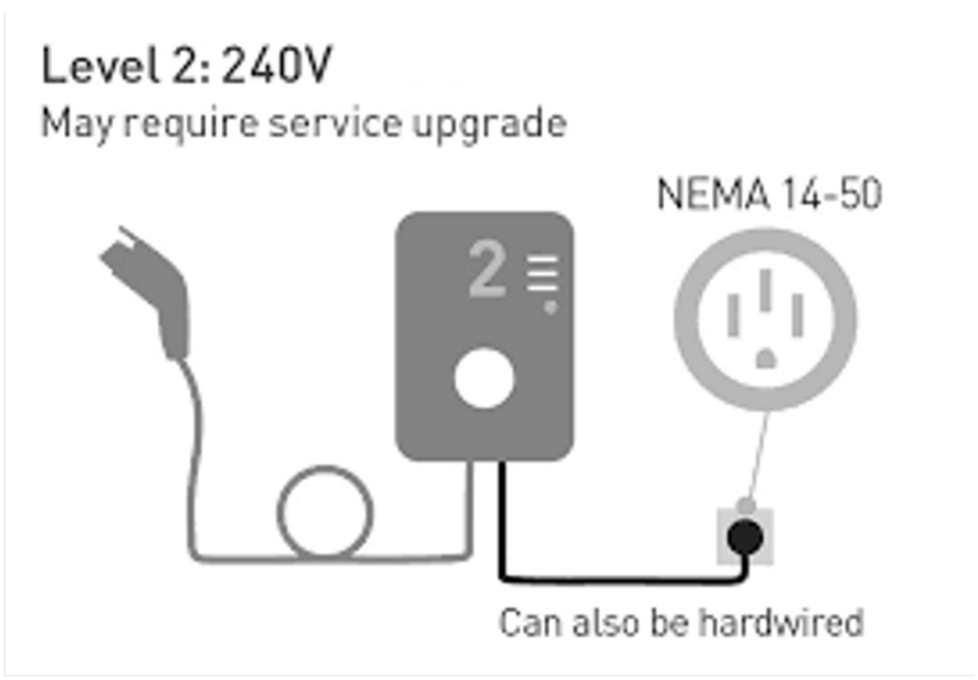
80

625.43(B) Fastened In-Place Equipment

- Equipment fastened in place shall be connected to the premises wiring by one or more of the following methods:



81



82

625.43(C) Fixed Equipment

- All other EVSE and WPTE shall be permanently wired and fixed in place to the supporting surface

83

625.46 Loss of Primary Source

- Means shall be provided to prevent the backfeed of power to the EV, EVSE or premises wiring system if power is lost.

- Exception is if a listed interactive system is installed

CAUTION!

DO NOT BACKFEED!

84

625.48 Interactive Systems

EVSE that incorporates a power export function and that is part of an interactive system that serves as an optional standby system, an electric power production source, or a bidirectional power feed shall be listed and marked as suitable for that purpose.

When used as an optional standby system, the requirements of Article 702 shall apply (Example: generartors)

When used as an electric power production source, the requirements of Article 705 shall apply (Example: Solar PV, Wind Turbine etc.)

EVPE that consists of a receptacle outlet only shall be in accordance with 625.60 (AC Receptacle Outlets Used for EVPE)

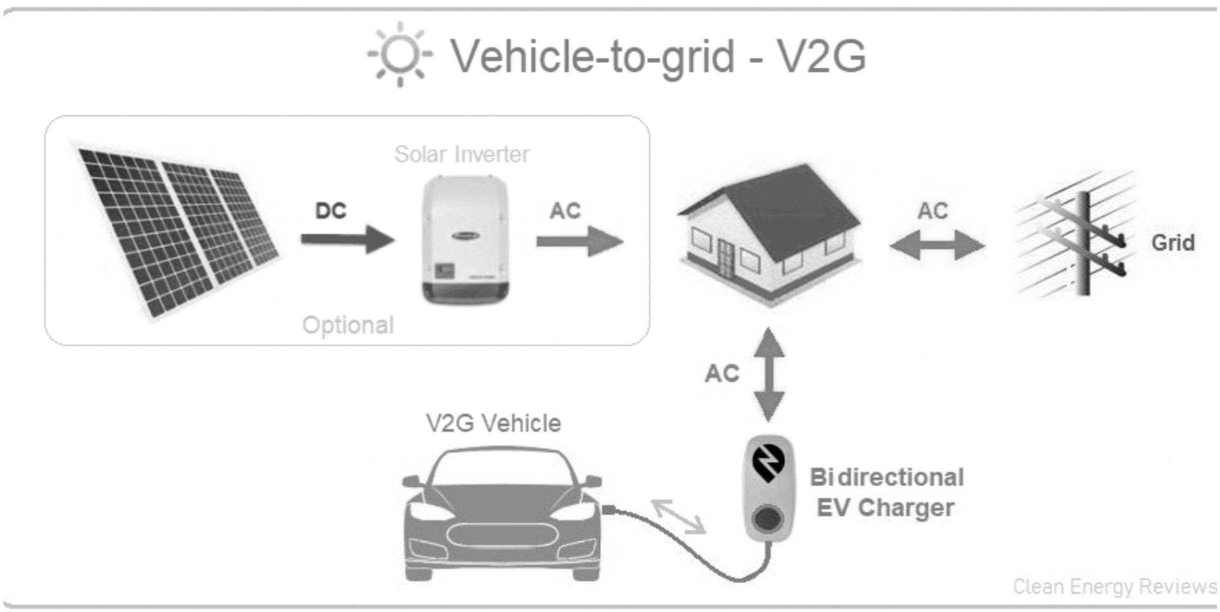
85

625.48 Interactive Systems

Informational Note:

- For further information on supply equipment, see ANSI/UL 1741, *Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources*, and ANSI/UL 9741, *Bidirectional Electric Vehicle (EV) Charging System Equipment*; for vehicle interactive systems, see SAE J3072, *Standard for Interconnection Requirements for Onboard, Utility-Interactive Inverter Systems*.

86



87

625.50 Location

- Minimum mounting height for fixed or fastened-in-place EVSE coupling connectors (cabling and connectors)
- Not less than 18 inches above the floor for indoor locations
- Not less than 24 inches above the grade for outdoor locations

- https://www.youtube.com/watch?v=vda14KgqaKg

88

625.25 Ventilation

- Some batteries can emit flammable vapors
- Most batteries used for electric vehicles do not emit vapors, but
- It is imperative to understand the types of batteries used and whether or not they require mechanical ventilation!

89

625.25 Ventilation

- There are ventilation requirements for charging an electric vehicle in an enclosed location
- Mechanical ventilation is not required when
  - Electric vehicle storage batteries are used, or
  - Where the equipment used for charging electric vehicles is listed for use without ventilation

90

625.25 Ventilation

- Mechanical ventilation is required when…
- Where the equipment used for charging electric vehicles is listed for use with ventilation
- Requirements:
  - Include both supply and exhaust equipment
  - be permanently installed
  - Located to intake outside air
  - Location to exhaust to outside air
- See Tables 625.25(B)(2)(a) and 625.25(B)(2)(b) for required ventilation in cubic feet per meter (CFM)

91

Pin Header

Table 625.52(B)(1)(a) Minimum Ventilation Required in Cubic Meters per Minute (m^3/min) for Each of the Total Number of Electric Vehicles That Can Be Charged at One Time

	Branch-Circuit Voltage						
		Single Phase			3 Phase		
Branch-Circuit Ampere Rating	DC ≥ 50 V	120 V	208 V	240 V or 120/240 V	208 V or 208Y/120 V	240 V	480 V or 480Y/277 V
15	0.5	1.1	1.8	2.1	—	—	—
20	0.6	1.4	2.4	2.8	4.2	4.8	9.7
30	0.9	2.1	3.6	4.2	6.3	7.2	15
40	1.2	2.8	4.8	5.6	8.4	9.7	19
50	1.5	3.5	6.1	7.0	10	12	24
60	1.8	4.2	7.3	8.4	13	15	29
100	2.9	7.0	12	14	21	24	48
150	—	—	—	—	31	36	73
200	—	—	—	—	42	48	97
250	—	—	—	—	52	60	120
300	—	—	—	—	63	73	145
350	—	—	—	—	73	85	170
400	—	—	—	—	84	97	195

92

625.54 Ground-Fault Circuit-Interrupter Protection for Personnel

- Portable and fastened-in-place EVSE that is permitted to be cord-and plug-connected must be supplied through a GFCI-protected receptacle.
- The outlet supplying direct-connected EVSE is not required to be GFCI protected unless specified in the manufacturer's instructions.

93

625.56 Receptacle Enclosures

- Receptacles for EV charging in a wet location shall be installed in a weatherproof enclosure
- Outlet box hood for the WP enclosure shall be listed and identified for Extra Duty
- If the the enclosure or assembly does not include a hood, it is not required to be marked as Extra Duty

94

95

625.60 AC Receptacle Outlets Used for EVPE

- EVPE refers to receptacles <u>inside</u> of the electric vehicle used to supply power to external loads
- Requirements:
  - Shall be listed
  - Have maximum rating of 250 V, single phase, 50 amps
  - Shall have overcurrent protection suitable to handle available fault current
  - Have GFCI protection

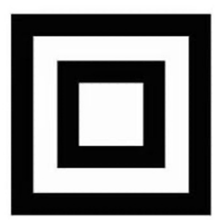
96

97

Part IV. Wireless Power Transfer Equipment

625.101 Grounding

- The primary pad base plate shall be made of a non-ferrous material (copper, aluminum e.g.)
- Shall be grounded unless it is listed as double insulated



98

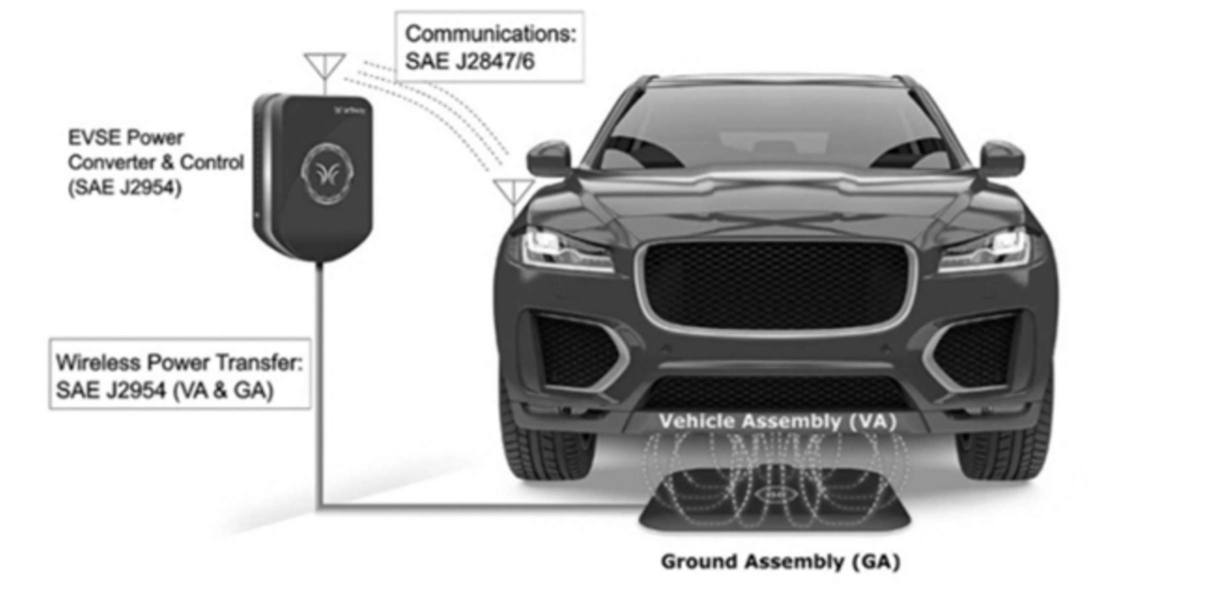


Figure 6: Genesis car with wireless charging (Source: WiTricity)

99

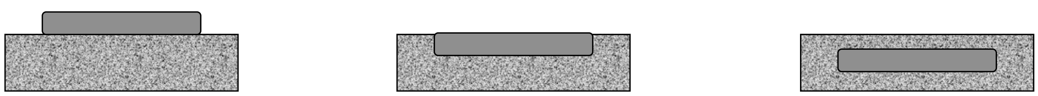
625.102 Installation

- The charger power converter, if not integral to the primary pad, shall be installed in a NEMA 3R enclosure
  - Mounted no less than 18 inches above the floor (indoor locations)
  - Mounted no less than 24 inches above grade (outdoor locations)
- The converter shall be mounted in one of the following ways:
  - Pedestal
  - Wall or pole
  - Building or structure
  - Raised concrete pad

100

625.102 Installation

- If the charger power converter is a part of the primary pad, it shall comply with the following:
- The primary pad shall be mounted by one of the following methods:
  - On the surface
  - Embedded in the surface of the floor with its top flush with the surface
  - Embedded in the surface of the floor with its top below the surface



101

625.102 Installation

- If the primary pad is located in an area requiring snow removal, it shall not be located on or above the surface.
- The enclosure shall be provided with a suitable enclosure rating, minimum Type 3.
- If the primary pad is located in an area subject to severe climatic conditions (e.g., flooding), it shall be suitably rated for those conditions or be provided with a suitably rated enclosure.

102

625.102 Installation: Protection of Output Cable

- The output cable to the primary pad shall be secured in place over its entire length for the purpose of restricting its movement and to prevent strain at the connection points
- If installed in conditions where drive-over could occur, the cable shall be provided with supplemental protection
- Where the charger power converter is a part of the primary pad assembly, the power supply cord to the primary pad shall also be protected.

103

625.102 Installation: Other Wiring Systems

- Other wiring systems and fittings specifically listed for use on the WPTE shall be permitted.

104

Maintenance

- Cord Management is single biggest issue with chargers
- Damage to cord
  - Insulation damage
  - Theft
  - Getting run over
  - Ice-clearing equipment

105

Example Calculations: Single Phase

106

Sample Calculations: 3-Phase

107

File Attachments for Item:

EC-1 Chapter 1 Code Administration Round Table (Northwest Ohio Building Officials Association)

All certifications (two 1.5-hour sessions)

Code Administration course credit.

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: CHARLES M. SUTPHIN

Organization: NWOBOA

Address: 1115 S. McCORD RD. HOLLAND, OHIO 43528

E-mail: CHAZMSUT@GMAIL.COM Telephone: 419-245-1223

Website: WWW.NWOBOA.ORG

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: ROUND TABLE DISCUSSION OF CHAPTER 1-CODE ADMINISTRATION

Course instructor: CHARLES M. SUTPHIN

Course description: ROUND TABLE, OPEN DISCUSSION OF CHAPTER 1-ADMINISTRATION WITH DESIGN PROFESSIONALS, CONTRACTORS, AND BUILDING DEPARTMENT PERSONNEL.

Instructional hours per session: 1.5 Number of Sessions: 2

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

ROUND TABLE DISCUSSION OF CHAPTER 1 – CODE ADMINISTRATION

The purpose of this course is to have an open discussion of chapter 1 between design professionals, contractors, and building department personnel. The intent of this course is for chapter 1, code administration questions and answers. The idea is that getting all involved in the building process, questions and answers that arise from this type of discussion will be beneficial to all. It is important that we all know and understand code administration. This open forum creates a better working relationship between all involved in the process. Also, sometimes the questions that may arise may be something that does not typically get asked which is also helpful so we all know and understand what chapter 1 allows.

CHARLES M. SUTPHIN
2727 KINGSFORD DR., TOLEDO, OH. 43614
(419)345-7010/CHAZMSUT@GMAIL.COM

SUMMARY OF QUALIFICATIONS

Over 25 years experience in the Plumbing, H.V.A.C., and Construction Industry
State of Ohio H.V.A.C. Contractor's License
City of Toledo H.V.A.C. Journeyman License
Universal Refrigerant Recovery License
OSHA 6 Foot Fall Protection Certification
OSHA 30 Hour Safety Certification
Ohio Board of Building Standards Mechanical Inspector, Residential Mechanical Inspector, Building Inspector, Residential Building Official, Mechanical Plans Examiner, Certification Number 4969
Northwest Ohio Building Officials Association Treasurer

EMPLOYMENT

8/14-Present City of Toledo, Certified Inspector 2
4/11-8/14 Lucas County Metropolitan Housing Authority, Plumbing & HVAC/R Technician
7/95-4/11 Local Union 33, Sheet Metal Worker Journeyman Specializing in Service and Unit Installation
10/93-7/95 Armstrong Mechanical Services, Service Department, Plumbing Department, Installation Department
10/92-10/93 A-1 Heating & Home Improvement Co., Service Department
Other jobs in my life experiences include Customer Service, Grocery, Landscaping, Painting, Automotive Repair, and General Labor

EDUCATION

Several service classes, and seminars on particular brands, equipment, codes, and procedures, including state of Ohio accredited continuing education classes, and Journeyman update classes
Local Union 33, five year Apprenticeship, Diploma 2000
RETS Institute of Technology, Diploma 1993
E.L. Bowsher High School, Diploma 1985

REFERENCES

Strong References are Available Upon Request

File Attachments for Item:

EC-2 Chapter 34 Existing Buildings Round Table (Northwest Ohio Building Officials Association)

All certifications (two 1.5-hour sessions)

Existing Building course credit.

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: CHARLES M. SUTPHIN

Organization: NWOBOA

Address: 1115 S. McCORD Rd. HOLLAND, OHIO 43528

E-mail: CHAZMSUT@ GMAIL.COM Telephone:

Website: WWW.NWOBOA.ORG

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: ROUND TABLE DISCUSSION OF CHAPTER 34 – EXISTING BUILDINGS

Course instructor: CHARLES M. SUTPHIN

Course description: ROUND TABLE OPEN DISCUSSION OF CHAPTER 34 – EXISTING BUILDINGS WITH DESIGN PROFESSIONALS, CONTRACTORS, AND BUILDING DEPARTMENT PERSONNEL.

Instructional hours per session: 1.5 Number of Sessions: 2

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

ROUND TABLE DISCUSSION OF CHAPTER 34 – CODE EXISTING BUILDINGS

The purpose of this course is to have an open discussion of chapter 34 between design professionals, contractors, and building department personnel. The intent of this course is for chapter 34, code questions and answers ON CHAPTER 34. The idea is that getting all involved in the building process, questions and answers that arise from this type of discussion will be beneficial to all. It is important that we all know and understand chapter 34 existing buildings. This open forum creates a better working relationship between all involved in the process. Also, sometimes the questions that may arise may be something that does not typically get asked which is also helpful so we all know and understand what chapter 34 allows.

CHARLES M. SUTPHIN

2727 KINGSFORD DR., TOLEDO, OH. 43614
(419)345-7010/CHAZMSUT@GMAIL.COM

SUMMARY OF QUALIFICATIONS

Over 25 years experience in the Plumbing, H.V.A.C., and Construction Industry
State of Ohio H.V.A.C. Contractor's License
City of Toledo H.V.A.C. Journeyman License
Universal Refrigerant Recovery License
OSHA 6 Foot Fall Protection Certification
OSHA 30 Hour Safety Certification
Ohio Board of Building Standards Mechanical Inspector, Residential Mechanical Inspector, Building Inspector, Residential Building Official, Mechanical Plans Examiner, Certification Number 4969
Northwest Ohio Building Officials Association Treasurer

EMPLOYMENT

8/14-Present City of Toledo, Certified Inspector 2
4/11-8/14 Lucas County Metropolitan Housing Authority, Plumbing & HVAC/R Technician
7/95-4/11 Local Union 33, Sheet Metal Worker Journeyman Specializing in Service and Unit Installation
10/93-7/95 Armstrong Mechanical Services, Service Department, Plumbing Department, Installation Department
10/92-10/93 A-1 Heating & Home Improvement Co., Service Department
Other jobs in my life experiences include Customer Service, Grocery, Landscaping, Painting, Automotive Repair, and General Labor

EDUCATION

Several service classes, and seminars on particular brands, equipment, codes, and procedures, including state of Ohio accredited continuing education classes, and Journeyman update classes
Local Union 33, five year Apprenticeship, Diploma 2000
RETS Institute of Technology, Diploma 1993
E.L. Bowsher High School, Diploma 1985

REFERENCES

Strong References are Available Upon Request

File Attachments for Item:

EC-3 Code Consistency Round Table (Northwest Ohio Building Officials Association)

All certifications (twelve one-hour sessions)

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: CHARLES M. SUTPHIN

Organization: NWOBOA

Address: 1115 S. McCORD RD., HOLLAND, OHIO 43528

E-mail: CHAZMSUT@GMAIL.COM Telephone: 419-245-1223

Website: WWW.NWOBOA.ORG

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: CODE CONSISTENCY MEETING

Course instructor: CHARLES M. SUTPHIN

Course description: TO INSURE CONSISTENCY BETWEE MUNICIPALITIES IN NW OHIO AND ALL OF OHIO TO PROVIDE BETTER SERVICE TO ALL WHO BUILD, REMODLE, MAINTAIN AND UTILIZE BUILDINGS AND PROPERTIES REGULATED BY THE APPLICABLE BUILDING CODES OF OHIO

Instructional hours per session: 1 Number of Sessions: 12

Course Date(s) and Location: 3RD THURSDAY OF EVERY MONTH, NWOBOA

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

CODE CONSISTENCY MEETINGS FOR NWOBOA

The objective of this course is to promote consistency among all municipalities providing service to all who build, remodel, and maintain, buildings and properties regulated by the applicable building codes of Ohio. This is to be an open forum (round table) type course where any and all questions are welcomed and encouraged. This course is open to all who wish to attend.

CHARLES M. SUTPHIN

2727 KINGSFORD DR., TOLEDO, OH. 43614
(419)345-7010/CHAZMSUT@GMAIL.COM

SUMMARY OF QUALIFICATIONS

Over 25 years experience in the Plumbing, H.V.A.C., and Construction Industry
State of Ohio H.V.A.C. Contractor's License
City of Toledo H.V.A.C. Journeyman License
Universal Refrigerant Recovery License
OSHA 6 Foot Fall Protection Certification
OSHA 30 Hour Safety Certification
Ohio Board of Building Standards Mechanical Inspector, Residential Mechanical Inspector, Building Inspector, Residential Building Official, Mechanical Plans Examiner, Certification Number 4969
Northwest Ohio Building Officials Association Treasurer

EMPLOYMENT

8/14-Present City of Toledo, Certified Inspector 2
4/11-8/14 Lucas County Metropolitan Housing Authority, Plumbing & HVAC/R Technician
7/95-4/11 Local Union 33, Sheet Metal Worker Journeyman Specializing in Service and Unit Installation
10/93-7/95 Armstrong Mechanical Services, Service Department, Plumbing Department, Installation Department
10/92-10/93 A-1 Heating & Home Improvement Co., Service Department
Other jobs in my life experiences include Customer Service, Grocery, Landscaping, Painting, Automotive Repair, and General Labor

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Local Union 33, five year Apprenticeship, Diploma 2000
RETS Institute of Technology, Diploma 1993
E.L. Bowsher High School, Diploma 1985

REFERENCES

Strong References are Available Upon Request

File Attachments for Item:

EC-4 Ohio Portable Fire Extinguishers (Fire Tech Productions)

All certifications (6.5 hours)

Ohio Course Submission

Included in this document: Course Outline, Instructor resume(s)

Course: Ohio Portable Fire Extinguishers - NFPA 10 2013 - PEOH 102

Course Outline:

- **01.**

Course Navigation Video (Optional)
  - Course Navigation Video (Optional)

- **02.**

Ohio Portable Fire Extinguishers
  - Introduction
  - Portable Fire Extinguishers Selection
  - Portable Fire Extinguishers Installation
  - Portable Fire Extinguishers Inspection, Maintenance, and Repair
  - Portable Fire Extinguishers Hydrostatic Testing
  - Portable Fire Extinguishers Annex Information
  - Portable Fire Extinguishers Ohio Building Code and Ohio Fire Code

- **03.**

Practice Exam
  - Practice Exam

- **04.**

Survey
  - Required End of Course Survey

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

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: 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 Portable Fire Extinguishers - NFPA 10 2013 - PEOH 102

Course instructor: Tom Doty

Course description: The Ohio Portable Fire Extinguishers online self-paced course provides training for the state of Ohio's Portable Fire Extinguishers exam so you can pass your test on the first attempt. Preparing both industry novices and veterans with the knowledge to successfully understand the requirements found in NFPA 10 2013.

Instructional hours per session: 6.5 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

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 Portable Fire Extinguishers - Introduction

Welcome to the Portable Fire Extinguishers 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:

- Key References
- Training Modules
- Preparing for the Practice Exams
- ***NFPA*** 10 2013 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

NFPA 10 2013

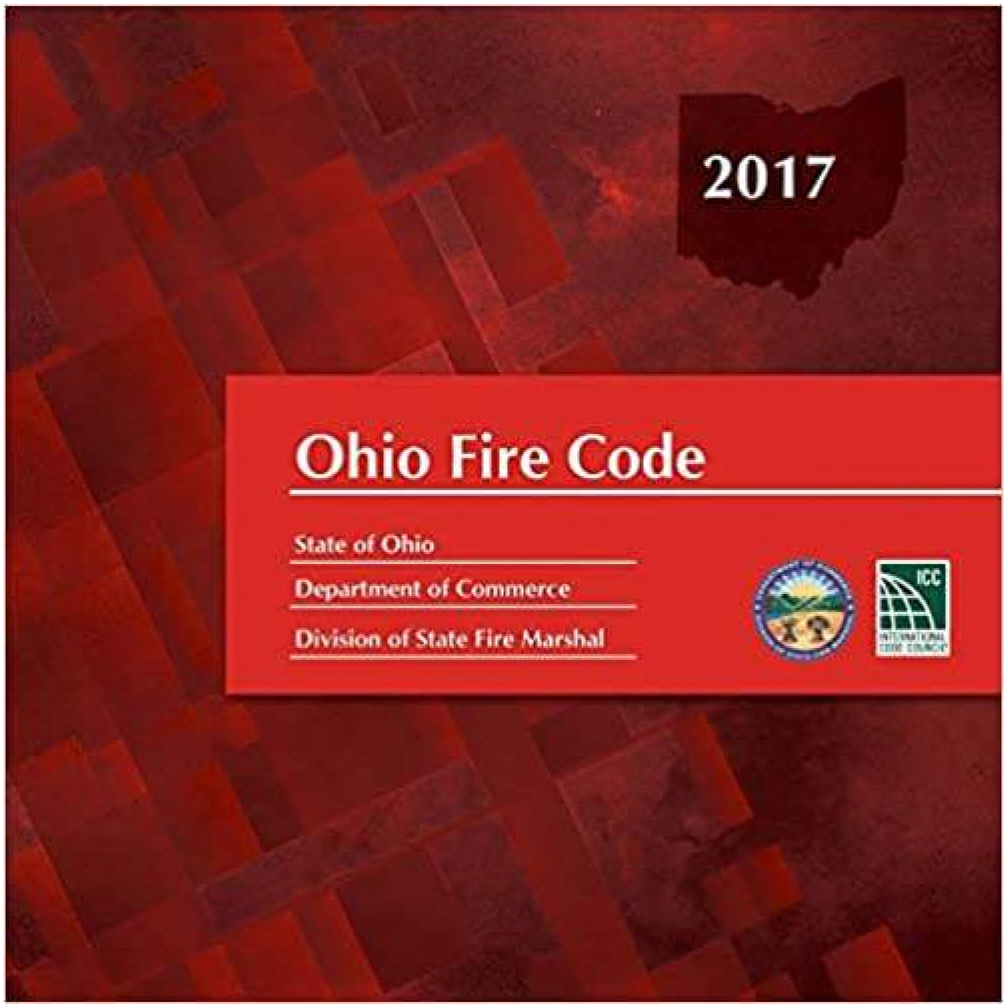
You will want to really focus on *NFPA* 10 – *Standard for Portable Fire Extinguishers,* 2013.

NFPA 10 2013 covers the selection, installation, inspection, maintenance, recharging, and testing of portable fire extinguishers and Class D extinguishing agents.

Ohio Fire Code, 2017

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.



Ohio Fire Code

The Ohio Fire Code link can be accessed by clicking on this "Click Here" button.

CLICK HERE

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 portable fire extinguishers. It ***does*** give the State Fire Marshal the responsibility for administration and enforcement of any matter related to the installation, repair, modification or removal of fire protection equipment.

The Ohio Fire Code states that portable fire extinguishers shall be installed, inspected, recharged, and maintained per *NFPA* 10 2013. The code also defines specific rules for Ohio as well as reinforce some of the *NFPA* 10 2013 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.

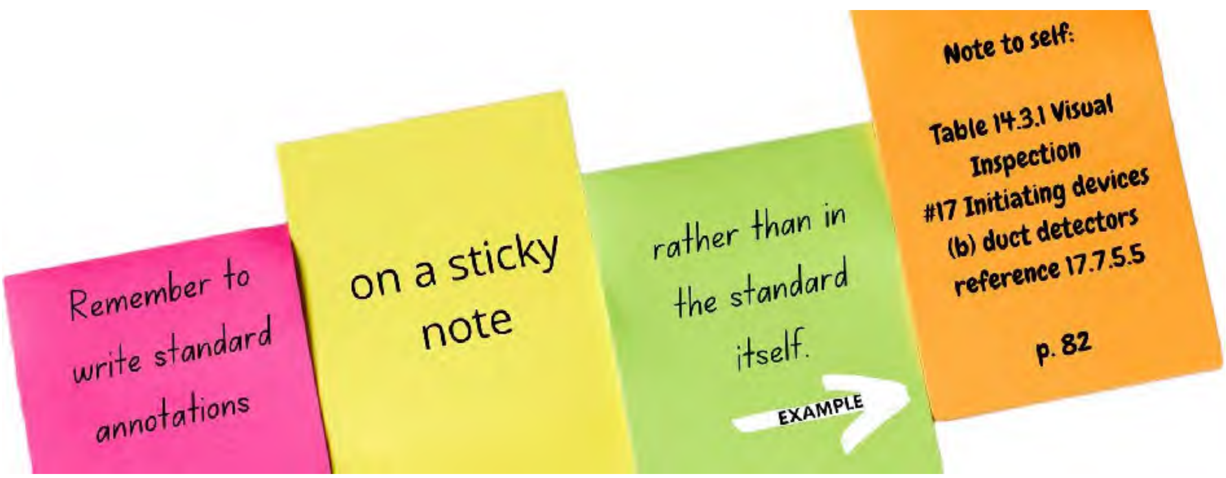
It is important to discover what works **best for you** and use your strengths to ensure you retain the material.

The 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 a beginning technician needs to know and understand**. 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.

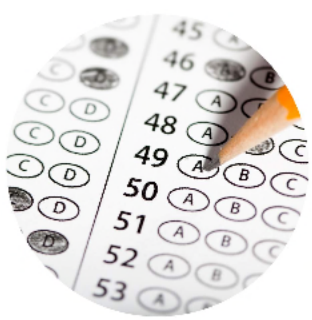
QUIZZES

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

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**.

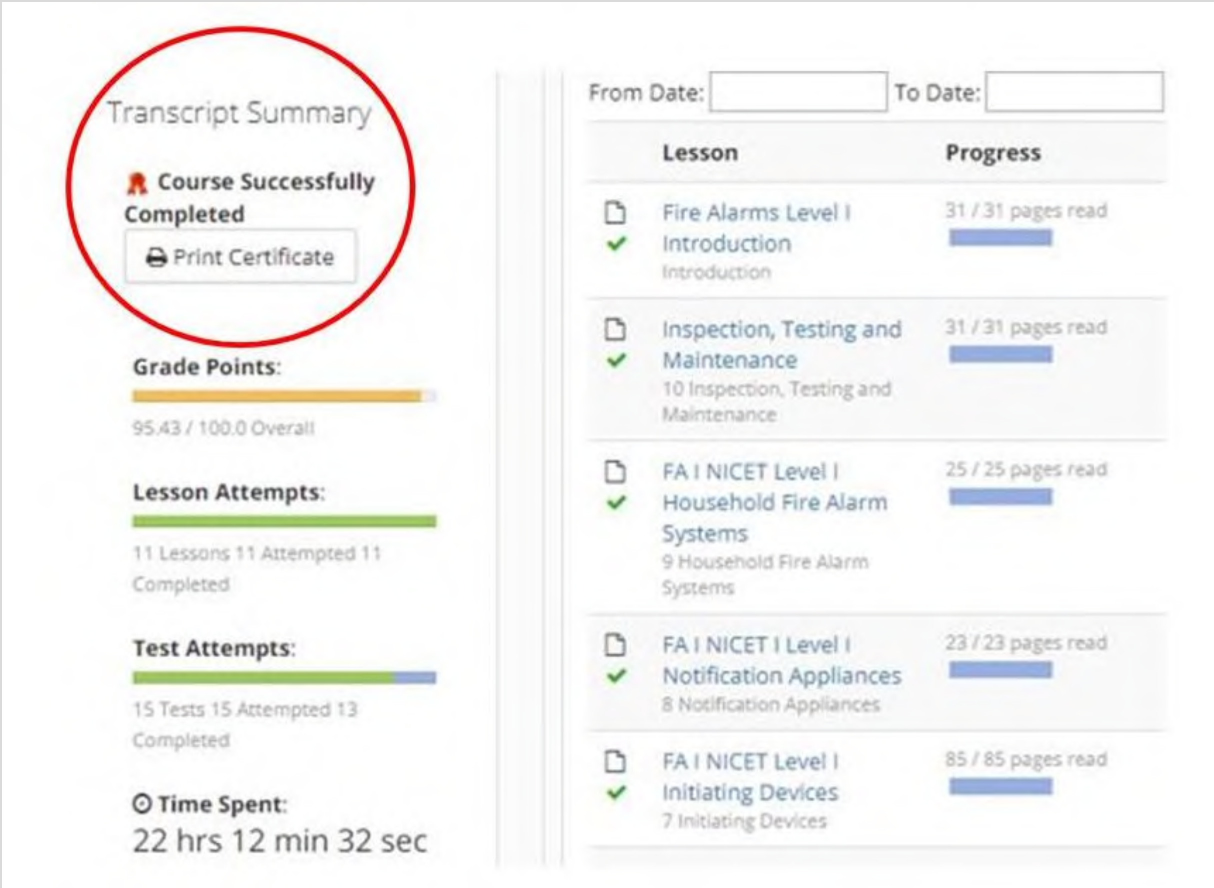
The Practice Exam consists of questions from the quizzes and are presented in a randomized manner. Fire Tech highly recommends that you take each of these practice exams.

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



Upon successful completion of the Practice Exam #1, you can download your **course completion certificate**, as shown in the transcript summary.

NFPA CODES

NFPA Codes

NFPA 10 2013 is the Portable Fire Extinguisher Standard

- **Chapter 1** (Administration) – Introduces the scope, purpose, and administration of *NFPA* 10 2013.
- **Chapter 2** (Referenced Publications) – Lists mandatory referenced publications.
- **Chapter 3** (Definitions) – Defines terms that are used in *NFPA* 10 2013.
- **Chapter 4** (General Requirements) – Contains general requirements for portable fire extinguishers.
- **Chapter 5** (Selection of Portable Fire Extinguishers) – Discusses the selection requirements of fire extinguishers.
- **Chapter 6** (Installation of Portable Fire Extinguishers) – Reviews various installation requirements that are in place for fire extinguishers.
- **Chapter 7** (Inspection, Maintenance, and Recharging) – Explores the procedures for the inspection, maintenance, and recharging of fire extinguishers.
- **Chapter 8** (Hydrostatic Testing) – Explains the requirements and procedures of hydrostatic testing for portable fire extinguishers and their components.

NFPA 10 2013 also contains several Annexes and supplements that have very valuable examples and information. It is recommended you study this material as well.

GLOSSARY

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* 10 - *Standard for Portable Fire Extinguishers*, 2013

LET'S BEGIN

Key Terms

NFPA 10 2013, 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* 10 2013, 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* 10 2013, Section 3.2.2)

Dry Chemical

A powder composed of very small particles, usually sodium bicarbonate-, potassium bicarbonate-, or ammonium phosphate-based with added particulate material supplemented by special treatment to provide resistance to packing, resistance to moisture absorption (caking), and the proper flow capabilities. (*NFPA* 10 2013, Section 3.3.4.1)

Dry Powder

Solid materials in powder or granular form designed to extinguish Class D combustible metal fires by crusting, smothering, or heat-transferring means. (*NFPA* 10 2013, Section 3.3.9)

Extinguisher Inspection

A quick check that a fire extinguisher is in its designated place, that it has not been actuated or tampered with, and that there is no obvious physical damage or condition to prevent its operation. (*NFPA* 10 2013, Section 3.3.14)

Extinguisher Maintenance

A thorough examination of the fire extinguisher that is intended to give maximum assurance that a fire extinguisher will operate effectively and safely and to determine if physical damage or condition will prevent its operation, if any repair or replacement is necessary, and if hydrostatic testing or internal maintenance is required. (*NFPA* 10 2013, Section 3.3.15)

Extinguisher Service Pressure

The normal operating pressure as indicated on the nameplate or cylinder of a fire extinguisher. (*NFPA* 10 2013, Section 3.3.22.1)

Factory Test Pressure

The pressure shown on the nameplate at which a shell was tested at time of manufacture. (*NFPA* 10 2013, Section 3.3.22.2)

Halocarbons

Halocarbon agents include hydrochlorofluorocarbon (HCFC), hydrofluorocarbon (HFC), perfluorocarbon (PFC), fluoroiodocarbon (FIC) types of agents, and other halocarbons that are found acceptable under the Environmental Protection Agency Significant New Alternatives Policy program. (*NFPA* 10 2013, Section 3.3.18.1)

Halogenated Agents

Halogenated (clean) agents referenced in this standard are of the following types: Halocarbons and Halons. (*NFPA* 10 2013, Section 3.3.18)

Halons

Halons include bromochlorodifluoromethane (Halon 1211), bromotrifluoromethane (Halon 1301), and mixtures of Halon 1211 and Halon 1301 (Halon 1211/1301). (*NFPA* 10 2013, Section 3.3.18.2)

Halon 1211 and Halon 1301 are included in the "Montreal Protocol on Substances that Deplete the Ozone Layer" that was signed on September 16, 1987.

In compliance with national regulations, the production of halons ceased on January 1, 1994.

High-Pressure Cylinder

Cylinders (and cartridges) containing nitrogen, compressed air, carbon dioxide, or other gases at a pressure higher than 500 psi at 70°F. (*NFPA* 10 2013, Section 3.3.7.1)

Hydrostatic Testing

Pressure testing of the extinguisher to verify its strength against unwanted rupture. (*NFPA* 10 2013, Section 3.3.19)

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* 10 2013, Section 3.2.4)

Low-Pressure Cylinder

Cylinders containing fire-extinguishing agent (medium), nitrogen, compressed air, or other compressed gases at a service pressure of 500 psi or lower at 70°F. (*NFPA* 10 2013, Section 3.3.7.2)

Mild Steel Shell

All steel shells other than stainless steel and steel shells used for high-pressure cylinders. (*NFPA* 10 2013, Section 3.3.21)

Nonrechargeable (Nonrefillable) Fire Extinguisher

A fire extinguisher that is intended to be used one time and not capable of or intended to be recharged and returned to service. (*NFPA* 10 2013, Section 3.4.2)

Portable Fire Extinguisher

A portable device, carried or on wheels and operated by hand, containing an extinguishing agent that can be expelled under pressure for the purpose of suppressing or extinguishing fire. (*NFPA* 10 2013, Section 3.4.3)

Rechargeable (Refillable) Fire Extinguisher

A fire extinguisher capable of undergoing complete maintenance, including internal inspection of the pressure vessel, replacement of all substandard parts and seals, and hydrostatic testing. (*NFPA* 10 2013, Section 3.4.4)

Servicing

Performing maintenance, recharging, or hydrostatic testing on a fire extinguisher. (*NFPA* 10 2013, Section 3.3.25)

Shall

Indicates a mandatory requirement. (*NFPA* 10 2013, Section 3.2.5)

Should

Indicates a recommendation or that which is advised but not required. (*NFPA* 10 2013, Section 3.2.6)

Standard

A document, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and which 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 Manual of Style for NFPA Technical Committee Documents. (*NFPA* 10 2013, Section 3.2.7)

Travel Distance

The actual walking distance from any point to the nearest fire extinguisher fulfilling hazard requirements. (*NFPA* 10 2013, Section 3.3.27)

Water Mist Fire Extinguisher

A fire extinguisher containing distilled or de-ionized water and employing a nozzle that discharges the agent in a fine spray. (*NFPA* 10 2013, Section 3.4.7)

Water-Type Fire Extinguisher

A fire extinguisher containing water-based agents, such as water, film-forming foam agents (AFFF, FFFP), antifreeze, loaded stream, and wet chemical. (*NFPA* 10 2013, Section 3.4.8)

Wet Chemical

Normally an aqueous solution of organic or inorganic salts or a combination thereof that forms an extinguishing agent. (*NFPA* 10 2013, Section 3.3.4.2)

Wetting Agent

A concentrate which, when added to water reduces the surface tension and increases its ability to penetrate and spread. (*NFPA* 10 2013, Section 3.3.28)

Wheeled Fire Extinguisher

A portable fire extinguisher equipped with a carriage and wheels intended to be transported to the fire by one person. (*NFPA* 10 2013, Section 3.4.9)

Refer to *NFPA* 10 2013, Section A.5.3.2.7 for further information.

CONTINUE

Click on the “Next” arrow up on the right-hand corner of the screen to continue to the quiz.

Ohio Portable Fire Extinguishers - Ohio Fire Code

This module will provide information on SOME of the Ohio Fire Code requirements for portable fire extinguishers.

It is not meant as a 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* 10, *Standard for Portable Fire Extinguishers*, 2013 edition.

You can reference the Ohio Fire Code at: http://codes.ohio.gov/oac/1301:7-7-09.
Key Reference for this module:

- Ohio Fire Code - Fire Protection Systems
    - https://codes.iccsafe.org/content/OHFCJAN2019E/ohio-administrative-code-1301-7-7-09-fire-protection-systems

Ohio Fire Code

Ohio Fire Code

Lesson Goal

By the end of this lesson, you will be able to do the following:

- [ ] Gain a working knowledge of Ohio Fire Alarm Code requirements for portable fire extinguishers.

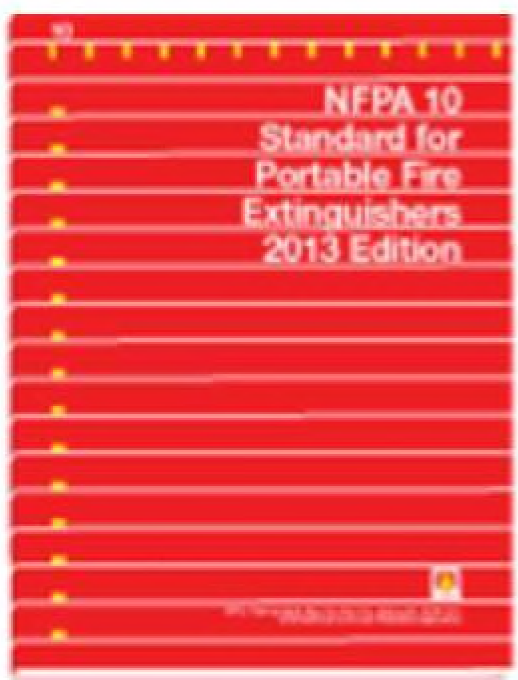
INTRODUCTION

Introduction

This module will provide information on **some** of the Ohio Fire Code requirements for portable fire extinguishers. This is not meant as a 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* 10, Standard for Portable Fire Extinguishers, 2013 edition.

In other instances, the Ohio Fire Code will refer you back to this standard for the necessary requirements, inspection, maintenance, and recharging of portable fire extinguishers.



Fire Protection Systems portion

You can reference the Ohio Fire Code by using this "Click Here" button to take you to the fire protection systems portion of the Fire Code

CLICK HERE

CONTINUE

The Ohio Fire Code lists all the sections that deal with portable fire extinguishers in Section 1301:7-7-80, Referenced Standards.

Referenced Standards Table

You can view these references by clicking on this "Click Here" button. The information you're looking for is in the NFPA table under the “Standard Reference Number” column and titled “10-13.”

CLICK HERE

Per the NFPA table, the sections of the building code covering portable fire extinguishers are:

- Section 308.1.4 and 308.1.4.1
- Section 906.2
- Section 906.3.2 and 906.3.4
- Section 3006.3

We will not cover every section listed above but will provide information so that you **get a feel for what the Ohio Fire Code entails**.

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OHIO FIRE CODE, SECTION 906

Ohio Fire Code, Section 906

The Ohio Fire Code 2017, Section 906 defines the requirements for portable fire extinguishers, which are to be selected and installed per *NFPA* 10 requirements.

SECTION 906.1

Section 906.1

Section 906.1 defines where portable fire extinguishers are required:

- Group A, B, E, F, H, I, M, R-1, R-2, R-4, and S occupancies (*note the exceptions*)
- Within 30 ft. of commercial cooking appliances and domestic cooking appliances in Group I-2 nursing homes
- In areas that store, use, or dispense flammable or combustible liquids
- On each floor of structures that are under construction, with the exception of R-3 occupancies
- Where required by Table 906.1, Additional Required Fire Extinguishers
- Special-hazards areas, such as laboratories, computer rooms, and generator rooms

ⓘ **The Ohio Fire Code 2017, Section 906.2.1, requires individuals conducting maintenance on portable fire extinguishers to hold a valid certificate issued for the type of work performed.**

SECTION 906.3

Section 906.3

Section 906.3 defines requirements pertaining to the size and distribution of portable fire extinguishers.

Click through the two tables (Table 906.3(1) and Table 906.3(2)) provided in this section.

Ohio Fire Code 2017, Table 906.3(1)
Fire Extinguishers for Class A Fire Hazards

	Light (Low) Hazard Occupancy	Ordinary (Moderate) Hazard Occupancy	Extra (High) Hazard Occupancy
Minimum rated single extinguisher	2-A [c]	2-A	4-A [a]
Maximum floor area per unit of A	3000 ft^2	1500 ft^2	1000 ft^2
Maximum floor area for extinguisher [b]	11,250 ft^2	11,250 ft^2	11,250 ft^2
Maximum distance of travel to extinguisher	75 ft.	75 ft.	75 ft.

Footnotes:

a. Two 2 ½ gallon water-type extinguishers shall be deemed the equivalent of one 4-A rated extinguisher.

b. Annex E.3.3 of NFPA 10 provides more details concerning application of the maximum floor area criteria.

c. Two water-type extinguishers each with a 1-A rating shall be deemed the equivalent of one 2-A rated extinguisher for Light (Low) Hazard Occupancies.

Table 906.3(1) lists the rating, maximum floor area, and maximum distance of travel for fire extinguishers suitable for Class A hazards

Ohio Fire Code 2017, Table 906.3(2) Flammable or Combustible Liquids with Depths of Less Than or Equal to 0.25 inch		
Type of Hazard	Basic Minimum Extinguisher Rating	Maximum Distance of Travel to Extinguishers (ft.)
Light (Low)	5-B 10-B	30 50
Ordinary (Moderate)	10-B 20-B	30 50
Extra (High)	40-B 80-B	30 50

Table 906.3(2) lists the extinguisher ratings and maximum travel distances for fire extinguishers based on types of hazard.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

According to Section 906.1, in what locations are portable fire extinguishers required? (Select all that apply)

- [ ] Group A occupancies
- [ ] Group B occupancies
- [ ] Group C occupancies
- [ ] Within 30 ft. of commercial cooking appliances and domestic cooking appliances in Group I-2 nursing homes
- [ ] Only on the first floor of structures that are under construction, with the exception of R-3 occupancies
- [ ] Laboratories
- [ ] Computer rooms

SUBMIT

____ is the minimum rated single extinguisher for Class A fire hazards in an ordinary hazard occupancy.

- 2-A
- 4-A
- 5-B
- 10-B

SUBMIT

SECTIONS 906.5 TO 906.8

Sections 906.5 to 906.8

Per Sections 906.5 – 906.8, portable fire extinguishers are to be located such that they are **easily accessible and immediately available** for use, along normal paths of travel, unless otherwise indicated by the building official.

The extinguishers must also **not be obstructed or obscured from view**. If a visual obstruction cannot be avoided, the **location must be indicated by other means**.

.

[Extinguisher cabinets]() that house extinguishers are required to **remain unlocked**.

Note the exceptions:

- In areas where the extinguishers may be used to damage or harm
- In Group I-3 occupancies and mental health areas of Group I-2 occupancies

SECTION 906.9

Section 906.9

Section 906.9 addresses installation requirements.

1. Portable fire extinguishers with a gross weight 40 lbs. or less are required to be installed with their tops no more than 5 ft. above the floor.

2. Hand-held portable fire extinguishers with a gross weight greater than 40 lbs. are required to be installed with their tops no more than 3.5 ft. above the floor.

3. The clearance between the floor and the bottom of an installed hand-held portable fire extinguisher shall be no less than 4 in.

LET'S REVIEW

Let's do a quick check about what has been covered so far.

Cabinets that house fire extinguishers are required to remain unlocked, except in the following areas: (Select all that apply)

- [ ] In areas where the extinguishers may be used to damage or harm

- [ ] In Group I-1 occupancies
- [ ] In mental health areas of Group I-2 occupancies
- [ ] In Group I-3 occupancies
- [ ] In Light Hazard Occupancies

SUBMIT

CONTINUE

Click on the "Next" arrow up on the right corner of the screen to continue to the quiz.

File Attachments for Item:

EC-5 Understanding the National Electric Code Based on the 2017 NEC (Master Electrical Contractors Association)

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 Course Approval

Provider Information:

Name: Laura Bachman

Organization: Master Electrical Contractors Association

Address: 1555 Stanley Avenue Dayton Ohio 45404

E-mail: Laurameca@aol.com Telephone: 937-264-0418

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: Understanding the NEC - Based on the 2017 National Electric Code

Course instructor: D.Dewayne Jenkins and Robert Barnett

Course description: The discuss and learn the purpose and intent of NEC, understand who it's written for and where it fits into your work.

Instructional hours per session: five (5) Number of Sessions: ______

Course Date(s) and Location: March 11, 2023 Presidential Banquet Center 4548 Presidential way Dayton Ohio 45429

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

CODE CLASSES - CONTINUING EDUCATION PROGRAM

LOCATION: PRESIDENTIAL BANQUET CENTER
4548 PRESIDENTIAL WAY DAYTON OHIO 45429
DATES: MARCH 11 AND MARCH 18, 2023
TIME: 7:00 AM – 7:30 AM – BREAKFAST
7:30 AM - 1:00 PM – CLASS

INTRODUCTION:

THESE CLASSES WILL BE DIRECTED TO THE MEN IN THE FIELD, CONTRACTORS AND ELECTRICAL INSPECTORS.

THE CLASSES ARE APPROVED BY THE STATE OF OHIO FOR RECERTIFICATION CREDITS WHICH ARE REQUIRED FOR THE STATE REGISTRATION AND RECERTIFICATION.

CONTRACTORS CAN RECEIVE A TOTAL OF TEN (10) CREDIT HOURS APPROVED BY THE OCILB.
(PENDING ACCEPTACE OF OBBS) INSPECTORS CAN RECEIVE TEN (10) CREDIT HOURS APPROVED BY OBBS.
THIS COURSE IS APPROVED FOR CONTINUING EDUCATION CREDIT IN KENTUCKY FOR ME/EE.

TOPICS TO BE COVERED:

THESE SESSIONS WILL CONSIST OF THE UNDERSTANDING THE NEC – BASED ON THE 2017 NEC

THE INSTRUCTORS:

DEWAYNE JENKINS - ESI & EPE for the City of Kettering Ohio
ROBERT BARNETT – Tri-County Electric Owner/Operator

ENROLLMENT –

OPEN TO MEMBERS AND NON-MEMBERS. CLASS SIZE – FIRST PAID 125 PERSONS. IF YOU ARE NOT NOTIFIED, PLEASE PLAN ON ATTENDING. (LAURA BACHMAN 937-264-0418)

FOR MORE INFORMATION:

LAURA BACHMAN - 937 264-0418 OR MECAIECDAYTON@GMAIL.COM

ATTENDEES SHOULD BRING A COPY OF THE 2017 NEC BOOK

(OVER)

Daniel Dewayne Jenkins

Dewayne started his career in the electrical field in August of 1982 in Dayton, Ohio and has over 40 years' 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 the Senior Building Inspector and conducts electrical plans examinations, electrical safety inspections and building inspections for the past 23 years.

Dewayne is an adjunct lecturer II for Sinclair Community College in the electrical trades for the past 20 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 serves as President of the Southwest Division of IAEI, Ohio Chapter (2018-2022) and President of the Miami Valley Building Officials Council (2002 & 2003). He also serves on the Electrical Safety Inspector Advisory Committee for the Ohio Board of Building Standards.

Address: 3600 Shroyer Road, Kettering, OH 45429

Robert L. Barnett

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Brookville, OH 45309

937.510.0424
rbarnett@tricountyelectricalservices.com

Small Business Owner

Strategic Planning • Project Management • Construction • Team Leadership • Customer Service • Value Engineering • Project Coordination • Highly Detailed • Organizational Effectiveness • Design-Build • Quality Control • Materials Management • Educational Leadership

A multi-skilled professional with a solid career history in the electrical industry. Able to manage complex projects in various environments. Able to lead projects in under budget by managing and supervising an effective team in the installation of a quality product. Making a professional appearance to customers and other employees.

Technical Proficiencies

Microsoft Office	Excel	AutoCAD	Networks
Internet & Research	Word	Accounting Software	Citrix
Database Management	PowerPoint	ExamView	PDF Software

Professional Experience

Tri-County Electric, Brookville OH (License# EL48489) **2018-Present**

Owner (Since 2018)

- Creating and implementing business plans and strategies based on long term visions. Implement high-level planning to measure progress, gather insight and readjust plans and goals as necessary.
- Establish and maintain business banking accounts, payment processing systems, taxes, insurance and manage day-to-day costs and business expenses.
- Procuring business and contractor licensing for compliance with state and local licensing requirements.
- Establish solid marketing strategies and maintaining working relationships with clients to ensure outstanding customer service.
- Manage day-to-day business operations by overseeing employees and projects. Addressing various issues with staffing, project and technical issues.

Reliable Electric, Dayton OH **2006-2017**

Project Manager (3 years)

- Establish and manage cost, schedules, manpower and performance of large, highly complex projects. Fully accountable for complex/diverse projects with a high degree of business risk.
- Collaborate with general contractors, design professionals, sales representatives and business owners to accomplish project objectives. Identify and resolve project issues and manage project risk.
- ***Project Examples:***
    - Managed a $1.5M energy conservation project at Wright State University. Successfully supervised a team of 10 electricians in a complex energy retrofit on an active college university. Completed the project on time and under budget.
    - Completed a $4M urban development project in Downtown Cincinnati with a two-year scope.

Project Foreman (3 years)

- Perform business management duties such as maintaining records and files, preparing reports and ordering supplies and materials.
- Layout and installation of lighting, power, equipment and special systems wiring, based on construction documents and local codes.
- Assign work to other employees, prioritize the work of others and organize and coordinate the work of the project.
- Direct and train workers to install, maintain, or repair electrical wiring, equipment and fixtures.

Commercial Service Technician (2 years)

- Created and maintained business relationships with commercial and industrial clients.
- Troubleshoot malfunctions in circuitry, equipment, motor control circuits and special systems wiring using test equipment to correctly diagnose and repair problems.
- Use a variety of tools and equipment such as power construction equipment, measuring devices, power tools and testing equipment.

Field Electrician (3 years)

- Assist project foreman and journeyman on large commercial construction sites.
- Install, maintain and repair of electrical wiring, equipment and fixtures.
- Perform physical demanding tasks such as digging trenches to lay conduit and moving/lifting heavy objects.
- Fire alarm system installation and troubleshooting.

Sinclair Community College, Dayton OH **2013-2020**

Adjunct Instructor (7 years)

- First year instructor for the Independent Electrical Contractors (IEC) Apprenticeship Training Program, sponsored by the Master Electrical Contractors Association Training School (MECATS) Dayton Ohio
- Responsible for creating a positive learning environment for 10-12 entry level apprentice electricians.
- Develop lesson plans, quizzes and exams for student development and evaluation. Provide support and direction for students in and out of the classroom.
- Previously an active member of the MECATS A&T Committee.

Education

- **Electrical Engineering Technology/IEC Apprenticeship Program,** Sinclair Community College, Dayton OH, 2010 (GPA: 4.0)
  Ohio licensed Journeyman
  Ohio Fire Alarm licensed
- **Architectural /Engineering Technology,** Miami Valley Career Technology Center, Clayton OH, 2006 (GPA: 3.5)
- **Milton-Union High School,** West Milton OH, 2006 (GPA: 3.0)

UNDERSTANDING THE NEC:

Based on the 2017 National Electrical Code

By:

Robert Barnett

Course Objectives:

- Discuss the purpose and intent of NEC, understand who it's written for and where it fits into your work.
- Understand the concepts, terms, punctuation and grammar in order to understand the complex structure of the rules and their intended purposes
- Identify key words and identifiers in the code and their meanings
- Understand the style and layout of the Code in order to use it effectively. Identify chapters, articles, tables, annexes, etc.
- Locating specific requirements using the specific tools inside and outside of the NEC (Indexes, tabs, electronic word searches)
- Use the NEC to work through practice questions based on common scenarios in the field

The Purpose of the NEC

- What is the purpose of the National Electrical Code?

90.1 Purpose.

(A) Practical Safeguarding. The purpose of this *Code* is the practical safeguarding of persons and property from hazards arising from the use of electricity. This *Code* is not intended as a design specification or an instruction manual for untrained persons.

(B) Adequacy. This *Code* contains provisions that are considered necessary for safety. Compliance therewith and proper maintenance result in an installation that is essentially free from hazard but not necessarily efficient, convenient, or adequate for good service or future expansion of electrical use.

Article 90 is the introduction. It lays the foundation for understanding the National Electrical Code's scope and purpose, and where it fits into your work.

What's Covered By The NEC & What's Not??

90.2 Scope.

(A) Covered. This *Code* covers the installation and removal of electrical conductors, equipment, and raceways; signaling and communications conductors, equipment, and raceways; and optical fiber cables and raceways for the following:

(1) Public and private premises, including buildings, structures, mobile homes, recreational vehicles, and floating buildings
(2) Yards, lots, parking lots, carnivals, and industrial substations
(3) Installations of conductors and equipment that connect to the supply of electricity
(4) Installations used by the electric utility, such as office buildings, warehouses, garages, machine shops, and recreational buildings, that are not an integral part of a generating plant, substation, or control center

(C) Special Permission. The authority having jurisdiction for enforcing this *Code* may grant exception for the installation of conductors and equipment that are not under the exclusive control of the electric utilities and are used to connect the electric utility supply system to the service conductors of the premises served, provided such installations are outside a building or structure, or terminate inside at a readily accessible location nearest the point of entrance of the service conductors.

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

(1) Installations in ships, watercraft other than floating buildings, railway rolling stock, aircraft, or automotive vehicles other than mobile homes and recreational vehicles

Informational Note: Although the scope of this *Code* indicates that the *Code* does not cover installations in ships, portions of this *Code* are incorporated by reference into Title 46, Code of Federal Regulations, Parts 110–113.

(2) Installations underground in mines and self-propelled mobile surface mining machinery and its attendant electrical trailing cable
(3) Installations of railways for generation, transformation, transmission, energy storage, or distribution of power used exclusively for operation of rolling stock or installations used exclusively for signaling and communications purposes
(4) Installations of communications equipment under the exclusive control of communications utilities located outdoors or in building spaces used exclusively for such installations
(5) Installations under the exclusive control of an electric utility where such installations

a. Consist of service drops or service laterals, and associated metering, or
b. Are on property owned or leased by the electric utility for the purpose of communications, metering, generation, control, transformation, transmission, energy storage, or distribution of electric energy, or
c. Are located in legally established easements or rights-of-way, or

The Intent of the NEC

- It isn’t intended as a design specification or an instruction manual for untrained persons. It is, in fact, a standard that contains the minimum requirements for electrical installations.
- Learning to understand and use the Code is critical to you working safely, whether you’re training to become an electrician, or are already an electrician, electrical contractor, inspector, engineer, designer, or instructor.
- The NEC was written for those who understand electrical terms, theory, safety procedures, and electrical trade practices.
- Learning to use the Code is a lengthy process and can be frustrating if you don’t approach it the right way.
- You must also understand the concepts and terms, and know grammar and punctuation in order to understand the complex structure of the rules and their intended purpose(s). Our goal during this course is to give you some guidelines and suggestions on using your Code book to help you understand what you’re trying to accomplish, and how to get there.

Language Considerations for the NEC

Terms and Concepts:

- The NEC contains many technical terms, so it's crucial for Code users to understand their meanings and applications. If you don't understand a term used in a rule, it will be impossible to properly apply the NEC requirement.

- Article 100 defines the terms that are used in two or more Code articles; for example, the term **"Dwelling Unit"** is found in many articles. If you don't know the NEC definition for a "dwelling unit" you can't properly identify the Code requirements for it. Chapter 1, Article 100 covers definitions.

  - Did you know code experts often resolve National Electrical Code misunderstandings by simply using excerpts from Article 100? Become familiar with this Chapter, and you'll be ahead of the game. Try it!

  - What is the true definition of a dwelling unit? Let's take a look to see what qualifies…

Dwelling Unit. A single unit, providing complete and independent living facilities for one or more persons, including permanent provisions for living, sleeping, cooking, and sanitation. (CMP-2)

Here are some NEC requirements that apply to dwelling units

210.12 Arc-Fault Circuit-Interrupter Protection. Arc-fault circuit-interrupter protection shall be provided as required in 210.12(A), (B), and (C). The arc-fault circuit interrupter shall be installed in a readily accessible location.

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

210.52 Dwelling Unit Receptacle Outlets. This section provides requirements for 125-volt, 15- and 20-ampere receptacle outlets. The receptacles required by this section shall be in addition to any receptacle that is:

DWELLING UNIT
120 volt AFCI Protected Receptacle Outlets - REQUIRED LOCATIONS

DATE OF NEC EDITION	BEDROOMS	FAMILY ROOMS	DINING ROOMS	LIVING ROOMS	PARLORS	LIBRARIES	DENS	SUNROOMS	RECREATION ROOMS	CLOSETS	HALLWAYS	SIMILAR AREAS OR ROOMS	KITCHENS	LAUNDRY AREAS
1999	X_{1a}													
2002	X_{2a}													
2005	X_{2a}													
2008	X_{2b}	X_{2b}	X_{2b}	X_{2b}	X_{2b}	X_{2b}	X_{2b}	X_{2b}	X_{2b}	X_{2b}	X_{2b}	X_{2b}		
2011	X_{2c}	X_{2c}	X_{2c}	X_{2c}	X_{2c}	X_{2c}	X_{2c}	X_{2c}	X_{2c}	X_{2c}	X_{2c}	X_{2c}		
2014 *	X_{2c}	X_{2c}	X_{2c}	X_{2c}	X_{2c}	X_{2c}	X_{2c}	X_{2c}	X_{2c}	X_{2c}	X_{2c}	X_{2c}	X_{2d}	X_{2d}

1a. All 120-volt 15 and 20 amp branch circuits supplying RECEPTACLE OUTLETS in all bedrooms, i.e., AFCI is at breaker panel - Effective Date is January 1, 2002.

2a. All 120-volt 15 and 20 amp branch circuits supplying all OUTLETS in all bedrooms, i.e., AFCI is at breaker panel.

2b. All 120-volt 15 and 20 amp branch circuits supplying all OUTLETS in family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, or similar rooms or area, i.e., AFCI is at breaker panel - EXCEPT:

Exception 1 Where rigid conduit, intermediate conduit, EMT, or Type AC steel armored cable using metal outlet and junction boxes is used between the breaker and the first receptacle of a circuit, the AFCI device is permitted to be installed at the first outlet in the circuit.

Exception 2 Power limited fire alarm circuits provided those circuits are installed in rigid conduit, intermediate conduit, EMT, or Type AC steel armored cable using metal outlet and junction boxes - no AFCI protection is required. This exception will rarely be applicable for dwelling units.

2c. All 120-volt 15 and 20 amp branch circuits supplying all OUTLETS in family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, or similar rooms or area, i.e., AFCI is at breaker panel - EXCEPT:

Exception 1 Where rigid conduit, intermediate conduit, EMT, Type MC, or Type AC steel armored cable using metal outlet and junction boxes is used between the breaker and the first receptacle of a circuit, the AFCI device is permitted to be installed at the first outlet in the circuit.

Exception 2 Where metal or nonmetallic conduit or tubing is encased in not less than 2 inches of concrete between the breaker and the first receptacle of a circuit, the AFCI device is permitted to be installed at the first outlet in the circuit.

Exception 3 Power limited fire alarm circuits provided those circuits are installed in rigid conduit, intermediate conduit, EMT, or Type AC steel armored cable using metal outlet and junction boxes - no AFCI protection is required. This exception will rarely be applicable for dwelling units.

2d Added kitchen and Laundry areas.

* NOTE: With the 2014 NEC, Kitchen and Laundry Areas REQUIRE both AFCI and GFCI protection

DWELLING UNIT
120 volt GFCI Protected Receptacle Outlets - REQUIRED LOCATIONS

DATE OF NEC EDITION	SWIMMING POOLS	SPAS & HOT TUBS	EXTERIOR	BATHROOMS	GARAGE & ACCESSORY	HYDRO TUBS MASSAGE	BOATHOUSES	KITCHENS	UNFINISHED BASEMENTS	CRAWLSPACES	ALL SINKS (formerly WET BARS)	LAUNDRY UTILITY
1971	X_{1a}		X_{3a}									
1975	X_{1a}		X	X								
1978	X_{1a}		X_{3b}	X	X_{5a}							
1981	X_{1a}	X_{2a}	X_{3b}	X	X_{5a}							
1984	X_{1b}	X_{2a}	X_{3b}	X	X_{5a}							
1987	X_{1b}	$X_{2a,b}$	X_{3b}	X	X_{5a}	X_{6a}	X	X_{8a}	X_{9a}			
1990	X_{1b}	$X_{2a,b}$	X_{3b}	X	X_{5a}	X_{6a}	X	X_{8a}	X_{9b}	X_{10}		
1993[a]	X_{1b}	$X_{2a,b}$	X_{3b}	X	X_{5a}	X_{6b}	X	X_{8a}	X_{9b}	X_{10}	X_{11a}	
1996[a]	X_{1c}	$X_{2a,b}$	X_{3c}	X	$X_{5a,b}$	$X_{6b,c}$	X	X_{8b}	$X_{9b,c}$	X_{10}	X_{11a}	
1999[a]	X_{1c}	$X_{2a,b}$	X_{3c}	X	$X_{5b,c}$	$X_{6b,c}$	X	X_{8b}	$X_{9b,c}$	X_{10}	X_{11a}	
2002[a]	X_{1c}	$X_{2a,b}$	X_{3c}	X	$X_{5b,c}$	$X_{6b,c}$	X	X_{8b}	$X_{9b,c}$	X_{10}	X_{11a}	
2005[a]	X_{1c}	$X_{2a,b}$	X_{3c}	X	$X_{5b,c}$	$X_{6b,c}$	X	X_{8b}	$X_{9c,d}$	X_{10}	X_{11a}	X_{12a}
2008[a,b]	X_{1d}	$X_{2a,c}$	X_{3c}	X	X	$X_{6b,d}$	X	X_{8c}	X_{9e}	X_{10}	X_{11a}	X_{12a}
2011[a,b]	X_{1d}	$X_{2a,c}$	X_{3c}	X	X	$X_{6b,d}$	X	X_{8c}	X_{9e}	X_{10}	X_{11a}	X_{12a}
2014[a,b,c]	X_{1d}	$X_{2a,c}$	X_{3c}	X_4	X	$X_{6b,d}$	X	$X_{8c,d}$	X_{9e}	X_{10}	X_{11b}	X_{12b}

1a. All receptacle outlets within 15 feet of the water, in any direction (also see EXTERIOR), NO receptacle outlets within 10 feet of inside of pool walls.
1b. All receptacle outlets within 20 feet of the water, in any direction (also see EXTERIOR), NO receptacle outlets within 10 feet of inside of pool walls.
1c. All receptacle outlets within 20 feet of the water, in any direction (also see EXTERIOR), NO receptacle outlets within 10 feet of inside of pool walls, except receptacle outlets for pump which must be at least 5 feet from of inside of pool walls.
1d. All receptacle outlets within 20 feet of the water, in any direction (also see EXTERIOR), NO receptacle outlets within 6 feet of inside of pool walls, receptacle outlets for pumps at least 10 feet, except not less than 6 feet if meet special requirements (single, twist-lock, GFCI protected, grounded receptacle)
2a. Outdoor spa or hot tub – see Swimming Pools.
2b. Indoor spa or hot tub, receptacle outlets within 10 feet, receptacle outlets must be at least 5 feet from inside wall of spa.
2c. Indoor spa or hot tub, receptacle outlets within 10 feet, NO receptacle outlets within 6 feet of inside of spa or hot tub walls.
3a. Effective January 1, 1973.
3b. Changed to 'with direct grade access to dwelling and receptacle outlets' in 1978. Direct grade access was defined in 1987 as 6 feet 6 inches or less above grade.
3c. Changed back to ALL dwelling unit exterior receptacle outlets in 1996; except an outlet for snow melting equipment IF on a dedicated circuit and NOT readily accessible.
4. Receptacle outlets within 6 feet of outside edge of bathtubs and shower stalls – EVEN IF NOT IN A BATHROOM.
5a. All, except receptacle outlets not readily accessible (6 feet 8 inches or higher) and receptacle outlets for dedicated appliances which are not easily movable (freezer/refrigerator/etc.).
5b. Unfinished accessory buildings are treated like garage.
5c. Accessory buildings that have a floor located at or below grade and not intended as habitable rooms and limited to storage areas, work areas, and areas of similar use.
6a. *CIRCUITS* serving hydromassage tub. All CIRCUITS (not receptacle outlets) supplying a hydromassage tub are required to be GFCI protected.
6b. Hydromassage tub and associate electric components shall be GFCI protected – by GFCI protected circuit or by GFCI receptacle outlet.
6c. Receptacle outlets serving hydromassage tub. All 125-volt receptacle outlets within 5 feet horizontally from inside walls of hydromassage tub.
6d. Receptacle outlets serving hydromassage tub. All 125-volt 30 amp and less outlets within 6 feet horizontally from inside walls of hydromassage tub.
7. (No notes for column 7 – Boathouses)
8a. Receptacle outlets within 6 feet of kitchen sink to serve as counter top outlets, outlets not to be installed face up in work surfaces and counter tops.
8b. All receptacle outlets which serve as counter top receptacle outlets, except outlets for refrigerator or freezer.
8c. All receptacle outlets which serve as counter top receptacle outlets.
8d. All receptacle outlets provided for DISHWASHERS – receptacles are no longer permitted installed behind the dishwasher as the GFCI receptacle would not be readily accessible.
9a. At least one receptacle outlet and which must be identified as being GFCI protected.
9b. Changed to all receptacle outlets in unfinished basements and crawl spaces, except: laundry, sump pump, refrigerator or freezer.
9c. Except where not readily accessible.
9d. Changed to all receptacle outlets in unfinished basements, except: laundry appliances, refrigerator or freezer, or permanently installed burglar or fire alarm.
9e. Changed to all receptacle outlets in unfinished basements, except permanently installed fire alarm or burglar alarm system.
10. At or below grade level.
11a. Receptacle outlets within 6 feet of wet bar sink to serve as counter top receptacle outlets, outlets not to be installed face up in work surfaces and counter tops.
11b. Receptacle outlets within 6 feet of *ANY* sink - bathroom sinks are covered under bathrooms, kitchen sinks under kitchens; additionally, ALL sinks are covered by this.
12a. Receptacle outlets within 6 feet of sink.
12b. All receptacle outlets in laundry area.
a. Beginning in 1993 ALL receptacle outlets which are replaced and which are in locations which require GFCI protection in the code applicable at the time of replacement require the replacement receptacle outlets to be GFCI protected.
b. Beginning in 2008 ALL receptacle outlets installed in damp and/or wet locations are required to be listed as weather-resistant, INCLUDING GFCI receptacle outlets, these are typically identified by the abbreviations 'WR' on the face of the receptacle outlet with the 'WR' visible after installation.
c. NOTE: With the 2014 NEC, Kitchen and Laundry Areas REQUIRE both GFCI and AFCI protection

Language Considerations for the NEC (Cont'd)

Terms and Concepts:

- Articles have terms unique to that specific article, and the definitions of those terms are only applicable to that given article. These definitions are usually found in the beginning of the article.
  - For example, Section 250.2 contains the definitions of terms that only apply to Article 250—Grounding and Bonding.

250.2 Definition.

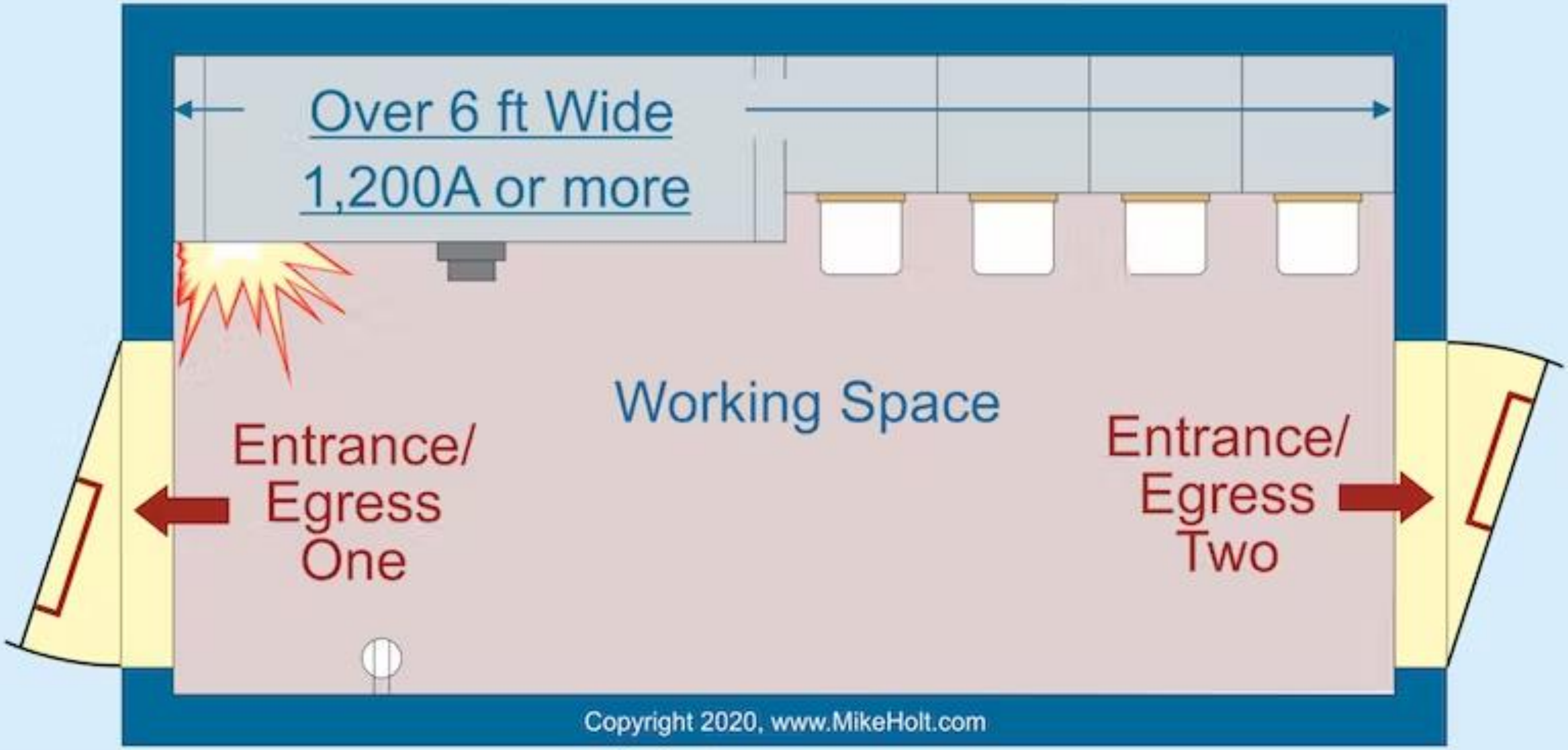
Bonding Jumper, Supply-Side. A conductor installed on the supply side of a service or within a service equipment enclosure(s), or for a separately derived system, that ensures the required electrical conductivity between metal parts required to be electrically connected.

Language Considerations for the NEC (Cont'd)

<u>Small Words, Grammar, and Punctuation</u>

- It's not only the technical words that require close attention since simple words can make a big difference to the application of a rule.
  - Was there a comma; was it "or," "and," "other than," "greater than," or "smaller than"? The word "or" can imply alternate choices for wiring methods. A word like "or" gives us choices while the word "and" can mean an additional requirement must be met.
  - An example of these words being used in the NEC is found in 110.26(C)(2), where it says equipment containing overcurrent, switching, **"or"** control devices that are 1,200A or more **"and"** over 6 ft wide that require a means of egress at each end of the working space. In this section, the word **"or"** clarifies that equipment containing any of the three types of devices listed must follow this rule. The word **"and"** clarifies that 110.26(C)(2) only applies if the equipment is both 1,200A or more and over 6 ft wide.

Access to and Egress from Working Space
Large Equipment
110.26(C)(2)(1)

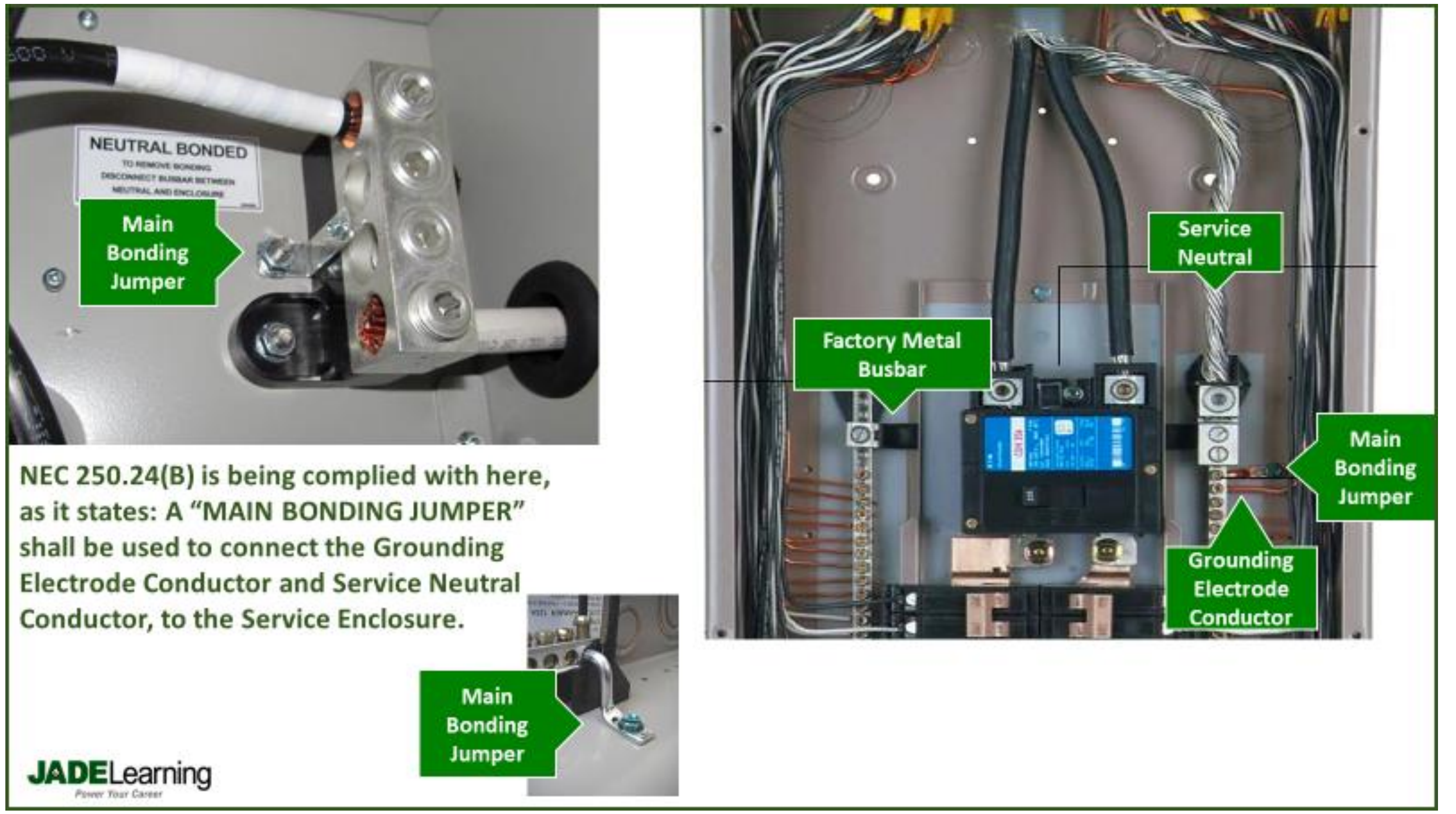


Equipment containing overcurrent devices or switching devices 1,200A or more and over 6 ft wide requires an entrance for the required working space not less than 24 in. wide and 6½ ft high at each end of the working space.

Language Considerations for the NEC (Cont'd)

- Grammar and punctuation play an important role in establishing the meaning of a rule.

- The location of a comma can dramatically change the requirement of a rule such as in 250.28(A), where it says a main bonding jumper must be a wire, bus, screw, or similar suitable conductor. If the comma between "bus" and "screw" was removed, only a "bus screw" could be used. That comma makes a big change in the requirements of the rule…



Language Considerations for the NEC (Cont'd)

<u>Slang Terms or Technical Jargon</u>

- Trade-related professionals in different areas of the country often use local "slang" terms that aren't shared by all. This can make it difficult to communicate if it isn't clear what the meaning of those slang terms are.

- Use the proper terms by finding out what their definitions and applications are before you use them.

  - For example, the term "pigtail" is often used to describe the short piece of conductor used to connect a device to a splice, but a "pigtail" is also a term used for a rubberized light socket with pre-terminated conductors. Although the term is the same, the meaning is very different and could cause confusion.

Identifying Key Words Used in the NEC

See NEC 90.5 Mandatory Rules, Permissive Rules, and Explanatory Material.

- **Mandatory Rules.** Mandatory rules of this *Code* are those that identify actions that are specifically required or prohibited and are characterized by the use of the terms *shall* or *shall not*.

- **Permissive Rules.** Permissive rules of this Code are those that identify actions that are allowed but not required, are normally used to describe options or alternative methods, and are characterized by the use of the terms shall be permitted or shall not be required.

- **Explanatory Material.** Explanatory material, such as references to other standards, references to related sections of this Code, or information related to a Code rule, is included in this Code in the form of informational notes. Such notes are informational only and are not enforceable as requirements of this Code.

- **Informative Annexes.** Non-mandatory information relative to the use of the NEC is provided in informative annexes.

NEC Style & Layout

- It’s important to understand the structure and writing style of the Code if you want to use it effectively. The National Electrical Code is organized using eleven major components.

1. Table of Contents
2. Chapters—Chapters 1 through 9 (major categories)
3. Articles—Chapter subdivisions that cover specific subjects
4. Parts—Divisions used to organize article subject matter
5. Sections—Divisions used to further organize article subject matter
6. Tables and Figures—Represent the mandatory requirements of a rule
7. Exceptions—Alternatives to the main *Code* rule
8. Informational Notes—explanatory material for a specific rule (not a requirement)
9. Tables—Applicable as referenced in the *NEC*
10. Annexes—Additional explanatory information such as tables and references (not a requirement)
11. Index

NEC Style & Layout (Cont'd)

Table of Contents

- The Table of Contents displays the layout of the chapters, articles, and parts as well as the page numbers. It's an excellent resource and should be referred to periodically to observe the interrelationship of the various NEC components.

- When attempting to locate the rules for a particular situation, knowledgeable Code users often go first to the Table of Contents to quickly find the specific NEC rule that applies.

NEC Style & Layout (Cont'd)

Chapters

- There are nine chapters, each of which is divided into articles. The articles fall into one of four groupings: General Requirements (Chapters 1 through 4), Specific Requirements (Chapters 5 through 7), Communications Systems (Chapter 8), and Tables (Chapter 9).

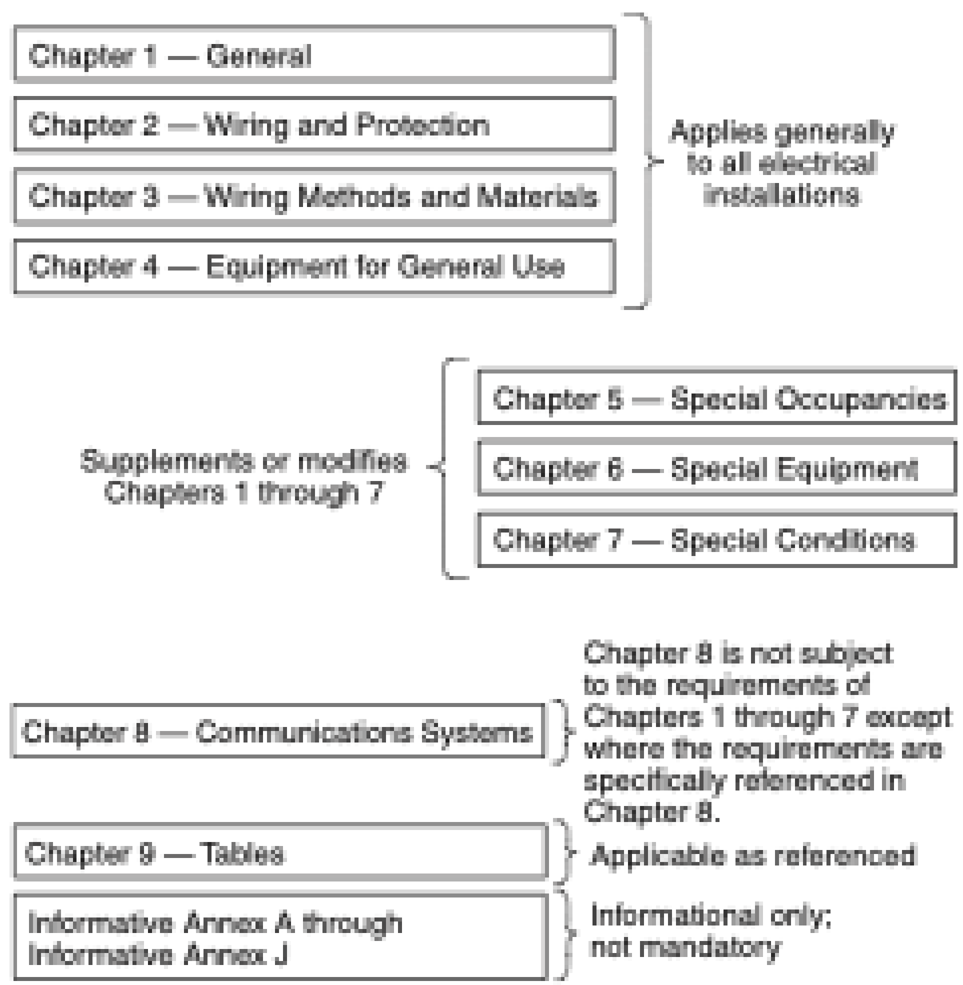


FIGURE 90.3 Code Arrangement.

NEC Style & Layout (Cont'd)

Chapter 1 - General :

- Article 100 - Definitions
- Article 110 - Requirements for Electrical Installation
  - 110.26 Spaces About Electrical Equipment

Table 110.26(A)(1) Working Spaces

Nominal Voltage to Ground	Minimum Clear Distance		
	Condition 1	Condition 2	Condition 3
0–150	900 mm (3 ft)	900 mm (3 ft)	900 mm (3 ft)
151–600	900 mm (3 ft)	1.0 m (3 ft 6 in.)	1.2 m (4 ft)
601–1000	900 mm (3 ft)	1.2 m (4 ft)	1.5 m (5 ft)

Note: Where the conditions are as follows:
Condition 1 — Exposed live parts on one side of the working space and no live or grounded parts on the other side of the working space, or exposed live parts on both sides of the working space that are effectively guarded by insulating materials.
Condition 2 — Exposed live parts on one side of the working space and grounded parts on the other side of the working space. Concrete, brick, or tile walls shall be considered as grounded.
Condition 3 — Exposed live parts on both sides of the working space.

Effective Ground-Fault Current Path to Open Overcurrent Device

Article 100 Definition

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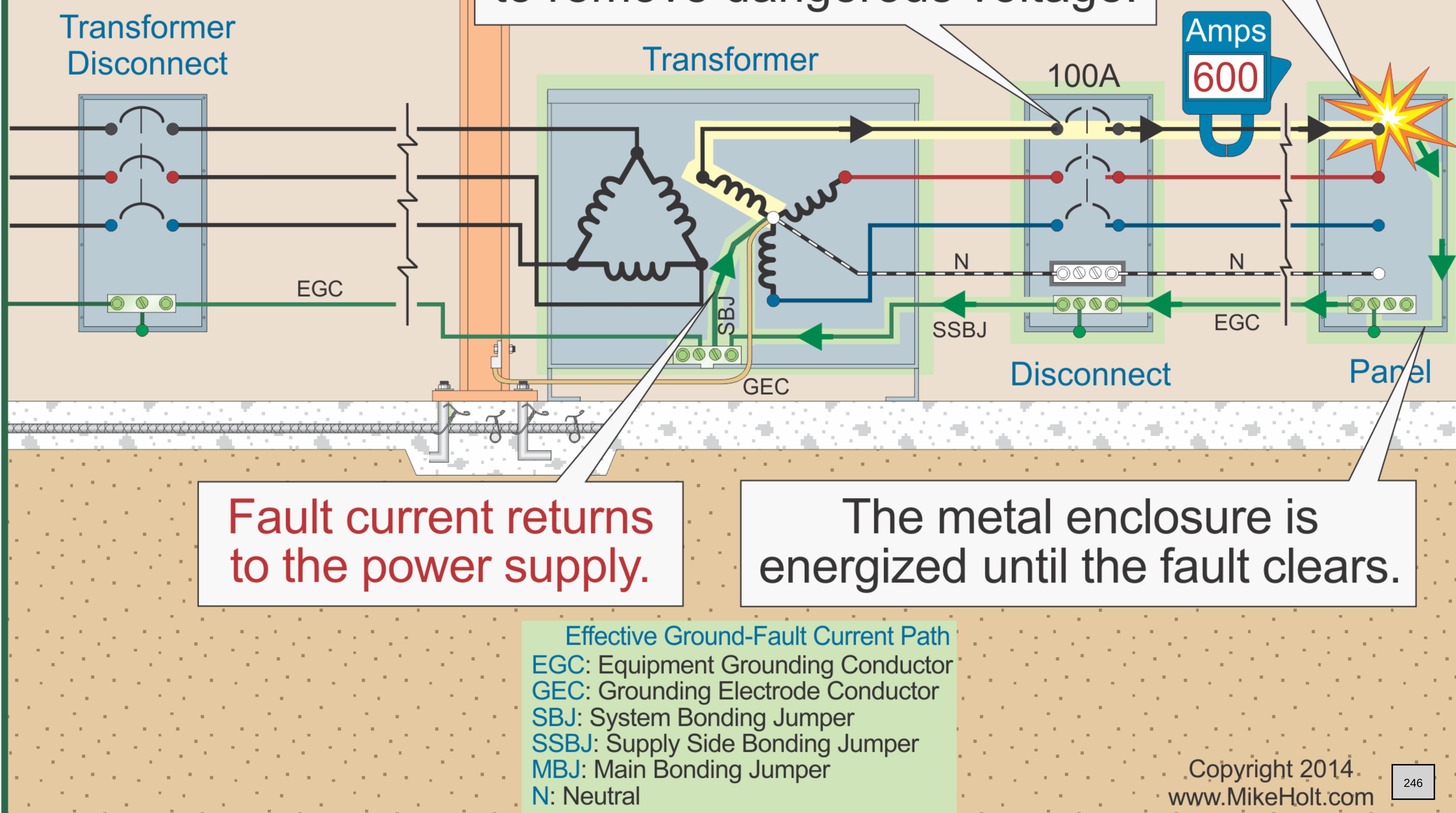


NEC Style & Layout (Cont'd)

Chapter 2 - Wiring & Protection

- 200 - Grounded Conductor Use & Identification
- 210 - Branch Circuits
    - GFCI & AFCI Protection requirements found in article 210
- 220 - Branch Circuit, Feeder & Service Calculations
- 230 - Services
- 240 - Overcurrent Protections
- 250 - Grounding & Bonding

200.6 Means of Identifying Grounded Conductors.

(A) Sizes 6 AWG or Smaller. An insulated grounded conductor of 6 AWG or smaller shall be identified by one of the following means:

(1) A continuous white outer finish.
(2) A continuous gray outer finish.
(3) Three continuous white or gray stripes along the conductor's entire length on other than green insulation.
(4) Wires that have their outer covering finished to show a white or gray color but have colored tracer threads in the braid identifying the source of manufacture shall be considered as meeting the provisions of this section.
(5) The grounded conductor of a mineral-insulated, metal-sheathed cable (Type MI) shall be identified at the time of installation by distinctive marking at its terminations.
(6) A single-conductor, sunlight-resistant, outdoor-rated cable used as a grounded conductor in photovoltaic power systems, as permitted by 690.31, shall be identified at the time of installation by distinctive white marking at all terminations.
(7) Fixture wire shall comply with the requirements for grounded conductor identification as specified in 402.8.
(8) For aerial cable, the identification shall be as above, or by means of a ridge located on the exterior of the cable so as to identify it.

(B) Sizes 4 AWG or Larger. An insulated grounded conductor 4 AWG or larger shall be identified by one of the following means:

(1) A continuous white outer finish.
(2) A continuous gray outer finish.
(3) Three continuous white or gray stripes along the conductor's entire length on other than green insulation.
(4) At the time of installation, by a distinctive white or gray marking at its terminations. This marking shall encircle the conductor or insulation.

250.119 Identification of Equipment Grounding Conductors. Unless required elsewhere in this *Code*, equipment grounding conductors shall be permitted to be bare, covered, or insulated. Individually covered or insulated equipment grounding conductors shall have a continuous outer finish that is either green or green with one or more yellow stripes except as permitted in this section. Conductors with insulation or individual covering that is green, green with one or more yellow stripes, or otherwise identified as permitted by this section shall not be used for ungrounded or grounded circuit conductors.

Exception No. 1: Power-limited Class 2 or Class 3 cables, power-limited fire alarm cables, or communications cables containing only circuits operating at less than 50 volts where connected to equipment not required to be grounded in accordance with 250.112(I) shall be permitted to use a conductor with green insulation or green with one or more yellow stripes for other than equipment grounding purposes.

Exception No. 2: Flexible cords having an integral insulation and jacket without an equipment grounding conductor shall be permitted to have a continuous outer finish that is green.

Informational Note: An example of a flexible cord with integral-type insulation is Type SPT-2, 2 conductor.

Exception No. 3: Conductors with green insulation shall be permitted to be used as ungrounded signal conductors where installed between the output terminations of traffic signal control and traffic signal indicating heads. Signaling circuits installed in accordance with this exception shall include an equipment grounding conductor in accordance with 250.118. Wire-type equipment grounding conductors shall be bare or have insulation or covering that is green with one or more yellow stripes.

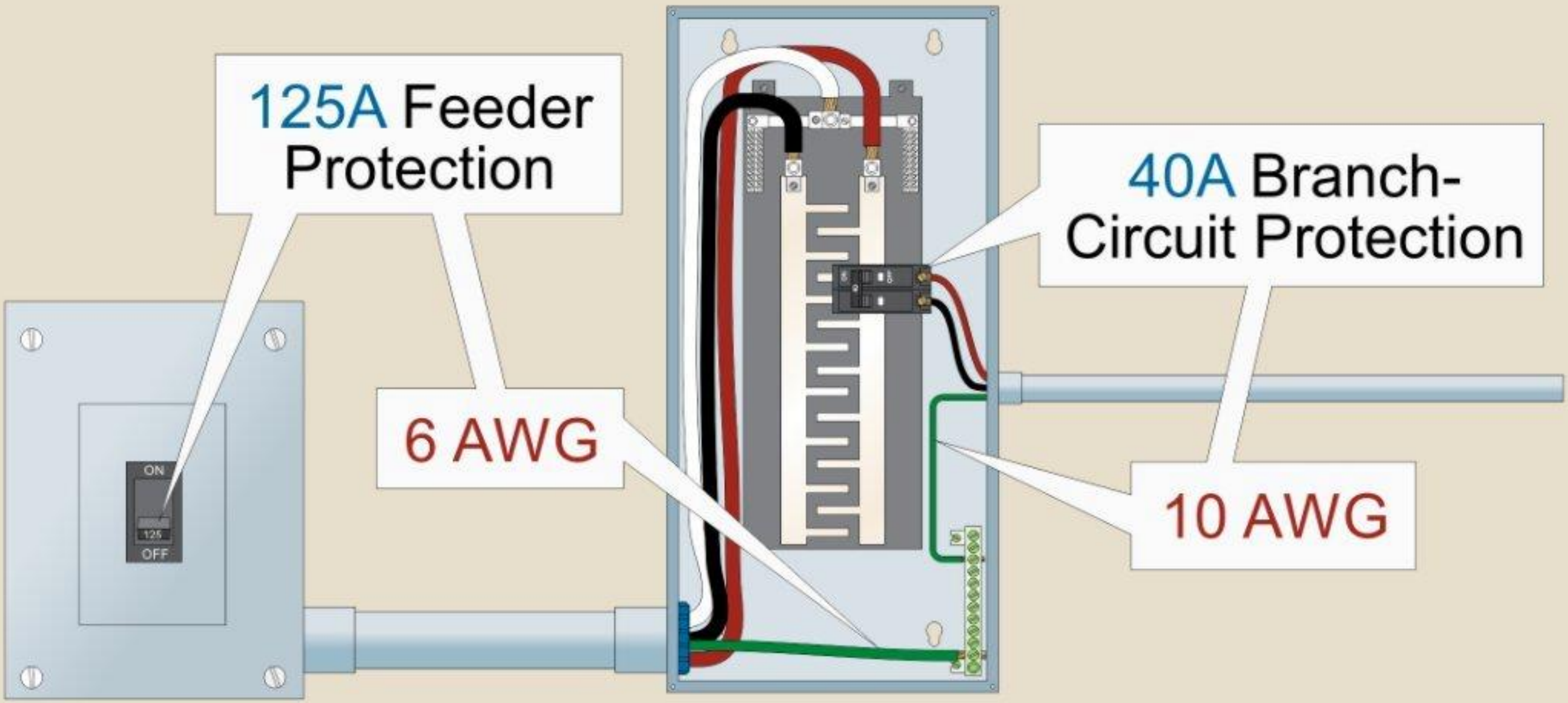
(A) Conductors 4 AWG and Larger. Equipment grounding conductors 4 AWG and larger shall comply with 250.119(A)(1) and (A)(2).

(1) An insulated or covered conductor 4 AWG and larger shall be permitted, at the time of installation, to be permanently identified as an equipment grounding conductor at each end and at every point where the conductor is accessible.

Exception: Conductors 4 AWG and larger shall not be required to be marked in conduit bodies that contain no splices or unused hubs.

(2) Identification shall encircle the conductor and shall be accomplished by one of the following:
   a. Stripping the insulation or covering from the entire exposed length
   b. Coloring the insulation or covering green at the termination
   c. Marking the insulation or covering with green tape or green adhesive labels at the termination

Sizing Equipment Grounding Conductor of the Wire Type
250.122(A) Example



An equipment grounding conductor is sized to the circuit's overcurrent device rating in accordance with Table 250.122.

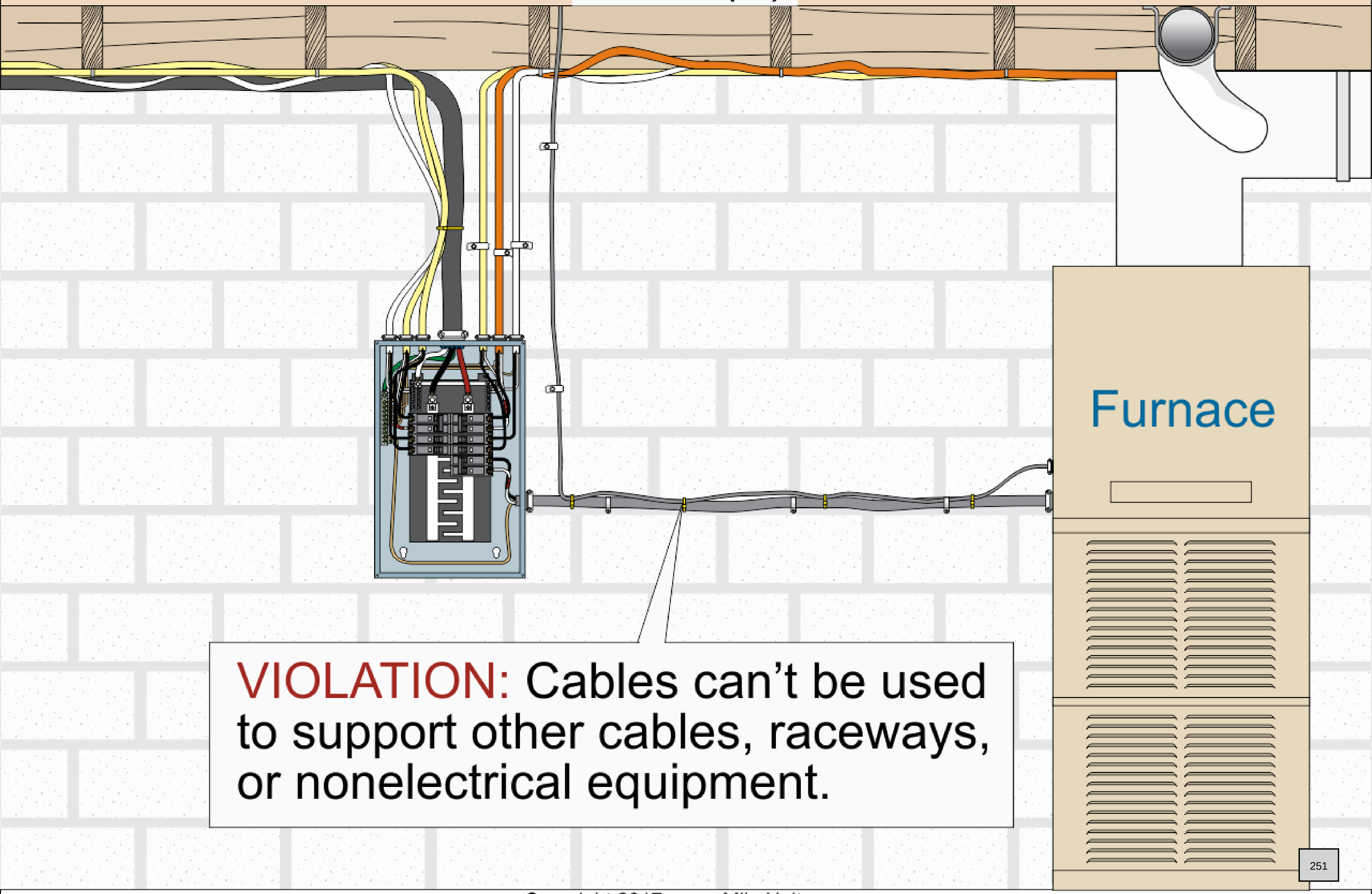
NEC Style & Layout (Cont'd)

Chapter 3 - Wiring Methods & Materials

- 300 - General Requirements
- 310 - Conductors for General Wiring
  - 310.15(B)(16) Conductor Ampacities
- 312 - Cabinet, Cutout Boxes and Meter Socket Enclosures
- 314 - Outlet, Device, Pull and Junction Boxes
  - 314.16 Box Fill
- 320-399 - Various Wiring Materials
  - MC Cable, Romex, FMC, LFMC, ETC.

Cables Not Used as Means of Support

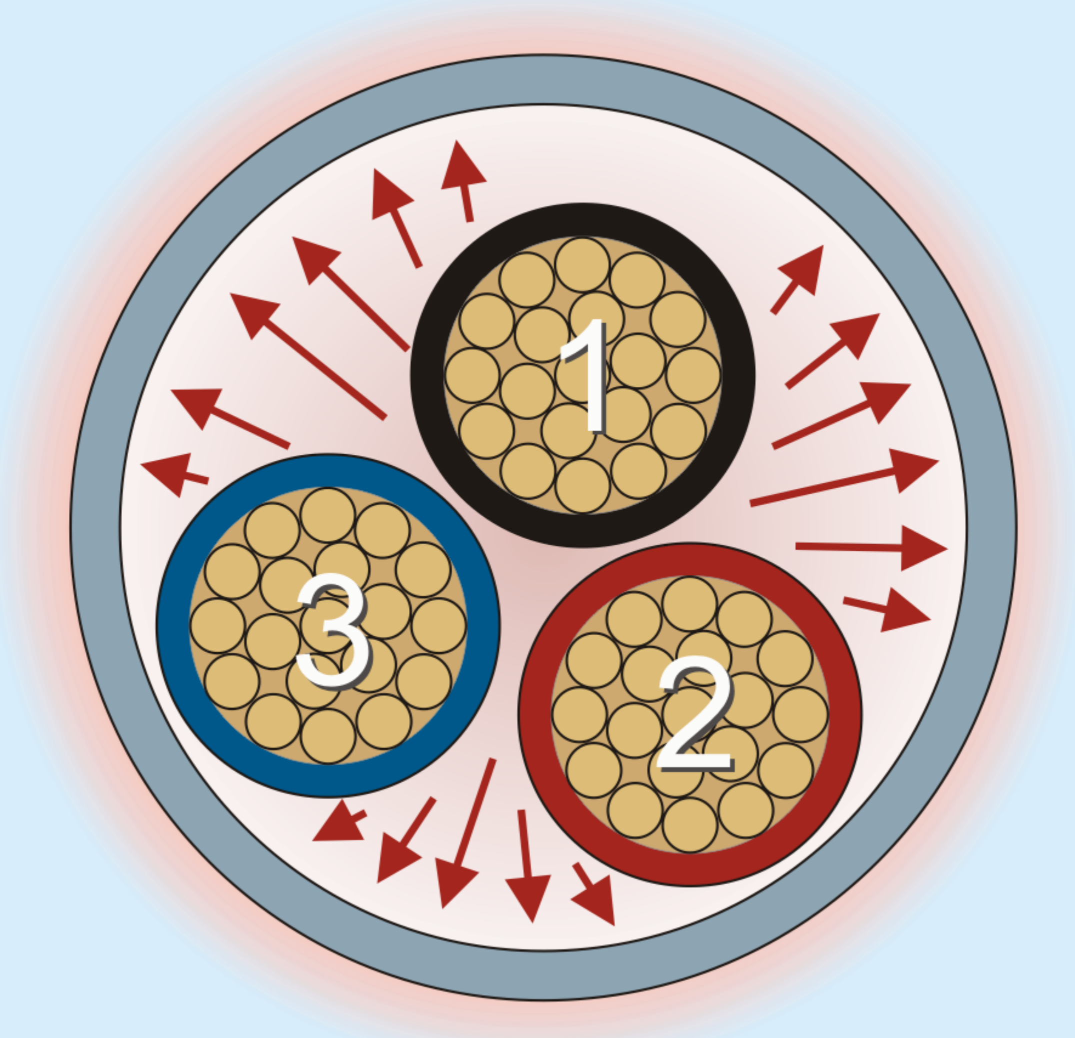
300.11(D)



VIOLATION: Cables can't be used to support other cables, raceways, or nonelectrical equipment.

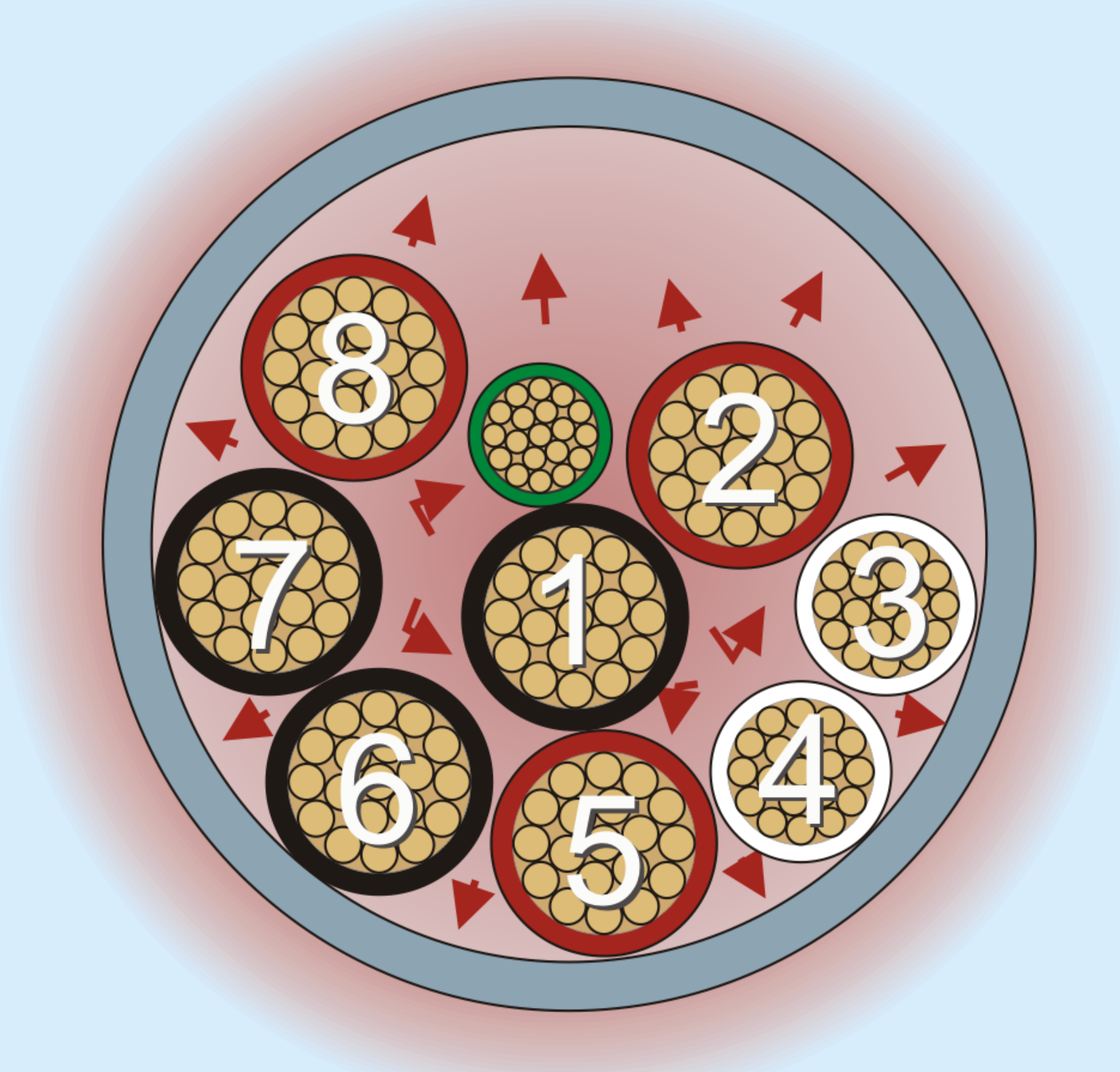
Conductor Ampacity Adjustment Factor
310.15(B)(3)(a)

No Ampacity Adjustment Three or Fewer Conductors



Conductors have more surface area for heat dissipation.

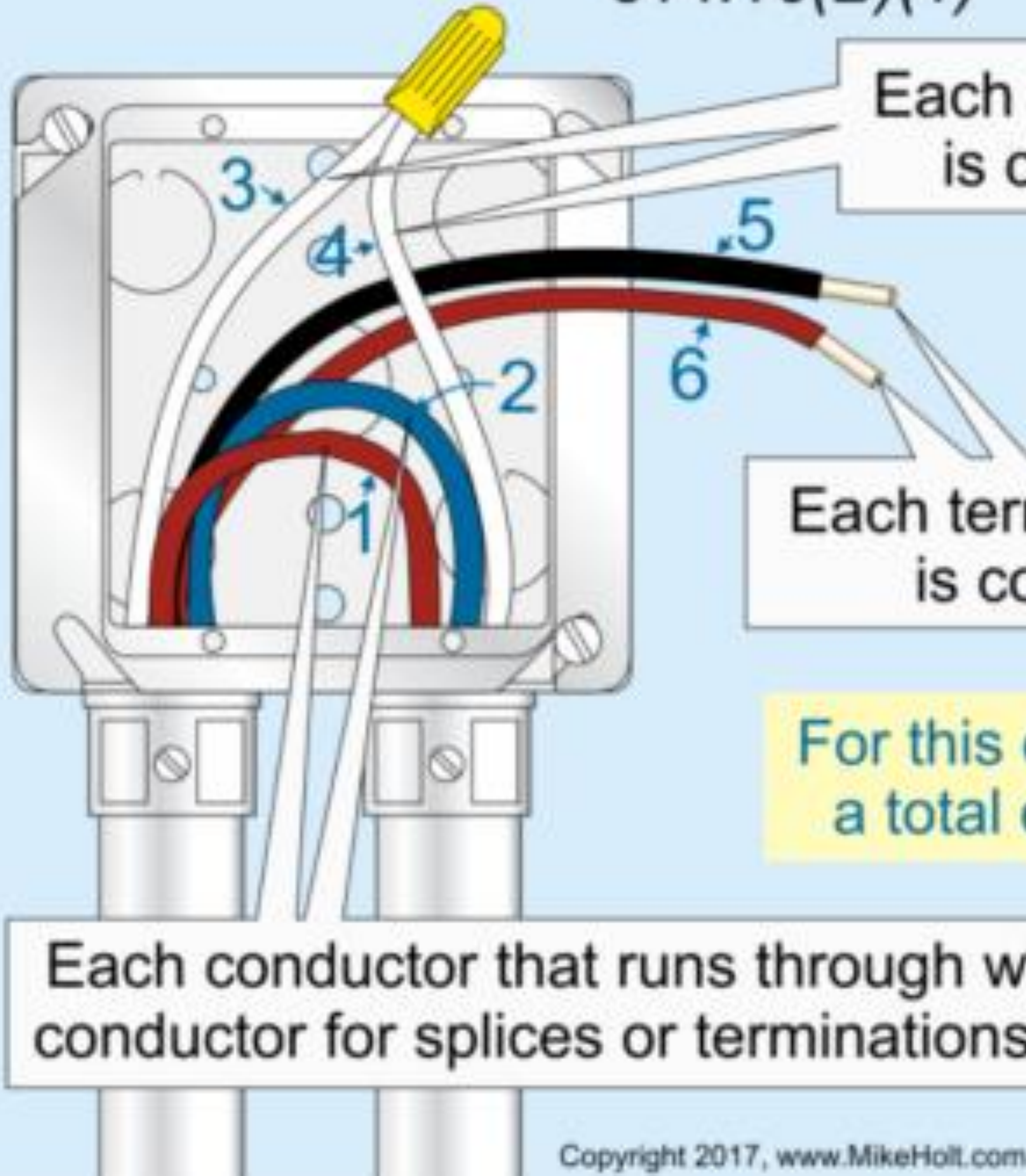
Ampacity Adjustment Factor = 70%



Bundled conductors have heat held in by other conductors.

Box Fill Calculations, Conductor Fill

314.16(B)(1)



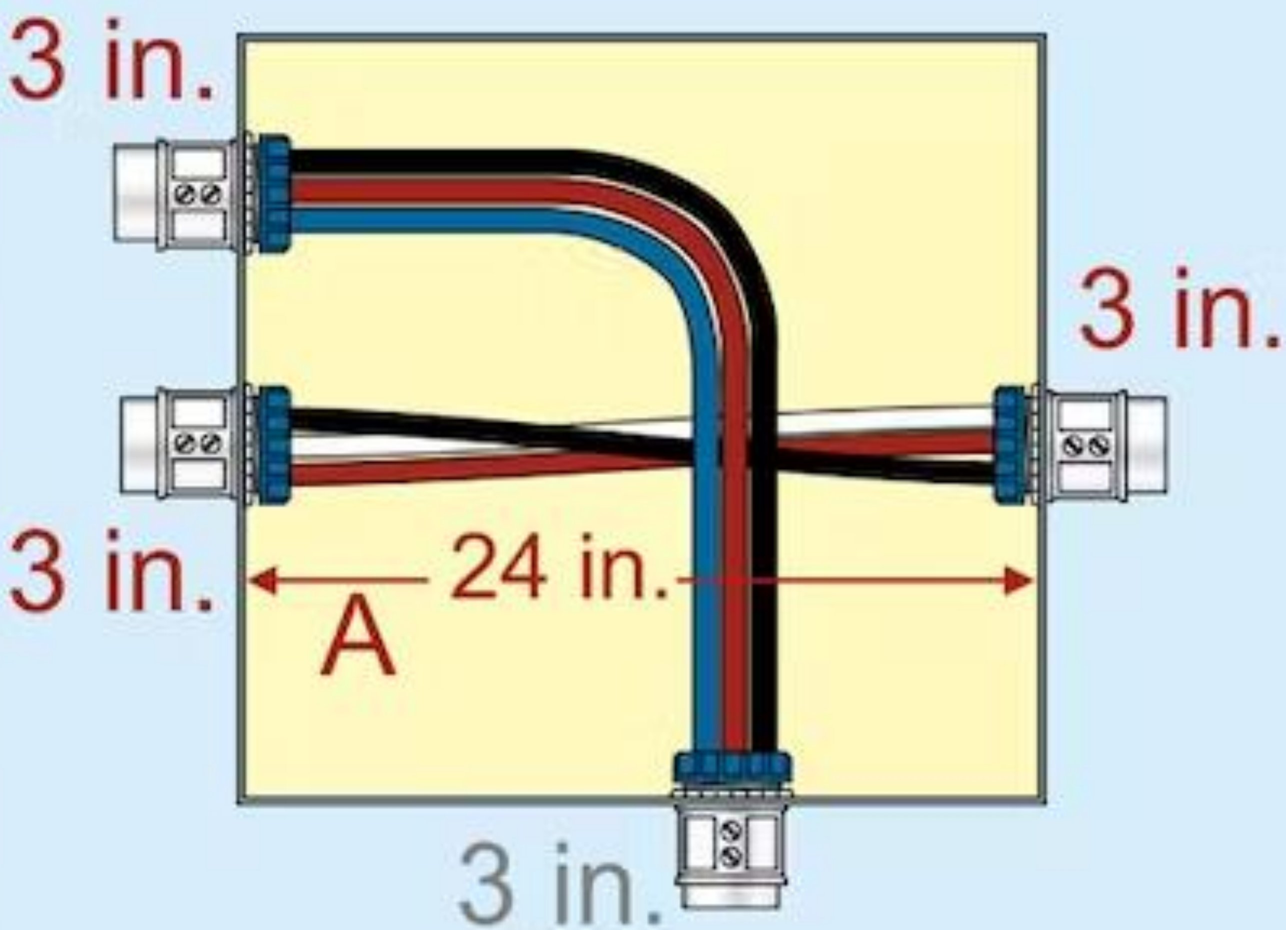
Each spliced conductor is counted as one.

Each terminating conductor is counted as one.

For this example, there are a total of six conductors.

Each conductor that runs through without 12 in. of free conductor for splices or terminations is counted as one.

Pull and Junction Boxes, Horizontal Conductors 4 AWG and Larger
314.28(A) Example



Horizontal Dimension A

Straight Pull:
Left to Right: 8 x 3 = 24 in.
Right to Left: 8 x 3 = 24 in.

Angle Pull:
Left to Right: (6 x 3) + 3 = 21 in.
Right to Left: No Calculation

Largest Calculation = 24 in.

NEC Style & Layout (Cont’d)

Chapter 3 - Cont’d

- Common Subsection Layout for Wiring Materials:
  - xxx.2 - Definitions
  - xxx.10 - Uses Permitted
  - xxx.12 - Uses Not Permitted
  - xxx.24 - Bending Radius
  - xxx.30 - Securing & Supporting

NEC Style & Layout (Cont'd)

Chapter 4 - Equipment For General Use

- 400 - Flexible Cords and Cables
  - Cord Ampacities
- 404 - Switches
  - Maximum mounting height of switches
- 406 - Receptacle, Cord Connectors and Attachment Plugs
  - TR & WR Requirements
- 408 - Switchboards, Switchgear and Panelboards
- 410 - Luminaires
- 430 - Motors
- 450 - Transformers

Table 400.5(A)(1) Allowable Ampacity for Flexible Cords and Flexible Cables [Based on Ambient Temperature of 30°C (86°F). See 400.13 and Table 400.4.]

Copper Conductor Size (AWG)	Thermoplastic Types TPT, TST	Thermoset Types C, E, EO, PD, S, SJ, SJO, SJOW, SJOO, SJOOW, SO, SOW, SOO, SOOW, SP-1, SP-2, SP-3, SRD, SV, SVO, SVOO, NISP-1, NISP-2 / Thermoplastic Types ETP, ETT, NISPE-1, NISPE-2, NISPT-1, NISPT-2, SE, SEW, SEO, SEOO, SEOW, SEOOW, SJE, SJEW, SJEO, SJEOO, SJEOW, SJEOOW, SJT, SJTW, SJTO, SJTOW, SJTOO, SJTOOW, SPE-1, SPE-2, SPE-3, SPT-1, SPT-1W, SPT-2, SPT-2W, SPT-3, ST, STW, SRDE, SRDT, STO, STOW, STOO, STOOW, SVE, SVEO, SVEOO, SVT, SVTO, SVTOO		Types HPD, HPN, HSJ, HSJO, HSJOW, HSJOO, HSJOOW
		Column A[a]	Column B[b]	
27[c]	0.5	—	—	—
20	—	5[d]	[e]	—
18	—	7	10	10
17	—	9	12	13
16	—	10	13	15
15	—	12	16	17
14	—	15	18	20
13	—	17	21	—
12	—	20	25	30
11	—	23	27	—
10	—	25	30	35
9	—	29	34	—
8	—	35	40	—
7	—	40	47	—
6	—	45	55	—
5	—	52	62	—
4	—	60	70	—
3	—	70	82	—
2	—	80	95	—

[a]The allowable currents under Column A apply to three-conductor cords and other multiconductor cords connected to utilization equipment so that only three-conductors are current-carrying.

[b]The allowable currents under Column B apply to two-conductor cords and other multiconductor cords connected to utilization equipment so that only two conductors are current-carrying.

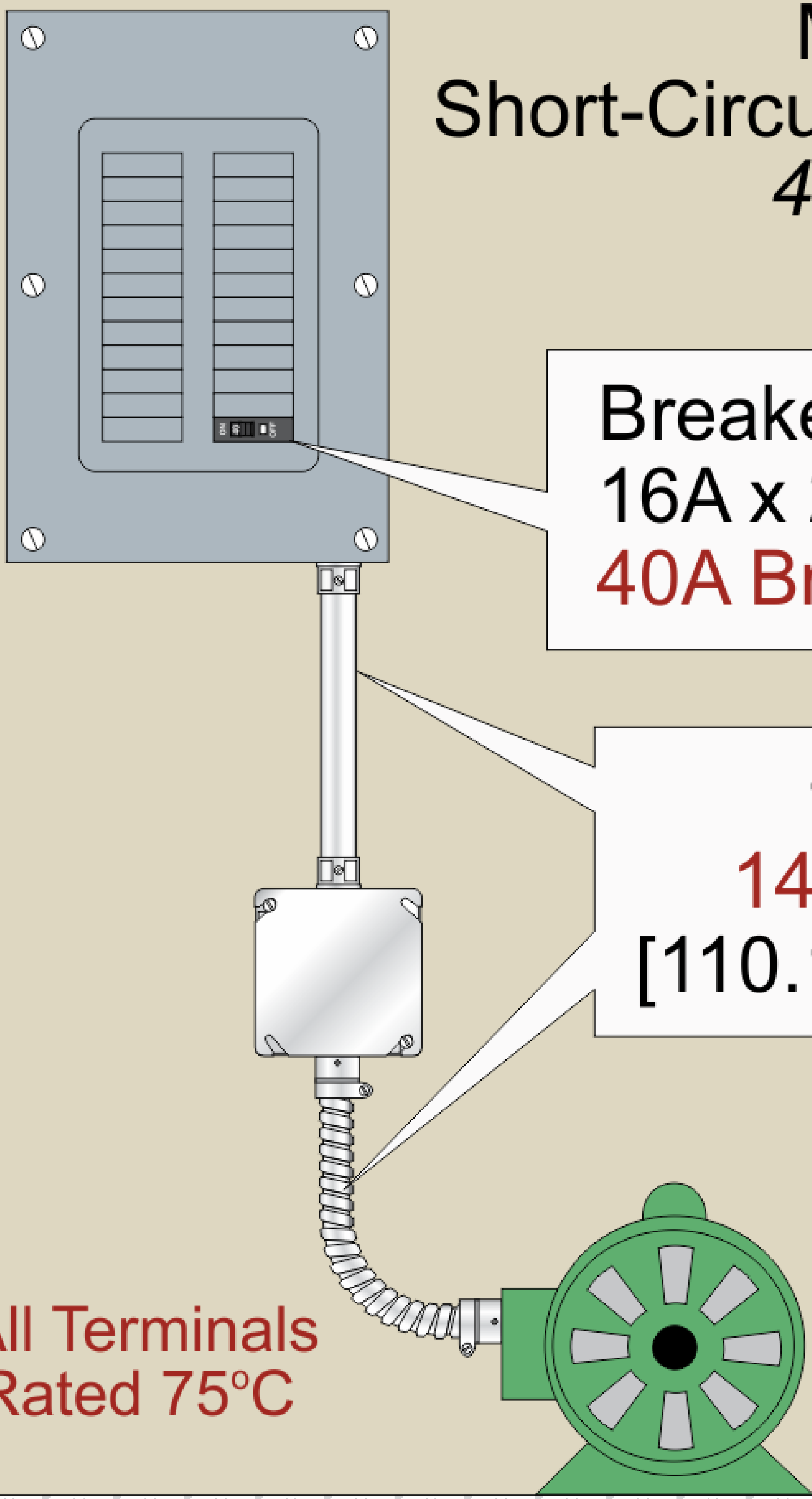
[c]Tinsel cord.

[d]Elevator cables only.

[e]7 amperes for elevator cables only; 2 amperes for other types.

Motor Branch-Circuit Short-Circuit and Ground-Fault Protection

430.52(C)(1) Example



Breaker, FLC x 250%
16A x 250% = 40A
40A Breaker [240.6(A)]

16A FLC x 125% = 20A
14 AWG Rated 20A at 75°C
[110.14(C)(1)(a)(3), Table 310.16]

All Terminals Rated 75°C

1 hp,
115 Volt
16A FLC
[Table 430.248]

Table 430.250 Full-Load Current, Three-Phase Alternating-Current Motors

The following values of full-load currents are typical for motors running at speeds usual for belted motors and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

	Induction-Type Squirrel Cage and Wound Rotor (Amperes)							Synchronous-Type Unity Power Factor* (Amperes)			
Horsepower	115 Volts	200 Volts	208 Volts	230 Volts	460 Volts	575 Volts	2300 Volts	230 Volts	460 Volts	575 Volts	2300 Volts
½	4.4	2.5	2.4	2.2	1.1	0.9	—	—	—	—	—
¾	6.4	3.7	3.5	3.2	1.6	1.3	—	—	—	—	—
1	8.4	4.8	4.6	4.2	2.1	1.7	—	—	—	—	—
1½	12.0	6.9	6.6	6.0	3.0	2.4	—	—	—	—	—
2	13.6	7.8	7.5	6.8	3.4	2.7	—	—	—	—	—
3	—	11.0	10.6	9.6	4.8	3.9	—	—	—	—	—
5	—	17.5	16.7	15.2	7.6	6.1	—	—	—	—	—
7½	—	25.3	24.2	22	11	9	—	—	—	—	—
10	—	32.2	30.8	28	14	11	—	—	—	—	—
15	—	48.3	46.2	42	21	17	—	—	—	—	—
20	—	62.1	59.4	54	27	22	—	—	—	—	—
25	—	78.2	74.8	68	34	27	—	53	26	21	—
30	—	92	88	80	40	32	—	63	32	26	—
40	—	120	114	104	52	41	—	83	41	33	—
50	—	150	143	130	65	52	—	104	52	42	—
60	—	177	169	154	77	62	16	123	61	49	12
75	—	221	211	192	96	77	20	155	78	62	15
100	—	285	273	248	124	99	26	202	101	81	20
125	—	359	343	312	156	125	31	253	126	101	25
150	—	414	396	360	180	144	37	302	151	121	30
200		552	528	480	240	192	49	400	201	161	40
250	—	—	—	—	302	242	60	—	—	—	—
300	—	—	—	—	361	289	72	—	—	—	—
350	—	—	—	—	414	336	83	—	—	—	—
400	—	—	—	—	477	382	95	—	—	—	—
450	—	—	—	—	515	412	103	—	—	—	—
500	—	—	—	—	590	472	118	—	—	—	—

*For 90 and 80 percent power factor, the figures shall be multiplied by 1.1 and 1.25, respectively.

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

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

Notes:

1. Where 125 percent of this current does not correspond to a standard rating of a fuse or nonadjustable circuit breaker, a higher rating that does not exceed the next higher standard rating shall be permitted.

2. Where secondary overcurrent protection is required, the secondary overcurrent device shall be permitted to consist of not more than six circuit breakers or six sets of fuses grouped in one location. Where multiple overcurrent devices are utilized, the total of all the device ratings shall not exceed the allowed value of a single overcurrent device.

3. A transformer equipped with coordinated thermal overload protection by the manufacturer and arranged to interrupt the primary current shall be permitted to have primary overcurrent protection rated or set at a current value that is not more than six times the rated current of the transformer for transformers having not more than 6 percent impedance and not more than four times the rated current of the transformer for transformers having more than 6 percent but not more than 10 percent impedance.

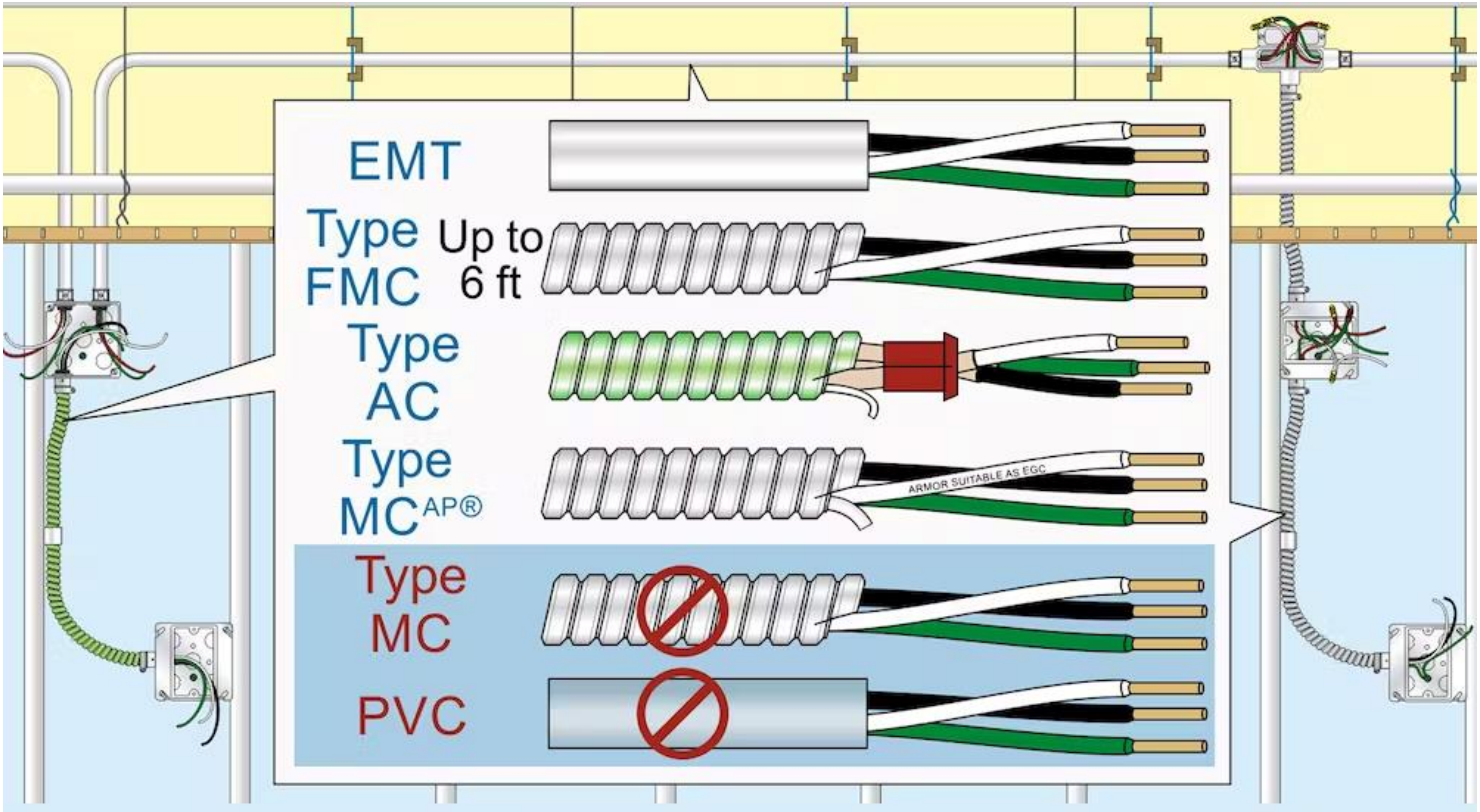
NEC Style & Layout (Cont’d)

Chapter 5 - Special Occupancies

- 500-503 - Hazardous (Classified) Locations
- 511 - Commercial Garages, Repair & Storage
- 517 - Healthcare Facilities

Chapter 5 supplements or modifies the requirements in Chapters 1-4 (wiring methods, etc.)

EGCs in Health Care Facilities

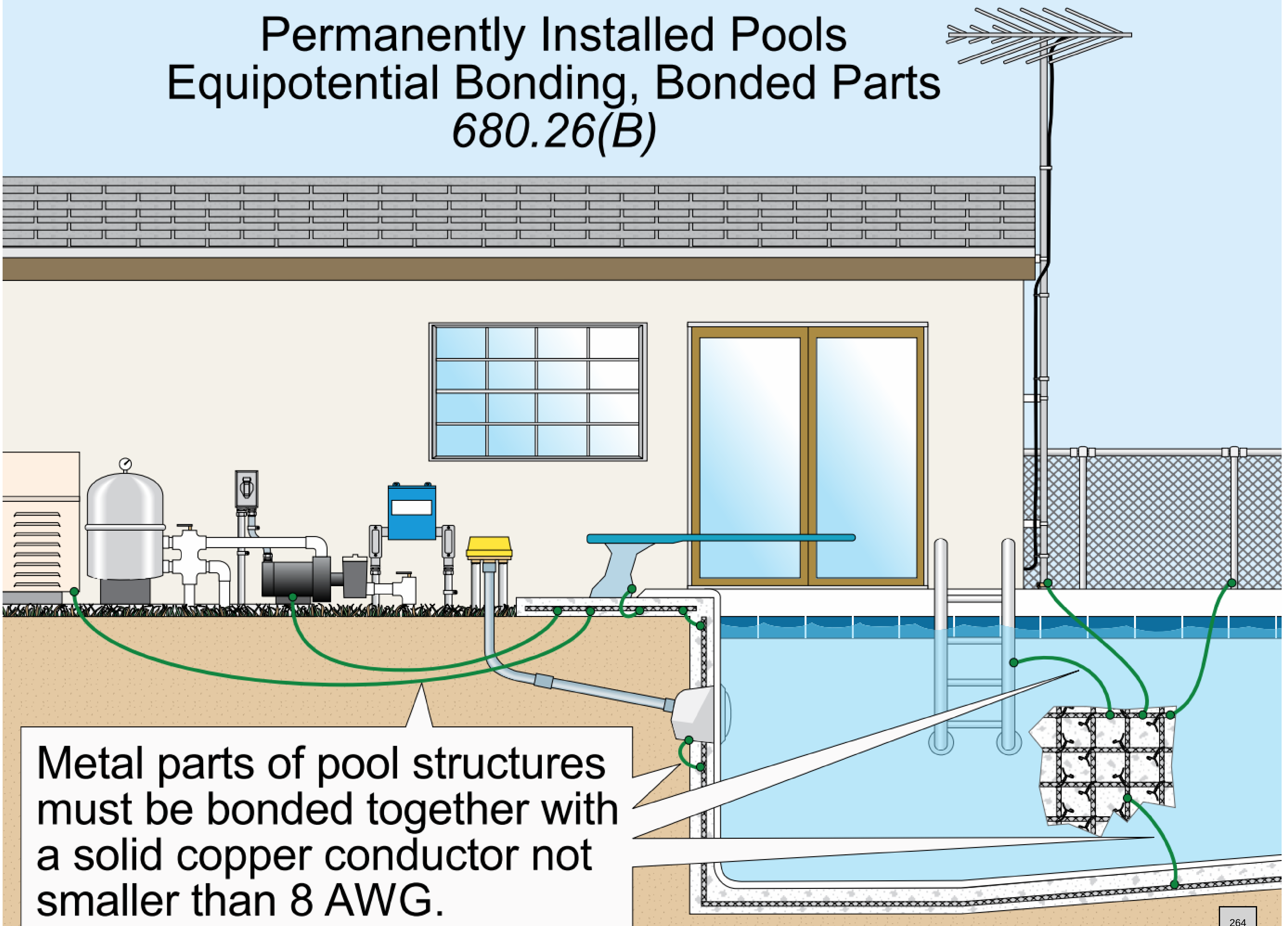


NEC Style & Layout (Cont'd)

Chapter 6 - Special Equipment

- 600 - Electric Signs
- 625 - Electric Vehicle Charging Systems
- 680 - Swimming Pools, Fountains and Similar Installations
- 690 - Solar (PV)
- 695 - Fire Pumps

Chapter 6 supplements or modifies the requirements in Chapters 1-4 (wiring methods, etc.)

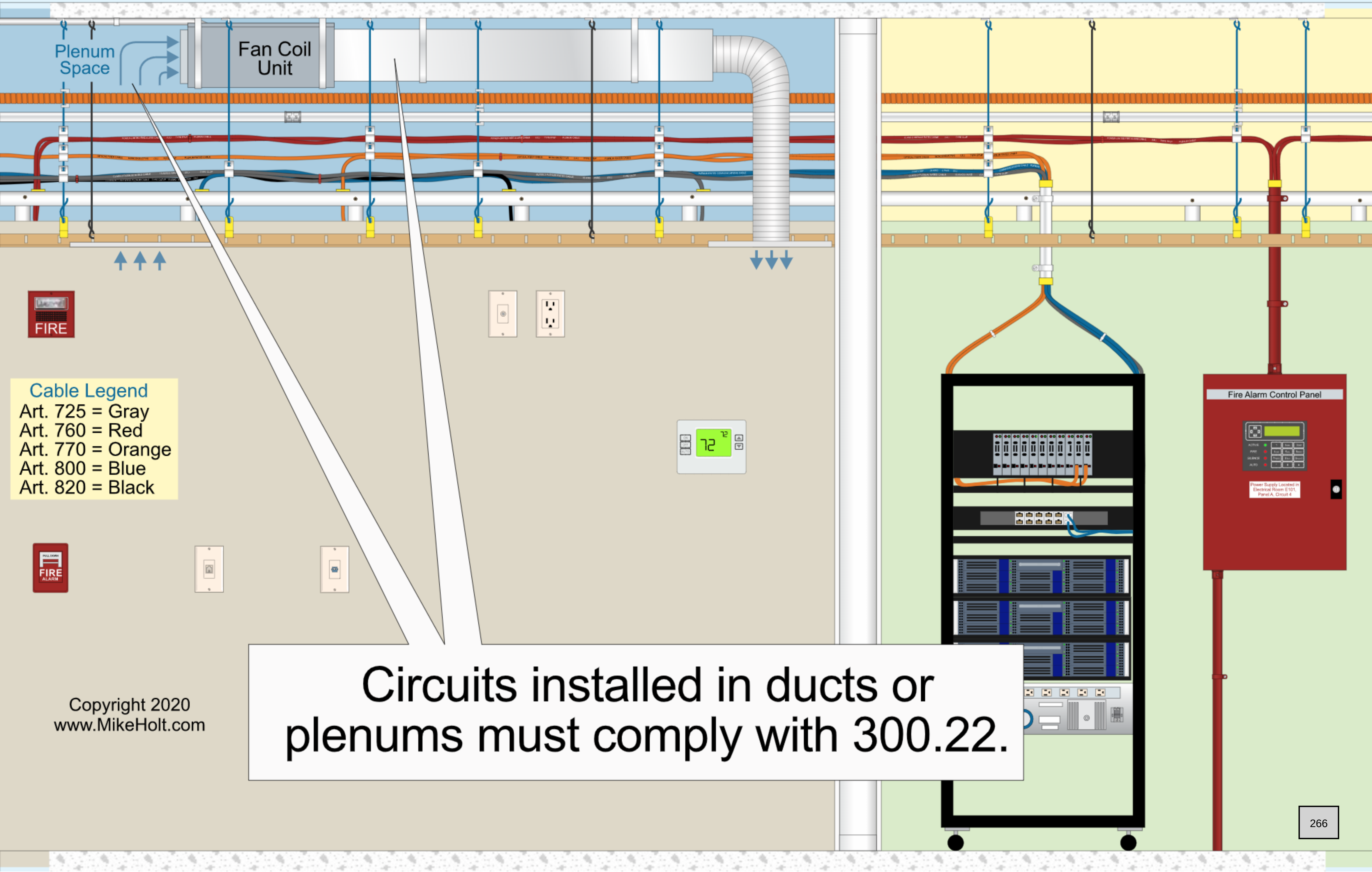

Permanently Installed Pools
Equipotential Bonding, Bonded Parts
680.26(B)
Metal parts of pool structures must be bonded together with a solid copper conductor not smaller than 8 AWG.
264

NEC Style & Layout (Cont'd)

Chapter 7 - Special Conditions

- 700 - Emergency Systems
  - What classifies a system as an *emergency system*?
- 701 - Legally Required Standby Systems
- 702 - Optional Standby Systems
- 760 - Fire Alarm Systems

Class 1 and Class 2 Circuits, Other Articles
Ducts and Plenums Spaces
725.3(C)



Circuits installed in ducts or plenums must comply with 300.22.

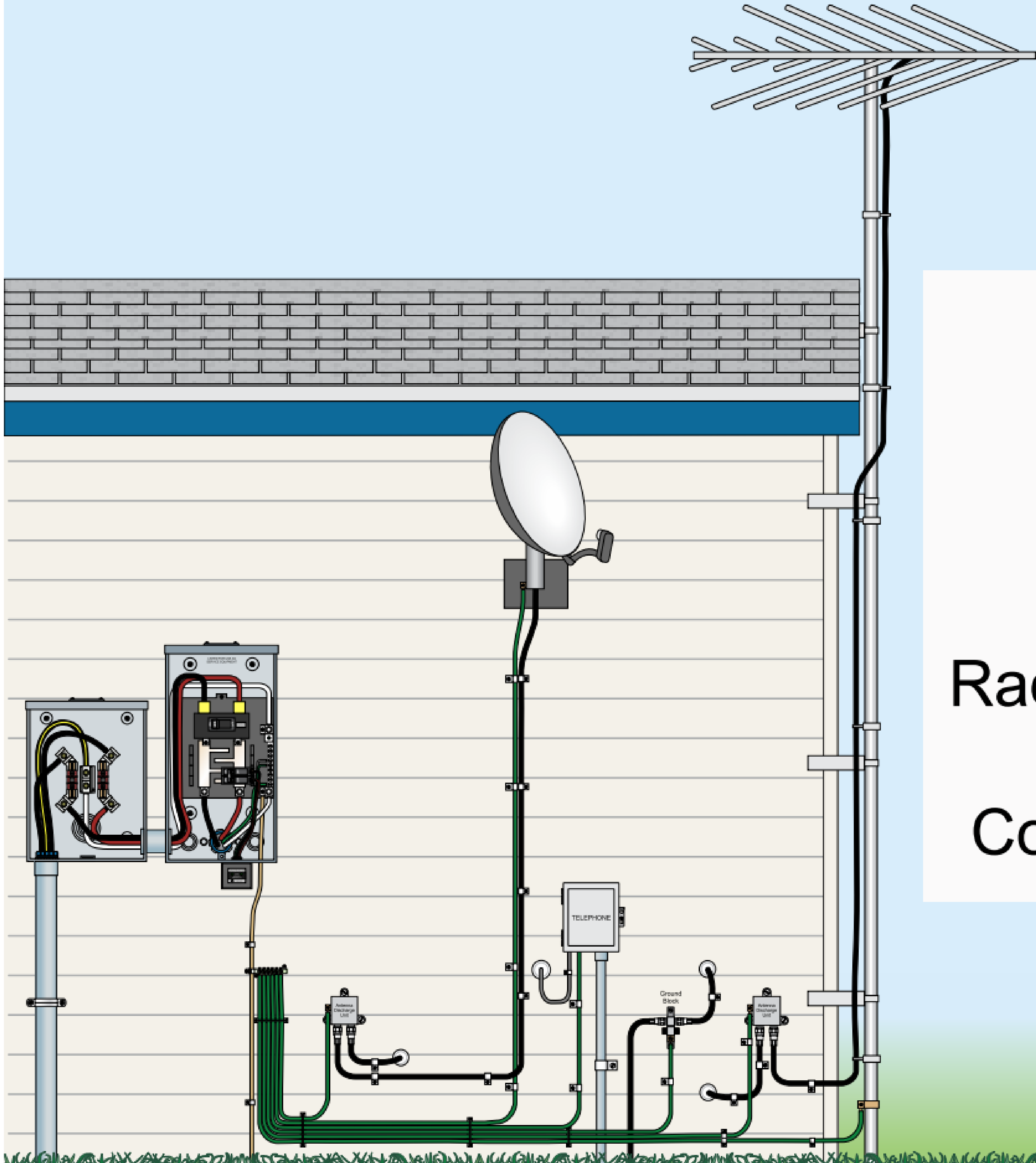
NEC Style & Layout (Cont'd)

Chapter 8 - Communication Systems

- Yeah, it's in our code!

800.24 Mechanical Execution of Work. Communications circuits and equipment shall be installed in a neat and workmanlike manner. Cables installed exposed on the surface of ceilings and sidewalls shall be supported by the building structure in such a manner that the cable will not be damaged by normal building use. Such cables shall be secured by hardware, including straps, staples, cable ties, hangers, or similar fittings, designed and installed so as not to damage the cable. The installation shall also conform to 300.4(D) and 300.11. Nonmetallic cable ties and other nonmetallic cable accessories used to secure and support cables in other spaces used for environmental air (plenums) shall be listed as having low smoke and heat release properties in accordance with 800.170(C).

Chapter 8
Communications Systems



Article 800
Communications Systems

Article 805
Communications Circuits

Article 810
Radio and Television Equipment

Article 820
Community Antenna Television

Buildings or Structures With Intersystem Bonding Termination
810.21(F)(1)

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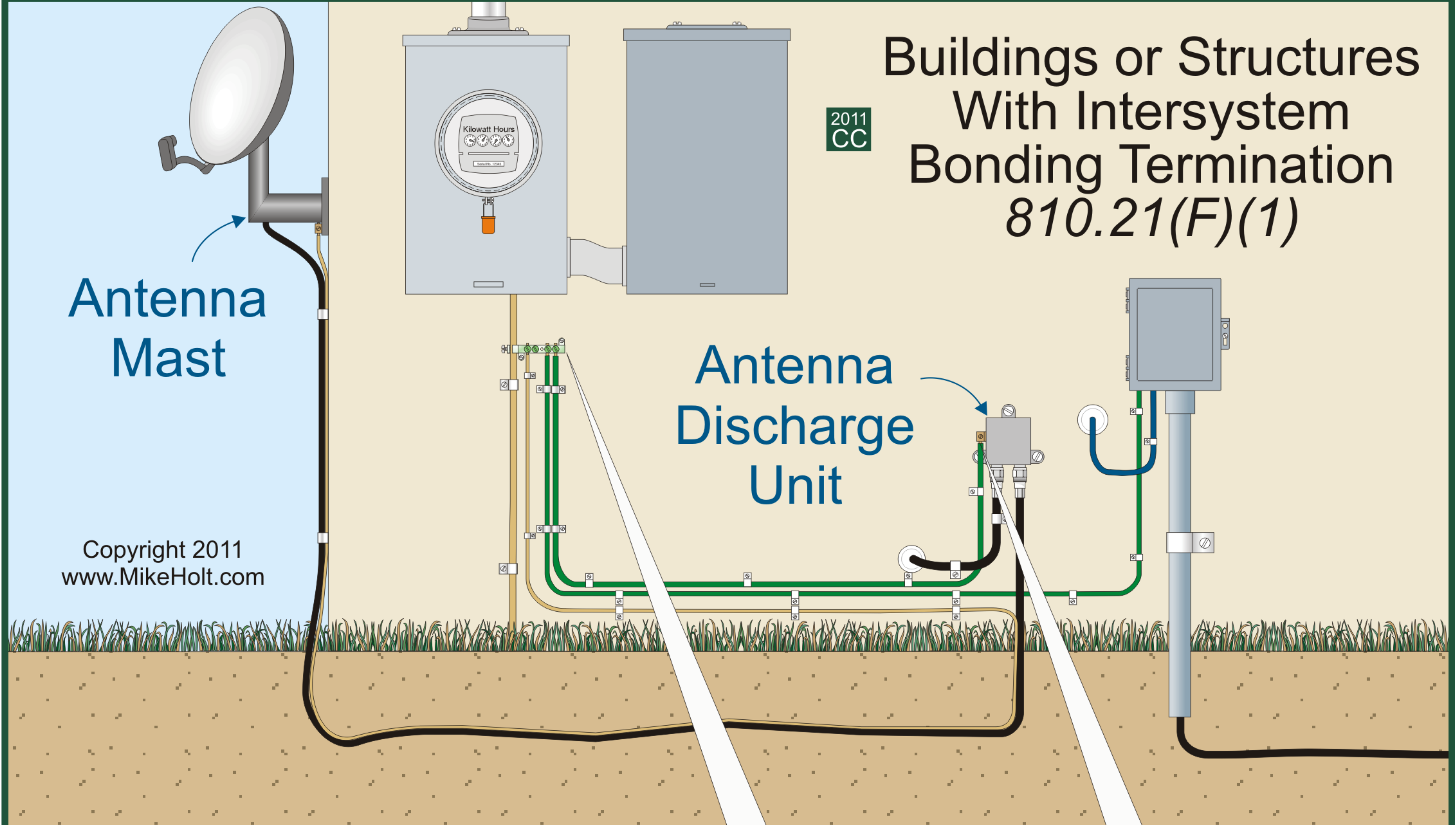


The bonding conductor for the antenna mast and antenna discharge unit must terminate to the intersystem bonding termination.

NEC Style & Layout (Cont'd)

Articles

- The NEC contains approximately 140 articles, each of which covers a specific subject.
- It begins with Article 90, the introduction to the Code, and contains the purpose of the NEC, what's covered and what isn't covered, along with how the Code is arranged. It also gives information on enforcement and how mandatory and permissive rules are written and how explanatory material is included. Article 90 also includes information on formal interpretations, examination of equipment for safety, wiring planning, and information about format- ting units of measurement.

NEC Style & Layout (Cont'd)

- Here are some other examples of articles you'll find in the NEC:

Article 110—Requirements for Electrical Installations
Article 250—Grounding and Bonding
Article 300—General Requirements for Wiring Methods and Materials
Article 430—Motors and Motor Controllers
Article 500—Hazardous (Classified) Locations
Article 680—Swimming Pools, Fountains, and Similar Installations
Article 725—Remote-Control, Signaling, and Power-Limited Circuits
Article 800—Communications Circuits

Can you give other examples of articles you'll find in the NEC???

NEC Style & Layout (Cont'd)

Parts

- Larger articles are subdivided into parts. Because the parts of a Code article aren't included in the section numbers, we have a tendency to forget what "part" an NEC rule is relating to.
    - For example, Table 110.34(A) contains working space clearances for electrical equipment. If we aren't careful, we might think this table applies to all electrical installations, but Table 110.34(A) is located in **Part III**, which only contains requirements for "Over 1,000 Volts, Nominal" installations. The rules for working clearances for electrical equipment for systems 1,000V, nominal, or less are contained in Table 110.26(A)(1), which is located in **Part II**—1,000 Volts, Nominal, or Less.

NEC Style & Layout (Cont'd)

Here's the part(s) layout for Article 250 (Grounding & Bonding) and Article 430 (Motors)

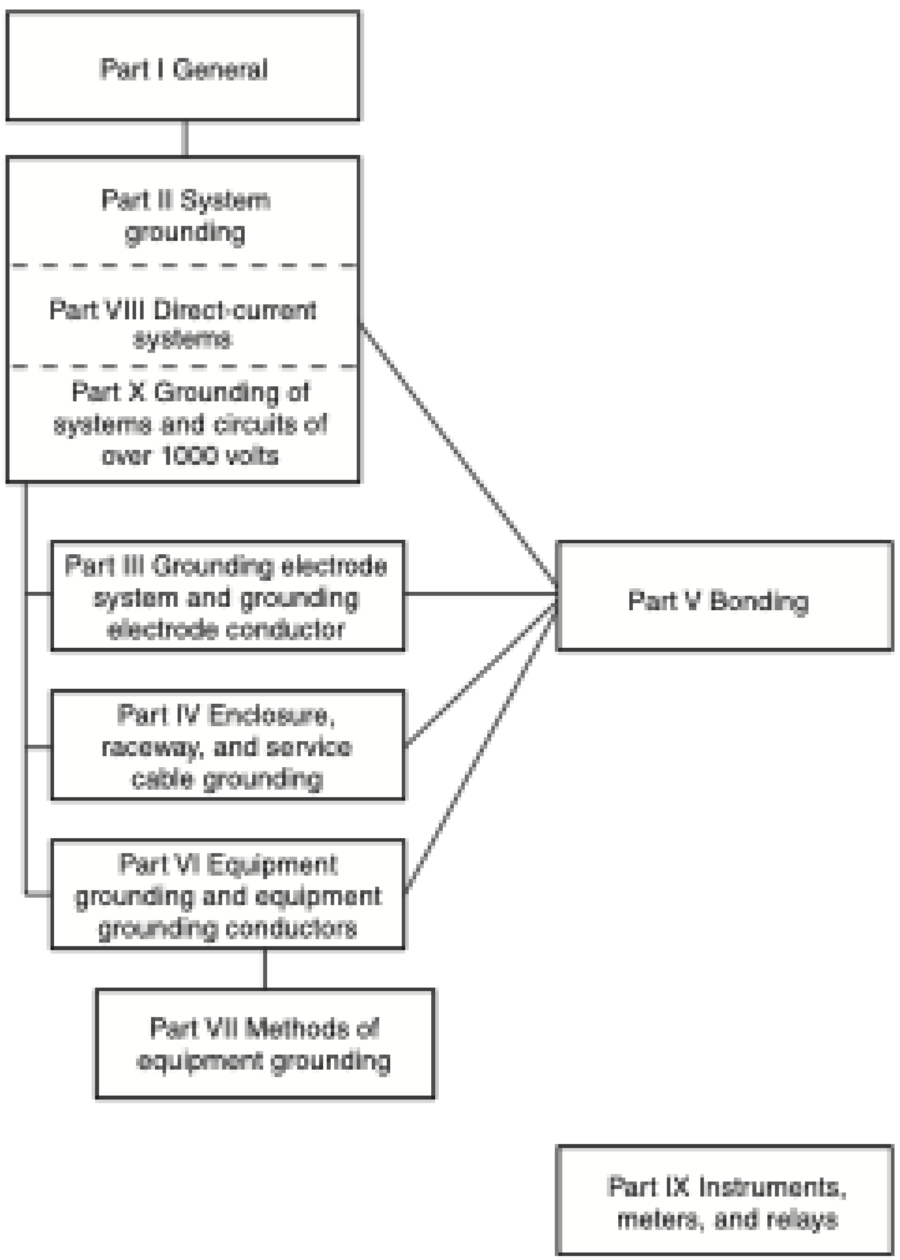


FIGURE 250.1 **Grounding and Bonding.**

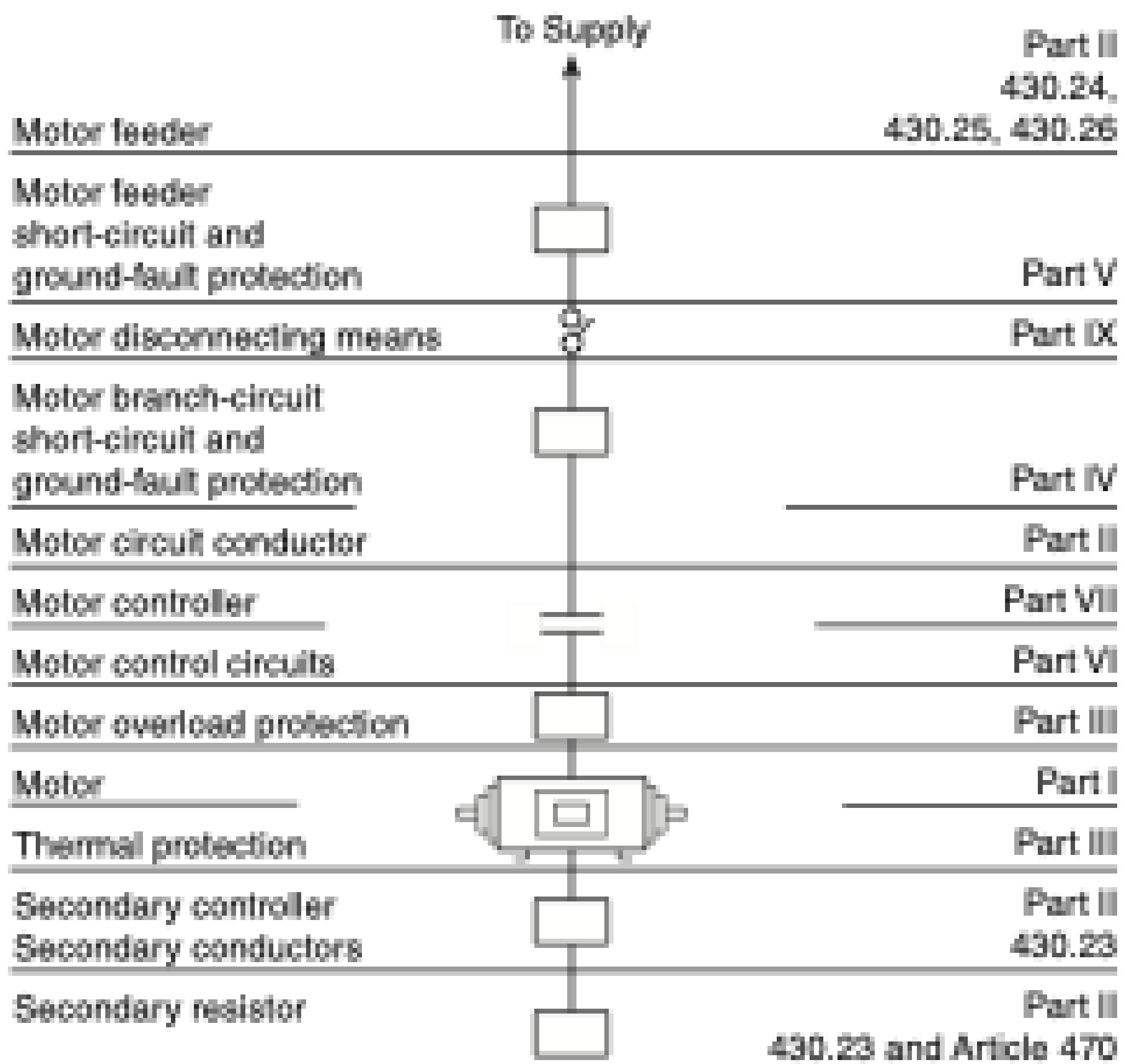
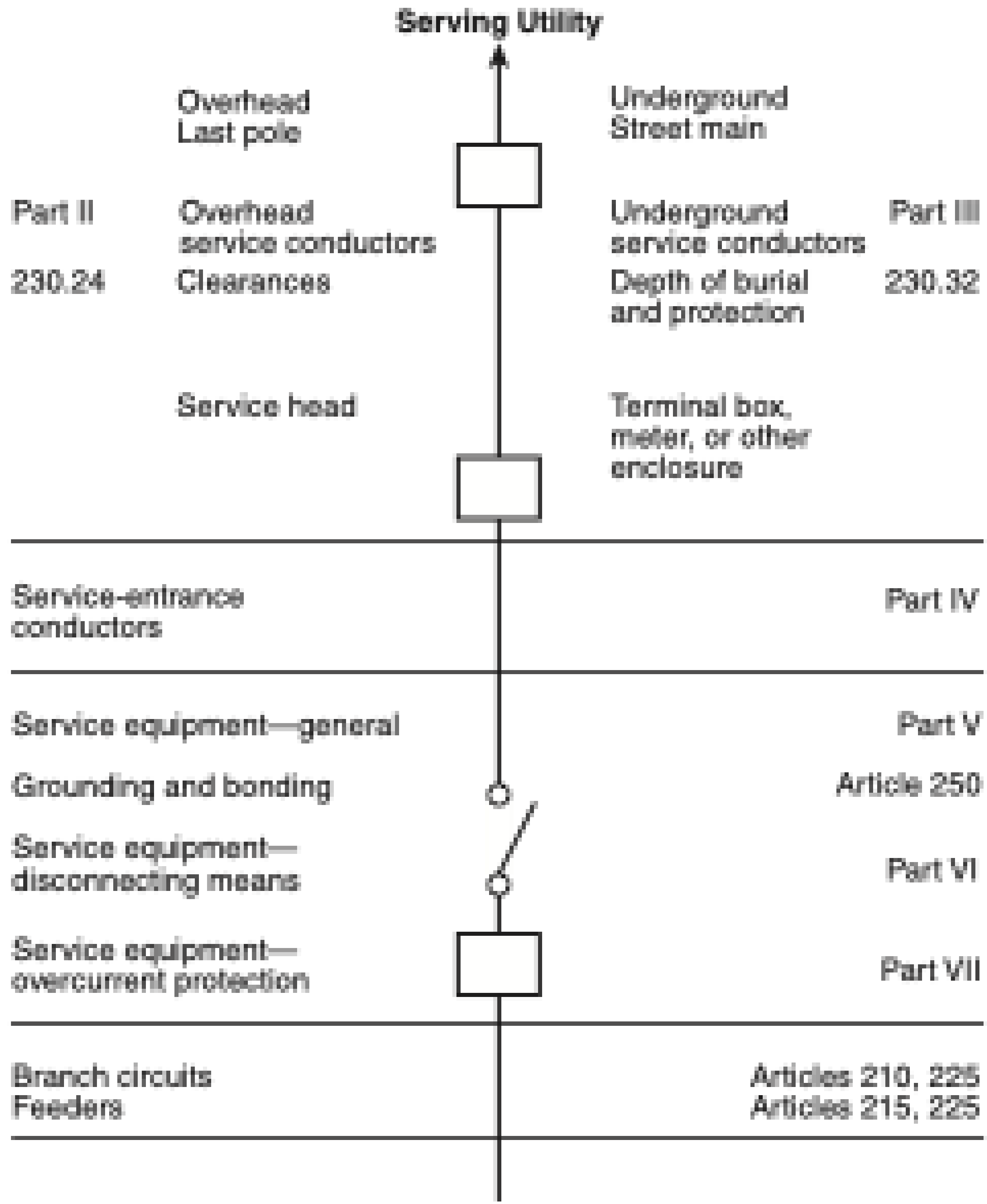


FIGURE 430.1 **Article 430 Contents.**



Serving Utility
Overhead
Last pole
Underground
Street main
Part II
Overhead
service conductors
Underground
service conductors
Part III
230.24
Clearances
Depth of burial
and protection
230.32
Service head
Terminal box,
meter, or other
enclosure
Service-entrance
conductors
Part IV
Service equipment—general
Part V
Grounding and bonding
Article 250
Service equipment—
disconnecting means
Part VI
Service equipment—
overcurrent protection
Part VII
Branch circuits
Feeders
Articles 210, 225
Articles 215, 225

NEC Style & Layout (Cont’d)

<u>Sections & Subsections</u>

- Each NEC rule is called a “Code Section.” A Code section may be broken down into subsections by letters in parentheses like (A), numbers in parentheses like (1), and lowercase letters like (a), (b), and so on, to further break the rule down to the second and third level.
    - For example, the rule requiring all receptacles in a dwelling unit bathroom to be GFCI protected is contained in Section 210.8(A)(1) which is located in Chapter 2, Article 210, Section 8, Subsection (A), Sub-subsection (1).
- Many in the industry incorrectly use the term “Article” when refer- ring to a Code section.
    - For example, they say “Article 210.8,” when they should say “Section 210.8.” Section numbers in this textbook are shown without the word “Section,” unless they begin a sentence. For example, Section 210.8(A) is shown as simply 210.8(A).

NEC Style & Layout (Cont'd)

<u>Tables and Figures</u>

- Many NEC requirements are contained within tables, which are lists of Code rules placed in a systematic arrangement. *<u>The titles of the tables are extremely important; you must read them carefully in order to understand the contents, applications and limitations of each table.</u>*

- Many times notes are provided in or below a table; be sure to read them as well since they're also part of the requirement.

  - For example, Note 1 for Table 300.5 explains how to measure the cover when burying cables and raceways, and Note 5 explains what to do if solid rock is encountered.

Table 300.5 Minimum Cover Requirements, 0 to 1000 Volts, Nominal, Burial in Millimeters (Inches)

Location of Wiring Method or Circuit	Type of Wiring Method or Circuit									
	Column 1 Direct Burial Cables or Conductors		Column 2 Rigid Metal Conduit or Intermediate Metal Conduit		Column 3 Nonmetallic Raceways Listed for Direct Burial Without Concrete Encasement or Other Approved Raceways		Column 4 Residential Branch Circuits Rated 120 Volts or Less with GFCI Protection and Maximum Overcurrent Protection of 20 Amperes		Column 5 Circuits for Control of Irrigation and Landscape Lighting Limited to Not More Than 30 Volts and Installed with Type UF or in 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	0 (in raceway or Type MC or Type MI cable identified for direct burial)	0	0	0	0	0	0 (in raceway or Type MC or Type MI cable identified for direct burial)	0	0 (in raceway or Type MC or Type MI cable identified for direct burial)	0
Under minimum of 102 mm (4 in.) thick concrete exterior slab with no vehicular traffic and the slab extending not less than 152 mm (6 in.) beyond the underground installation	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, and parking lots	600	24	600	24	600	24	600	24	600	24
One- and two-family dwelling driveways and outdoor parking areas, and used only for dwelling-related purposes	450	18	450	18	450	18	300	12	450	18
In or under airport runways, including adjacent areas where trespassing prohibited	450	18	450	18	450	18	450	18	450	18

[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 mm (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.

Table 310.15(B)(16) (formerly Table 310.16) Allowable Ampacities of Insulated Conductors Rated Up to and Including 2000 Volts, 60°C Through 90°C (140°F Through 194°F), Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)*

	Temperature Rating of Conductor [See Table 310.104(A).]						
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE	Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	
Size AWG or kcmil	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			Size AWG or kcmil
18**	—	—	14	—	—	—	—
16**	—	—	18	—	—	—	—
14**	15	20	25	—	—	—	—
12**	20	25	30	15	20	25	12**
10**	30	35	40	25	30	35	10**
8	40	50	55	35	40	45	8
6	55	65	75	40	50	55	6
4	70	85	95	55	65	75	4
3	85	100	115	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	145	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0
250	215	255	290	170	205	230	250
300	240	285	320	195	230	260	300
350	260	310	350	210	250	280	350
400	280	335	380	225	270	305	400
500	320	380	430	260	310	350	500
600	350	420	475	285	340	385	600
700	385	460	520	315	375	425	700
750	400	475	535	320	385	435	750
800	410	490	555	330	395	445	800
900	435	520	585	355	425	480	900
1000	455	545	615	375	445	500	1000
1250	495	590	665	405	485	545	1250
1500	525	625	705	435	520	585	1500
1750	545	650	735	455	545	615	1750
2000	555	665	750	470	560	630	2000

*Refer to 310.15(B)(2) for the ampacity correction factors where the ambient temperature is other than 30°C (86°F). Refer to 310.15(B)(3)(a) for more than three current-carrying conductors.

**Refer to 240.4(D) for conductor overcurrent protection limitations.

Table 250.66 Grounding Electrode Conductor for Alternating-Current Systems

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

Notes:
1. If multiple sets of service-entrance conductors connect directly to a service drop, set of overhead service conductors, set of underground service conductors, or service lateral, the equivalent size of the largest service-entrance conductor shall be determined by the largest sum of the areas of the corresponding conductors of each set.
2. Where there are no service-entrance conductors, the grounding electrode conductor size shall be determined by the equivalent size of the largest service-entrance conductor required for the load to be served.

[a]This table also applies to the derived conductors of separately derived ac systems.
[b]See installation restrictions in 250.64(A).

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

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

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

*For the purposes of applying this table and its notes, the term *bonding jumper* refers to main bonding jumpers, system bonding jumpers, and supply-side bonding jumpers.

NEC Style & Layout (Cont'd)

Exceptions

- Exceptions are Code requirements or permissions that provide an alternative method to a specific rule. There are two types of exceptions—mandatory and permissive. When a rule has several exceptions, those exceptions with mandatory requirements are listed before the permissive exceptions.
- **Mandatory Exceptions.** A mandatory exception uses the words "shall" or "shall not." The word "shall" in an exception means that if you're using the exception, you're required to do it in a particular way. The phrase "shall not" means it isn't permitted.
- **Permissive Exceptions.** A permissive exception uses words such as "shall be permitted," which means it's acceptable (but not mandatory) to do it in this way.

NEC Style & Layout (Cont'd)

Informational Notes

- An Informational Note contains explanatory material intended to clarify a rule or give assistance, but it isn't a Code requirement.

210.19 Conductors — Minimum Ampacity and Size.

(A) Branch Circuits Not More Than 600 Volts.

Informational Note No. 1: See 310.15 for ampacity ratings of conductors.

Informational Note No. 2: See Part II of Article 430 for minimum rating of motor branch-circuit conductors.

Informational Note No. 3: See 310.15(A)(3) for temperature limitation of conductors.

Informational Note No. 4: Conductors for branch circuits as defined in Article 100, sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest outlet does not exceed 5 percent, provide reasonable efficiency of operation. See Informational Note No. 2 of 215.2(A)(1) for voltage drop on feeder conductors.

250.4 General Requirements for Grounding and Bonding. The following general requirements identify what grounding and bonding of electrical systems are required to accomplish. The prescriptive methods contained in Article 250 shall be followed to comply with the performance requirements of this section.

(A) Grounded Systems.

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

Informational Note No. 1: An important consideration for limiting the imposed voltage is the routing of bonding and grounding electrode conductors so that they are not any longer than necessary to complete the connection without disturbing the permanent parts of the installation and so that unnecessary bends and loops are avoided.

NEC Style & Layout (Cont'd)

Tables

- Chapter 9 consists of tables applicable as referenced in the NEC. The tables are used to calculate raceway sizing, conductor fill, the radius of raceway bends, and conductor voltage drop.

Chapter 9 Tables

Table 1 Percent of Cross Section of Conduit and Tubing for Conductors and Cables

Number of Conductors and/or Cables	Cross-Sectional Area (%)
1	53
2	31
Over 2	40

Informational Note No. 1: Table 1 is based on common conditions of proper cabling and alignment of conductors where the length of the pull and the number of bends are within reasonable limits. It should be recognized that, for certain conditions, a larger size conduit or a lesser conduit fill should be considered.

Informational Note No. 2: When pulling three conductors or cables into a raceway, if the ratio of the raceway (inside diameter) to the conductor or cable (outside diameter) is between 2.8 and 3.2, jamming can occur. While jamming can occur when pulling four or more conductors or cables into a raceway, the probability is very low.

Notes to Tables

(1) See Informative Annex C for the maximum number of conductors and fixture wires, all of the same size (total cross-sectional area including insulation) permitted in trade sizes of the applicable conduit or tubing.

(2) Table 1 applies only to complete conduit or tubing systems and is not intended to apply to sections of conduit or tubing used to protect exposed wiring from physical damage.

(3) Equipment grounding or bonding conductors, where installed, shall be included when calculating conduit or tubing fill. The actual dimensions of the equipment grounding or bonding conductor (insulated or bare) shall be used in the calculation.

(4) Where conduit or tubing nipples having a maximum length not to exceed 600 mm (24 in.) are installed between boxes, cabinets, and similar enclosures, the nipples shall be permitted to be filled to 60 percent of their total cross-sectional area, and 310.15(B)(3)(a) adjustment factors need not apply to this condition.

(5) For conductors not included in Chapter 9, such as multiconductor cables and optical fiber cables, the actual dimensions shall be used.

(6) For combinations of conductors of different sizes, use actual dimensions or Table 5 and Table 5A for dimensions of conductors and Table 4 for the applicable conduit or tubing dimensions.

(7) When calculating the maximum number of conductors or cables permitted in a conduit or tubing, all of the same size (total cross-sectional area including insulation), the next higher whole number shall be used to determine the maximum number of conductors permitted when the calculation results in a decimal greater than or equal to 0.8. When calculating the size for conduit or tubing permitted for a single conductor, one conductor shall be permitted when the calculation results in a decimal greater than or equal to 0.8.

(8) Where bare conductors are permitted by other sections of this *Code*, the dimensions for bare conductors in Table 8 shall be permitted.

(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.

(10) The values for approximate conductor diameter and area shown in Table 5 are based on worst-case scenario and indicate round concentric-lay-stranded conductors. Solid and round concentric-lay-stranded conductor values are grouped together for the purpose of Table 5. Round compact-stranded conductor values are shown in Table 5A. If the actual values of the conductor diameter and area are known, they shall be permitted to be used.

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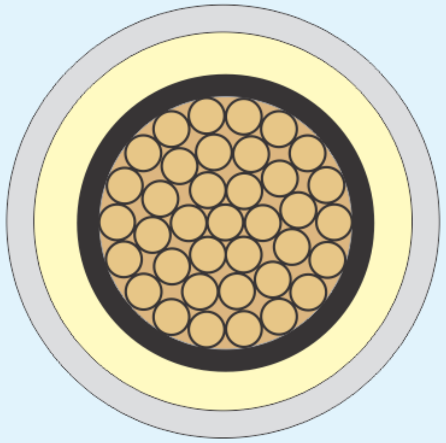
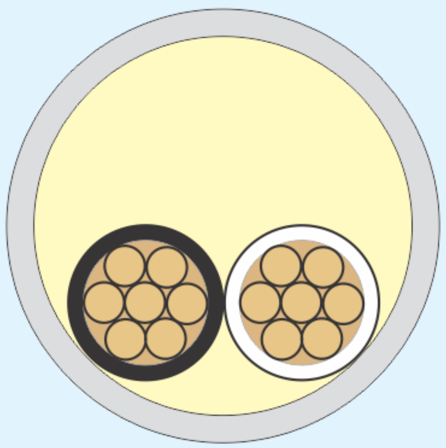
Raceway Fill Limitation

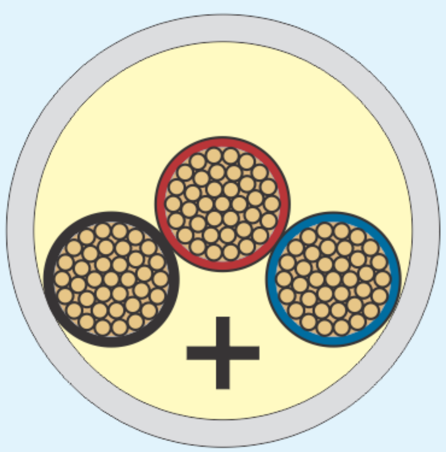
Chapter 9, Table 1



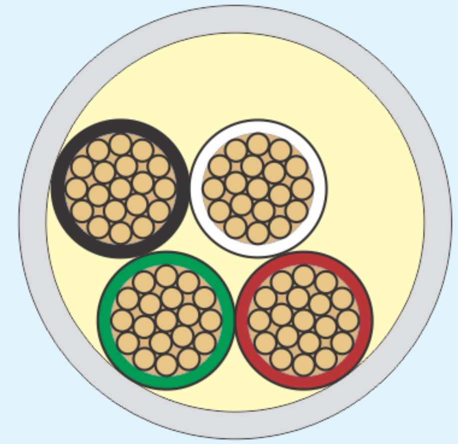
One Conductor
53% Fill



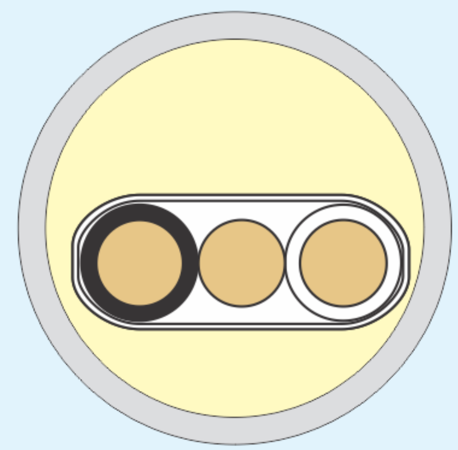
Two Conductors
31% Fill



Three or More Conductors
40% Fill



Raceway Length 24 in. or Less:
60% Fill
Note (4)



Cable is Treated as 1 Conductor
53% Fill, Note (9)

When conductors and/or cables are installed in a raceway, conductor fill is limited to the above percentages.

Table 8 Conductor Properties

Size (AWG or kcmil)	Area		Conductors							Direct-Current Resistance at 75°C (167°F)					
			Stranding			Overall				Copper				Aluminum	
				Diameter		Diameter		Area		Uncoated		Coated			
	mm^2	Circular mils	Quantity	mm	in.	mm	in.	mm^2	$in.^2$	ohm/km	ohm/kFT	ohm/km	ohm/kFT	ohm/km	ohm/kFT
18	0.823	1620	1	—	—	1.02	0.040	0.823	0.001	25.5	7.77	26.5	8.08	42.0	12.8
18	0.823	1620	7	0.39	0.015	1.16	0.046	1.06	0.002	26.1	7.95	27.7	8.45	42.8	13.1
16	1.31	2580	1	—	—	1.29	0.051	1.31	0.002	16.0	4.89	16.7	5.08	26.4	8.05
16	1.31	2580	7	0.49	0.019	1.46	0.058	1.68	0.003	16.4	4.99	17.3	5.29	26.9	8.21
14	2.08	4110	1	—	—	1.63	0.064	2.08	0.003	10.1	3.07	10.4	3.19	16.6	5.06
14	2.08	4110	7	0.62	0.024	1.85	0.073	2.68	0.004	10.3	3.14	10.7	3.26	16.9	5.17
12	3.31	6530	1	—	—	2.05	0.081	3.31	0.005	6.34	1.93	6.57	2.01	10.45	3.18
12	3.31	6530	7	0.78	0.030	2.32	0.092	4.25	0.006	6.50	1.98	6.73	2.05	10.69	3.25
10	5.261	10380	1	—	—	2.588	0.102	5.26	0.008	3.984	1.21	4.148	1.26	6.561	2.00
10	5.261	10380	7	0.98	0.038	2.95	0.116	6.76	0.011	4.070	1.24	4.226	1.29	6.679	2.04
8	8.367	16510	1	—	—	3.264	0.128	8.37	0.013	2.506	0.764	2.579	0.786	4.125	1.26
8	8.367	16510	7	1.23	0.049	3.71	0.146	10.76	0.017	2.551	0.778	2.653	0.809	4.204	1.28
6	13.30	26240	7	1.56	0.061	4.67	0.184	17.09	0.027	1.608	0.491	1.671	0.510	2.652	0.808
4	21.15	41740	7	1.96	0.077	5.89	0.232	27.19	0.042	1.010	0.308	1.053	0.321	1.666	0.508
3	26.67	52620	7	2.20	0.087	6.60	0.260	34.28	0.053	0.802	0.245	0.833	0.254	1.320	0.403
2	33.62	66360	7	2.47	0.097	7.42	0.292	43.23	0.067	0.634	0.194	0.661	0.201	1.045	0.319
1	42.41	83690	19	1.69	0.066	8.43	0.332	55.80	0.087	0.505	0.154	0.524	0.160	0.829	0.253
1/0	53.49	105600	19	1.89	0.074	9.45	0.372	70.41	0.109	0.399	0.122	0.415	0.127	0.660	0.201
2/0	67.43	133100	19	2.13	0.084	10.62	0.418	88.74	0.137	0.3170	0.0967	0.329	0.101	0.523	0.159
3/0	85.01	167800	19	2.39	0.094	11.94	0.470	111.9	0.173	0.2512	0.0766	0.2610	0.0797	0.413	0.126
4/0	107.2	211600	19	2.68	0.106	13.41	0.528	141.1	0.219	0.1996	0.0608	0.2050	0.0626	0.328	0.100
250	127	—	37	2.09	0.082	14.61	0.575	168	0.260	0.1687	0.0515	0.1753	0.0535	0.2778	0.0847
300	152	—	37	2.29	0.090	16.00	0.630	201	0.312	0.1409	0.0429	0.1463	0.0446	0.2318	0.0707
350	177	—	37	2.47	0.097	17.30	0.681	235	0.364	0.1205	0.0367	0.1252	0.0382	0.1984	0.0605
400	203	—	37	2.64	0.104	18.49	0.728	268	0.416	0.1053	0.0321	0.1084	0.0331	0.1737	0.0529
500	253	—	37	2.95	0.116	20.65	0.813	336	0.519	0.0845	0.0258	0.0869	0.0265	0.1391	0.0424
600	304	—	61	2.52	0.099	22.68	0.893	404	0.626	0.0704	0.0214	0.0732	0.0223	0.1159	0.0353
700	355	—	61	2.72	0.107	24.49	0.964	471	0.730	0.0603	0.0184	0.0622	0.0189	0.0994	0.0303
750	380	—	61	2.82	0.111	25.35	0.998	505	0.782	0.0563	0.0171	0.0579	0.0176	0.0927	0.0282
800	405	—	61	2.91	0.114	26.16	1.030	538	0.834	0.0528	0.0161	0.0544	0.0166	0.0868	0.0265
900	456	—	61	3.09	0.122	27.79	1.094	606	0.940	0.0470	0.0143	0.0481	0.0147	0.0770	0.0235
1000	507	—	61	3.25	0.128	29.26	1.152	673	1.042	0.0423	0.0129	0.0434	0.0132	0.0695	0.0212
1250	633	—	91	2.98	0.117	32.74	1.289	842	1.305	0.0338	0.0103	0.0347	0.0106	0.0554	0.0169
1500	760	—	91	3.26	0.128	35.86	1.412	1011	1.566	0.02814	0.00858	0.02814	0.00883	0.0464	0.0141
1750	887	—	127	2.98	0.117	38.76	1.526	1180	1.829	0.02410	0.00735	0.02410	0.00756	0.0397	0.0121
2000	1013	—	127	3.19	0.126	41.45	1.632	1349	2.092	0.02109	0.00643	0.02109	0.00662	0.0348	0.0106

Notes:

1. These resistance values are valid **only** for the parameters as given. Using conductors having coated strands, different stranding type, and, especially, other temperatures changes the resistance.
2. Equation for temperature change: $R_2 = R_1 [1 + \alpha (T_2 - 75)]$, where $\alpha_{cu} = 0.00323$, $\alpha_{AL} = 0.00330$ at 75°C.
3. Conductors with compact and compressed stranding have about 9 percent and 3 percent, respectively, smaller bare conductor diameters than those shown. See Table 5A for actual compact cable dimensions.
4. The IACS conductivities used: bare copper = 100%, aluminum = 61%.
5. Class B stranding is listed as well as solid for some sizes. Its overall diameter and area are those of its circumscribing circle.

Informational Note: The construction information is in accordance with NEMA WC/70-2009 or ANSI/UL 1581-2011. The resistance is calculated in accordance with National Bureau of Standards Handbook 100, dated 1966, and Handbook 109, dated 1972.

Table 4 Dimensions and Percent Area of Conduit and Tubing (Areas of Conduit or Tubing for the Combinations of Wires Permitted in Table 1, Chapter 9)

Article 358 — Electrical Metallic Tubing (EMT)

Metric Designator	Trade Size	Over 2 Wires 40%		60%		1 Wire 53%		2 Wires 31%		Nominal Internal Diameter		Total Area 100%	
		mm²	in.²	mm²	in.²	mm²	in.²	mm²	in.²	mm	in.	mm²	in.²
16	½	78	0.122	118	0.182	104	0.161	61	0.094	15.8	0.622	196	0.304
21	¾	137	0.213	206	0.320	182	0.283	106	0.165	20.9	0.824	343	0.533
27	1	222	0.346	333	0.519	295	0.458	172	0.268	26.6	1.049	556	0.864
35	1¼	387	0.598	581	0.897	513	0.793	300	0.464	35.1	1.380	968	1.496
41	1½	526	0.814	788	1.221	696	1.079	407	0.631	40.9	1.610	1314	2.036
53	2	866	1.342	1299	2.013	1147	1.778	671	1.040	52.5	2.067	2165	3.356
63	2½	1513	2.343	2270	3.515	2005	3.105	1173	1.816	69.4	2.731	3783	5.858
78	3	2280	3.538	3421	5.307	3022	4.688	1767	2.742	85.2	3.356	5701	8.846
91	3½	2980	4.618	4471	6.927	3949	6.119	2310	3.579	97.4	3.834	7451	11.545
103	4	3808	5.901	5712	8.852	5046	7.819	2951	4.573	110.1	4.334	9521	14.753

Article 362 — Electrical Nonmetallic Tubing (ENT)

Metric Designator	Trade Size	Over 2 Wires 40%		60%		1 Wire 53%		2 Wires 31%		Nominal Internal Diameter		Total Area 100%	
		mm²	in.²	mm²	in.²	mm²	in.²	mm²	in.²	mm	in.	mm²	in.²
16	½	73	0.114	110	0.171	97	0.151	57	0.088	15.3	0.602	184	0.285
21	¾	131	0.203	197	0.305	174	0.269	102	0.157	20.4	0.804	328	0.508
27	1	215	0.333	322	0.499	284	0.441	166	0.258	26.1	1.029	537	0.832
35	1¼	375	0.581	562	0.872	497	0.770	291	0.450	34.5	1.36	937	1.453
41	1½	512	0.794	769	1.191	679	1.052	397	0.616	40.4	1.59	1281	1.986
53	2	849	1.316	1274	1.975	1125	1.744	658	1.020	52	2.047	2123	3.291
63	2½	—	—	—	—	—	—	—	—	—	—	—	—
78	3	—	—	—	—	—	—	—	—	—	—	—	—
91	3½	—	—	—	—	—	—	—	—	—	—	—	—

Article 348 — Flexible Metal Conduit (FMC)

Metric Designator	Trade Size	Over 2 Wires 40%		60%		1 Wire 53%		2 Wires 31%		Nominal Internal Diameter		Total Area 100%	
		mm²	in.²	mm²	in.²	mm²	in.²	mm²	in.²	mm	in.	mm²	in.²
12	⅜	30	0.046	44	0.069	39	0.061	23	0.036	9.7	0.384	74	0.116
16	½	81	0.127	122	0.190	108	0.168	63	0.098	16.1	0.635	204	0.317
21	¾	137	0.213	206	0.320	182	0.283	106	0.165	20.9	0.824	343	0.533
27	1	211	0.327	316	0.490	279	0.433	163	0.253	25.9	1.020	527	0.817
35	1¼	330	0.511	495	0.766	437	0.677	256	0.396	32.4	1.275	824	1.277
41	1½	480	0.743	720	1.115	636	0.985	372	0.576	39.1	1.538	1201	1.858
53	2	843	1.307	1264	1.961	1117	1.732	653	1.013	51.8	2.040	2107	3.269
63	2½	1267	1.963	1900	2.945	1678	2.602	982	1.522	63.5	2.500	3167	4.909
78	3	1824	2.827	2736	4.241	2417	3.746	1414	2.191	76.2	3.000	4560	7.069
91	3½	2483	3.848	3724	5.773	3290	5.099	1924	2.983	88.9	3.500	6207	9.621
103	4	3243	5.027	4864	7.540	4297	6.660	2513	3.896	101.6	4.000	8107	12.566

Article 342 — Intermediate Metal Conduit (IMC)

Metric Designator	Trade Size	Over 2 Wires 40%		60%		1 Wire 53%		2 Wires 31%		Nominal Internal Diameter		Total Area 100%	
		mm²	in.²	mm²	in.²	mm²	in.²	mm²	in.²	mm	in.	mm²	in.²
12	⅜	—	—	—	—	—	—	—	—	—	—	—	—
16	½	89	0.137	133	0.205	117	0.181	69	0.106	16.8	0.660	222	0.342
21	¾	151	0.235	226	0.352	200	0.311	117	0.182	21.9	0.864	377	0.586

(continues)

Table 5 Dimensions of Insulated Conductors and Fixture Wires

Type	Size (AWG or kcmil)	Approximate Area mm²	Approximate Area in.²	Approximate Diameter mm	Approximate Diameter in.
Type: FFH-2, RFH-1, RFH-2, RFHH-2, RHH*, RHW* , RHW-2*, RHH, RHW, RHW-2, SF-1, SF-2, SFF-1, SFF-2, TF, TFF, THHW, THW, THW-2, TW, XF, XFF					
RFH-2, FFH-2, RFHH-2	18	9.355	0.0145	3.454	0.136
	16	11.10	0.0172	3.759	0.148
RHH, RHW, RHW-2	14	18.90	0.0293	4.902	0.193
	12	22.77	0.0353	5.385	0.212
	10	28.19	0.0437	5.994	0.236
	8	53.87	0.0835	8.280	0.326
	6	67.16	0.1041	9.246	0.364
	4	86.00	0.1333	10.46	0.412
	3	98.13	0.1521	11.18	0.440
	2	112.9	0.1750	11.99	0.472
	1	171.6	0.2660	14.78	0.582
	1/0	196.1	0.3039	15.80	0.622
	2/0	226.1	0.3505	16.97	0.668
	3/0	262.7	0.4072	18.29	0.720
	4/0	306.7	0.4754	19.76	0.778
	250	405.9	0.6291	22.73	0.895
	300	457.3	0.7088	24.13	0.950
	350	507.7	0.7870	25.43	1.001
	400	556.5	0.8626	26.62	1.048
	500	650.5	1.0082	28.78	1.133
	600	782.9	1.2135	31.57	1.243
	700	874.9	1.3561	33.38	1.314
	750	920.8	1.4272	34.24	1.348
	800	965.0	1.4957	35.05	1.380
	900	1057	1.6377	36.68	1.444
	1000	1143	1.7719	38.15	1.502
	1250	1515	2.3479	43.92	1.729
	1500	1738	2.6938	47.04	1.852
	1750	1959	3.0357	49.94	1.966
	2000	2175	3.3719	52.63	2.072
SF-2, SFF-2	18	7.419	0.0115	3.073	0.121
	16	8.968	0.0139	3.378	0.133
	14	11.10	0.0172	3.759	0.148
SF-1, SFF-1	18	4.194	0.0065	2.311	0.091
RFH-1,TF, TFF, XF, XFF	18	5.161	0.0088	2.692	0.106
TF, TFF, XF, XFF	16	7.032	0.0109	2.997	0.118
TW, XF, XFF, THHW, THW, THW-2	14	8.968	0.0139	3.378	0.133
TW, THHW, THW, THW-2	12	11.68	0.0181	3.861	0.152
	10	15.68	0.0243	4.470	0.176
	8	28.19	0.0437	5.994	0.236
RHH*, RHW*, RHW-2*	14	13.48	0.0209	4.140	0.163
RHH*, RHW*, RHW-2*, XF, XFF	12	16.77	0.0260	4.623	0.182
Type: RHH*, RHW*, RHW-2*, THHN, THHW, THW, THW-2, TFN, TFFN, THWN, THWN-2, XF, XFF					
RHH,* RHW,* RHW-2,* XF, XFF	10	21.48	0.0333	5.232	0.206

(continues)

NEC Style & Layout (Cont'd)

Annexes

- Annexes aren't a part of the NEC requirements, and are included in the Code for informational purposes only.

Annex A. Product Safety Standards
Annex B. Application Information for Ampacity Calculation
Annex C. Raceway Fill Tables for Conductors and Fixture Wires of the Same Size
Annex D. Examples
Annex E. Types of Construction
Annex F. Critical Operations Power Systems (COPS)
Annex G. Supervisory Control and Data Acquisition (SCADA)
Annex H. Administration and Enforcement
Annex I. Recommended Tightening Torques
Annex J. ADA Standards for Accessible Design

Table C.1 Maximum Number of Conductors or Fixture Wires in Electrical Metallic Tubing (EMT) (Based on Chapter 9: Table 1, Table 4, and Table 5)

Type	Conductor Size (AWG/kcmil)	Trade Size (Metric Designator)												
		3/8 (12)	1/2 (16)	3/4 (21)	1 (27)	1¼ (35)	1½ (41)	2 (53)	2½ (63)	3 (78)	3½ (91)	4 (103)	5 (129)	6 (155)
CONDUCTORS														
RHH, RHW, RHW-2	14	—	4	7	11	20	27	46	80	120	157	201	—	—
	12	—	3	6	9	17	23	38	66	100	131	167	—	—
	10	—	2	5	8	13	18	30	53	81	105	135	—	—
	8	—	1	2	4	7	9	16	28	42	55	70	—	—
	6	—	1	1	3	5	8	13	22	34	44	56	—	—
	4	—	1	1	2	4	6	10	17	26	34	44	—	—
	3	—	1	1	1	4	5	9	15	23	30	38	—	—
	2	—	1	1	1	3	4	7	13	20	26	33	—	—
	1	—	0	1	1	1	3	5	9	13	17	22	—	—
	1/0	—	0	1	1	1	2	4	7	11	15	19	—	—
	2/0	—	0	1	1	1	2	4	6	10	13	17	—	—
	3/0	—	0	0	1	1	1	3	5	8	11	14	—	—
	4/0	—	0	0	1	1	1	3	5	7	9	12	—	—
	250	—	0	0	0	1	1	1	3	5	7	9	—	—
	300	—	0	0	0	1	1	1	3	5	6	8	—	—
	350	—	0	0	0	1	1	1	3	4	6	7	—	—
	400	—	0	0	0	1	1	1	2	4	5	7	—	—
	500	—	0	0	0	0	1	1	2	3	4	6	—	—
	600	—	0	0	0	0	1	1	1	3	4	5	—	—
	700	—	0	0	0	0	0	1	1	2	3	4	—	—
	750	—	0	0	0	0	0	1	1	2	3	4	—	—
	800	—	0	0	0	0	0	1	1	2	3	4	—	—
	900	—	0	0	0	0	0	1	1	1	3	3	—	—
	1000	—	0	0	0	0	0	1	1	1	2	3	—	—
	1250	—	0	0	0	0	0	0	1	1	1	2	—	—
	1500	—	0	0	0	0	0	0	1	1	1	1	—	—
	1750	—	0	0	0	0	0	0	1	1	1	1	—	—
	2000	—	0	0	0	0	0	0	1	1	1	1	—	—
TW, THHW, THW, THW-2	14	—	8	15	25	43	58	96	168	254	332	424	—	—
	12	—	6	11	19	33	45	74	129	195	255	326	—	—
	10	—	5	8	14	24	33	55	96	145	190	243	—	—
	8	—	2	5	8	13	18	30	53	81	105	135	—	—
RHH*, RHW*, RHW-2*	14	—	6	10	16	28	39	64	112	169	221	282	—	—
	12	—	4	8	13	23	31	51	90	136	177	227	—	—
	10	—	3	6	10	18	24	40	70	106	138	177	—	—
	8	—	1	4	6	10	14	24	42	63	83	106	—	—
TW, THW, THHW, THW-2, RHH*, RHW*, RHW-2*	6	—	1	3	4	8	11	18	32	48	63	81	—	—
	4	—	1	1	3	6	8	13	24	36	47	60	—	—
	3	—	1	1	3	5	7	12	20	31	40	52	—	—
	2	—	1	1	2	4	6	10	17	26	34	44	—	—
	1	—	1	1	1	3	4	7	12	18	24	31	—	—
	1/0	—	0	1	1	2	3	6	10	16	20	26	—	—
	2/0	—	0	1	1	1	3	5	9	13	17	22	—	—
	3/0	—	0	1	1	1	2	4	7	11	15	19	—	—
	4/0	—	0	0	1	1	1	3	6	9	12	16	—	—
	250	—	0	0	1	1	1	3	5	7	10	13	—	—
	300	—	0	0	1	1	1	2	4	6	8	11	—	—
	350	—	0	0	0	1	1	1	4	6	7	10	—	—
	400	—	0	0	0	1	1	1	3	5	7	9	—	—
	500	—	0	0	0	1	1	1	3	4	6	7	—	—
	600	—	0	0	0	1	1	1	2	3	4	6	—	—
	700	—	0	0	0	0	1	1	1	3	4	5	—	—
	750	—	0	0	0	0	1	1	1	3	4	5	—	—

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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.)

Informative Annex I Recommended Tightening Torque Tables from UL Standard 486A-B

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

In the absence of connector or equipment manufacturer's recommended torque values, Table I.1, Table I.2, and Table I.3 may be used to correctly tighten screw-type connections for power and lighting circuits*. Control and signal circuits may require different torque values, and the manufacturer should be contacted for guidance.

*For proper termination of conductors, it is very important that field connections be properly tightened. In the absence of manufacturer's instructions on the equipment, the torque values given in these tables are recommended. Because it is normal for some relaxation to occur in service, checking torque values sometime after installation is not a reliable means of determining the values of torque applied at installation.

Table I.1 Tightening Torque for Screws

Test Conductor Installed in Connector		Tightening Torque, N-m (lbf-in.)							
		Slotted head No. 10 and larger[a]							
AWG or kcmil	mm²	Slot width 1.2 mm (0.047 in.) or less and slot length 6.4 mm (¼ in.) or less		Slot width over 1.2 mm (0.047 in.) or slot length over 6.4 mm (¼ in.)		Split-bolt connectors		Other connectors	
30–10	0.05–5.3	2.3	(20)	4.0	(35)	9.0	(80)	8.5	(75)
8	8.4	2.8	(25)	4.5	(40)	9.0	(80)	8.5	(75)
6–4	13.2–21.2	4.0	(35)	5.1	(45)	18.5	(165)	12.4	(110)
3	26.7	4.0	(35)	5.6	(50)	31.1	(275)	16.9	(150)
2	33.6	4.5	(40)	5.6	(50)	31.1	(275)	16.9	(150)
1	42.4	—		5.6	(50)	31.1	(275)	16.9	(150)
1/0–2/0	53.5–67.4	—		5.6	(50)	43.5	(385)	20.3	(180)
3/0–4/0	85.0–107.2	—		5.6	(50)	56.5	(500)	28.2	(250)
250–350	127–177	—		5.6	(50)	73.4	(650)	36.7	(325)
400	203	—		5.6	(50)	93.2	(825)	36.7	(325)
500	253	—		5.6	(50)	93.2	(825)	42.4	(375)
600–750	304–380	—		5.6	(50)	113.0	(1000)	42.4	(375)
800–1000	405–508	—		5.6	(50)	124.3	(1100)	56.5	(500)
1250–2000	635–1010	—		—		124.3	(1100)	67.8	(600)

[a]For values of slot width or length not corresponding to those specified, select the largest torque value associated with the conductor size. Slot width is the nominal design value. Slot length shall be measured at the bottom of the slot.

Table I.2 Tightening Torque for Slotted Head Screws Smaller Than No. 10 Intended for Use with 8 AWG (8.4 mm²) or Smaller Conductors

Slot Length of Screw[a]		Tightening Torque, N-m (lbf-in.)	
mm	in.	Slot width of screw smaller than 1.2 mm (0.047 in.)[b]	Slot width of screw 1.2 mm (0.047 in.) and larger[b]
Less than 4	Less than 5/32	0.79 (7)	1.0 (9)
4	5/32	0.79 (7)	1.4 (12)
4.8	3/16	0.79 (7)	1.4 (12)
5.5	7/32	0.79 (7)	1.4 (12)
6.4	1/4	1.0 (9)	1.4 (12)
7.1	9/32		1.7 (15)
Above 7.1	Above 9/32		2.3 (20)

[a]For slot lengths of intermediate values, select torques pertaining to next shorter slot lengths. Also, see 9.1.9.6 of UL 486A-2003, *Wire Connectors and Soldering Lugs for Use with Copper Conductors*, for screws with multiple tightening means. Slot length shall be measured at the bottom of the slot.
[b]Slot width is the nominal design value.

Table I.3 Tightening Torque for Screws with Recessed Allen or Square Drives

Socket Width Across Flats[a]		Tightening Torque, N-m (lbf-in.)	
mm	in.		
3.2	1/8	5.1	(45)
4.0	5/32	11.3	(100)
4.8	3/16	13.5	(120)
5.5	7/32	16.9	(150)
6.4	1/4	22.5	(200)
7.9	5/16	31.1	(275)
9.5	3/8	42.4	(375)
12.7	1/2	56.5	(500)
14.3	9/16	67.8	(600)

[a]See 9.1.9.6 of UL 486A-2003, *Wire Connectors and Soldering Lugs for Use with Copper Conductors*, for screws with multiple tightening means.

Informative Annex J ADA Standards for Accessible Design

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

The provisions cited in Informative Annex J are intended to assist the users of the *Code* in properly considering the various electrical design constraints of other building systems and are part of the 2010 ADA Standards for Accessible Design. They are the same provisions as those found in ANSI/ICC A117.1-2009, *Accessible and Usable Buildings and Facilities.*

J.1 Protruding Objects. Protruding objects shall comply with Section J.2.

J.2 Protrusion Limits. Objects with leading edges more than 685 mm (27 in.) and not more than 2030 mm (80 in.) above the finish floor or ground shall protrude a maximum of 100 mm (4 in.) horizontally into the circulation path. *(See Figure J.2.)*

Exception: Handrails shall be permitted to protrude 115 mm (4½ in.) maximum.

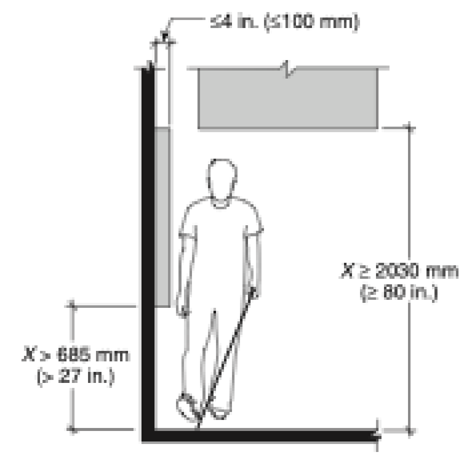


FIGURE J.2 Limits of Protruding Objects.

J.3 Post-Mounted Objects. Freestanding objects mounted on posts or pylons shall overhang circulation paths 305 mm (12 in.) maximum where located 685 mm (27 in.) minimum and 2030 mm (80 in.) maximum above the finish floor or ground. Where a sign or other obstruction is mounted between posts or pylons, and the clear distance between the posts or pylons is greater than 305 mm (12 in.), the lowest edge of such sign or obstruction shall be 685 mm (27 in.) maximum or 2030 mm (80 in.) minimum above the finish floor or ground. *(See Figure J.3.)*

Exception: The sloping portions of handrails serving stairs and ramps shall not be required to comply with Section J.3.

J.4 Vertical Clearance. Vertical clearance shall be 2030 mm (80 in.) high minimum. Guardrails or other barriers shall be provided where the vertical clearance is less than 2030 mm (80 in.) high. The leading edge of such guardrail or barrier shall be located 685 mm (27 in.) maximum above the finish floor or ground. *(See Figure J.4.)*

Exception: Door closers and door stops shall be permitted to be 1980 mm (78 in.) minimum above the finish floor or ground.

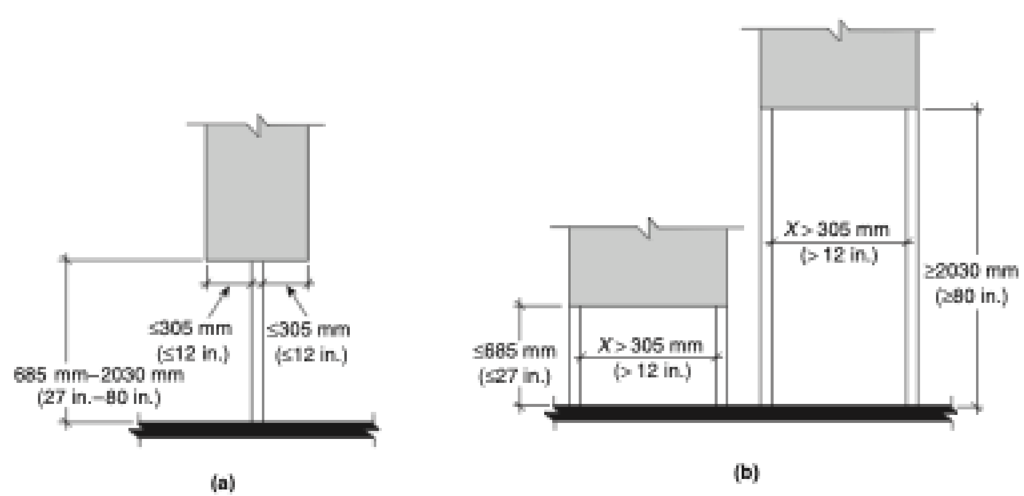


FIGURE J.3 Post-Mounted Protruding Objects.

How to Locate a Specific Requirement in the NEC

- How to go about finding what you're looking for in the Code book depends, to some degree, on your experience with the NEC.
- Experts typically know the requirements so well that they just go to the correct rule. Very experienced people might only need the Table of Contents to locate the requirement they're looking for.
- On the other hand, average users should use all of the tools at their disposal, including the Table of Contents, the Index, and the search feature on electronic versions of the Code book.

Let's work through a simple example: What NEC rule specifies the maximum number of disconnects permitted for a service?

How to Locate a Specific Requirement in the NEC (Cont'd)

Table of Contents Method

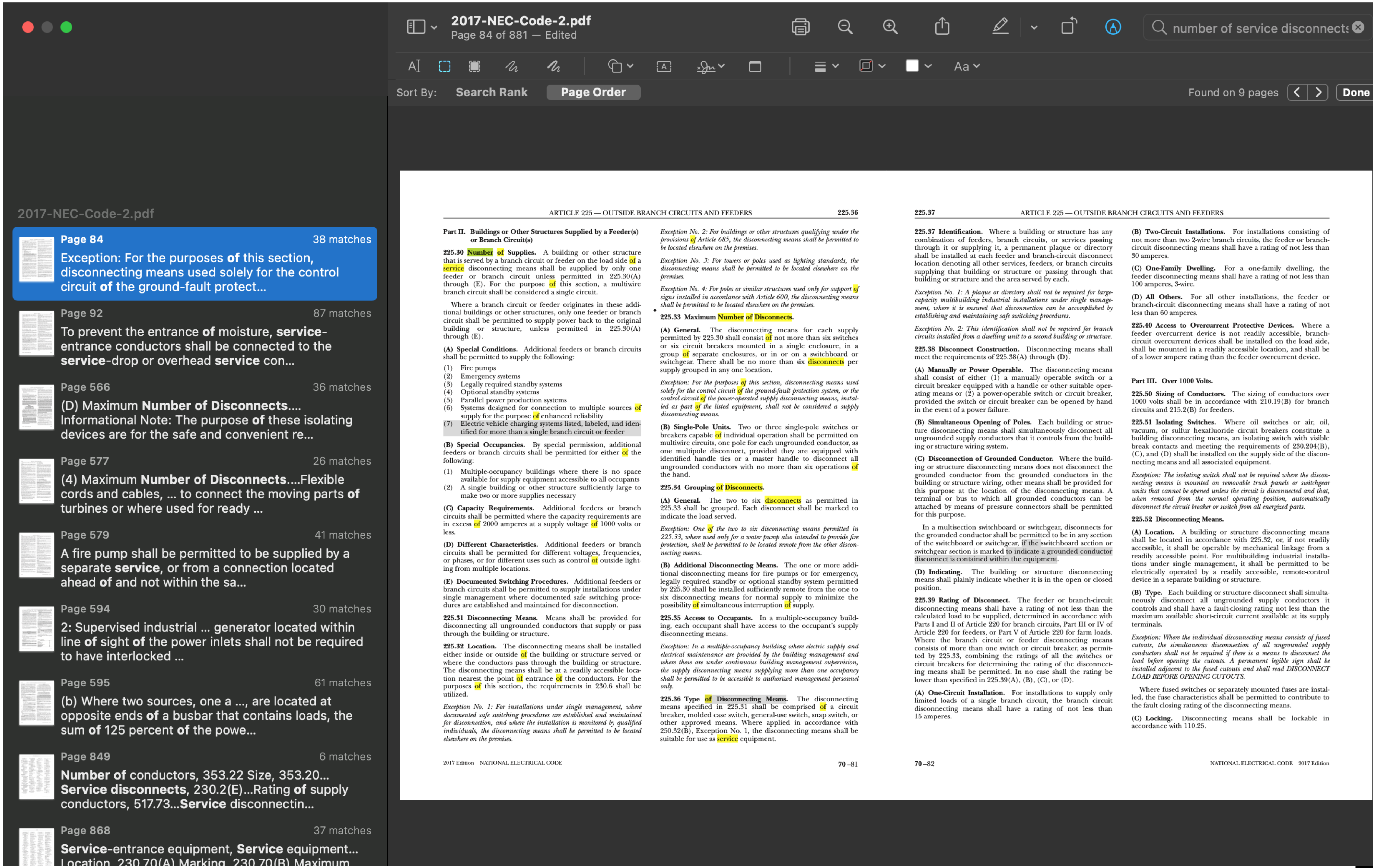
- If you're an experienced Code user, you might use the Table of Contents. You'll know Article 230 applies to "Services," and because this article is so large, it's divided up into multiple parts (actually eight parts). With this knowledge, you can quickly go to the Table of Contents and see it lists the Service Equipment Disconnecting Means requirements in Part VI.

How to Locate a Specific Requirement in the NEC (Cont'd)

Index Method

- If you use the Index, which lists subjects in alphabetical order, to look up the term "service disconnect," you'll see there's no listing. If you try "disconnecting means," then "services," you'll find that the Index indicates the rule is located in Article 230, Part VI.
  - Because the NEC doesn't give a page number in the Index, you'll need to use the Table of Contents to find it, or flip through the Code book to Article 230, then continue to flip through pages until you find Part VI.
- Many people complain that the NEC only confuses them by taking them in circles. Once you gain experience in using the Code and deepen your understanding of words, terms, principles, and practices, you'll find the NEC much easier to understand and use than you originally thought.

USING WORD SEARCH FOR ELECTRONIC VERSIONS OF THE NEC



Practice Questions

- Electrical nonmetallic tubing (ENT) shall be securely fastened in place within __________ of each cabinet, device box, fitting, junction box, or outlet box where it terminates.

362.30 Securing and Supporting. ENT shall be installed as a complete system in accordance with 300.18 and shall be securely fastened in place by an approved means and supported in accordance with 362.30(A) and (B).

(A) Securely Fastened. ENT shall be securely fastened at intervals not exceeding 900 mm (3 ft). In addition, ENT shall be securely fastened in place within 900 mm (3 ft) of each outlet box, device box, junction box, cabinet, or fitting where it terminates. Where used, cable ties shall be listed as suitable for the application and for securing and supporting.

Exception No. 1: Lengths not exceeding a distance of 1.8 m (6 ft) from a luminaire terminal connection for tap connections to lighting luminaires shall be permitted without being secured.

Exception No. 2: Lengths not exceeding 1.8 m (6 ft) from the last point where the raceway is securely fastened for connections within an accessible ceiling to luminaire(s) or other equipment.

Exception No. 3: For concealed work in finished buildings or prefinished wall panels where such securing is impracticable, unbroken lengths (without coupling) of ENT shall be permitted to be fished.

Practice Questions

- What is the minimum size for a copper grounding electrode conductor attached to the concrete-encased steel reinforcing bars used as a grounding electrode, when the ungrounded service-entrance conductors for a residence are size 3/0 AWG copper conductors?

Table 250.66 Grounding Electrode Conductor for Alternating-Current Systems

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

Notes:
1. If multiple sets of service-entrance conductors connect directly to a service drop, set of overhead service conductors, set of underground service conductors, or service lateral, the equivalent size of the largest service-entrance conductor shall be determined by the largest sum of the areas of the corresponding conductors of each set.
2. Where there are no service-entrance conductors, the grounding electrode conductor size shall be determined by the equivalent size of the largest service-entrance conductor required for the load to be served.

[a]This table also applies to the derived conductors of separately derived ac systems.
[b]See installation restrictions in 250.64(A).

Practice Questions

- Capable of being reached quickly for operation, renewal, or inspections without resorting to portable ladders or the use of tools (other than keys) is known as "_____."

Accessible, Readily (Readily Accessible). Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to take actions such as to use tools (other than keys), to climb over or under, to remove obstacles, or to resort to portable ladders, and so forth. (CMP-1)

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.

Practice Questions

- Receptacles outlets in or on floors shall not be considered as the required number of receptacle outlets unless the installed receptacles located _____ inches of wall
- 18” of the wall
- NEC 210.52(A)(3)

(3) Floor Receptacles. Receptacle outlets in or on floors shall not be counted as part of the required number of receptacle outlets unless located within 450 mm (18 in.) of the wall.

Practice Questions

- In dwelling units, at least one receptacle outlet shall be installed in bathrooms within ___ of the outside edge of each basin.
- 36”
- 210.52(D)

(D) Bathrooms. At least one receptacle outlet shall be installed in bathrooms within 900 mm (3 ft) of the outside edge of each basin. The receptacle outlet shall be located on a wall or partition that is adjacent to the basin or basin countertop, loca-

Practice Questions

- What is the unit load in volt ampere per square foot for stores?

Table 220.12 General Lighting Loads by Occupancy

Type of Occupancy	Unit Load: Volt-amperes/ m^2	Unit Load: Volt-amperes/ ft^2
Armories and auditoriums	11	1
Banks	39[b]	3½ [b]
Barber shops and beauty parlors	33	3
Churches	11	1
Clubs	22	2
Courtrooms	22	2
Dwelling units[a]	33	3
Garages — commercial (storage)	6	½
Hospitals	22	2
Hotels and motels, including apartment houses without provision for cooking by tenants[a]	22	2
Industrial commercial (loft) buildings	22	2
Lodge rooms	17	1½
Office buildings	39[b]	3½ [b]
Restaurants	22	2
Schools	33	3
Stores	33	3
Warehouses (storage)	3	¼
In any of the preceding occupancies except one-family dwellings and individual dwelling units of two-family and multifamily dwellings:		
Assembly halls and auditoriums	11	1
Halls, corridors, closets, stairways	6	½
Storage spaces	3	¼

[a]See 220.14(J).
[b]See 220.14(K).

File Attachments for Item:

EC-6 Carbon Monoxide Alarm and Detection Requirements IBC/NFPA 720 (Fire Code Academy)

All certifications (1 hour)

Application for Continuing Education Course Approval

Provider Information:

Name: Randy Hormann

Organization: Fire Code Academy

Address: 81 Mill Street - Suite 300 Gahanna, Ohio 43230

E-mail: RandyH@FireCodeAcademy.com Telephone: 614-416-8077

Website: www.FireCodeAcademy.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: Carbon Monoxide Alarm and Detection Requirements IBC/NFPA 720

Course instructor: DOMINIC S. SZORENTINI, JR.

Course description:

There is confusion industry wide regarding what is a Carbon Monoxide (CO) Alarm and what is a CO Detector and how these devices differ in the International Building Code (IBC). The IBC specifically defines when CO alarms are required, and CO detection is optional. When the detection option is utilized, many do not realize that all of NFPA 720 now applies except for location of devices.

Instructional hours per session: 1.0 Hours 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? 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: _______

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

Carbon Monoxide Alarm and Detection Requirements IBC/NFPA 720

Presented by:
D. Szorentini Associates

1.0 Hour

Program Description:
There is confusion industry wide regarding what is a Carbon Monoxide (CO) Alarm and what is a CO Detector and how these devices differ in the International Building Code (IBC).

The IBC specifically defines when CO alarms are required, and CO detection is optional. When the detection option is utilized, many do not realize that all of NFPA 720 now applies except for location of devices. This can be a costly error creating turmoil in an occupancy for the Owner, Designer and Contractor.

Learning Objectives:
1. Properties of CO
2. UL2034 VS UL2075
3. What is a CO Alarm?|
4. What is a CO Detection System?
5. Required Locations of CO Alarms/Detectors
6. Requirements in IBC Chapter 9 Section 915
7. Requirements of NFPA 720

DOMINIC S. SZORENTINI, JR.

dszorentinijr@gmail.com | 484.201.4534 | Allentown, PA

Fire & Life Safety Professional

Project Management | Fire Alarm System Engineering | Field Technical Expertise | Quality Assurance

Summary

Versatile **Fire & Life Safety Professional** with over 20 years of experience in the design, engineering, implementation, and testing of early warning fire detection systems including smoke control, mass notification systems (MNS), and emergency voice alarm communications systems (EVACS). Unique ability to combine technical expertise with team leadership and interpersonal skills for seamless project fulfillment that meets goals and initiatives on time and on budget without compromising safety. Adept at managing client expectations and coordinating the efforts of diverse teams and parties for concurrent projects, infusing extensive industry knowledge with flexibility to ensure compliance, satisfaction, and integrity.

Education

Intro to Fire Protection
Building Construction
Fire and Arson Investigation
Fire Suppression and Detection Systems
Fire Strategy and Tactics
| Middlesex County College | Fall 1999-Spring 2001 GPA 4.0 Credits 15.0

NICET Level 3 Engineering Technician #103256 |NICET | 2001

NJ State Fire Inspector/Fire Official | Bergen Community College | 1995 – 1996

Experience Focus

Power Design, Inc. | St. Petersburg, FL | 2021 – Present

As a **Systems Fire Alarm Technician** I am responsible for overseeing the installation, troubleshooting and commissioning of fire alarm systems on large scale construction projects.

- As the technical advisor on fire alarm systems programming and configuration, work with installation team and local Fire Marshal to ensure that all code requirements are met.
- Act as a liaison between the project team, other trades and customers, partnering with the Superintendent and Foremen to ensure production is on schedule.
- Utilize technology, such as company provided Tablet and Smartphone, to ensure the project is completed on schedule adhering to contract and construction documents while meeting and exceeding customer expectations.

Keystone Fire Protection Co. | N. Wales, PA | 2020 – 2021

As a **Alarm Installation Project Manager** I was responsible for the technical, financial, administrative and customer-relations success of the projects assigned.

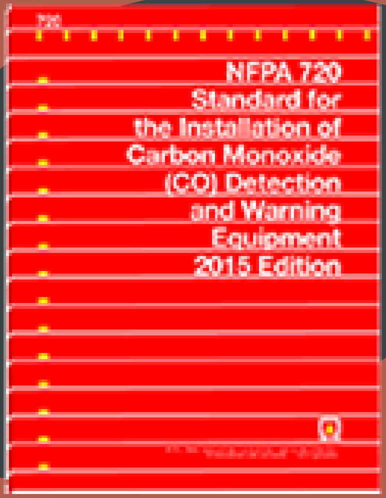
- Manage the project within defined profitability and timing parameters.
- Develops and nurtures relationships with contractors, owners, government agencies and other potential customers and influencers.
- Complete all projects to the satisfaction of the customer.

Carbon Monoxide Alarm and Detection Requirements

- IBC 2015 [Ohio Edition Section 915]
- CO Alarms
- CO Detection Systems
- NFPA 720-15 CO Detection and Warning Equipment

Participant Takeaways:

- Properties of CO
- UL2034 vs UL2075
- What is a CO Alarm?
- What is a CO Detection System?
- Required Locations of CO Alarms/Detectors
- Additional requirements in NFPA 720-15



Properties of Carbon Monoxide(CO)

- Develops from incomplete combustion process
- Colorless, Odorless, Tasteless, TOXIC
- Flammable
- Lighter than air
- Can migrate thru sheetrock
- Used in meat packing methods

Carbon Monoxide Level Standards and Effects

9ppm	EPA/ASHRAE 8 Hour Average
35ppm	NIOSH 8 Hour Average
50ppm	OSHA 8 Hour Average
200ppm	NIOSH 15 Minute Short Term Exposure Limit

Less Than 29ppm	No alarm
30-69ppm	Alarm after 30 Days
70-149 ppm	Alarm in 60-240 minutes
150-399ppm	Alarm in 10-50 minutes
400ppm and up	Alarm in 4-15 minutes

50ppm	No adverse effects within 8 hours
200ppm	Headache, fatigue, dizzy, nausea after 2-3 hours of exposure
400ppm	Headache, fatigue, dizzy and nausea after 1-2 hours. Life threatening after 3 hours.
800ppm	Headache, fatigue, dizzy and nausea after 45 minutes. Unconscious after 120 minutes.
1000ppm	Unconscious after 60 minutes.

2034

- ANSI/UL 2034, Single and Multiple Station Carbon Monoxide Alarms, is the product standard for self-contained CO alarms. These alarms are not designed to be connected to an alarm control panel. The primary operating power for these devices is derived from a battery, a plug-in that uses a two- or three-prong attachment plug or is wired into the dwelling's AC power line with secondary power backup.
- Ordinary indoor locations of dwelling units, including recreational vehicles, mobile homes, and recreational boats with enclosed accommodation spaces and cockpit areas.

- ANSI/UL 2075, Gas and Vapor Detectors and Sensors, is the product standard for CO detectors that are intended to be system-connected to an alarm control panel. This is typically done via conductors, extending from the detector to the control panel or low-power radio frequency signal.
- Even though there are two standards for CO detection devices, both have the same alarm thresholds. ANSI/UL 2075 requires detectors to operate within the sensitivity parameters defined in ANSI/UL 2034. The alarm thresholds, set by CO concentration measured in parts per million (ppm), are: no alarm below 30 ppm. 30 ppm to 69 ppm after 30 days; 70 ppm for one to four hours (but not less than one hour); 150 ppm for 10 to 50 minutes; 400 ppm for four to 15 minutes.

2075

What Is a CO Alarm??

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

IBC Chapter 2

What Is a CO Detection System?

- A system or portion of a combination system that consists of a control unit, components, and circuits arranged to monitor and annunciate the status of carbon monoxide alarm initiating devices and initiate the appropriate response to those signals.

NFPA 720-2015 3.3.25.1

CO Requirements For a Fuel Burning Appliance, Fireplace Or Forced Air Furnace

- Carbon monoxide detection shall be installed in NEW BUILDINGS designated I-1, I-2, I-4, R and E use groups in accordance with the following:
- In DWELLING units, SLEEPING units, or classrooms that contain a fuel burning appliance, fuel burning fireplace or SERVED by a fuel burning forced air furnace.

IBC 915.1, 915.1.1, 915.1.2, 915.1.3.

Fuel Burning Forced Air Furnace ONLY Exception!!!!!

- Carbon monoxide detection shall NOT be required in DWELLING units, SLEEPING units, or classrooms if a carbon monoxide detector is provided in the first room or area served by EACH main duct leaving the furnace, and the carbon monoxide alarm signals are automatically transmitted to an APPROVED location.
- APPROVED: Acceptable to the AHJ.
- ALARM SIGNAL: A signal indicating an emergency requiring immediate action
- MAIN DUCT: No definition in IBC, IMC or NFPA 720.

IBC 915.1.3

CO Requirements When the Source Is Outside Dwelling/Sleeping Units And Classrooms

- Carbon monoxide detection shall be provided In DWELLING units, SLEEPING units, and classrooms located in buildings that contain a fuel burning appliances or fuel burning fireplaces.

IBC 915.1.4

Fuel Burning Appliances And Fireplaces OUTSIDE Dwelling Units, Sleeping Units And Classrooms EXCEPTION!!!!!

- Carbon monoxide detection shall NOT be required:
- In DWELLING units, SLEEPING units, or classrooms without communicating openings between the fuel burning appliance/fireplace and the DWELLING units, SLEEPING units or classrooms.
- Where a carbon monoxide detector is provided in one of the following locations: in an APPROVED location between the fuel burning appliance/fireplace and the DWELLING units, SLEEPING units, or classrooms or on the ceiling of the room containing the fuel burning appliance/fireplace.

IBC 915.1.4

CO Requirements For Attached Private Garages

- Carbon monoxide detection shall be provided In DWELLING units, SLEEPING units, or classrooms with attached private garages.

IBC 915.1.5

Attached Private Garages EXCEPTION!!!!!

- Carbon monoxide detection shall NOT be required:
- In DWELLING units, SLEEPING units, or classrooms without communicating openings between the private garage and the DWELLING units, SLEEPING units or classrooms.
- Where a carbon monoxide detector is provided in an APPROVED location between openings to a private garage and the DWELLING units, SLEEPING units or classrooms.
- Where the DWELLING units, SLEEPING units or classrooms are more than one floor above or one floor below the private garage.
- Where the private garage connects to the building through an open-ended corridor.

IBC 915.1.5

Exempt Garages

- For determining compliance with Private Garages, an Open Parking Garage complying with 406.5 or an enclosed parking garage complying with 406.6 shall not be considered a private garage.

IBC 915.1.6

CO Detection Locations

In Sleeping Units

Other Occupancies

Group E Occupancy

In Dwelling Units

Dwelling Units CO Detection Location

Outside of each separate sleeping area in the immediate vicinity of the bedrooms.

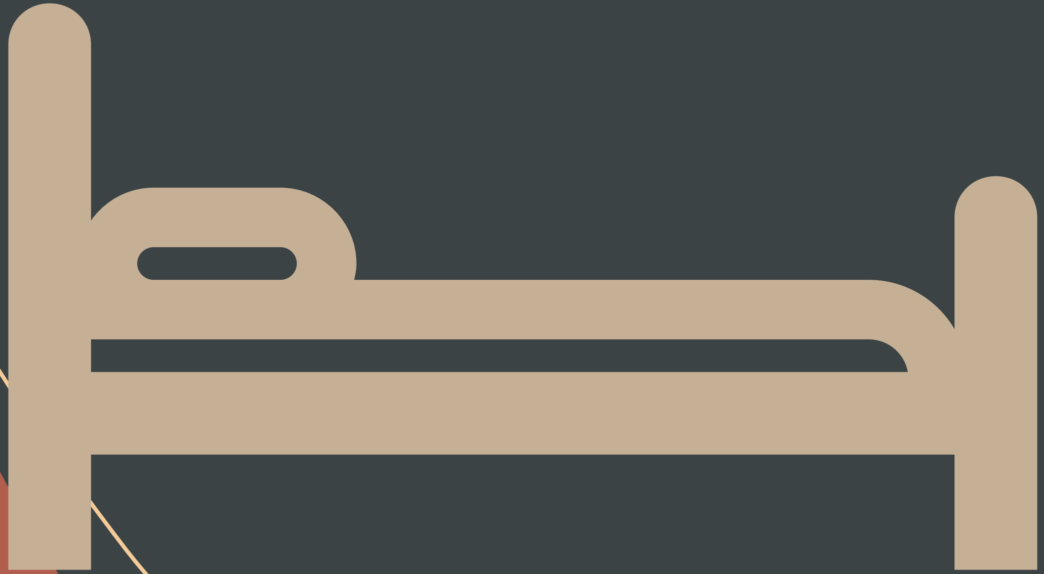
Where a fuel burning appliance is located within a bedroom or its attached bathroom, CO detection shall be installed within the bedroom.

IBC 915.2.1

Sleeping Units CO Detection Locations

- Shall be installed in sleeping units EXCEPT may be installed outside of each separate sleeping area in the immediate vicinity of the sleeping unit where the sleeping unit or its attached bathroom does not contain a fuel burning appliance and is not served by a forced air furnace.

IBC 915.2.2



Group E Occupancy CO Detection Locations

- CO DETECTORS shall be installed in classrooms.
- CO detector alarm signals shall be automatically transmitted to an onsite location that is staffed by school personnel.
- CO detector alarm signals are not required to be automatically transmitted to an onsite location where the occupant load is 30 or less.

IBC 915.2.3

Clarifying “Carbon Monoxide Detection”

Sorta, Maybe……Stay Tuned!!

- CO Detection required by 915.1 thru 915.2.3 shall be provided by CO ALARMS complying with 915.4 or CO DETECTION SYSTEMS (Optional sometimes) complying with 915.5.

IBC 915.3

CO Alarms SHALL…….

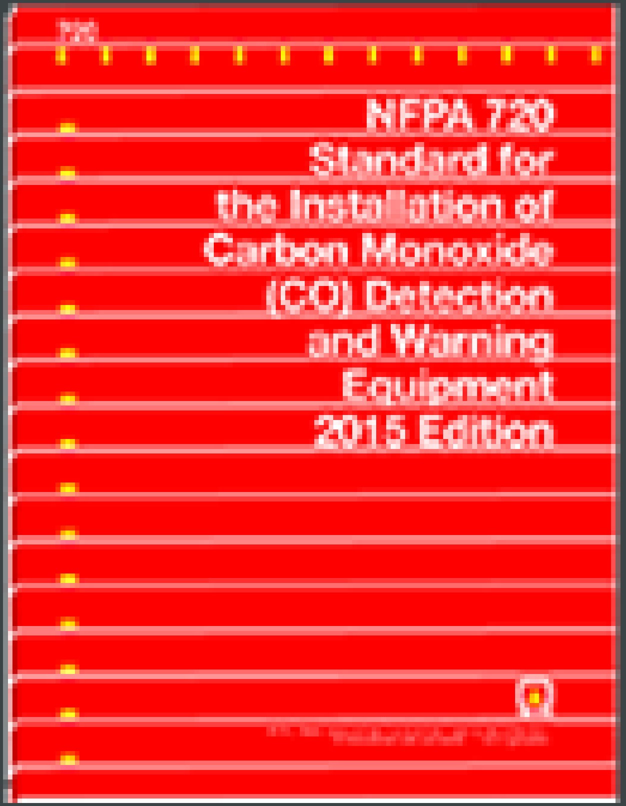
- Receive their primary power source from the building wiring where such wiring is served from a commercial source, and when primary power is interrupted, shall receive power from a battery. Wiring shall be permanent and without a disconnecting switch other than that required for overcurrent protection.
- Battery powered only permitted in occupancies without commercial power.
- CO Only: UL2034
  CO/Smoke: UL217/2034
- ONLY be used in DWELLING and SLEEPING UNITS!!!!!

IBC 915.4, 915.4.1, 915.4.2, 915.4.3, 915.4.4

Carbon Monoxide Detection Systems SHALL…

- Be an acceptable alternative to CO Alarms
- Comply with NFPA 720-2015 and be UL2075.
- Installed in locations specified in 915.2.1, 915.2.2, 915.2.3 and 915.2.4. These locations supersede NFPA 720-2015.
- CO/Smoke: UL268/2075

IBC 915.5.1, 915.5.2, 915.5.3



NFPA 720-2015 Purpose

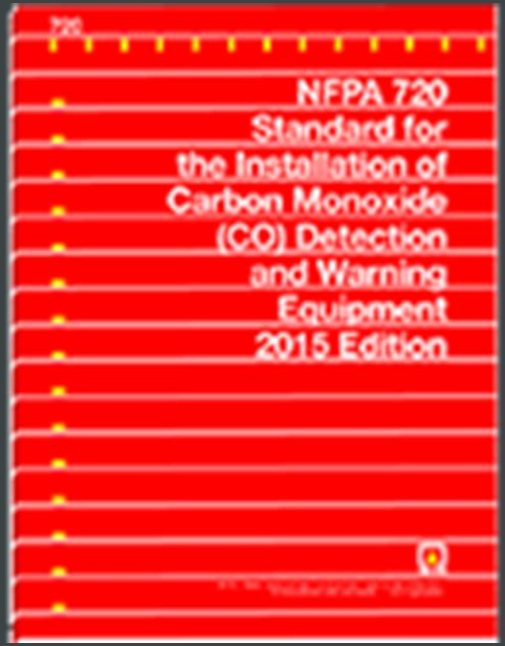
- Provide requirements for CO detection and warning equipment intended to warn occupants of the presence of CO in sufficient time to escape or take other appropriate action and where required summon aid.
- The requirements provided by this standard address the means of signal initiation, transmission, notification and annunciation, the levels of performance, and the reliability of CO detection and warning equipment.

720-2015 Chapter 1

NFPA 720-2015 Fundamentals

4.3.1: Equipment constructed and installed in conformity with 720 shall be listed for the purpose for which it is used. (UL 864, UL 1480, UL1971, UL2017, UL2075)

4.3.2: System components shall be installed, tested, inspected, and maintained in accordance with the manufacturer's published instructions and 720.



NFPA 720-2015 Fundamentals

- 4.4.1.3: System Designer
- 4.4.2.3: System Installer
- 4.4.3.2: ITM Personnel
- Shall provide evidence of qualifications and/or certifications when requested by the AHJ.

NFPA 720-2015 Fundamentals

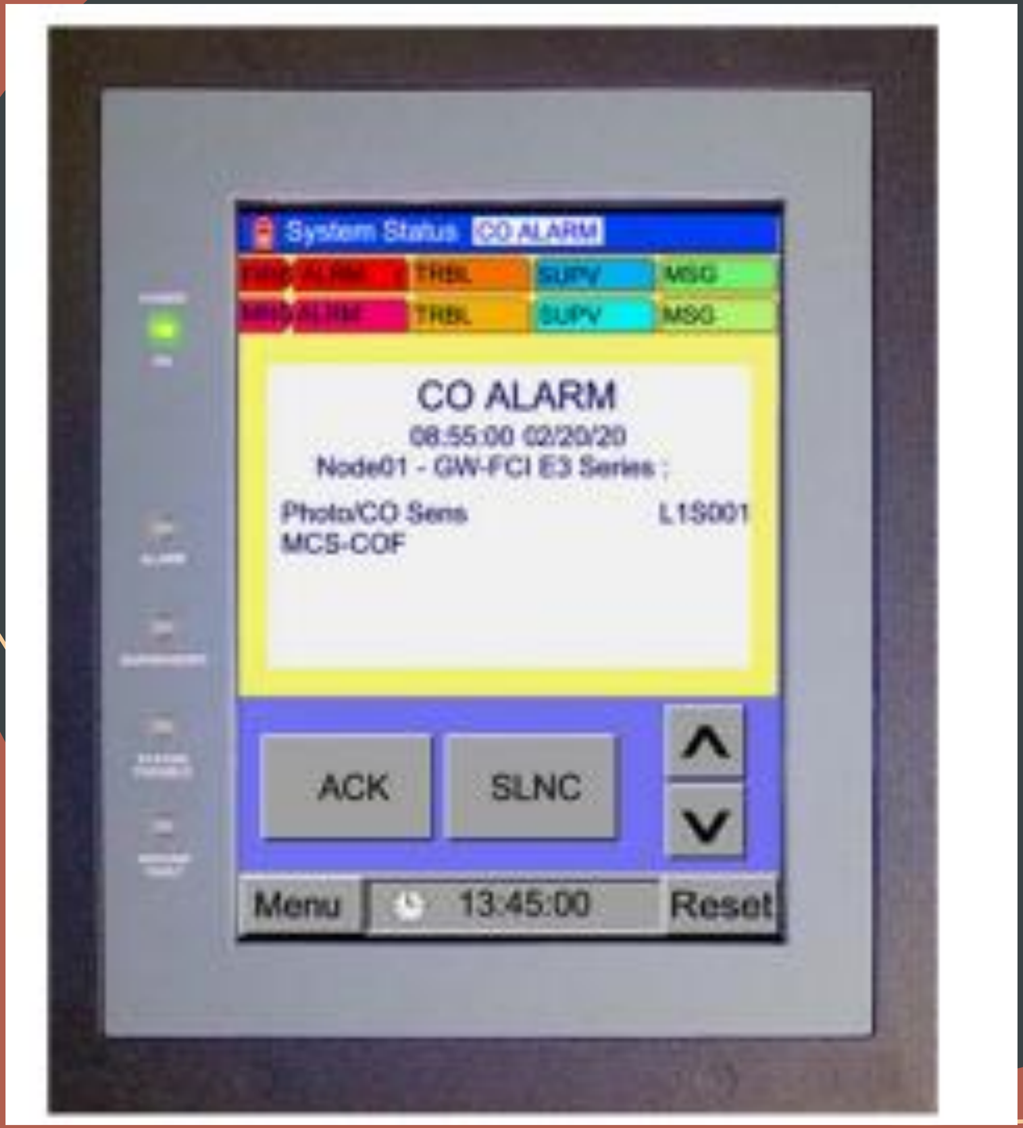
- 4.5.3.2/4.5.3.3: Unless using a UPS, at least two (2) independent and reliable power supplies shall be provided, one (1) primary and one (1) secondary of adequate capacity for the application.
- 4.5.5.1: Branch circuit supplying the equipment shall supply no other loads.
- 4.5.5.2.1: Location of the branch circuit disconnect shall be permanently identified at the control unit.
- 4.5.5.2.2: The circuit disconnecting means shall be clearly marked and be accessible only to authorized personnel.

NFPA 720-2015 Fundamentals

- 4.5.6.2.3: Secondary power supply shall have the capacity to operate the CO detection system under nonalarm condition for a minimum 24 hours and, at the end of 24 hours, operate the CO detection system and all notification appliances for 12 HOURS. The 12-hour requirement may be reduced to 5 minutes where the system is monitored by a supervising station and the supervising station notifying the emergency response agency and contacting the responsible party(s) in accordance with the notification plan.

NFPA 720-2015 Fundamentals

- 4.6.1: CO alarm, supervisory and trouble signals shall be distinctively and descriptively annunciated.
- 4.6.2: Audible alarm notification appliances for a CO detection system shall produce signals that are distinctive (TEMPORAL 4) from other similar appliances used for other purposes in the same area that are not part of the CO detection system.



NFPA 720-2015 Fundamentals

- 4.11.2.1: All systems shall be installed in accordance with the manufacturer's published installation instructions and applicable codes and standards.
- 4.12.3: All required annunciation means shall be readily accessible to responding personnel and shall be located as required by the AHJ to facilitate an efficient response to the situation.

NFPA 720-2015 Fundamentals

- 4.14.2: CO detection system required documents in an approved enclosure at the control unit:
- An owner's manual and manufacturer's published instructions for ALL equipment.
- Record Drawings
- Record copy of site specific software
- Written sequence of operation
- CO detection system Record Of Completion (NFPA 720 not NFPA 72)

NFPA 720-2015 Protected Premise CO Detection Systems

- 5.8.4.1: CO detection systems shall be permitted to share components, equipment, circuitry, and installation wiring with non-CO detection systems.
- 5.8.4.2: Operation of non-CO detection system function(s) originating within a connected non-CO detection system shall not interfere with the required operation of the CO detection system.
- Combination System: Fire, Intrusion and CO Detection
- Combination CO Detection System: Fire and CO Detection

NFPA 720-2015 Protected Premise CO Detection Systems

5.8.4.5: Speakers used as a MNS or EVACS installed in accordance with NFPA 72-2016 shall also be permitted to be used as alarm notification appliances for CO detection systems.

5.8.4.6: In combination CO detection systems, CO alarm signals shall be distinctive, recognizable, and take priority over signals associated with property protection.

NFPA 720-2015 Protected Premise CO Detection Systems

5.8.5.1.1: Where subject to mechanical damage, a CO detector shall be protected.

5.8.5.1.3: CO Detectors shall be installed in a manner that provides accessibility for periodic ITM.

5.8.5.3.9.1: Where CO detectors are installed for signal initiation during construction, they shall be replaced prior to the final commissioning of the system.

NFPA 720-2015 Protected Premise CO Detection Systems

- 5.8.5.4.1: System designers shall consider the spread of CO through an occupancy through the HVAC system.

NFPA 720-2015 Protected Premise CO Detection Systems

- 5.8.6.2: Occupant notification shall be throughout the protected premises except where CO alarm signals are transmitted to a constantly attended on-site location or off-premises location in accordance with Chapter 7, selective public mode occupant notification shall be permitted to be limited to the notification zone encompassing the area where the carbon monoxide alarm signal was initiated.
- 5.8.6.3: Notification zones shall be consistent with the emergency response plan for the protected premises. The boundaries of notification zones shall be coincident with the area where the alarm initiation originated and other signaling zones in accordance with the building's emergency response plan.

NFPA 720-2015 Protected Premise CO Detection Systems

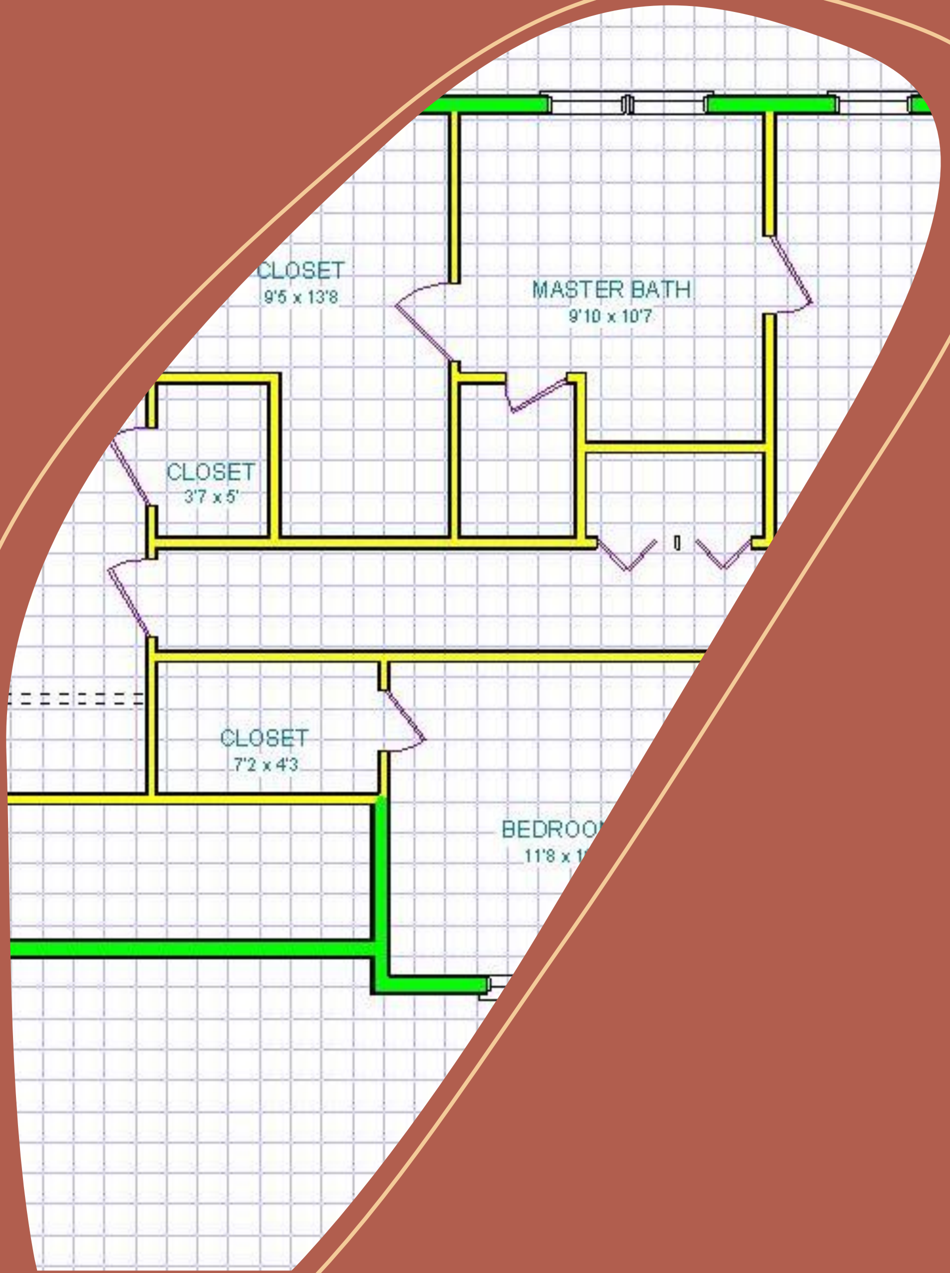
- 5.8.6.5: The audible CO alarm signal shall be a four-pulse temporal pattern.
- The audible alarm signal shall be synchronized within in a notification zone.
- 5.8.7: Where an EVACS is installed for the purpose of occupant notification related to CO detection, it shall comply with NFPA 72-2016 24.4.2 excluding 24.4.8.5 (Survivability)
- EVACS typically involves selective, partial or full evacuation pending occupancy classification.

NFPA 720-2015 Protected Premise CO Detection Systems

- 5.10.1: CO detection systems requiring transmission of signals to continuously attended locations providing supervising station service shall comply with Chapter 7.
- 5.10.2: Relays or modules providing transmission of trouble signals to a supervising station shall be arranged to provide fail-safe operation. (Normally closed powered contact)

NFPA 720-2015 Notification Appliances

- 6.3.3.2: Notification appliances used for CO signaling SHALL NOT have the word FIRE, or any FIRE SYMBOL in any form on the appliance visible to the public. Notification appliances with multiple visible elements shall be permitted to have fire markings ONLY on those visible elements used for fire signaling.
- 6.3.4: Appliances subject to mechanical damage shall be suitably protected, protection is listed for use with the appliance and any effects of the protection on the appliance field performance shall be in accordance with the listing.

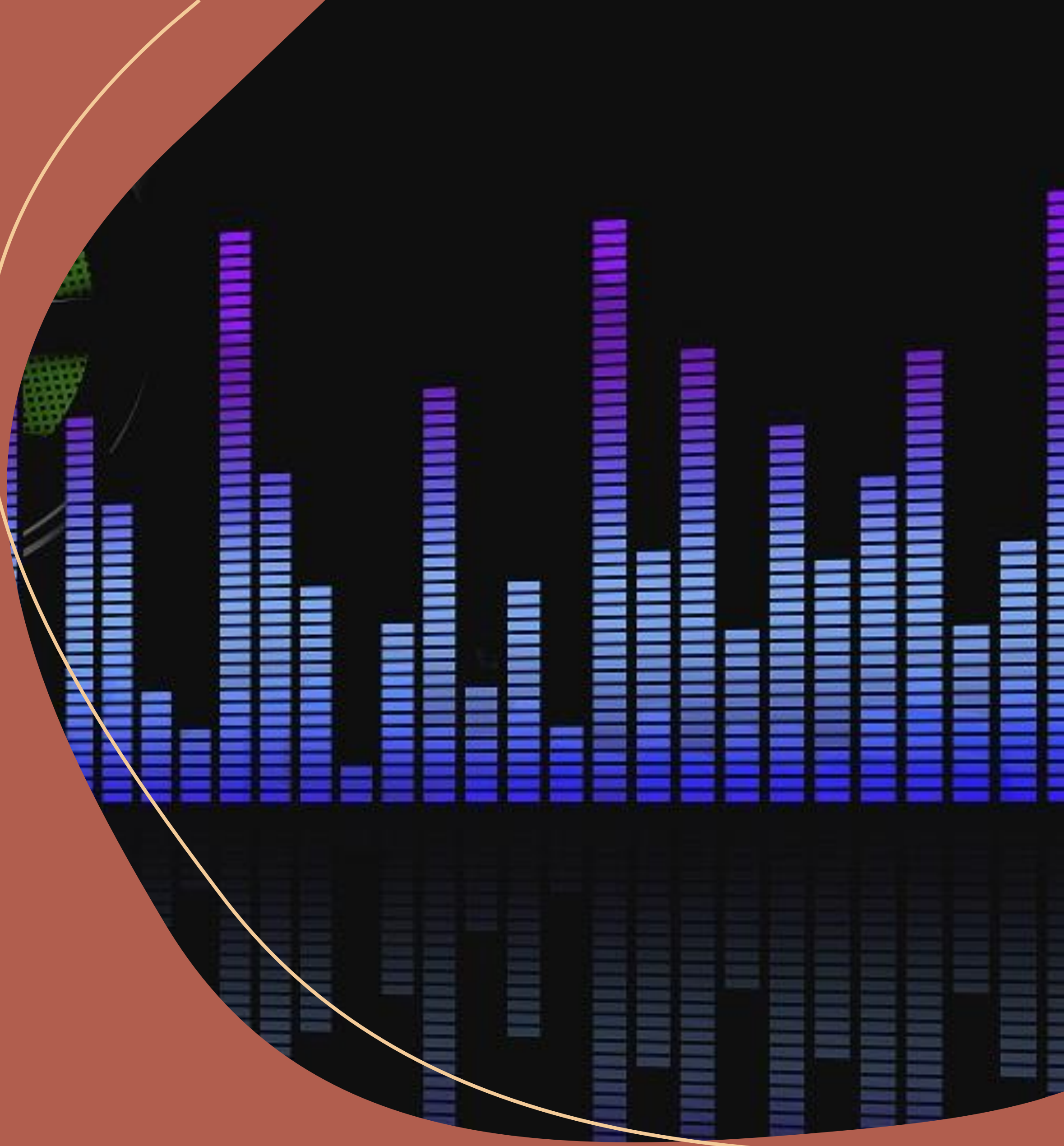


NFPA 720-2015 Notification Appliances

- 6.4.1.4.3: The sound pressure levels that must be produced by audible appliances in the coverage area to meet the requirements of this standard shall be documented by the system designer during the planning and design of the notification system.
- 6.4.1.4.4: The design sound pressure levels to be produced by the notification appliances for the various coverage areas shall be documented for use during acceptance testing.
- 6.4.1.4.5: Where required by the AHJ, documentation of the design sound pressure levels for the various coverage areas shall be submitted for review and approval.
- 6.4.1.5: Voice messages shall meet the intelligibility requirements.

NFPA 720-2015 Notification Appliances

- 6.4.4.1: Sleeping areas shall have a sound level at least 15dBA above the average ambient sound level (24-hour measurement) or 5dBA above the maximum sound level for 60 seconds, or sound level minimum of 75dBA at pillow level at furthest point from the barrier, whichever is greater. All barriers must be in place (doors, curtains, retractable partition closed).
- 6.4.4.3: Audible appliances in sleeping areas shall be low frequency 520Hz square wave temporal 4.



NFPA 720-2015 Notification Appliances

- 6.5.2.3: Where required by the AHJ, documentation of the effective intensity (candela) of the visible appliances for the area of coverage shall be submitted for review and approval.
- 6.5.3.4: Lights (color not intensity) used for CO alarm signaling shall be as required by the emergency plan and the AHJ.
- 6.5.5.6: Any design that provides a minimum of .0375 lumens/ft2 of illumination at any point within the covered area at all angles specified by the polar dispersion planes in UL1971. Inverse Square Law calculations shall be provided to the AHJ.
- 6.5.5.7.2: Where the visible appliance is not used for fire alarm signaling, the intensity shall not be required to be greater than 110cd. Visible appliance must be within 16 feet of the pillow.
- 6.9: Textual and graphic visible appliances should be considered for hearing impaired occupants.

NFPA 720-2015 Off-Premise Signaling

- 7.2.2: Upon receipt of a CO alarm signal, supervising station personnel shall provide the following:
- Where required by the emergency response agency, immediately retransmit indication of the CO alarm to the comm center.
- Contact the responsible party(s) in accordance with the notification plan.

Questions???

Dominic Szorentini

dszorentinijr@gmail.com

484-201-4534

Technical Proficiencies

- AutoCad
- REVIT
- Microsoft Word, PowerPoint, Outlook
- Siemens XLS XLSV CerberusPro
- GWFCI 7100 7075 S3 E3 MNS
- Faraday 1000 1500 6000 7000
- Bosch Intrusion
- FLIR Security Certified Professional

Volunteer Work

Volunteer, Notre Dame Bethlehem School: Pro *bono* maintenance and repair of smart boards, smart displays, and projectors
2009 – 2020

Knights of Columbus, Trinity Council 313
2014 – 2021

Volunteer Firefighter, Paramus, NJ
1988 – 1998

Additional Professional Experience

Pro-Tec Systems, Inc. | Somerset, NJ | 2004 – 2020

As **Fire/Mass Notification Systems (MNS) Project Manager** I design, program, commission, and inspect early warning fire detection systems with smoke control, emergency voice alarm communications systems (EVACS) and mass notification systems (MNS) in military, high rise, mercantile, office, data center, educational, multi-family residential, and aviation occupancies.

Comprehensive Project Management

- Manage all aspects of fire/MNS projects from ideation and design to installation, commissioning, and testing.
- Compose and submit Army Corps of Engineers (ACOE) compliant submittal packages.

Relationship Building

- Forge and cultivate relationships with new and existing clients resulting in growth of customer base and loyalty.
- Support design engineers as well as existing and potential clients via expert informational and sales consultation.

Quality Assurance & Compliance

- Review project documentation to ensure compliance with NJ adopted model building codes and national standards.
- Advance collegial understanding of and adherence to NJ adopted model building codes and referenced standards via Lunch and Learns for design engineers in mechanical and electrical engineering firms.

Fire Security Technologies, Inc. | Wall Twp., NJ | 2000 – 2004

As **Inspection Division Manager** I orchestrated and oversaw annual testing and inspection of 100+ educational, multi-family residential, mercantile, and office occupancies in compliance with NJ Uniform Fire Code. I transitioned into the role of **Project Manager,** designing and heading projects for educational facility early warning fire detection systems.

- Provided quality control in reviewing all reports for completion and compliance.
- Supervised a team of 6 field inspectors, providing training, scheduling, and monitoring of tasks to ensure project integrity.
- Developed techniques and provided inspectors with tools and resources for increased efficiency and productivity.

Complete Security Systems, Inc. | Marlboro, NJ | 1999 – 2000

As **Fire System Inspector** I tested and inspected fire alarm systems in office and mercantile occupancies.

File Attachments for Item:

EC-7 Emergency Responder Communication Enhancement Systems and the UL Certification Program (Fire Code Academy)

All certifications (1 hour)

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: Randy Hormann

Organization: Fire Code Academy

Address: 81 Mill Street - Suite 300 Gahanna, Ohio 43230

E-mail: RandyH@FireCodeAcademy.com Telephone: 614-416-8077

Website: www.FireCodeAcademy.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: Emergency Responder Communication Enhancement Systems (ERCES) and the UL Certification Program

Course instructor: Christopher Creamer

Course description:

The UL Solutions certification program forms a strong connection among the ERCES service providers, building owners, code authorities and UL Solutions. Certification provides confidence to all stakeholders that these systems comply with all of the elements found in the model codes, along with National Fire Protection Association NFPA 1221 or NFPA 1225, the Ohio Building Code and Ohio Fire Code.

Instructional hours per session: 1.0 Hours 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? 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: _______

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

UL Emergency Responder Communication Enhancement Systems (ERCES) Certification Program

Program Description

- This program will provide an update on UL Solutions' latest certificate program on Emergency Responder Communication Enhancement Systems (ERCES).
- The UL Solutions certification program forms a strong connection among the ERCES service providers, building owners, code authorities and UL Solutions. Certification provides confidence to all stakeholders that these systems comply with all of the elements found in the model codes, along with National Fire Protection Association NFPA 1221 or NFPA 1225, the Ohio Building Code and Ohio Fire Code.
- In-building emergency responder radio systems are an important life safety technology that provide emergency responders an effective and reliable means with which to communicate in environments that present interference and coverage concerns.

Time:

- 1 .0 Hour of CEU

Course Outline / Agenda

- ERCES Background/Need
- Model Codes/Standards Requirements
- ERCES Technology/Technical Aspects
- UL ERCES Certification Program
- Q & A Session

Christopher Creamer

3952 Long Branch Lane
Apopka, FL 3272
407.947.1386
chrisgc1972@gmail.com

PROFESSIONAL PROFILE

Dynamic and goal orientated professional with over 22 years of Management experience. Team player with exceptional communication and interpersonal skills. Adept at managing multiple, diverse tasks simultaneously; works well under pressure. Proven skills in leadership, decision-making and team building. Areas of expertise include:

- Sales
- Business Development
- Employee Relations
- Training & Development
- Recruitment
- Team Building
- Policy Development & Documentation
- Change Management
- Organizational Development
- Performance Management

PROFESSIONAL EXPERIENCE

UL, Northbrook Illinois
November 1, 2021-Present
Alarm Auditor I & SME for ERCES

- Work within the BE in Alarm Certificate Services
- Currently the Program lead for ERCES, a new Certificate Program under development within UL
- Member of the UL Fire Alarm Advisory Committee
- Member of the UL National Industrial Security Committee (UL 2050)

Emergency Responder Communication Enhancement Systems (ERCES) and the UL Certification Program

Chris Creamer
February 2023

Speaker

<u>Expert</u>: **Chris Creamer**

UL Solutions

- *1 Year: Fire and Security Service Solutions (FSSS)/Florida ~ Nationwide*
- *ERCES SME/AHJ Education Specialist/Alarm System Auditor*
- *Represent UL ~ NFPA Technical Committee's 72, 420, 715 & 1225*

Fire Alarm/ERCES Industry

- *16 Years (Florida)*
- *Florida AFAA President (Current)*
- *AFAA National Board of Directors*
- *AFAA Codes and Standards Steering Committee (Chair)*
- *Florida Fire College Instructor*

UL Safety Moment

Make your kitchen safer

Follow these tips to help avoid contamination that can cause food poisoning

- Wash your hands with warm water and soap before cooking
- Cut and slice raw meat and vegetables with different knives and cutting boards to avoid cross-contamination
- Use a meat thermometer to make sure food is fully cooked
- Scrub produce with a vegetable brush and rinse well to remove dirt and bacteria.

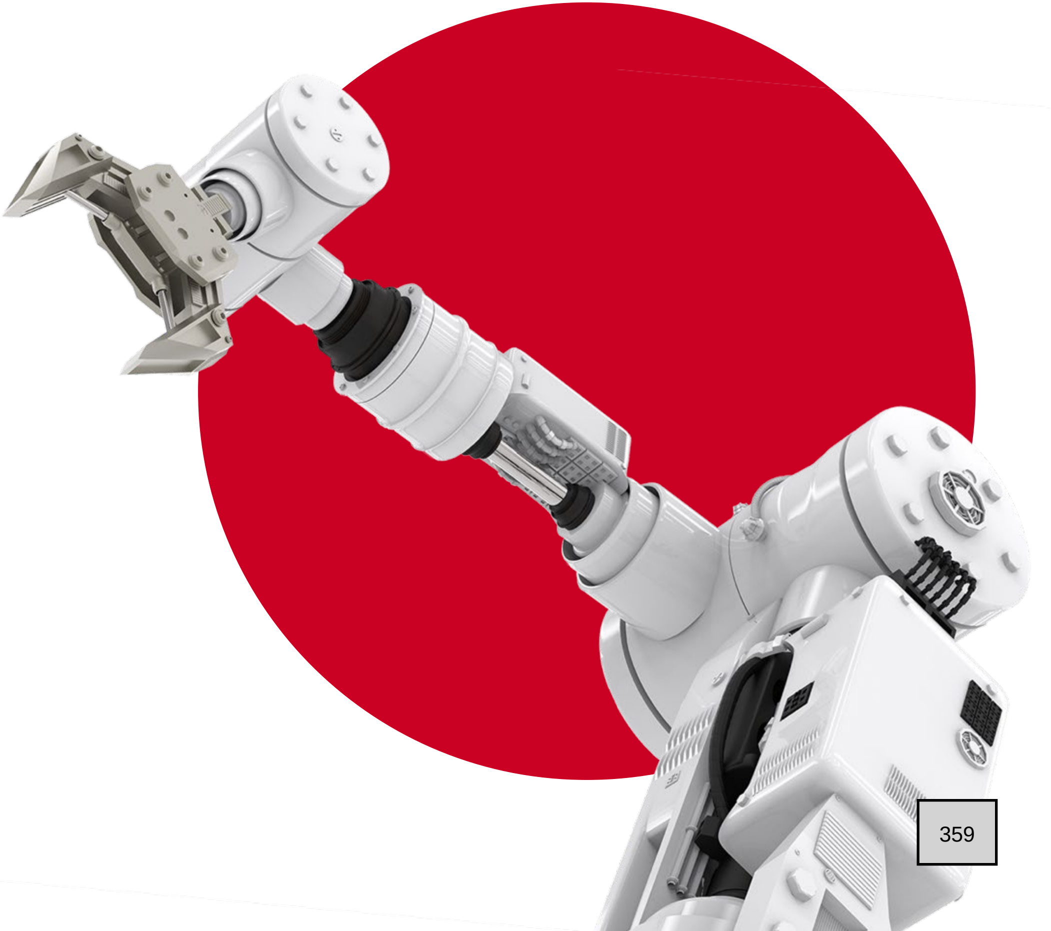
Solutions

UL Solutions

We are now UL Solutions

New brand. Same mission.

Evolving safety science, exploring the world's pressing challenges and continuing to empower our customers to innovate with confidence.



Safety. Science. Transformation.™

Disclaimer

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Any references to situations, incidents, or responses to said incidents are for educational and demonstrative purposes and not intended as incident debriefs or criticisms toward said incidents, first responders, victim's, survivors or victim’s families.

All information noted within is the presenter's perspective and based on the most current information available at time of delivery. The content is intended and delivered in good faith as accurate, factual and is the viewpoint of the presenter(s), not necessarily that of UL Solutions. Information provided is provided either verbally or in written fashion to allow for appropriate citation and recognition of informational source(s) and material(s), where applicable.

What does UL Solutions do?

- Audits
- Certifies
- Validates
- Tests
- Inspects
- Advises
- Educates
- Researches

UL Solutions functions are geared to the Built Environment

Building Quality and Compliance

Alarm Certificates
Building Envelope
Building Inspection
Field Services

Fire and Security Solutions Service (FSSS)
https://www.ul.com/services/fire-and-security-service-solutions

- Fire and Security Companies
- Certificated Systems
- Central Stations

Fire Suppression

Fire Detection

Building Products and Systems

Personal Protective and Rescue Equipment

UL Solutions

Presentation Agenda

- ERCES Background/Need
- Model Codes/Standards Requirements
- ERCES Technology/Technical Aspects
- UL ERCES Certification Program
- Q & A Session

Terminology

ERCES = *Emergency Responder Communication Enhancement Systems*	*2-Way Radio Communications Enhancement System*
	Emergency Responder Communication Coverage
	Emergency Responder Radio Coverage
	In-Building Two-Way Emergency Responder Communication
	Two-Way Radio Communications Enhancement System
	In-Building Emergency Responder Communication Enhancement Systems

ERCES Background/Need

Background/Need

Post WTC collapse:

- National Institute of Standards and Technology's (NIST) funded from Congress through FEMA conducts a building and fire safety investigation
- Forty (40) code changes are adopted ranging from increased egress capacity and stability in super high rises, to increased fire resistance for certain types structural framing, to ***robust radio coverage within building envelopes***

https://www.nist.gov/blogs/taking-measure/how-911-changed-me-and-first-responder-communications

https://www.nist.gov/world-trade-center-investigation

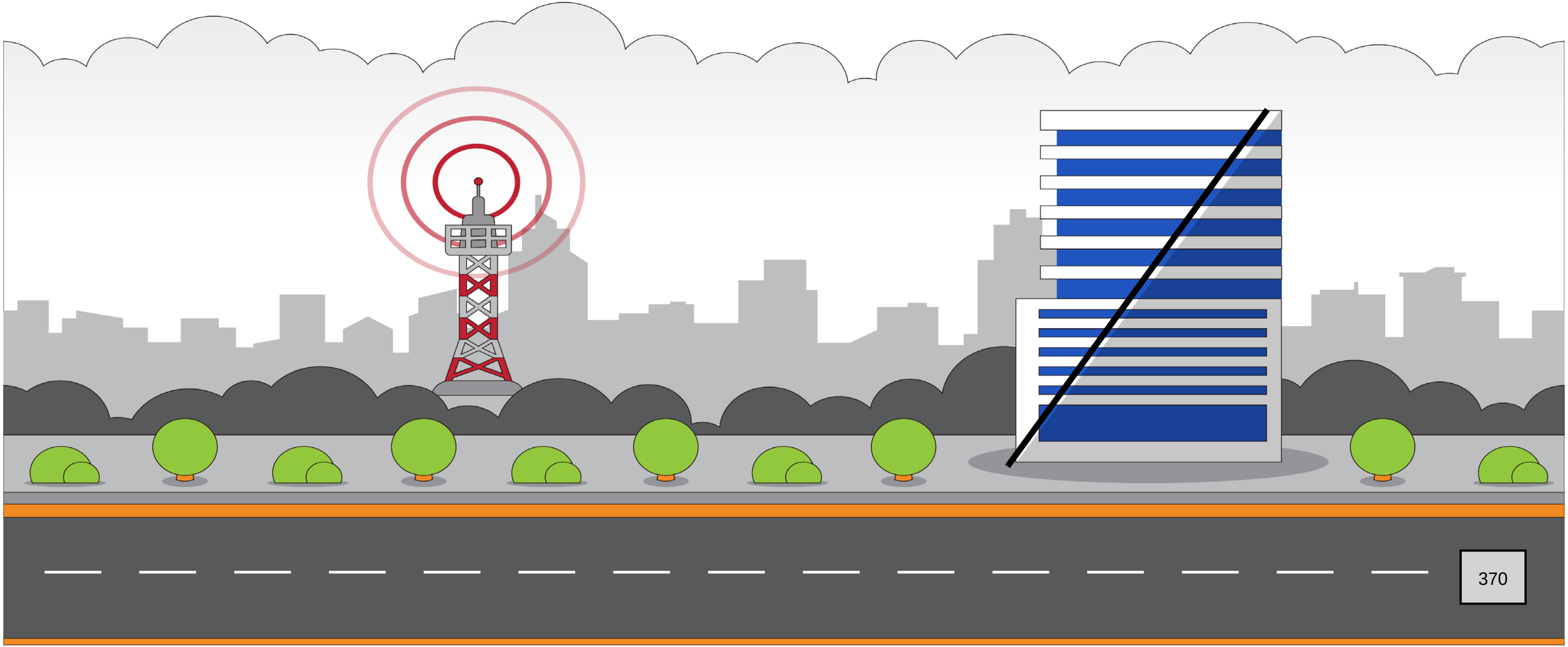
Background/Need

Fire Department/***First Responder*** Communication Issues:

- Lack of/Poor/No common radio equipment
- Analog to digital transformation
- Culture change ~ Purposeful communications…
- Expanded radio issuance/Commonplace
- …Incompatible radios ~ frequencies/*Changing events*
- ***Building construction***

Building construction interferes with communication signals

ERCES Concerns



Public Safety ~ Lives Depend On It!

Portable Land Mobile Radios (LMRs) are *essential* life-safety tools for firefighters and emergency responders

- *Many buildings prevent receipt or transmission of LMR messages due to construction elements and/or building configuration*
- *Enhancement systems provide assurance that emergency messages can be transmitted and received into and out of every building*
- *Enhancement systems do not rely on alternate communication equipment or fixed locations for transmissions (i.e., firefighter's telephone handsets)*
- *Current technology allows economical and reliable installation and maintenance of these systems.*

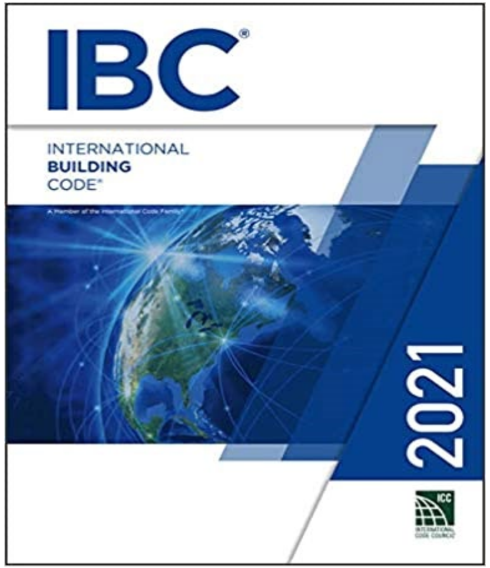
Background/Need

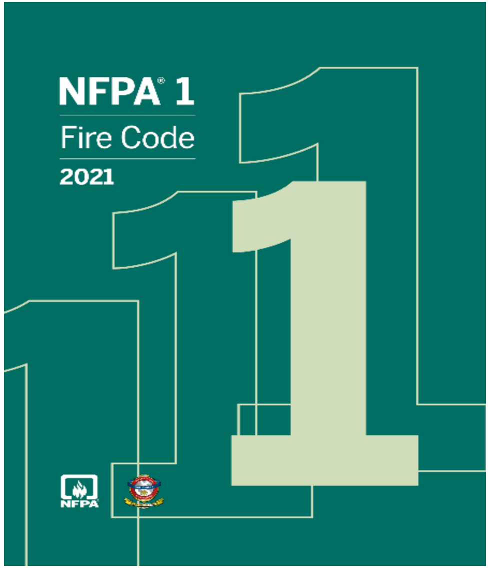
"Reliable communications as important as water when fighting building fires"

- International Association of Fire Chiefs (IAFC) 2017 survey found 56% of fire departments have experienced a communication failures in buildings during an emergency event
- Communication signals in and out of buildings *(large or small)* can be impeded / blocked by concrete, rebar, glass, sheetrock, Low-E glass windows, energy-saving materials *(cladding / wall composition)*, or location *(basements, underground structures or parking areas, stairwells, etc…)*

Model codes/standards requirements

Overview of Model Code Requirements: ICC/NFPA

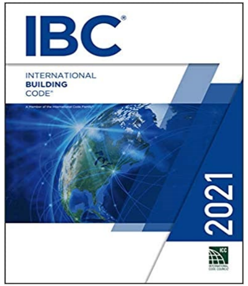




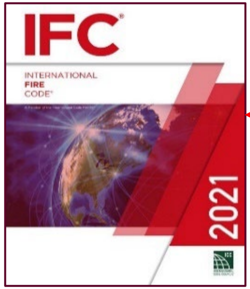
Documents that apply to ERCES

ICC/NFPA/UL (Code, Standards)

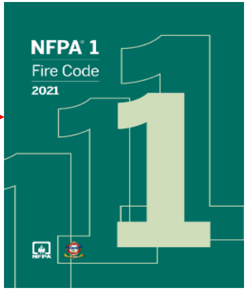
IBC



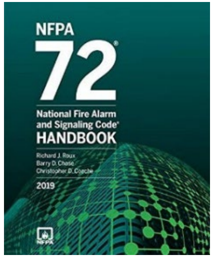
IFC



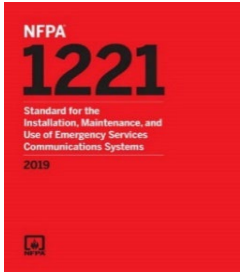
NFPA 1



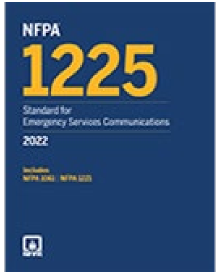
NFPA 72



NFPA 1221

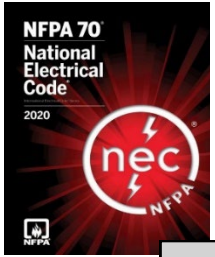


NFPA 1225



UL 2524

NEC



International Fire Code (IFC) ~ Section 510

- First introduced in ***2009 Edition***
- All buildings to have approved radio coverage for emergency responders available throughout the interior of building ***at the same coverage levels that exist outside the building***
- References NFPA 72 and NFPA 1221 (1225) for design, installation and performance requirements
- ***2021 IFC will require system listing to UL 2524, Standard for In-building 2-Way Emergency Radio Communication Enhancement Systems.***

NFPA 1 Fire Code ~ Section 11.10

- ERCES first introduced in ***2012 edition***
- Covers new and existing buildings *(unless amended by adopting Jurisdiction)*
- All buildings to have *approved* radio coverage for emergency responders throughout interior of building ***at same coverage levels that exist outside the building, as determined by AHJ***
- References NFPA 72 & NFPA 1221 (1225) for design, installation and performance requirements
- If ERCES interfere with facility’s normal operation, AHJ may accept an automatically activated system
- ***2021 NFPA 1 requires ERCES listing to UL 2524***

UL Solutions

General Code Requirements for ERCES *(2021)*

- New/Existing Buildings
- Fire Code Official Approval(s)
- Qualifications
- Per UL 2524
- Specific coverage levels
- IBC ~ Building Code
- Maintained Operational
- Testing =
  - *Acceptance*
  - *Annual*
  - *5 Year*
  - *DAQ**

- Signal Strength *(Inside/Outside)*
- Monitoring *(Supervisory Condition(s))*
- FCC Compliance and License Holder Approval(s)
- Frequencies
- Stand-By Power
- Boosters (where needed)
- Per NFPA 1221 ~ 1225
- Survivability

**Delivered Audio Quality (DAQ) is a qualitative measurement of voice intelligibility or clarity*

Delivered Audio Quality (DAQ)

The DAQ scale includes a scale ranging from 1 to 5, with 1 being unusable audio output and 5 being perfect.

DAQ 1:	Unusable / Speech present but not understandable
DAQ 2:	Speech understandable with considerable effort / Requires frequent repetition due to noise or distortion
DAQ 3:	***Requires occasional repetition due to noise or distortion**
DAQ 3.4:	Speech understandable without repetition / Some noise or distortion present
DAQ 4:	Speech easily understandable / Little noise or distortion
DAQ 5:	Perfect / No distortion or noise discernible

Coverage Requirements

Critical Area Coverage

99% required in critical areas:

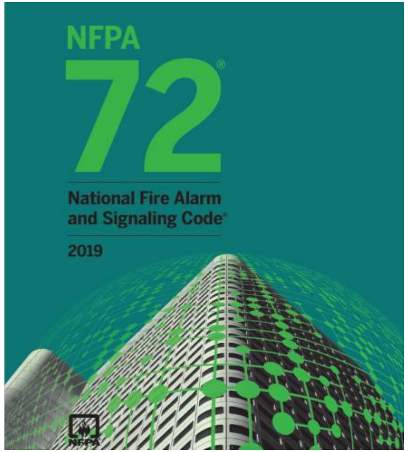
- *Emergency command center(s)*
- *Fire protection equipment room(s)*
- *Control valve locations*
- *Exit stairs*
- *Exit passageways*
- *Elevator and Lobbies*
- *Any areas designated as critical by Fire Code Official*

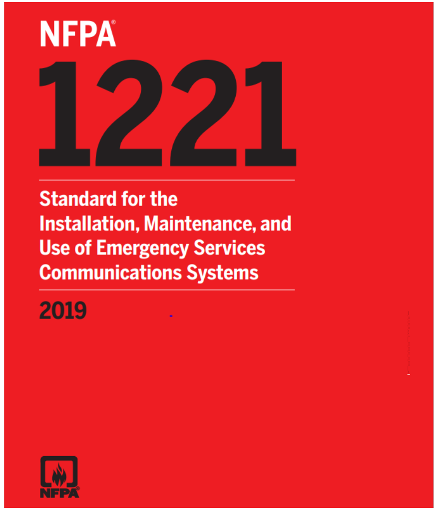
General Area Coverage

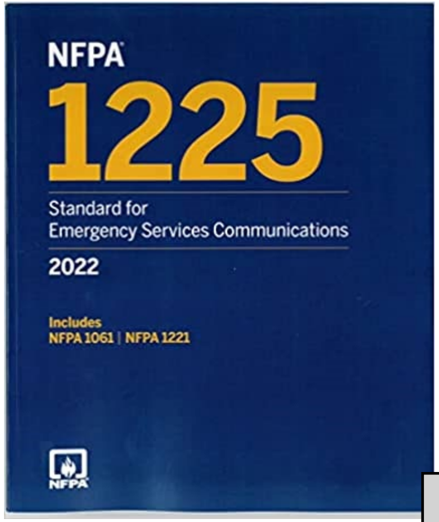
All areas shall have **95%**

NFPA Standards: 72/1221/1225

NFPA 1221 (*changing to NFPA 1225 in 2021*) includes Two-Way *Radio* Communication Enhancement Systems with technical requirements for design, installation and performance generally consistent with the latest model fire codes and best practices. *(Prior to NFPA 1221, NFPA 72 housed initial requirements)*







Overview of UL 2524


JOINT CANADA-UNITED STATES NATIONAL STANDARD

ANSI/CAN/UL 2524:2019

STANDARD FOR SAFETY

In-building 2-Way Emergency Radio Communication Enhancement Systems

ANSI

ANSI/UL 2524-2018

Standards Council of Canada
Conseil canadien des normes

UL 2524 Technical Timeline

December
2017
Published UL 2524 as Outline of Investigation

Spring
2018
Standards Technical Panel (STP) formed US/CAN

October
2018
Published First Edition

January
2019
Published Second Edition Bi- National Standard

UL Solutions

UL 2524 Technical Requirements

This standard addresses the following:

- Construction and Testing requirements
  - *Safety requirements (Fire & Shock risks)*
  - *Reliability requirements (Life Safety Systems)*
- Compliance with specific performance requirements in accordance with:
  - *IFC 2018 / NFPA 1221-2019*
- Product marking and installation documentation

Note: UL 2524 includes additional critical safety and performance requirements not found in UL 60950 / UL 62368

UL 2524 Technical Clarifications

Level	Meaning	Recommendations for Customers
UL Listed/Certified	**Meets** the definition of "Listed" in all model codes	Meets code requirements in **all** states/countries
Classified	**Meets only** fire and shock requirements of UL 2524	Meet AHJ requirements in **certain** states/countries
Conforms to	**Does not** meet the definition of "Listed" in the model codes	**Does not** meet AHJ or code requirements in most states/countries
Compliant/complies with	**Does not** meet the definition of "Listed" in the model codes	**Does not** meet AHJ or code requirements in most states/countries

UL 2524 Technical Requirements

SCOPE

Covers products like a repeater, transmitter, receiver, signal booster components, remote annunciators and operational consoles, power supply, and battery charging system components used for in-building two-way radio emergency radio communication enhancement systems installed in a location to improve wireless communication at that location.

UL 2524 Technical Requirements

SCOPE

Does not cover passive RF components which are defined in the Standard as "any device that RF passes through that does not have an active electronic component that requires external power." This includes, antennas, splitters, couplers, coaxial cable and connectors.

- *Passive components cannot amplify RF signals.*

UL 2524 Technical Requirements

Performance / Operation

- Loss of normal AC power *
- Battery charger failure *
- Loss of battery capacity (to 70% depletion) *
- Donor antenna disconnection *
- Active RF emitting device malfunction *
- System component malfunction, other than passive RF component, which affects system performance *
- Donor antenna malfunction **

** = Visual and audible annunciation within 200 seconds of fault*

*** = Visual and audible annunciation within 24 hours of fault*

UL 2524 Technical Requirements

Performance / Operation

- Confirm capability of simultaneously supporting both analog and digital communications
- Bidirectional Amplifiers (BDA) shall have oscillation detection and control functionality
- Confirm the maximum propagation delay, in microseconds, for a maximum rated system configuration
- Radio enhancement systems supporting more than one channel or talk path shall have the capability to support two radios simultaneously transmitting on different talk paths or channels.

UL 2524 Technical Requirements

Considerations

1. Model Codes are model codes. With respect to the ERCES industry, there are many local requirements *(e.g., Municipal ordinance(s), Checklist(s))* for the RF designer to consider. SEEK LOCAL information before design.
2. With respect to item #1, throughout the country there are requirements for 3rd party testing for validation of design prior to final acceptance. Where those requirements are present, certified manufacturer training or NICET RF design certification is often required.
3. Both the 2021 IFC and NFPA 1 Editions mandate UL 2524 listing.

UL 2524 Technical Requirements Summary

- Systems must meet specific survivability requirements ensuring operation during fire conditions
- Systems must have redundant primary power sources and stand-by or back-up power to operate at 100% capacity, for at least 12 hours
- Systems performance and reliability must be tested upon installation
- Systems must be maintained in operational condition at all times
- Annual inspection is required
- Systems must be monitored through the building’s fire alarm system for:
  - *Loss of power*
  - *Failure of the battery charger*
  - *Low-battery capacity indication when 70% of 12-hour operating capacity has been depleted*
  - *Malfunction of the donor antenna and active RF-emitting devices(s)*
  - *Failure of any critical system components and provide either an audible warning or “trouble” signal*

Data Dictionary

Class A Signal Booster

A signal booster designed to retransmit signals on one or more specific channels. A signal booster is deemed to be a Class A signal booster if none of its passbands exceed 75 kHz.

Class B Signal Booster

A device connected to a radio receiver, transmitter, or transceiver that radiates the transmitted signal, receives a signal, or both.

- *The FCC differentiates Class A device from Class B device by the bandwidth of channel filter. If the channel filters are set to 75KHz bandwidth or narrower, then the device is classified and a Class A narrowband BDA. When the device channel filters are set for wider than 75KHz, the BDA is classified and a Class B broadband device.*
- *Public Safety industry refer to the FCC's definition of a Signal Booster device as a BDA, or Bi-directional Amplifier. A "Class A" BDA is the same as a Class A Signal Booster and "Class B" BDA is the same as Class B Signal Booster. Other common names for Class A devices are "Channelized", or "Channel Selective" BDA's. And for Class B devices, "Band Selective", or "Broadband" BDAs.*
- *All Class B Signal Boosters devices must be registered with the FCC so they can be managed and shut down if found to cause interference.*

Data Dictionary

Backbone Cable

Coaxial cable, optical fiber cable and other cables utilized within the backbone to acquire and distribute RF signals to the in-building emergency responder communications enhancement systems.

Backbone Cable Components

Splitters, couplers, and connectors utilized within the backbone to acquire and distribute RF signals to the in-building emergency responder communications enhancement systems.

Contract

An agreement between the ESC and the building owner/agent(s) for the prescribed maintenance requirements listed in the UL ERCES Program.

Delivered Audio Quality (DAQ)

A measure of speech intelligibility of land mobile radios (LMR).

Data Dictionary

Distribution Antenna

A radio antenna that is specifically designed to radiate RF energy into a specific and limited building area, usually from a ceiling- or wall-mounted antenna.

Donor Antenna

Antennas used with in-building emergency responder communications enhancement systems that provide the connection between the wide area communications system of interest and the in-building system.

Donor Site

The specific wide-area communications site from which the donor antenna acquires services

Uplink

The measurement of signal from the radio tower site to the donor site.

Downlink

The signal measurement from donor site to the radio tower.

Data Dictionary

ERCES Service Provider (ESC)

The ERCES Service provider of record for the system being evaluated.

Frequency License Holder(s)

The person(s) or entity(ies) that hold the license from the licensing authority of the country of jurisdiction for the frequencies being used by both the in-building emergency responder communications enhancement system and the emergency services communications system that it enhances.

In-building Emergency Responder Communications Enhancement System

A combination of components, RF-emitting devices, antennas, cables, power supplies, control circuitry, and programming installed at a specific location to improve wireless communications within the building and between on-scene first responders and communications centers

Data Dictionary

Link Budget

Engineering calculations that estimate the RF signal strength from a portable radio or other field device used by ERUs to the first responder communications fixed network (i.e., uplink) and the RF signal strength back from the first responder communications fixed network to the portable radio or other field device used by ERUs (i.e., downlink).

Radiating Cable

A coaxial cable that distributes small amounts of RF energy along its length by means of periodic breaks in the shield surrounding the center conductor.

RF-Emitting Device

An active or passive device that emits a radio frequency signal as part of an in-building emergency responder communications enhancement system.

Data Dictionary

Active RF-Emitting Device

Any type of circuit component that requires an ac or dc power source with the ability to electrically control electron flow or amplification of an RF signal, including, but not limited to, signal boosters, repeaters, bidirectional amplifiers, and fiber distributed antenna systems.

Passive RF-Emitting Device

A device that does not require an external ac or dc source of power for its operation and does not provide amplification of an RF signal, including, but not limited to, coax cable, couplers, splitters, and passive antennas.

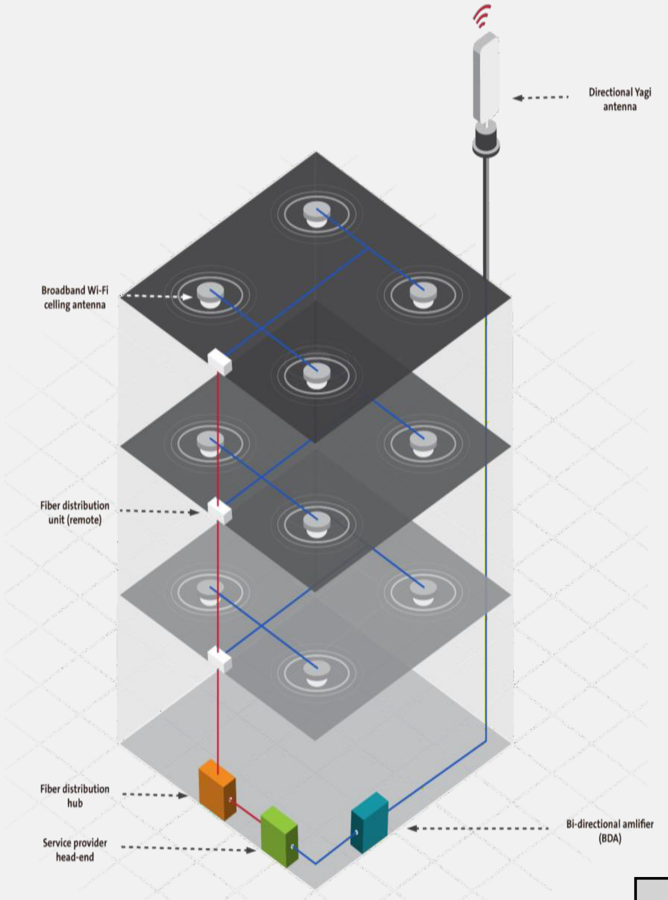
RF System Designer

An individual who has the education, experience, training, and understanding of RF theory and application to design an in-building emergency responder communications enhancement system (ERCES) that complies with this standard and the requirements of the licensing authority of the country of jurisdiction.

ERCES Technology/Technical Aspects

Overview of Available Technology

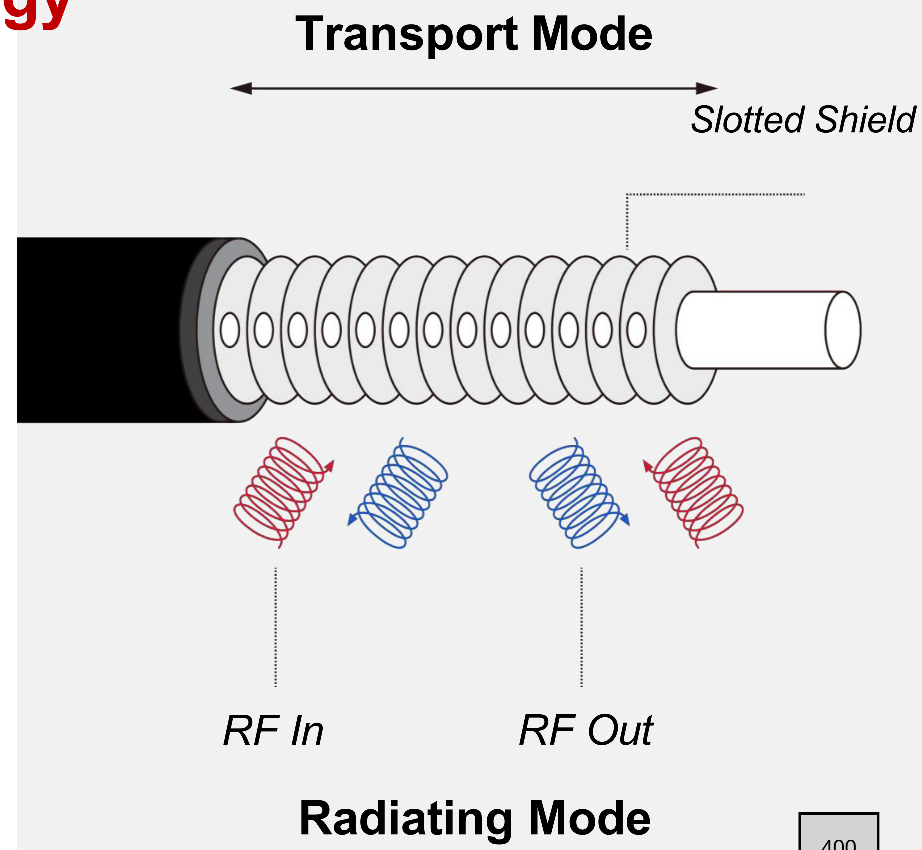
Distributed Antenna System (DAS)



UL Solutions

Overview of Available Technology

Radiating Coax Cable / Leaky Cable



Emergency Responder Radio Coverage System

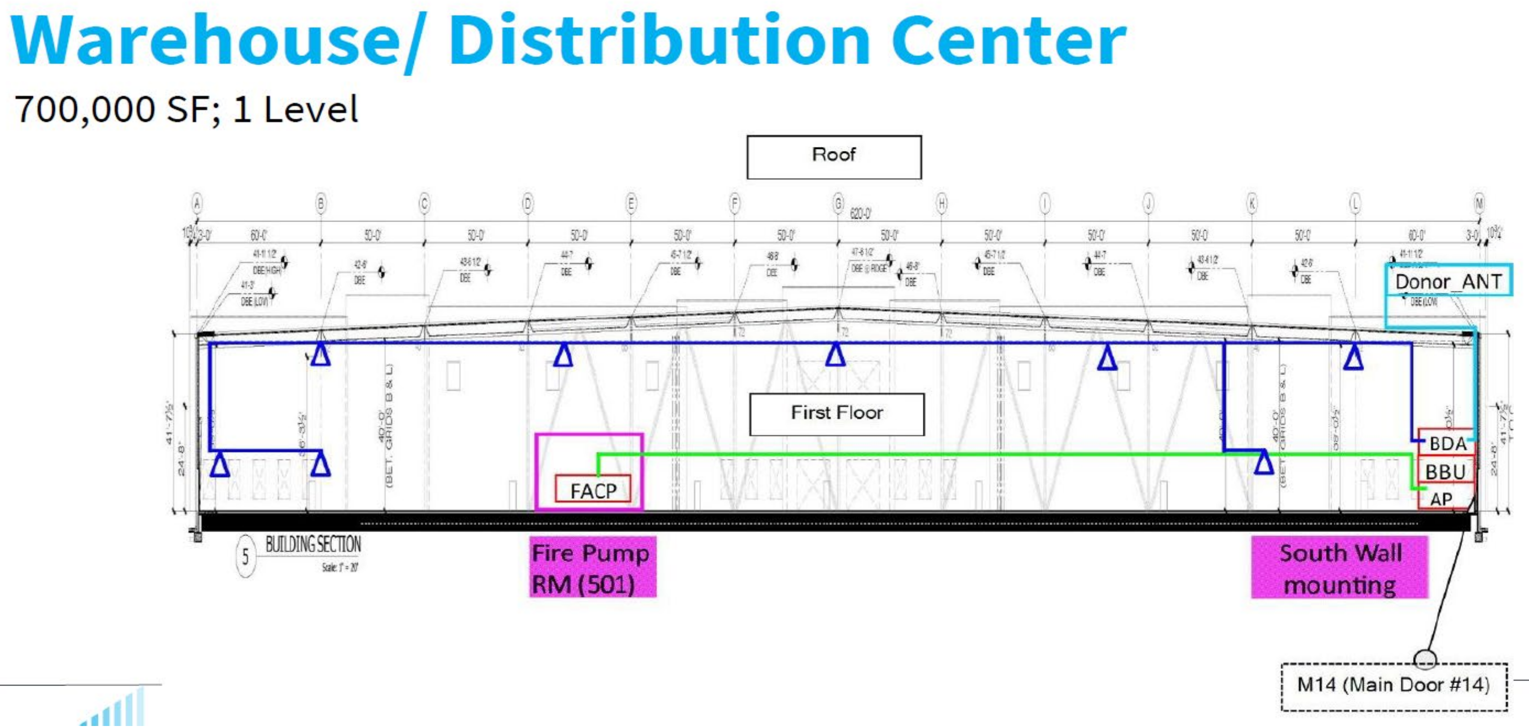
Engineered System of Antennas & Repeaters Capture, Re-Broadcast + Amplify Public Safety Radio Signal Inside

- ROOFTOP DONOR ANTENNA: Sends/receives signal from nearest Public Safety radio tower
- VERTICAL BACKBONE: Coax/ fiber cable connects active ERRCS equipment in Headend Room to Rooftop Donor Antenna + active equipment to passive components on each floor
- PASSIVE COMPONENTS: Omni-Directional Antennas, splitters, connectors, couplers + coax/ fiber cable distribute signal throughout the building
- ACTIVE EQUIPMENT: BDA, Battery Backup Unit + Alarm Panel located in ERRCS Headend Room

Sample Timeline for ERCES in Construction Phase

▪ MEET WITH ARCHITECT + ENGINEER:	Early Recommendations: Headend Location, Rooftop Donor Antenna, Cable Routes, Timeline + Budget
▪ CONFIRM AHJ REQUIREMENTS:	Contact AHJ Re: Code Enforcement, Technical Requirements, Plan Review, Permit, Inspection, Etc.
▪ CONFIRM RADIO SYSTEM REQUIREMENTS:	Contact PS Radio System FCC Licensee Re: System, Control Channel(s), Frequency(s) + Towers
▪ CONDUCT RF SIGNAL TESTING:	RF Analysis of In-Building Unamplified Signal Coverage + Donor Signal Strength
▪ PRODUCE SYSTEM DESIGN:	Engineered iBwave ERRCS System Design, BOM + Predictive Signal Coverage Model
▪ SECURE APPROVALS:	Plan Review, Permit + FCC Re-Broadcast Authorization: AHJ/Bldg. Dept. + Radio System Admin
▪ INSTALL SYSTEM:	Penetrations, Cable + Active & Passive Components: Donor Antenna, BDA, DAS, BBU, Alarm Panel, Etc.
▪ CONNECT TO FACP:	Fire Alarm Contractor Connects ERRCS Supervisory Alarm Points to FACP
▪ COMMISSION, START UP + TEST:	Commission, Start Up + Post Installation 20 Grid RF Signal Test
▪ ACCEPTANCE TESTING:	Accompany AHJ Inspection/ Acceptance Testing
▪ CLOSEOUT PACKAGE:	As-Built System Design, RF Test Report, Cert. of Compliance, Data Sheets & Owner's Manuals + Warranty
▪ ANNUAL RE-CERTIFICATION:	Yearly System Test + 20 Grid RF Signal Test

Sample Layout



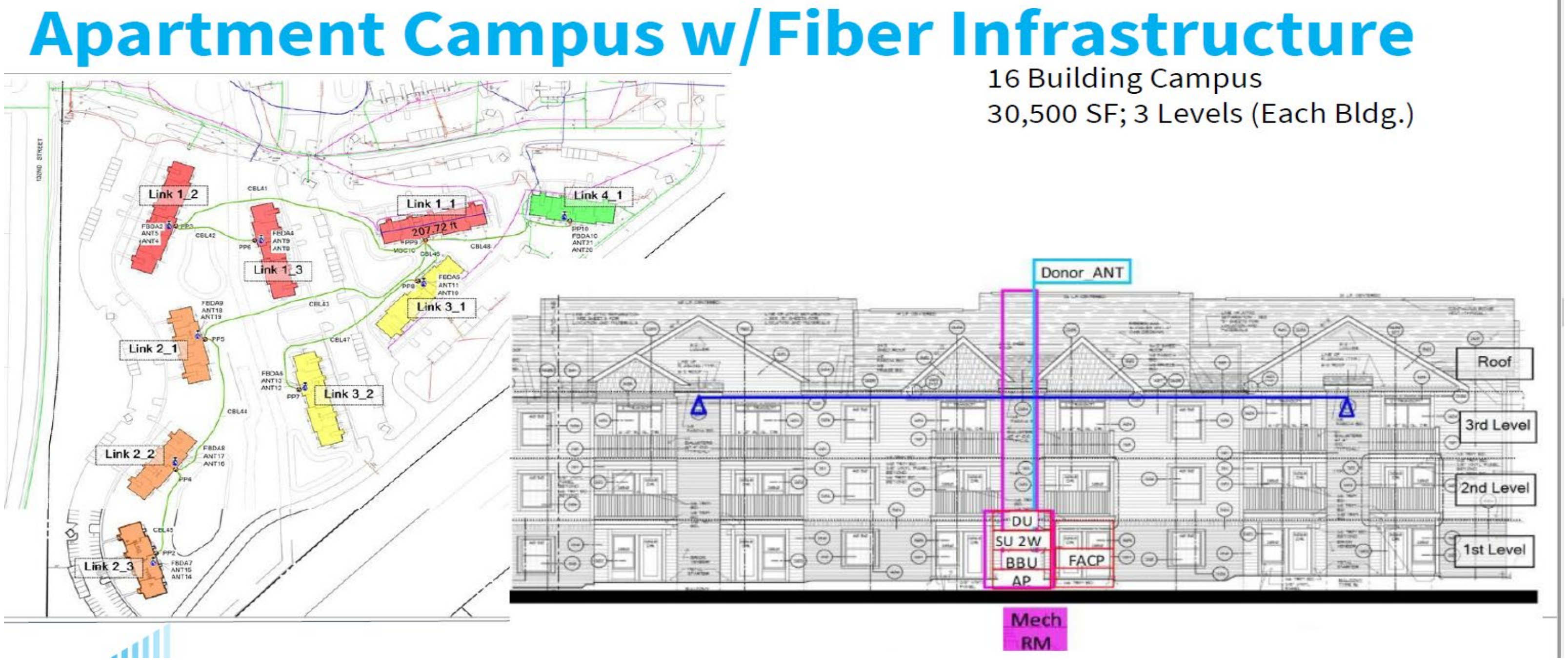
UL Solutions

Sample Layout

Hotel

350,000 SF; 23 Levels

Sample Layout



UL ERCES Certification Program

UL Solutions

Code authority concerns

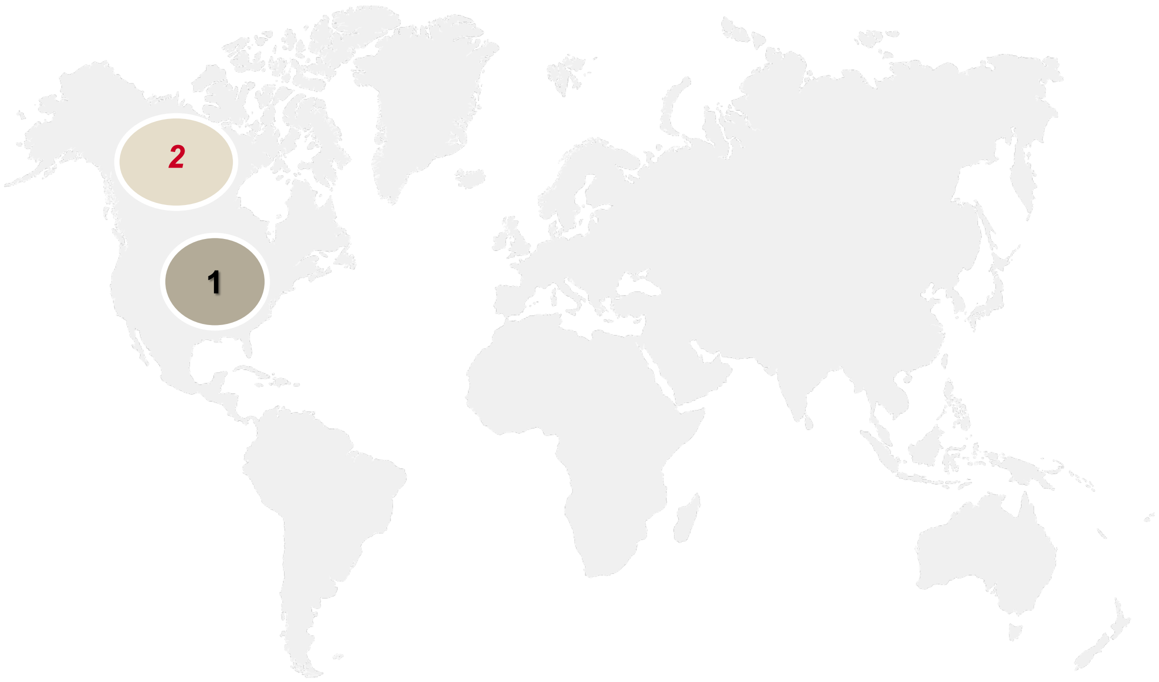
- ERCES design / installation concerns
- ERCES design / installations *prior* to model codes / standards process
- Acceptance testing ~ *(floor coverage and DAQ measurement)*
- Reliability / component failures
- Adaptability to new frequencies
- Competency challenges and catch up to NICET certification(s)
- NFPA FPRF project underway on survivability of ERCES systems
- AHJ’s seeking ERCES service-based assistance

UL Solutions best practices

To ensure confidence and reliability

- Model Code Compliance (IFC / NFPA 1)
- Standard Compliance (NFPA 72 / 1221 / 1225)
- Equipment Certification (UL 2524)
- Installation Certification / Declaration of Compliance

UL ERCES Certification Adoption Roadmap



1. United States *(2022)*
2. *Canada (tentative 2023)*

ERCES: Q3 2022

Completed Pilot Program and Evaluate outcomes / findings:

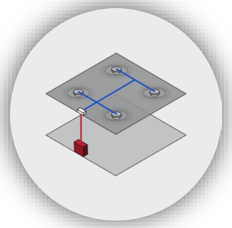
- *Agencies involved: Memphis, TN/Palm Beach County, FL/San Mateo County, CA/San Francisco, CA*
- *What worked? / Didn’t work? / What did we learn? = Refined program as appropriate…*

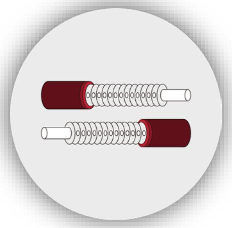
Create / Deliver Educational Sessions to Fire and ERCES Community:

- *AHJ’s, The Monitoring Association, SFPE, Building Owners (BOMA), ERCES Manufacturers/Distributors, AFAA National Conference, NASFM, and many other national and regional deliveries*

Complete reevaluation/confirmation(s) and Prep **Go-Live** time frame:

- *Available now!*





UL ERCES Certification Program pillars

- Documentation
- Inspection / Testing / Maintenance
- Repairs
- Audit Process

UL ERCES Certification Program

ERCES installation land scape:

- Installations pre-2009
- Installations 2009 – 2018
- Installations 2021 ➡

The establishment of the UL ERCES Certification Program requires both traditional and non-traditional application as compared to the UL fire alarm program

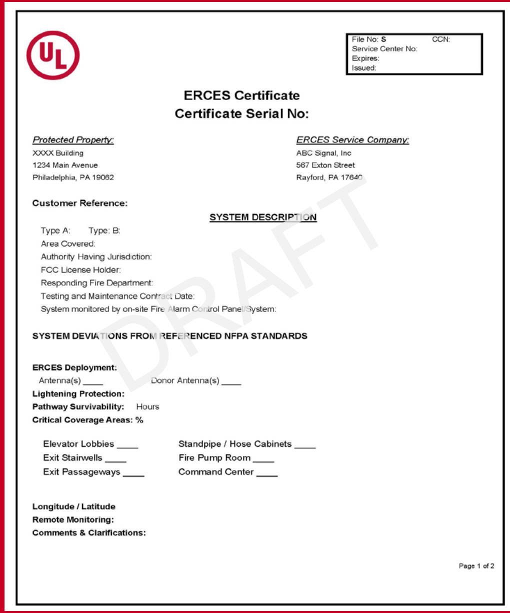
Option #1

ERCES Certificate Issued

LISTED

CLASSIFIED

All components listed to UL 2524 by UL Solutions


File No: S CCN:
Service Center No:
Expires:
Issued:

ERCES Certificate
Certificate Serial No:

Protected Property:
XXXX Building
1234 Main Avenue
Philadelphia, PA 19062

ERCES Service Company:
ABC Signal, Inc
567 Exton Street
Rayford, PA 17640

Customer Reference:

SYSTEM DESCRIPTION

Type A: Type: B:
Area Covered:
Authority Having Jurisdiction:
FCC License Holder:
Responding Fire Department:
Testing and Maintenance Contract Date:
System monitored by on-site Fire Alarm Control Panel/System:

SYSTEM DEVIATIONS FROM REFERENCED NFPA STANDARDS

ERCES Deployment:
Antenna(s) ____ Donor Antenna(s) ____
Lightening Protection:
Pathway Survivability: Hours
Critical Coverage Areas: %

Elevator Lobbies ____ Standpipe / Hose Cabinets ____
Exit Stairwells ____ Fire Pump Room ____
Exit Passageways ____ Command Center ____

Longitude / Latitude
Remote Monitoring:
Comments & Clarifications:

Page 1 of 2

DRAFT

Solutions

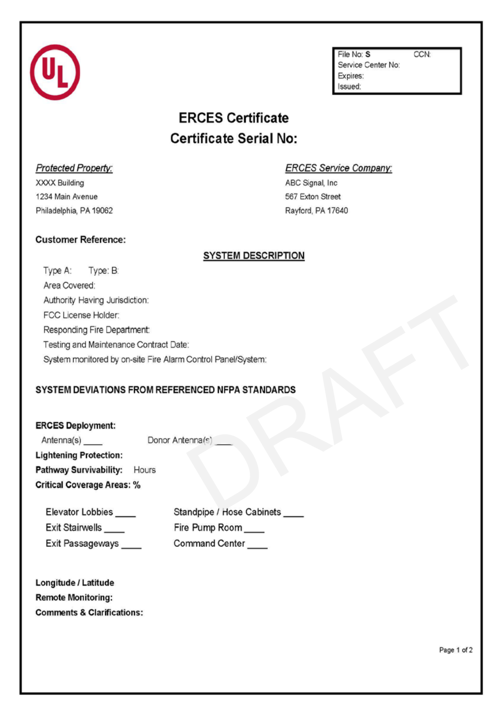
Option #2

ERCES Certificate Issued

SGS C US

Intertek

All components listed to UL 2524 by other NRTL


File No: S CCN:
Service Center No:
Expires:
Issued:

ERCES Certificate
Certificate Serial No:

Protected Property:
XXXX Building
1234 Main Avenue
Philadelphia, PA 19062

ERCES Service Company:
ABC Signal, Inc
567 Exton Street
Rayford, PA 17640

Customer Reference:

SYSTEM DESCRIPTION

Type A: Type: B
Area Covered:
Authority Having Jurisdiction:
FCC License Holder:
Responding Fire Department:
Testing and Maintenance Contract Date:
System monitored by on-site Fire Alarm Control Panel/System:

SYSTEM DEVIATIONS FROM REFERENCED NFPA STANDARDS

ERCES Deployment:
Antenna(s) ____ Donor Antenna(s) ____
Lightening Protection:
Pathway Survivability: Hours
Critical Coverage Areas: %

Elevator Lobbies ____ Standpipe / Hose Cabinets ____
Exit Stairwells ____ Fire Pump Room ____
Exit Passageways ____ Command Center ____

Longitude / Latitude
Remote Monitoring:
Comments & Clarifications:

DRAFT

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Option #3

Declaration of Installation issued

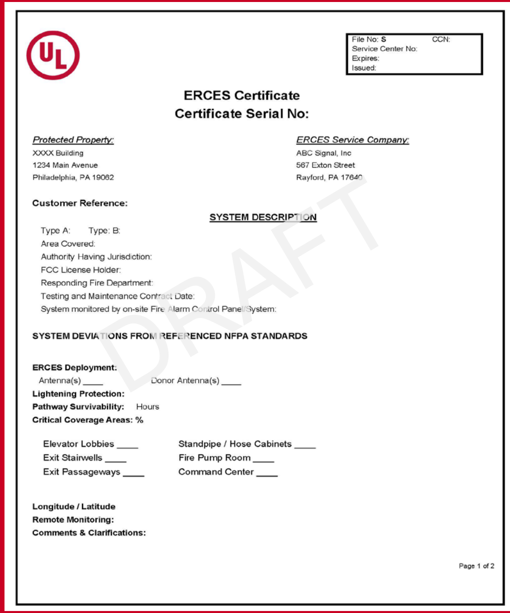
Components installed with limited or without any regulatory and/or performance requirements

Components installed to any UL Standard less than UL 2524 requirements

Existing system(s) *reviewed for documentation / Inspection, Testing and Maintenance (ITM), and manufacturer's instructions*

…Then…

Declarations of Installation will, in time, be converted to Option # 1 or #2 as they're phased out due to manufacturer support, technological advances, occupancy or code changes


File No: S
CCN:
Service Center No:
Expires:
Issued:

ERCES Certificate
Certificate Serial No:

Protected Property:
XXXX Building
1234 Main Avenue
Philadelphia, PA 19062

ERCES Service Company:
ABC Signal, Inc
567 Exton Street
Rayford, PA 17640

Customer Reference:

SYSTEM DESCRIPTION

Type A: Type: B:
Area Covered:
Authority Having Jurisdiction:
FCC License Holder:
Responding Fire Department:
Testing and Maintenance Contract Date:
System monitored by on-site Fire Alarm Control Panel/System:

SYSTEM DEVIATIONS FROM REFERENCED NFPA STANDARDS

ERCES Deployment:
Antenna(s) ____ Donor Antenna(s) ____
Lightening Protection:
Pathway Survivability: Hours
Critical Coverage Areas: %

Elevator Lobbies ____ Standpipe / Hose Cabinets ____
Exit Stairwells ____ Fire Pump Room ____
Exit Passageways ____ Command Center ____

Longitude / Latitude
Remote Monitoring:
Comments & Clarifications:

DRAFT

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UL ERCES Certification Program Options Table

Option #1	Option #2	Option #3
All Critical Elements* must be: *Certified to UL 2524*	All Critical Elements* must be: *Certified to UL 2524*	One or more Critical Elements* not Certified by any NRTL
Certification must be: *by UL Solutions*	Certification any one of Critical Elements* by: *Non-UL NRTL (SGS / ETL)*	One **OR** more Critical Elements* certified to standards *other than UL2524* by UL Solutions / or other NRTL.

*Critical Elements
Amplifier / BDA
Power Supply
Annunciator
Non-critical element examples *(can be non-UL Certified)*
Power extenders
BDA connectors to supplementary computer

UL Solutions

UL ERCES Certification Program

Where does ERCES Certification fit in the First Responder Communications ecosystem?

UL ERCES Certification Program: *Initial evaluation*

Contractor Listing

Based upon evaluation by a UL Auditor of the contractor's ability to meet model codes and technical standards requirements and best practices for ERCES system installation and on-going compliance. Upon successful completion of the listing evaluation process, a contractor is issued a *Certification of Compliance* (COC) indicating their UL Listing and can issue UL Certificates on ERCES systems as the Prime Contractor.

System Certification

Based upon compliance with model or amended codes, technical standards, and any additional requirements by the AHJ regarding system installation and permitting. These certificates can only be issued by a listed UL ERCES Service Contractor.

UL ERCES Certification Program: *Annual Audit*

System	Contractor
Certificates selected by the assigned UL Auditor.	Certification of Compliance is confirmed via annual audit.

Solutions

Helpful resources

UL Solutions resources

ERCES Website at UL.com

Emergency Responder Communication Enhancement Systems (ERCES)

Emergency Responder Communication Enhancement Systems (ERCES) Service Provider UL Certification Program

UL Product iQ

UL Product iQ marries the longstanding UL certification information relied upon by millions of users with the intuitive design and user-friendliness of a modern search engine

UL Solutions contacts

Christopher Creamer

ERCES SME/AHJ Education Specialist/Alarm System Auditor

Built Environment

Christopher.Creamer@ul.com

407-947-1386

Todd M Iaeger

AHJ Education Specialist/ Alarm System Auditor

Built Environment

Todd.Iaeger@ul.com

610-850-2303

Bruce Johnson

Regulatory Services Regional Manager

Codes and Regulatory Services

Bruce.johnson@ul.com

631-680-5174

Allan Sanedrin

Principal Engineer (PDE)

Built Environment

Allan.P.Sanedrin@ul.com

847-664-1823

DynaFire, Casselberry, Florida
2007 – November 1, 2021
Business Development Manager

- Provide and facilitate new business opportunities within sales team of 10 team members.
- Worked within team and company core values with exceptional results. Company sales growth maintained at 30 % growth yearly since 2007.
- Developed and Managed our Statewide Wireless Fire and Security Monitoring RF Mesh Network (to date over 3,600 customer sites)
- Present and perform technical board room style sales presentations and assist in closing sales with Service Sales Representatives
- Coach, mentor, and assist in training of all new sales associates
- Personally Account Manage Multi Site, Key Customer Accounts
- Design and develop practices and objectives that provide proven results and customer satisfaction
- Partner with the Regional Operations Team to create the best possible new customer successes (Sales Transition to Operations and Service Teams)
- Coach, develop, and maintain the highest performing employees by determining performance improvement needs and designing local incentive plans; develop and execute programs to improve overall success and associate engagement with a focus on training, team culture, team building, and enhanced communication.
- Assist Regional Service Operations team with educating customers on our service recommendations and deficiency repairs
- Protected bottom line by maintaining Company wide attrition rate of 2.9%
- FSO for Company's DOD, UL 2050 National Industrial Security Program
- Security Clearance through Homeland Security and Chemical Security Assesement

Marlin Central Monitoring, Kissimmee, Florida
Assistant Central Station Manager
2001 - 2007

- SIA Certified CSAA 4 Diamond Central Station
- Started with company as an operator monitoring critical fire, security, video accounts when Central had 4500 accounts. Lead team of 25 operators on 24/7 Call Center in 2007 with over 185,000 Accounts.
- Directed all functions of training and alarm dealer sales development
- Assisted with Management transition when Company was purchased.

Hardee's CKE Restaurant Group , Orlando, Florida
1994-2001
Corporate General Manager

- Succeeded in Sales Growth of 22% or greater of Ocoee Florida Store 1995-1998
- Transferred to help struggling location in Port Orange (12th out of 14th stores in sales at takeover 1998, left 5th out of 14 stores in 2000, transferred to Kissimmee Florida Location)

- Partnered with District Manager to create and implement training , food safety, sales, cleanliness programs programs.
- Forecasted Sales, Executed Inventory levels for all products.
- Hired, Trained, Mentored, and particiated in all exit interviews to better the overall organization and business.

PROFESSIONAL ACHIEVEMENTS

- Company wide Employee of the Year 2010 (DynaFire)
- Company wide Employee of the Year 2011 (DynaFire)
- Employee of the Year-Sales Department 2016 (DynaFire)
- Membership Director of the AFAA-Florida Chapter (September 2014-2016)
- President of the AFAA-Florida Chapter (2016- Present)
- FASA/BASA Instructor
- Instructor for Florida Fire Marshals and Inspectors Association, Florida Fire Chiefs Association, Florida Arson Conference (Alternative Monitoring Technologies Course through Florida Fire College (4 CEU Hours) (2009 to Present)
- AFAA National Board of Director (2 terms) (2019- Present
- AFAA Chair, Codes & Standards Advisory Committee
- NFPA Technical Committee Achievements (25, 72 (SIG-SSS) for the 2022 Edition, 76, 420, and 715 under previous employer)

EDUCATION

Valencia Community College
1995
AA Business Management
Bilingual- Spanish

File Attachments for Item:

EC-8 Fire Sprinkler Considerations for Tall Clear-Height Warehousing (Fire Code Academy)

All certifications (1 hour)

Application for Continuing Education Course Approval

Provider Information:

Name: Randy Hormann

Organization: Fire Code Academy

Address: 81 Mill Street - Suite 300 Gahanna, Ohio 43230

E-mail: RandyH@FireCodeAcademy.com Telephone: 614-416-8077

Website: www.FireCodeAcademy.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: Fire Sprinkler Considerations for Tall Clear Height Warehousing

Course instructor: Daniel Lampke P.E. - VP / Project Manager /Fire Protection Engineer

Course description: As the demand for warehousing grows, the industry is also faced with the fact that land suitable for a large-footprint warehouse development is getting more difficult to find. Therefore, the new warehousing being built is growing taller to provide more storage space within

Instructional hours per session: 1.0 Hours 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? 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: ________

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

Fire Sprinkler Considerations for Tall Clear Height Warehousing

Harrington Group Inc.
We are a dedicated fire protection engineering firm which specializes in fire protection design, property loss control, dust hazard analysis, and construction administration.

1.0 Hour

The growth of warehousing has dramatically accelerated across the United States, particularly driven by the supply chain shortfalls and disruptions as a result of COVID-19. As the demand for warehousing grows, the industry is also faced with the fact that land suitable for a large-footprint warehouse development is getting more difficult to find. Therefore, the new warehousing being built is growing taller to provide more storage space within; however, that expansion poses additional considerations on operations, structure, and, importantly, fire protection.

The "Early Suppression Fast Response" or "ESFR" sprinkler was developed decades ago to provide adequate protection to racked and stacked commodities from only the ceiling sprinkler system, providing options to eliminate in-rack automatic sprinklers. However, as warehouse heights increase, they are quickly outpacing the prescriptive options available within NFPA 13, pushing users, engineers, and AHJ's to understand and utilize new technologies and testing data. This presentation will discuss some fire sprinkler considerations for warehouses with tall clear heights, review standard commodities used as basis for the suppression testing, and identify some specific-application sprinklers which can be utilized for these taller warehouse structures

HARRINGTON GROUP INC

DANIEL LAMPKE, P.E.

VP / Project Manager /Fire Protection Engineer

Mr. Lampke has been working in the fire protection engineering industry since 2011, successfully completing a wide range of project types for a diverse client base. He is an expert in fire suppression, fire alarm/occupant notification systems, smoke control system design and commissioning, high expansion foam systems design, life safety analysis, and egress modeling. He also has experience in clean agent system design and various aspects of industrial fire protection.

QUALIFICATIONS

- M.S., Fire Protection Engineering, Worcester Polytechnic Institute (WPI), Worcester, MA, 2011
- B.S., Mechanical Engineering, Worcester Polytechnic Institute (WPI), Worcester, MA, 2010

LICENSES / P.E. REGISTRATIONS

- Registered Professional Engineer, Fire Protection - Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, North Carolina, Ohio

EXPERTISE

Codes & Standards

NFPA, FM Global, IBC, IFC, UFC, Veterans Administration (VA), General Services Administration (GSA) (P-100)

Systems

Wet, Dry, Pre-Action, Deluge, and Foam Sprinkler Systems; Gaseous Suppression Systems; Fire Alarm Systems; Standpipe Systems; Fire Pumps, and Smoke Control Systems

Facilities

High-Rise, Warehouse, Office, Distribution, Fulfillment Centers, Historic Healthcare, Industrial, Residential, Correctional, Aeronautical, High-Piled Storage

Services

Design of Fire Protection Systems, Fire Hazard Analysis, Code Analysis, Code Equivalency Negotiation, Fire and Egress Computer Modeling, Commissioning, Due Diligence Surveys, Fire Safety Audits, Water Supply Testing and Analysis, GSA Fire Protection & Life Safety Property Lease Surveys

FIRE SPRINKLER CONSIDERATIONS FOR TALL CLEAR HEIGHT WAREHOUSING

Life Safety Conference

Columbus, Ohio

February 28, 2023

Presenter

HGI
HARRINGTON GROUP INC

Daniel Lampke, P.E.
Vice President
Project Manager –
Midwest Region

dlampke@hgi-fire.net
937-422-271
Physical Location:
Dayton

We are a dedicated fire protection engineering firm which specializes in fire protection design, property loss control, dust hazard analysis, and construction administration.

Presentation Synopsis

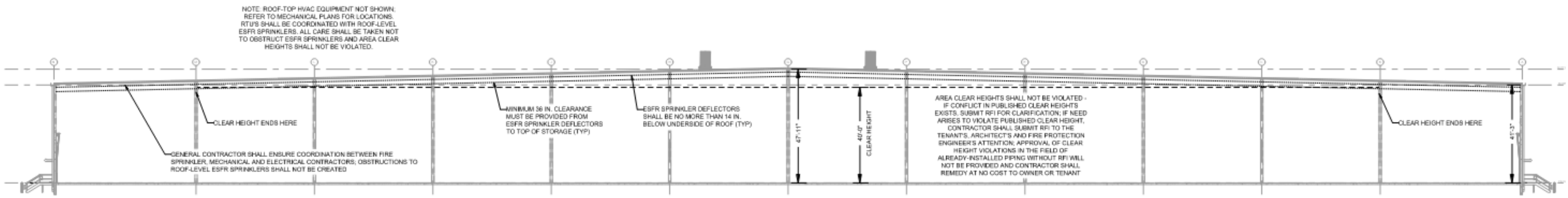
The growth of warehousing has dramatically accelerated across the United States, particularly driven by the supply chain shortfalls and disruptions as a result of COVID-19. As the demand for warehousing grows, the industry is also faced with the fact that land suitable for a large-footprint warehouse development is getting more difficult to find. Therefore, the new warehousing being built is growing taller to provide more storage space within; however, that expansion poses additional considerations on operations, structure, and, importantly, fire protection. The "Early Suppression Fast Response" or "ESFR" sprinkler was developed decades ago to provide adequate protection to racked and stacked commodities from only the ceiling sprinkler system, providing options to eliminate in-rack automatic sprinklers. However, as warehouse heights increase, they are quickly outpacing the prescriptive options available within NFPA 13, pushing users, engineers, and AHJ's to understand and utilize new technologies and testing data. This presentation will discuss some fire sprinkler considerations for warehouses with tall clear heights, review standard commodities used as basis for the suppression testing, and identify some specific-application sprinklers which can be utilized for these taller warehouse structures.

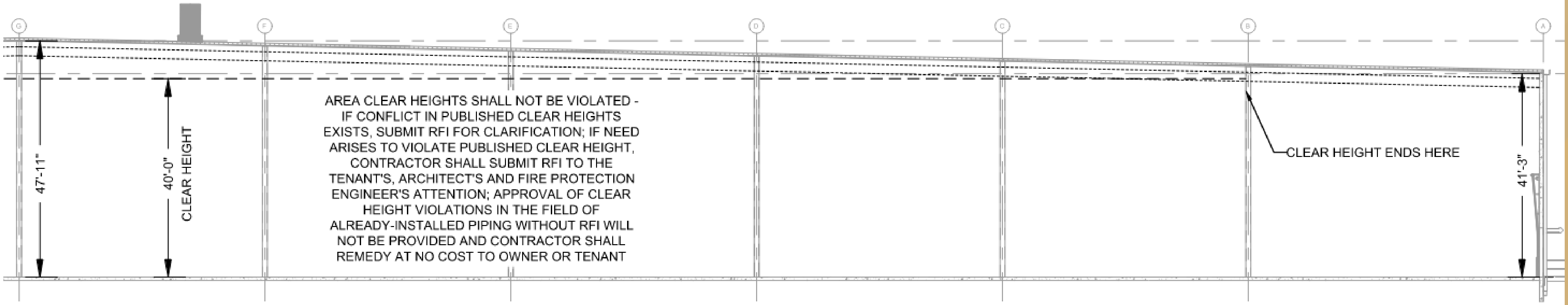
Chapters

1. Clear Heights, Roof Deck Heights, and Sprinkler Installation Locations
2. Brief Architectural & Structural Design Considerations
3. Classification of the “Standard” Tested Commodity
4. Sprinkler Protection Considerations
5. Special Application Listed Sprinklers available on Market
6. Other Options for Higher Hazards and/or Taller Buildings

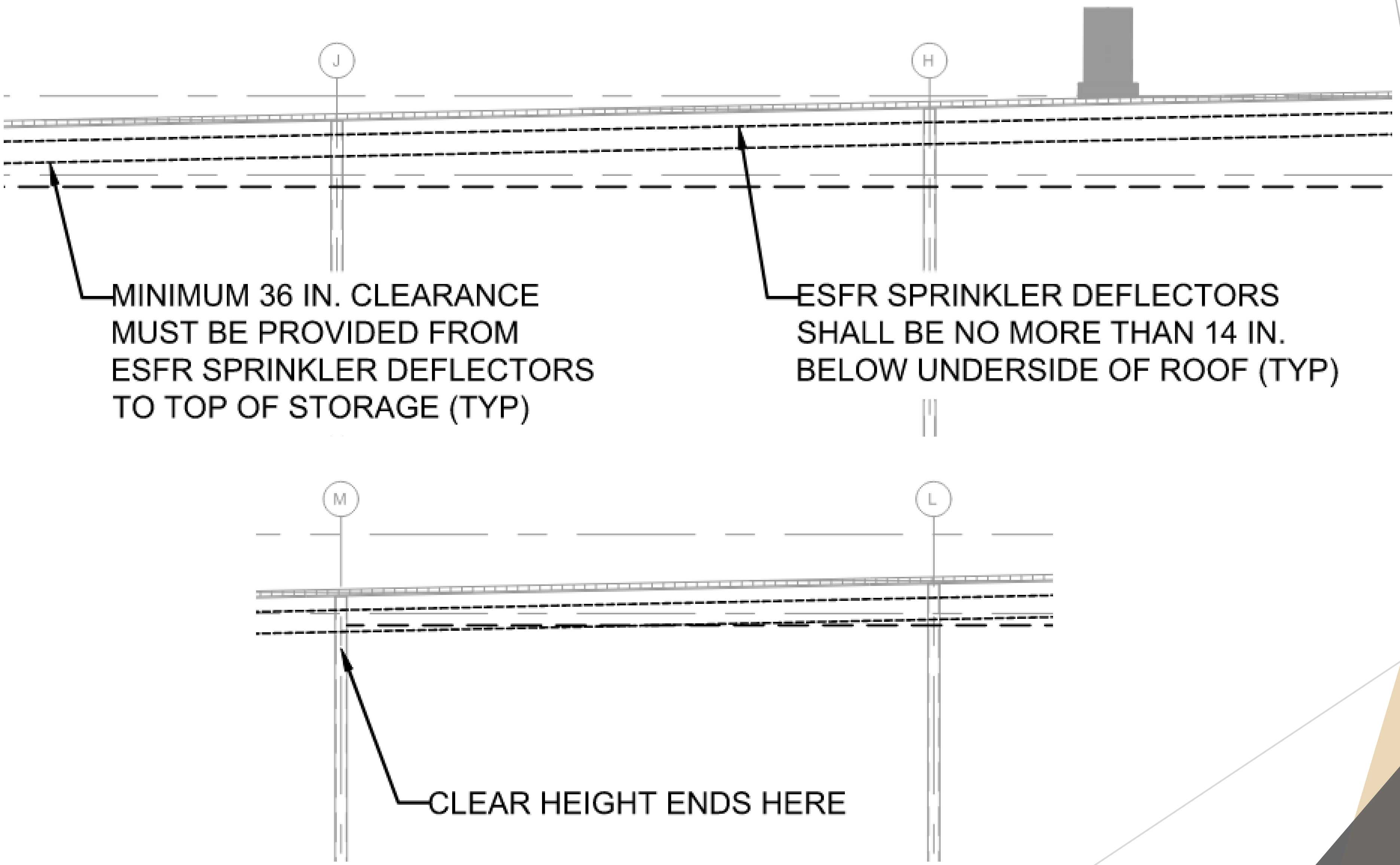
Clear Height vs. Roof/Deck Height

Clear Height vs Maximum Interior Roof Height





Clear Height vs Maximum Interior Roof Height



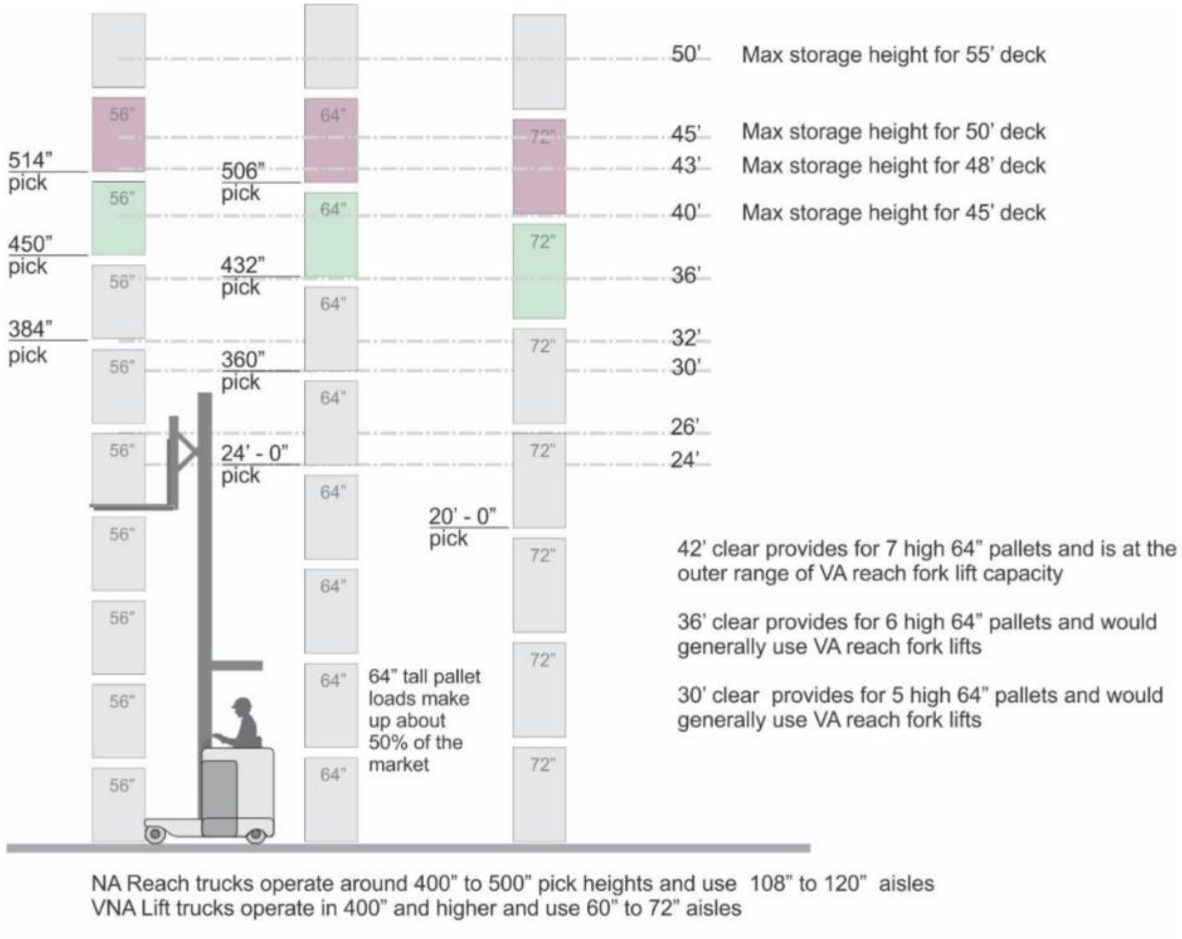
Clear Height vs Maximum Interior Roof Height

Be aware of:

- The difference between clear height and maximum interior roof height – fire sprinkler protection is based on the latter, not the former; and
- How structural clear height interacts with maximum storage height, and the required clearance from top of storage to sprinkler deflectors.

Racking Heights

40’ clear or 43’ clear: What makes the most sense?



- From HPA Tall Tales paper

Maximum Interior Roof Heights in Industry

What are you seeing in your area? What are the demands? What is going up?

- 45’ ?
- 48’ ?
- 50’ ?
- 55’ ?

Maximum Interior Roof Heights in Industry

Typical industry correlations between clear height and maximum interior roof height:

- 32’ clear typically means 40’ max.
- 36’ clear typically means 45’ max.
- 40’ clear typically means 48’ max.
- 42’ clear means 50’ max…?
- 47’ clear means 55’ max…?

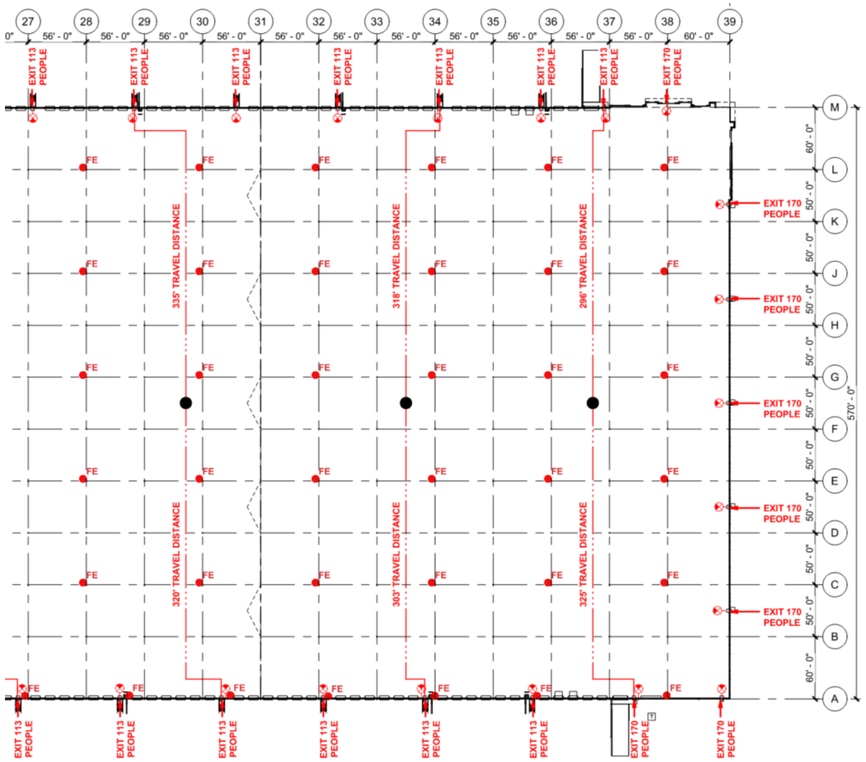
Maximum Interior Roof Heights in Industry

There are typical industry correlations between clear height and maximum interior roof height, but they are not necessarily hard and fast rules – be sure everyone is on the same page when discussing warehouse protections.

(Brief) Architectural Considerations

Building Width

- Some of the excellent architects we work with prefer for buildings to be 570’ deep or less on cross docks
- Exiting issues with deeper buildings (400’ max travel)



Roof Slope

- Typical roof slope is 1/4” per foot which meets code and roof warranties
- 1/8” per foot roof slope can be used if approved
  - AHJ must approve per code requirements
  - Roofing manufacturer must approve for warranty
  - Structure will require to be designed for ponding and will increase steel cost for the roof

Classification of the “Standard” Tested Commodity

Standard Commodities

- The standard plastic commodity classification is Group A Plastics.
  - There are four (4) sub-categories of Group A plastics
  - Cartoned unexpanded Group A plastics ("CUP") is the standard and least hazardous.
  - The sub-categories are comprised of packaging and the makeup of plastics themselves.
- Packaging refers to either exposed (i.e., uncartoned) or cartoned.

Standard Commodities

The makeup of the plastic refers to either unexpanded or expanded.

The four (4) sub-categories of Group A plastics are, in order of least to worst:

Cartoned Unexpanded Group A plastics (“CUP”);

Cartoned Expanded Group A plastics (“CEP”);

Exposed Unexpanded Group A plastics (“EUP”); &

Exposed Expanded Group A plastics (“EEP”).

Standard CUP

Standard CEP

Standard EUP

Standard EEP

Sprinkler Protection Considerations

Point of going through commodities first…

- Once you get over 40’ max. roof/ceiling height, the **only** commodity that is protectable with ceiling-only sprinkler schemes is CUP for both NFPA and FM.
- Anything worse than CUP (e.g., CEP, EUP, & EEP) may be protected with ceiling-only sprinklers as long as the max. ceiling height does not exceed 40’.
- …If you have worse than CUP and taller than 40’ ceiling, in-rack sprinklers or a drop-ceiling come into play.

- NFPA 13 provides protection criteria for max. 45’ ceilings/roofs. So… what happens if you exceed and want to protect from ceiling?
  - Option 1: UL Special Application Sprinklers.
  - Option 2: Factory Mutual Design Standards

FMDS 8-9 provides protection schemes for max. 50' and 55' ceilings without needing in-rack sprinklers!

Table 17.3.3.1 *Continued*

Storage Arrangement	Commodity	Maximum Storage Height		Maximum Ceiling/Roof Height		Nominal K-Factor	Orientation	Minimum Operating Pressure		In-Rack Sprinkler Requirements
		ft	m	ft	m			psi	bar	
		$\boxed{40}$	12	$\boxed{45}$	14	14.0 (200)	Pendent	90	6.2	Yes
						16.8 (240)	Pendent	63	4.3	Yes
						22.4 (320)	Pendent	40	2.7	No
						25.2 (360)	Pendent	40	2.7	No

UL Special Application

- There are a few commercially available sprinklers that are "special application" listed by Underwriter's Laboratories ("UL") for taller ceiling heights (i.e., 48').
- We have found that, nationwide, AHJs are more likely to accept the protection criteria that comes with the UL Listing to be equivalent to NFPA 13.
    - Same design area and # of sprinklers as NFPA, just increased pressure.
- Talk more on this later

Factory Mutual (FM Global)

- Another available option is FM Global Data Sheet 8-9 ("FMDS 8-9").
  - FM has more updated testing than NFPA. NFPA can be 5-15 years out of sync, depending on locality.
  - 8-9 has sprinkler criteria up to **55 ft.**
  - However, 8-9 was revised in 2020 to **reduce** the number of sprinklers required in a design area for most sprinkler types.
  - Due to this, depending on locality, we have found that using FM is not as straightforward an 'equivalent' scheme as it used to be.
  - We always feel that it is prudent to check with local AHJ for discussion and their approval prior to design.

FMDS 8-9 Protection Schemes

FMDS 8-9 provides protection schemes for max. 50’ and 55’ ceilings without needing in-rack sprinklers!

Table 17b. Quick-Response, 160ºF (70ºC) Nominally Rated, Standard-Coverage Pendent Storage Sprinkler Ceiling-Only Designs for Ceiling Heights Over 40 ft (12.0 m)

Storage Arrangement	*Commodity*	*Max. Storage Height, ft (m)*	*Max. Ceiling Height, ft (m)*	*Ceiling Sprinkler K-Factor*	*Max. Vertical Distance from Ceiling to Sprinkler's Thermal Element, in. (mm)*	*Min. Aisle Width, ft (m)*	*Sprinkler System Design*		
							Ceiling Sprinkler System, No. of AS @ psi (bar)	Hose Demand, gpm (L/min)	System Duration, min
Solid-Piled, Palletized, Bin-Box, Shelf, and Open-Frame Racks*	Class 1, 2, 3, 4 and Cartoned Unexpanded Plastics	45 (13.7)	50 (15.2)	22.4 (320)	13 (325)	6 (1.8)	10 @ 63 (4.3)	250 (950)	60
				25.2 (360)	13 (325)	6 (1.8)	10 @ 50 (3.5)		
					17 (425)	6 (1.8)	10 @ 75 (5.2)		
				28.0** (400**)	13 (325)	6 (1.8)	10 @ 40 (2.8)		
				33.6 (480)	17 (425)	6 (1.8)	9 @ 55 (3.8)		
		50 (15.2)	55 (16.8)	28.0 (400)	13 (325)	8 (2.4)	9 @ 80 (5.5)		
				33.6 (480)	17 (425)	6 (1.8)	9 @ 55 (3.8)		

* See the guidelines in Section 2.2.3.2 to confirm that any multiple-row racks being protected in accordance with this table meet the requirements to be considered open-frame.

** The design of 10 AS @ 40 psi (2.8 bar) can be reduced to 9 AS @ 40 psi (2.8 bar) when the water supply can also provide a minimum pressure of 80 psi (5.5 bar) from the most remote 4 sprinklers (2 sprinklers on 2 lines).

Factory Mutual (FM Global) Caveats

- Be aware of the specific application and use case.
- While 8-9 could be used for permit approval with AHJ acceptance, there is the chance that the tenant's insurer may push back.
- Also, importantly, **the use of FMDS 8-9 *also* requires the use of FMDS 2-0**, *Installation Guidelines for Automatic Sprinklers*
  - Referenced in body of document.
  - Much more defined (and possibly restrictive) ceiling-level obstruction criteria than NFPA 13.
  - Something to watch out for if you are reviewing/accepting an FMDS 8-9 alternative design for a warehouse.

Special Application Listed Sprinklers

UL Listed Sprinklers for Max. 48’

There are a few UL listed sprinklers available for max. 48’ ceilings.

- Reliable K22.4 (RA1011)*
- Tyco K25.2 (TY9226)
- Victaulic K25.2 (V4802 & V4804)
- Viking K28.0 (VK514)

*Reliable is no longer mass-producing this sprinkler and has replaced it with a different K22.4 that does not have the UL listing.

Installation Pictures

Figure 3 Sprinkler Photographs

UL Listed Sprinklers for Max. 48’

These are not all created equal!

- Varying operating **design pressures** (e.g., 45 psi vs 35 psi)
- Varying minimum **aisle width** limitations (e.g., 4’ vs 5’ vs 6’)
- Varying **storage configurations** (e.g., single- and double-row racks vs that plus multiple-row racks)

What else?

- What do you do if:
  - A client wants an even taller roof/ceiling
  - Has commodities worse than CUP?
  - Both?
- Generally, in-rack sprinklers are required.
- However, the days of in-racks “everywhere” are over…
- There are newer in-rack sprinkler protection schemes that do not require a level of sprinklers for every tier of storage.

Alternative in-rack schemes

"Modular" in-rack fire sprinkler protection schemes.

- Schemes are available where the level of in-rack sprinklers can act as a virtual floor/ceiling.
- Vertical spacing can be as much as 40' apart (depending on type of commodities being stored).
- Common to see maximum vertical spacing of 20' or 30', adequate to protect all sub-categories of Group A plastics.

Alternative in-rack schemes

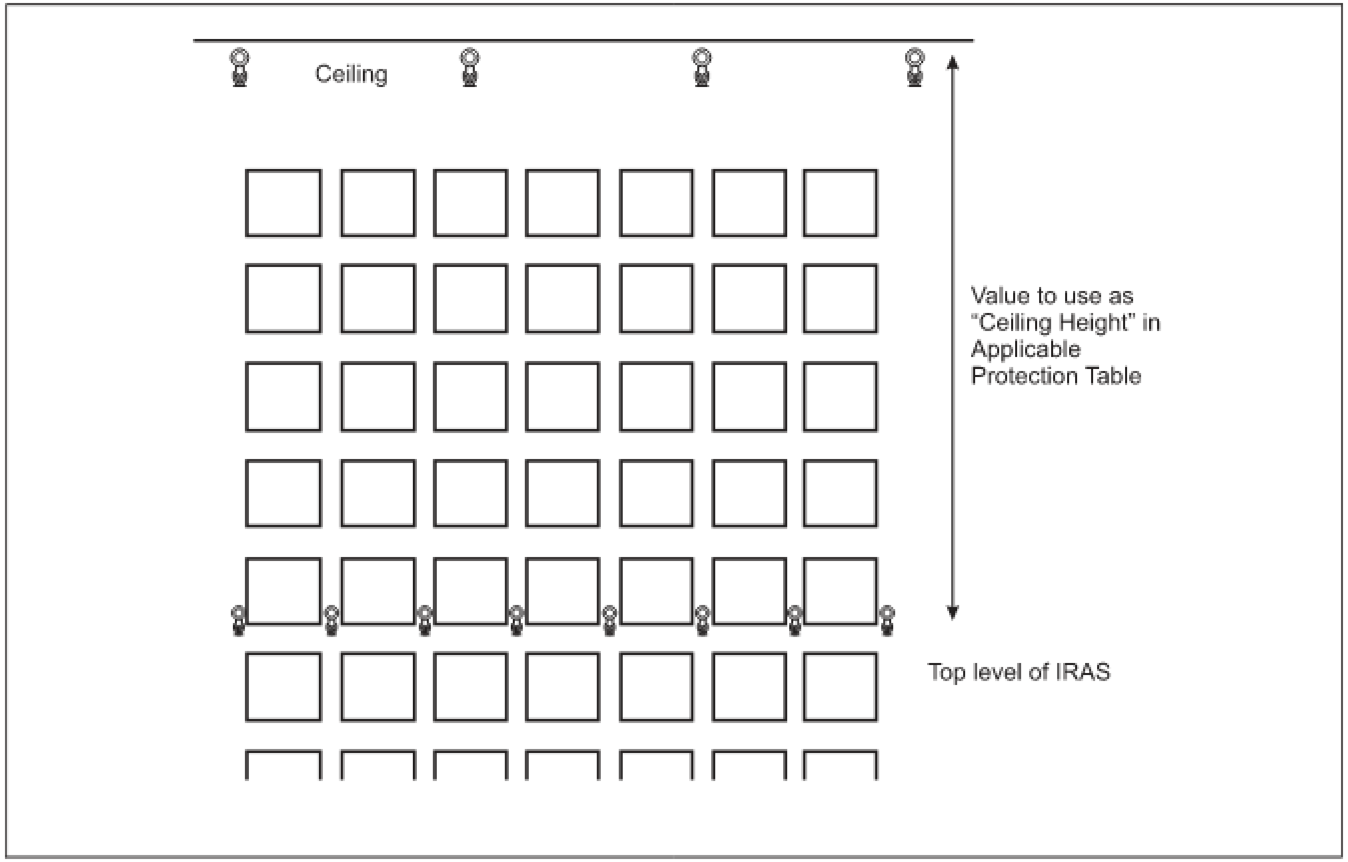
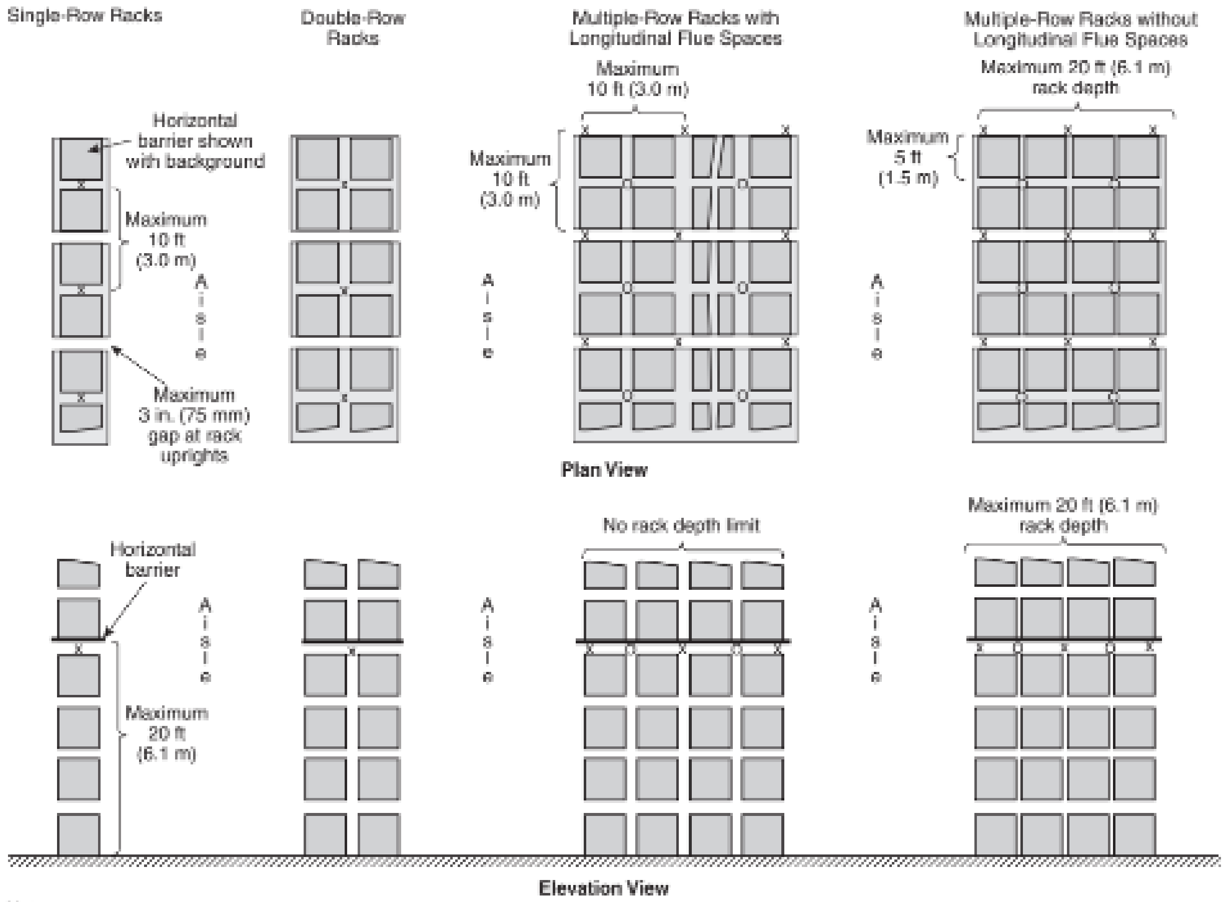


Fig. 22. Determining ceililng height in applicable protection table

Alternative in-rack schemes

ESFR sprinklers used as in-racks, or large orifice extended coverage (K25.2ECs) with solid horizontal barriers.

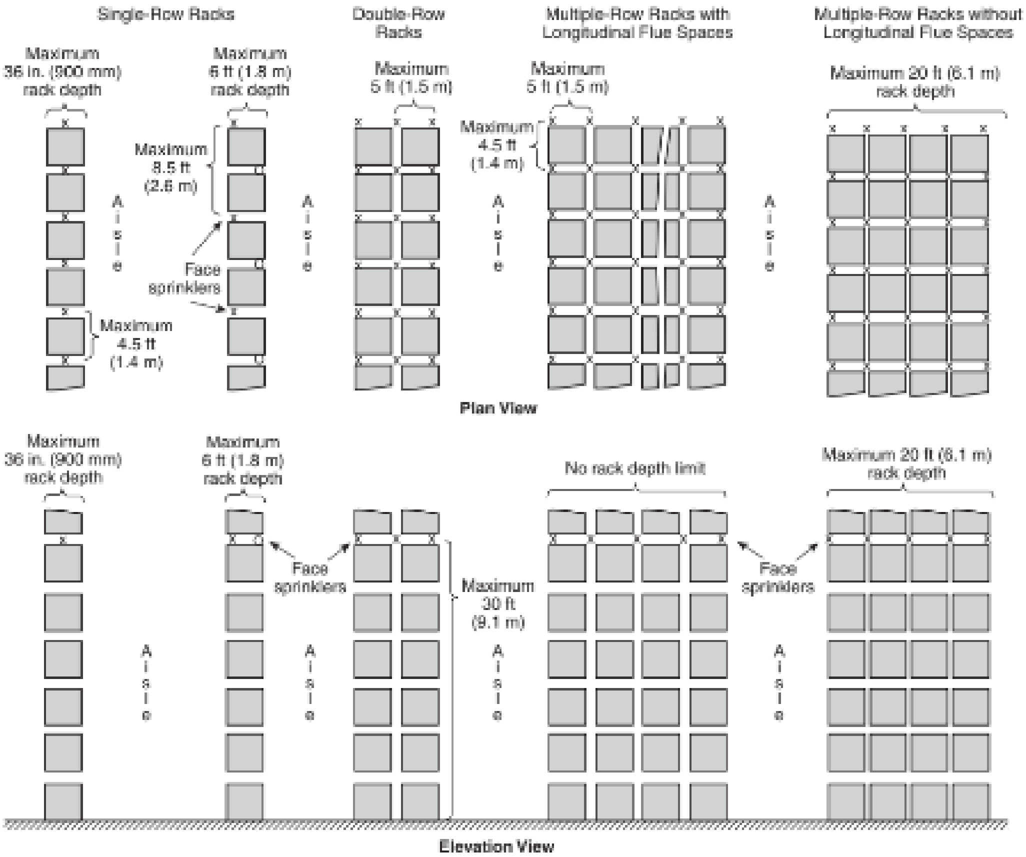
Alternative in-rack schemes



Notes:
(1) In-rack sprinklers are intermediate-temperature-rated, fast-response, pendent, and minimum K-25.2 (K-360) extended-coverage CMDA sprinklers.
(2) Where Class I through Class IV and cartoned and exposed Group A plastic commodities are maintained in single- or double-row racks, the in-rack sprinkler system is to be designed for a mimimum of four in-rack sprinklers operating at 138 gpm (520 L/min).
(3) Where Class I through Class IV and cartoned and exposed Group A plastic commodities are maintained in multiple-row racks, the in-rack sprinkler system is to be designed for a minimum of eight in-rack sprinklers (three at each face and two in between) operating at 138 gpm (520 L/min).
(4) The symbol X represents in-rack sprinklers.
(5) Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as two loads or as many as 13 loads between in-rack sprinklers that are spaced 20 ft (6.1 m) apart vertically.

FIGURE 25.6.2.3.1(f) In-Rack Sprinkler Arrangements for Class I through Class IV and Group A Plastic Commodities, Maximum 20 ft (6.1 m) Vertical Increments.

Alternative in-rack schemes



Notes:

(1) In-rack sprinklers are ordinary-temperature-rated, fast-response, pendent, and minimum K-22.4 (K-320) ESFR sprinklers.

(2) Where Class I through Class IV and cartoned and exposed Group A plastic commodities are maintained in single-row racks having a maximum rack depth of 36 in. (900 mm), the in-rack sprinkler system is to be designed for a minimum of four in-rack sprinklers operating at 120 gpm (455 L/min).

(3) Where Class I through Class IV and cartoned and exposed Group A plastic commodities are maintained in single-row racks having a maximum rack depth over 3 ft (0.9 m) and up to and including 6 ft (1.8 m), the in-rack sprinkler system is to be designed for a minimum of five in-rack sprinklers operating at 120 gpm (455 L/min).

(4) Where Class I through Class IV and cartoned and exposed Group A plastic commodities are maintained in double- or multiple-row racks, the in-rack sprinkler system is to be designed for a minimum of 10 in-rack sprinklers (five in-rack sprinklers on the top level of the most remote rack as well as five in-rack sprinklers on the top level of the nearest adjacent storage rack) operating at 120 gpm (455 L/min).

(5) The symbols X and O represent in-rack sprinklers.

(6) Each square represents a storage cube measuring 4 ft to 5 ft (1.2 m to 1.5 m) on a side. Actual load heights can vary from approximately 18 in. to 10 ft (450 mm to 3.0 m). Therefore, there could be as few as three loads or as many as 20 loads between in-rack sprinklers that are spaced 30 ft (9.1 m) apart vertically.

FIGURE 25.6.2.3.1(c) In-Rack Sprinkler Arrangements for Class I through Class IV and Group A Plastic Commodities, Maximum 30 ft (9.1 m) Vertical Increments.

Questions

???

HARRINGTON GROUP INC

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937-422-2711

EXAMPLES OF VALUE DELIVERED

Performance-Based Analysis and Code Official Negotiation

A large banking firm in Ohio was in the process of retrofitting a 2.5-million square foot office building with a large central atrium connecting through the entire building's footprint. During the site investigation phase, it was discovered by the design team that the 20-year-old system did not meet the strict requirements of the new code. Faced with upgrading the system for permitting compliance due to the extensive building renovations, the client was very concerned that the total system upgrade costs would exceed $5 million. Mr. Lampke conducted a system functional review and performed a CFD-based smoke exhaust and occupant evacuation performance-based design on the facility, and was able to prove to the State Building Appeals board that the system was functional, protected, and could provide life safety performance-based equivalency compliance to the new code of the new code with minor architectural modifications. Mr. Lampke's thorough work resulted in savings of over $4.7 million in equipment and construction costs to the client.

Mass Notification Fire Alarm System Design

Mr. Lampke was the principal engineer in a project which analyzed and upgraded the existing fire alarm system to a mass notification-capable system. A government body wanted to install a mass notification system within their high rise for occupant messaging purposes. The predominant challenge was that the existing system was fully encased in conduit and hidden behind walls faced with historic and delicate finishes, so the overall renovation impact had to be minor. Mr. Lampke

performed a thorough study analyzing the existing system's capability and flexibility, and ultimately provided a unique design which increased system redundancy while minimizing installation impact to the workforce. Additionally, the implementation of new acoustic technology was able to dramatically reduce the number of speaker devices required in large assembly areas, saving time and money. Mr. Lampke's design ultimately shaved two months off the construction schedule and saved the client a significant amount in equipment costs. While minimizing construction impact to the historic wall coverings.

Fire Suppression System Code Analysis and Design

A developer was targeting a renovation project of an existing historic high-rise in the Midwest, with the objective to convert the office spaces into condominiums. The electric power in the area was not deemed reliable by the local power company, and the client was alarmed that a generator would be required to support the fire pump. Mr. Lampke performed a code analysis and was able to provide a comprehensive alternative design that eliminated the need for a generator on the project site while still providing a high degree of reliability to the fire suppression system in the building. Mr. Lampke's work resulted in a savings of over $150,000 in costs driven by the fire protection prescriptive code requirements.

HGI-FIRE.COM
3237 Satellite Boulevard
Building 300, Suite 525
Duluth, GA 30096

PROFESSIONAL INVOLVEMENT

- National Fire Protection Association (NFPA) – Member
- NFPA 770: Standard for Hybrid (Water and Gas) Fire Extinguishing Systems.
- NFPA 32 - Standard on Dry Cleaning Facilities - Principal
- Society of Fire Protection Engineers (SFPE) – Member
- Society of Fire Protection Engineers (SFPE) Cincinnati Tri-State Chapter Past President, Past Vice President and Past Secretary
- SFPE PE Exam Review Course - Introduction: Smoke Control - Instructor
- Other instructional P.E. exam review course teaching roles: Detection, Alarm, and Communications Systems, Human Behavior (Egress & Occupant Movement)

PREVIOUS EXPERIENCE

- HEAPY - Senior Fire Protection Engineer (2012-2020)
- American Electric Power - Fire Protection Engineer III (2011-2012)
- Worcester Polytechnic Institute - Teaching Assistant - 850N People in Fires

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Duluth, GA 30096

File Attachments for Item:

EC-9 Past, Current, and Future of the Alarm Transmission Ecosystem (Fire Code Academy)

All certifications (1 hour)

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: Randy Hormann

Organization: Fire Code Academy

Address: 81 Mill Street - Suite 300 Gahanna, Ohio 43230

E-mail: RandyH@FireCodeAcademy.com Telephone: 614-416-8077

Website: www.FireCodeAcademy.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: Past, Current and Future of the Alarm Transmission Ecosystem

Course instructor: Richard Roberts

Course description: An informative presentation that provides an overview of the Alarm Transmission Ecosystem as well as providing information as to why changes are being made that will enhance public life safety.

Instructional hours per session: 1.0 Hours 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? 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: _______

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**

Richard Roberts
Senior Industry Affairs Manager
Honeywell Fire Safety
3825 Ohio Avenue
St. Charles, IL 60174
1-630-338-7025
richard.roberts@systemsensor.com

Past, Current and Future of the Alarm Transmission Ecosystem

Course Description: An informative presentation that provides an overview of the Alarm Transmission Ecosystem as well as providing information as to why changes are being made that will enhance public life safety. This discussion is important because the technologies for transmitting alarm, trouble, and supervisory signals from the protected premises to the fire department is changing rapidly. Several of the legacy technologies are becoming or are obsolete.

Time: 1.0 Hours

Presentation Agenda:

1. History of U.S. Alarm Transmission EcoSystem
2. Issues with Legacy Alarm Transmission Technologies
    - 3G Sunset
    - FCC Mandate for POTS
3. Alarm Transmission Requirements in the 2022 edition of NFPA 72®

Presenter: Richard Roberts is Senior Industry Affairs Manager at Honeywell Security and Fire with over 35 years in the fire alarm and life safety markets. His experience spans the installation, sales, and the development of products/systems. Currently, Mr. Roberts is a member of thirten NFPA Technical Committees, member of several ICC Fire Code Action Committee (FCAC) Working Groups and a member of two Underwriters Laboratories (UL) Standards Technical Panel (STP). He serves on the Board of Directors for the Fire and Life safety Section (FLSS) of the International Association of Fire Chiefs (IAFC), Safer Buildings Coalition (SBC), Center for Campus Fire Safety (CCFS) and is the Chair of NEMA's Building Codes Committee as well as a member of the Model Codes Committee of the National Assocation of State Fire Marshals (NASFM).

Presentor:

Richard Roberts
Senior Industry Affairs Manager
Honeywell Fire Safety
richard.roberts@systemsensor.com
1-630-338-7025

Bio:

Over thirty-five years of experience in the installation, sales, commissioning and product management of code compliant commercial fire alarm, carbon monoxide detection, emergency communication and security systems. Mr. Roberts is responsible for codes & standards development at the federal, state, and local level as well as legislation.

Currently Mr, Roberts is serving on:

- 14 National Fire Protection Association (NFPA) Technical Committees
- 2 Underwriters Laboratories (UL) Standards Technical Panels for carbon monoxide detection
- Member of numerous ICC Fire Code Action Committee (FCAC) working groups
- Board member of the International Association of Fire Chiefs (IAFC) Fire and Life Safety Section (FLSS)
- Member of the National Association of State Fire Marshals (NASFM) Model Codes Committee (MCC)
- Board member of the Center for Campus Fire Safety (CCFS)
- Board member of the Safer Buildings Coalition (SBC)
- Chair of the Safer Buildings Coalition (SBC) Government Affairs Committee
- Chair of the National Electrical Manufacturers Association (NEMA) Building Codes Committee (BCC)
- Chair of the U.S. TAG to the International Organization for Standardization (ISO) TC 21/SC 3 (Fire Detection and Alarm Systems)

PAST, CURRENT & FUTURE OF THE ALARM TRANSMISSION ECOSYSTEM

RICHARD ROBERTS
SENIOR INDUSTRY AFFAIRS MANAGER

Honeywell

LEARNING OBJECTIVES

- History of U.S. Alarm Transmission Ecosystem
- Issues with Legacy Alarm Transmission Technologies
  - 3G Sunset
  - FCC Mandate for POTS
- Alarm Transmission Requirements in the 2022 Edition of NFPA 72®

INTRODUCTION

Comments and opinions during the presentation are exclusively the presenter and do not reflect an official position of the International Code Council (ICC), National Fire Protection Association (NFPA), its employees, or any of the Technical Committees.

This presentation will not cover all the revisions, editorial changes, details, requirements or exceptions.

Highly recommend purchasing a copy of the ICC or NFPA Code or the Handbook for all the changes, requirements and details:

www.nfpa.org

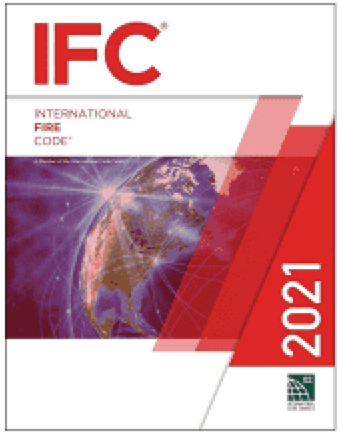
www.iccsafe.org

HISTORY OF ALARM TRANSMISSION ECOSYSTEM

NFPA & ICC Require Fire Alarm Systems to Automatically Transmit Signals to a Supervising Station

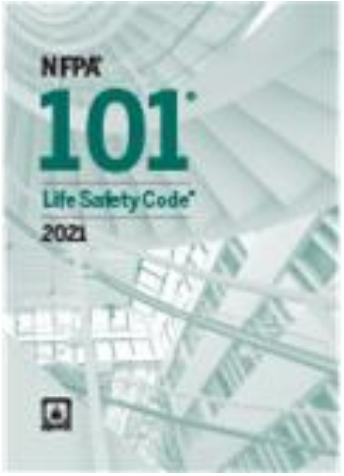
<u>International Fire Code (IFC):</u>

907.6.6 Monitoring. Fire alarm systems shall be monitored by an approved supervising station in accordance with NFPA 72.



<u>NFPA 101, *Life Safety Code*:</u>

9.6.4.1 Where required by another section of this Code, emergency forces notification shall be provided to alert the municipal fire department and fire brigade (if provided) of fire or other emergency.



HISTORY OF ALARM TRANSMISSION ECOSYSTEM

Supervising Station Requirements in NFPA 71 and NFPA 72

Prior to 1993: Requirements located in NFPA 71

1993 and 1996 NFPA 72: Chapter 4

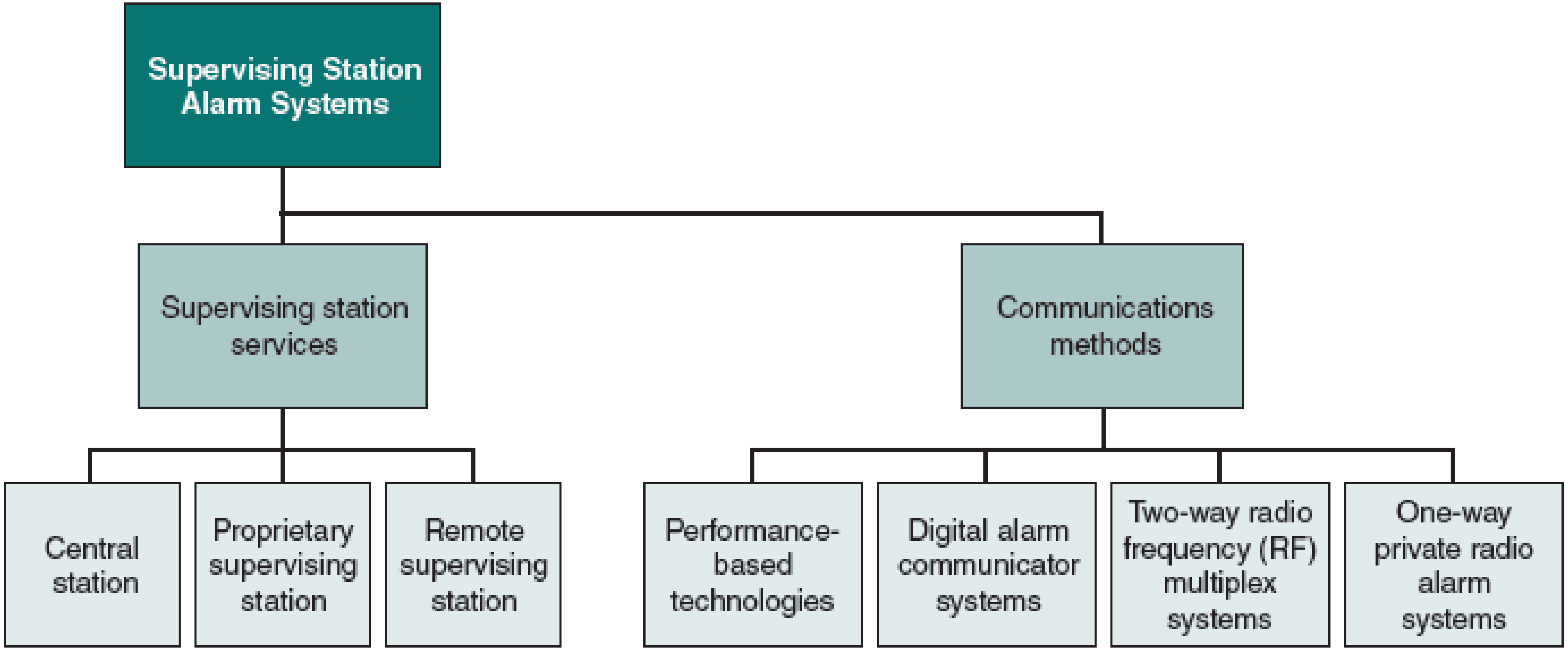
1999 NFPA 72: Chapter 5

2002 and 2007 NFPA 72: Chapter 8

2010, 2013, 2016, 2019 and 2022 NFPA 72: Chapter 26

HISTORY OF ALARM TRANSMISSION ECOSYSTEM

Supervising Station Requirements in NFPA 72



HISTORY OF ALARM TRANSMISSION ECOSYSTEM

Supervising Station Services

Supervising Station: A facility that receives signals from alarm systems and has personnel in attendance (24/7/365) to respond to these signals

Central Supervising Station: A supervising station that is listed for central station service and commonly provides less stringent supervising station services such as remote supervising services

Proprietary Supervising Station: A supervising station under the same ownership as the protected premises fire alarm system(s)

Remote Supervising Station: A supervising station that receives signals from protected premises fire alarm systems are received

COMMUNICATION METHODS

How Two-Way Radio Systems Work

- Consists of a traditional multiplex fire alarm system that uses a licensed two-way radio system to receive interrogation signals from the supervising station to the protected premises and transmits signals from the protected premises to the supervising station

- These systems must use licensed two-way radio because of the restrictions that current FCC regulations place on the number of times in a 1-hour period that an unlicensed radio transmitter may transmit information

- **Currently there are no products listed for two-way radio system**

COMMUNICATION METHODS

How One-Way Radio Systems Work

- Use of a single radio alarm transmitter (RAT) at a protected premises that transmits signals from the protected premises to at least two radio alarm repeater station receivers (RARSRs) located at a protected premises
- These systems do not have interrogation and response capability
- The use of multiple RARSRs will increase the likelihood that the single transmitter will successfully transmit signals to the supervising station

COMMUNICATION METHODS

How Digital Alarm Communications Systems (DACS) Work

- A DACT is required to be connected to the public switched telephone network (PSTN) ahead of any customer owned equipment
- Connection needs to be on **two** loop-start “plain old telephone service” (POTS) lines and they are required to seize the telephone line and disconnect any other use of the line
- DACTs get a dial tone, dial the digital alarm communicator receiver (DACR) at the supervising station, get verification that the DACR is ready to receive, transmit the signal, and receive acknowledgement that the DACR has received and understood the signal

COMMUNICATION METHODS

Managed Facilities-Based Voice Network (MFVN)

- Is a physical facilities-based network capable of transmitting real-time signals that is managed, operated, and maintained by the service provider to ensure service quality and reliability from the subscriber location to the interconnection point with other MFVN peer networks or the supervising station.

- MFVN service is functionally equivalent to traditional PSTN-based services provided by public utility telephone companies with respect to dialing, dial plan, call completion, carriage of signals and protocols, and loop voltage treatment

- MFVN interfaces with the premises FACU through a DACT by means of equipment that emulates the loop start telephone circuit and then transmits the signals over a pathway using packet switched (IP) networks or other communications methods that are part of an MFVN

ISSUES WITH LEGACY TECHNOLOGIES

3G Sunset

- The telecommunications industry is continuing to upgrade their cellular networks
- All major mobile carriers have shut down their 3G networks in 2022
- Communicators using 3G technology will no longer function leaving businesses and occupants vulnerable during a life safety event
- All communicators using 3G technology MUST be upgraded to 5G LTE and/or IP technology

ISSUES WITH LEGACY TECHNOLOGIES

Digital Alarm Communications Systems (DACTS)

- **Plain Old Telephone System (POTS):** This technology uses copper line to transmit signals from the protected premises FACU to the supervising station is becoming obsolete

- **Federal Communications Commission (FCC):** In 2019 the FCC issued Forbearance Order 19-72A1, which officially granted telecommunications carriers permission to abandon outdated, degraded copper POTS lines
  - This FCC order effectively severed the ties that forced carriers to maintain a specific standard of traditional POTS connectivity
  - At present, the legacy carries have not announced an official date when they will no longer support this technology

REQUIREMENTS IN 2022 EDITION OF NFPA 72®

Digital Alarm Communications Systems (DACTS) Requirements

26.6.4.2.1 Managed Facilities-Based Voice Network. A DACT shall be connected to a managed facilities-based voice network upstream of any private telephone system at the protected premises.

26.6.4.2.4.1 A system employing a DACT shall employ a single telephone line (number) and one of the following transmission means:

1) One-way private radio alarm system
2) Two-way RF multiplex system
3) Transmission means complying with 26.6.3

REQUIREMENTS IN 2022 EDITION OF NFPA 72®

Digital Alarm Communications Systems (DACTS) Requirements

26.6.4.2.4.1

4) A second telephone line (number), where all of the following are met:
   a) Access to one of the technologies in 26.6.4.2.4.1(1), 26.6.4.2.4.1(2), or 26.6.4.2.4.1(3) is not available at the protected premises.
   b) The authority having jurisdiction approves the arrangement.
   c) The DACT is programmed to call a second DACR line (number) when the signal transmission sequence to the first called line (number) is unsuccessful
   d) The DACT is capable of selecting the operable means of transmission in the event of failure of the other means.
   e) Each telephone line is tested in accordance with 26.6.4.2.4.2 or at alternating 6-hour intervals.

REQUIREMENTS IN 2022 EDITION OF NFPA 72®

Performance Based Alarm Transmission Technologies

2013 edition of NFPA 72: Created a Performance-Based Technology section

Performance Based Requirements: Do not to provide prescriptive details of technologies but rather give basic operating parameters of the transmission supervision rates of technologies

3G Cellular Networks: Utilize expansive cell tower infrastructure of the major wireless carriers where wireless cell coverage tends to be prevalent

Internet Protocol (IP): Communicators that convert the FACU output data stream to the internet

REQUIREMENTS IN 2022 EDITION OF NFPA 72®

Performance Based Alarm Technologies Requirements

26.6.3* Performance-Based Technologies.

26.6.3.2 Communications Integrity. Provision shall be made to monitor the integrity of the transmission technology and its communications path.

26.6.3.3 Single Communications Path. Unless prohibited by the enforcing authority, governing laws, codes, or standards, where a single communications path is used, the following requirements shall be met:

1) The path shall be supervised at an interval of not more than 60 minutes.
2) A failure of the path shall be annunciated at the supervising station within not more than 60 minutes.
3) The failure to complete a signal transmission shall be annunciated at the protected premises in accordance with Section 10.15.

REQUIREMENTS IN 2022 EDITION OF NFPA 72®

Performance Based Alarm Technologies Requirements

26.6.3.4 Multiple Communications Paths. If multiple transmission paths are used, the following requirements shall be met:

1) Each path shall be supervised within not more than 6 hours.
2) The failure of any path of a multipath system shall be annunciated at the supervising station within not more than 6 hours.
3) Multiple communications paths shall be arranged so that a single point of failure shall not cause more than a single path to fail.
4) The failure to complete a signal transmission shall be annunciated at the protected premises in accordance with Section 10.5.

REQUIREMENTS IN 2022 EDITION OF NFPA 72®

Performance Based Alarm Technologies Requirements

26.6.3.5* Single Technology. A single technology shall be permitted to be used to create the multiple paths provided that the requirements of 26.6.3.4(1) through 26.6.3.4(4) are met.

26.6.3.8 End-to-End Communication Time for Alarm. The maximum duration between the initiation of an alarm signal at the protected premises, transmission of the signal, and subsequent display and recording of the alarm signal at the supervising station shall not exceed 90 seconds.

REQUIREMENTS IN 2022 EDITION OF NFPA 72®

Performance Based Alarm Technologies Requirements

26.6.3.12* Sharing Communications Equipment On-Premises. If the fire alarm transmitter is sharing on-premises communications equipment, the shared equipment shall be listed as communications or information technology equipment.

26.6.3.13 Secondary Power.

26.6.3.13.1* Premises Equipment. The secondary power capacity for all transmitters and shared equipment necessary for the transmission of alarm, supervisory, trouble, and other signals located at the protected premises shall be a minimum of 24 hours or as permitted by 10.6.7.3.1(2), 26.6.3.13.1.1, or 26.6.3.13.1.2.

REQUIREMENTS IN 2022 EDITION OF NFPA 72®

Performance Based Alarm Technologies Requirements

26.6.3.13.1.1 Secondary power capacity for shared equipment shall be permitted to have a capacity of 8 hours where acceptable to the authority having jurisdiction and where a risk analysis is performed to ensure acceptable availability is provided.

26.6.3.13.1.2* Secondary power capacity for shared and premises equipment used in additional communications paths shall not be required where the first communications path meets the performance requirements of 26.6.3.3.

QUESTIONS?

RICHARD ROBERTS
GLOBAL SENIOR INDUSTRY AFFAIRS MANAGER
HONEYWELL FIRE SAFETY
RICHARD.ROBERTS@SYSTEMSENSOR.COM
630.338.7025

THANK YOU

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630.338.7025

Honeywell

File Attachments for Item:

EC-10 The Five Specialty Sprinkler Types and Design Approaches (Fire Code Academy)

All certifications (1 hour)

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: Randy Hormann

Organization: Fire Code Academy

Address: 81 Mill Street - Suite 300 Gahanna, Ohio 43230

E-mail: RandyH@FireCodeAcademy.com Telephone: 614-416-8077

Website: www.FireCodeAcademy.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: The 5 Specialty Sprinkler Types and (Sprinkler) Design Approaches

Course instructor: Bryan Berkley - Viking Fire Sprinklers

Course description: Some fire sprinkler types in specific systems are designed to completely suppress the fire in more challenging environments like storage facilities and institutions, etc..

Instructional hours per session: 1.0 Hours 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? 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: _______

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

The 5 Specialty Sprinkler Types and (Sprinkler) Design Approaches

Presented by:
Viking Fire Sprinklers

Time:
1.0 Hours

Program Overview:
Fire sprinkler systems save lives. When a fire occurs, standard spray sprinklers control the blaze by cooling and wetting surfaces to deprive it of fuel sources and prevent the fires spread and movement. Some sprinkler types in specific systems take this further—they're designed to completely suppress the fire in more challenging environments like storage facilities and institutions, etc.. How fire sprinkler systems are designed using specialty sprinklers can sometimes be a complicated process.

Learning Objectives:
1. Gain knowledge of the advantages of using attic sprinklers over standard spray sprinkler designs
2. Discuss the challenges of combustible interstitial space fires and how to provide protection
3. Understand the necessity and importance of using institutional and other specialty sprinklers
4. Describe how using window sprinklers allows for architectural freedom in building design

Bryan Berkley - Business Development of Special Hazards
Viking Fire Sprinklers - Viking Group Inc.

BIO

- 24 years in all aspects of fire protection inspection, installation, design and manufacturing and applications:

    - Nicet IV in water based systems, II in special hazards, and II in inspection & testing
    - Started in 1996 as an inspector for water based fire protection systems for 2 years.
    - Became a fitter installing water based fire protection systems for 4 years.
    - Moved into the designing role for 9 years and became design manager for the last 3 years in the designing of water based fire protection systems, foam systems, and clean agent systems.
    - Over the past 10 years I have been a national technical representative, special hazards business manager for Viking, covering the East and South America.
    - My responsibilities include working with engineers on specifications for the Viking and Fireflex products, working with AHJ on new standards, and training for contractors.
    - Performed fire sprinkler and clean agent seminars for SFPE(Society of Fire Protection Engineers) and ASPE (American Society of Plumbing Engineers)

VIKING

Trusted above all.

Five Special Sprinkler's

Date: 11-9-22
Speaker: Bryan Berkley

Special Sprinkler

5 Sprinklers that Solve Design Problems

Special Sprinkler

Learning Outcomes

- 1. Explain the advantages of using attic sprinklers over standard spray sprinkler designs
- 2. Discuss the challenges of combustible interstitial space fires and how to provide protection
- 3. Explain the necessity of using institutional sprinklers
- 4. Describe how using window sprinklers allows for architectural freedom in building design.
- 5. Detail the challenges of ever increasing storage heights and the sprinklers that address them.

Special Sprinkler

What is a Special Sprinkler

1. Intended for specific hazards or construction features.
2. Evaluated and listed for performance under the following conditions:
   a) Fire tests related to the intended hazard
   b) Distribution of the spray pattern with respect to wetting of floors and wall.
   c) Distribution of the spray pattern with respect to obstructions.
   d) Evaluation of the thermal sensitivity of the sprinkler
   e) Performance under horizontal or sloped ceilings
   f) Area of design
   g) Allowable clearance to ceilings

Special Sprinkler

Special Sprinkler Characteristics

1. Typical K-Factors.
2. Typical Temperature Ratings.
3. The protection area of coverage shall not exceed 400 ft^2 (37 m^2) for light hazard and ordinary hazard occupancies.
4. The protection area of coverage shall not exceed 196 ft^2 (18 m^2) for extra hazard and high-piled storage occupancies.

Special Sprinkler

Special Sprinklers

Combustible Interstitial Space Sprinklers

Attic Sprinklers

Institutional Sprinklers

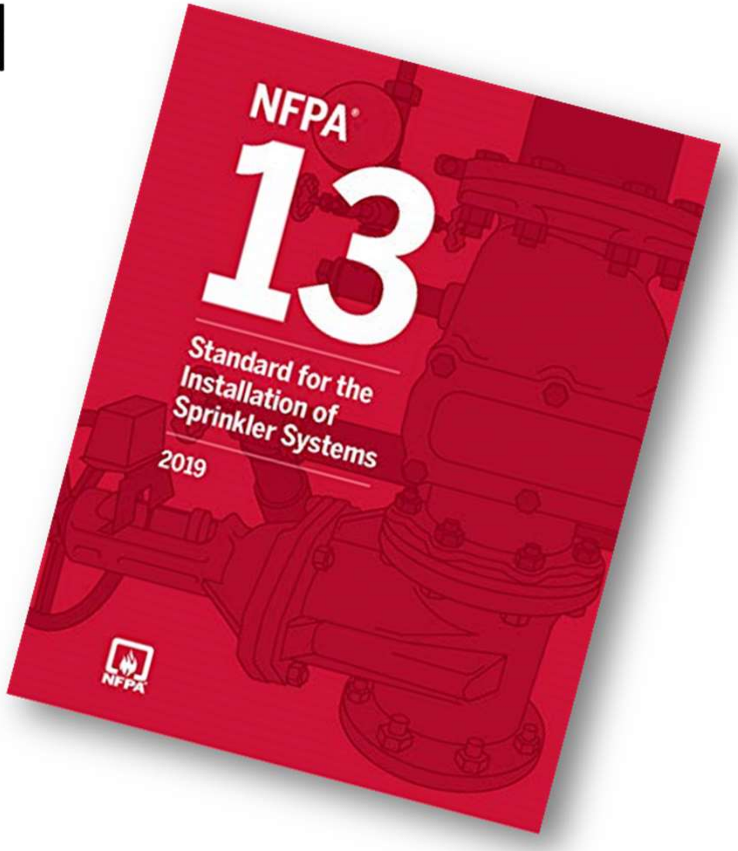
Window Sprinklers

Special Sprinkler

What is a Combustible Concealed Space

Special Sprinkler

When is Protection Required



Special Sprinkler

The Fire Challenge

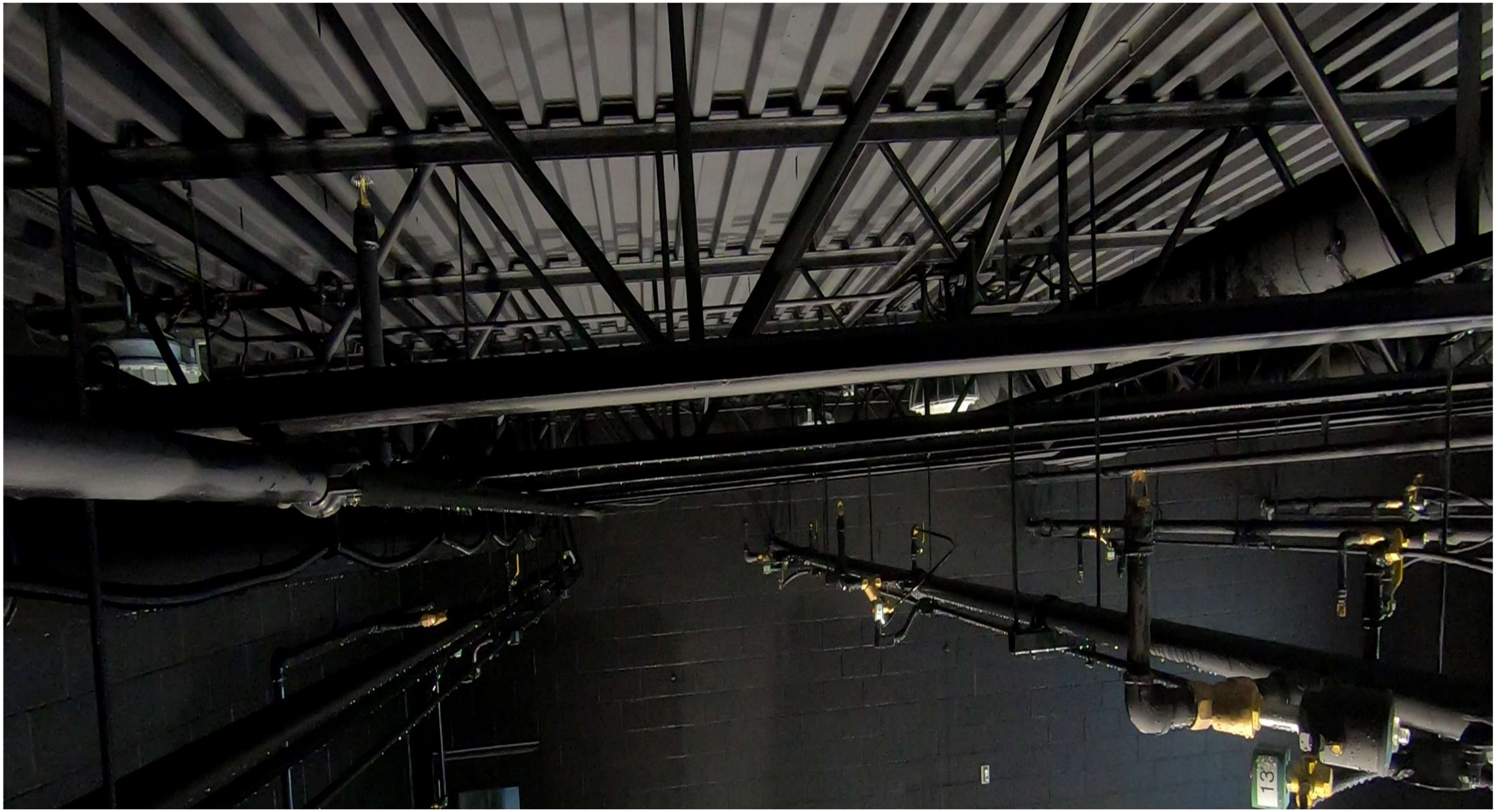
Special Sprinkler

What are Combustible Interstitial Space Sprinklers?

Special Sprinkler

What are Combustible Interstitial Space Sprinklers?

Special Sprinkler



Special Sprinkler

Draft Curtains

Special Sprinkler

Open Truss Construction

Special Sprinkler

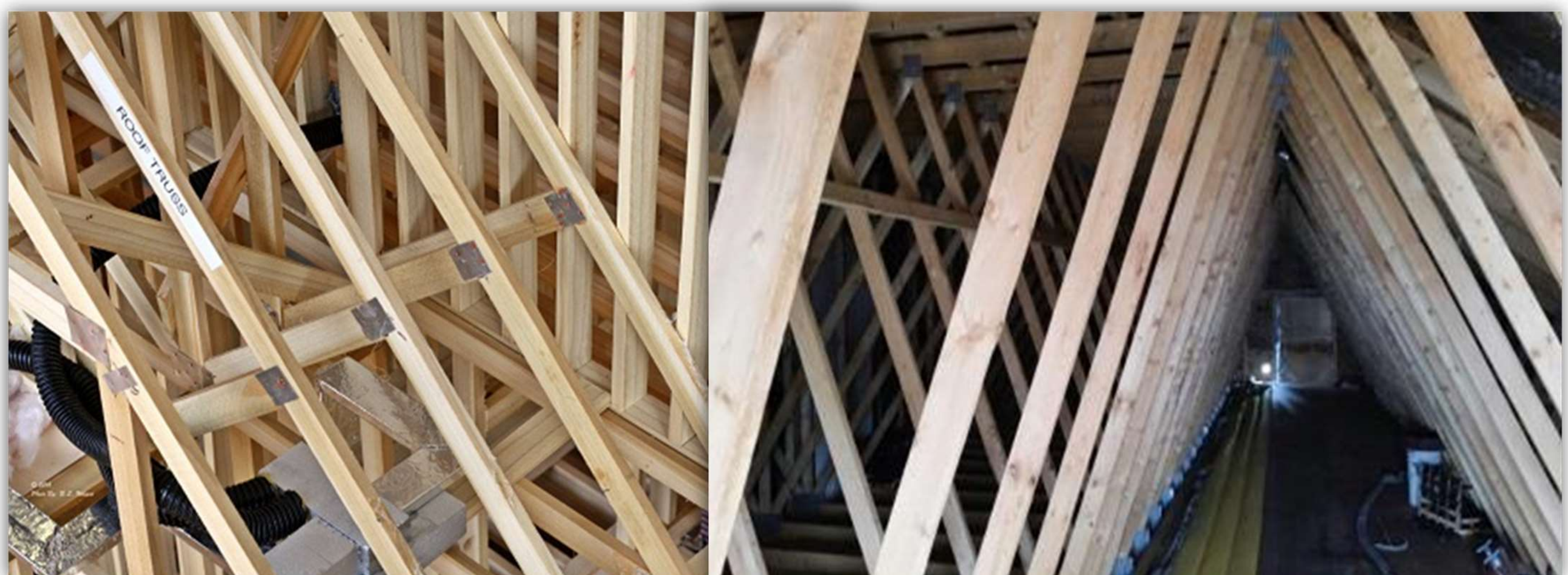
Open Truss Construction

Special Sprinkler

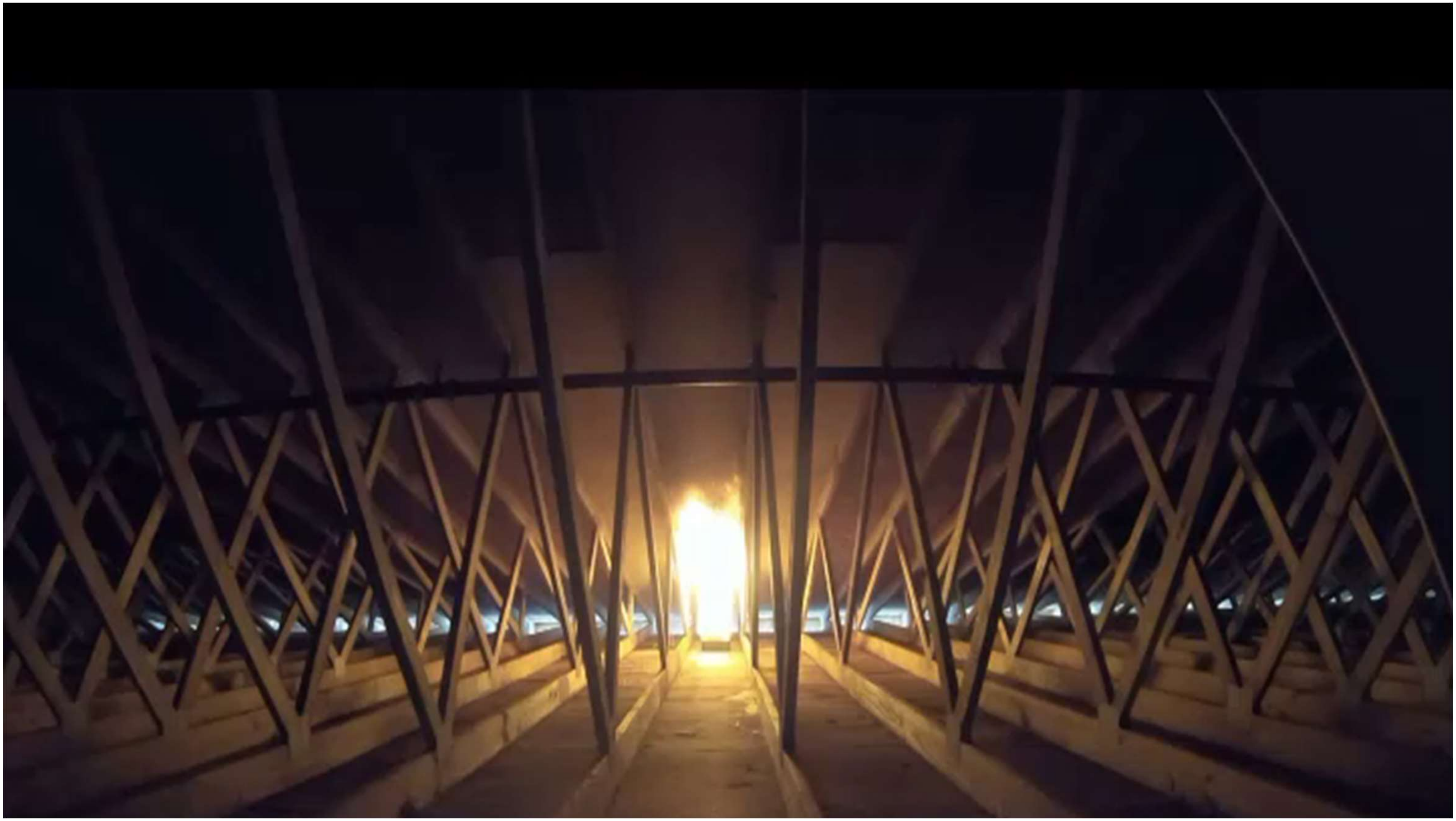
Attic Sprinklers

Special Sprinkler

What is the Fire Challenge in an Attic Space?



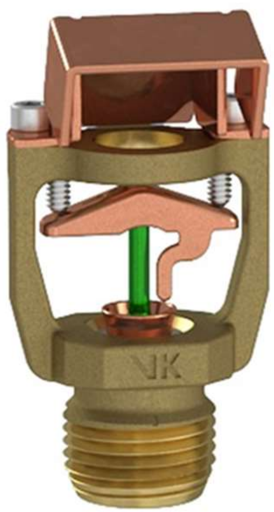
Special Sprinkler



Special Sprinkler

Attic Sprinklers

Back-to-Back



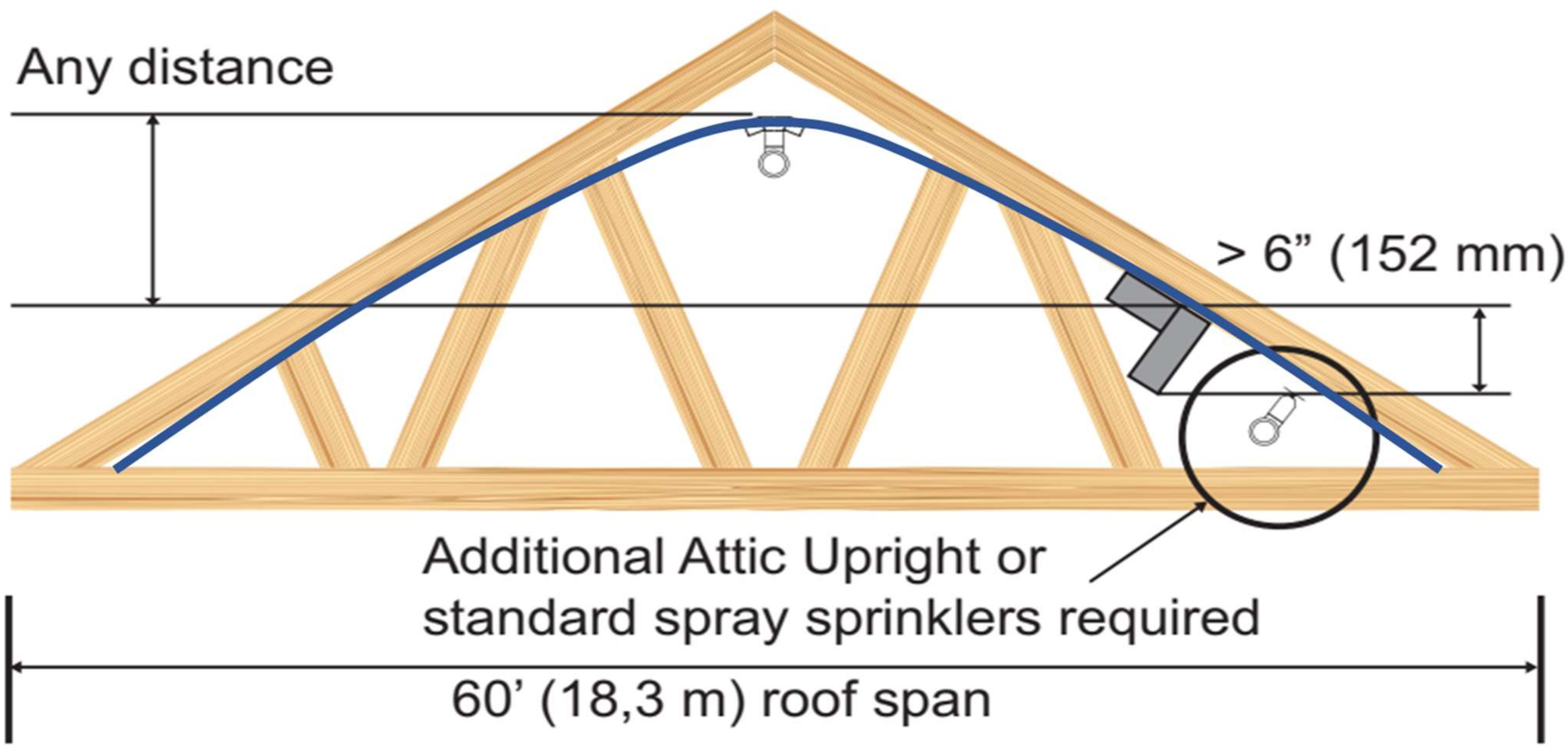
Single Direction

Eave Protection

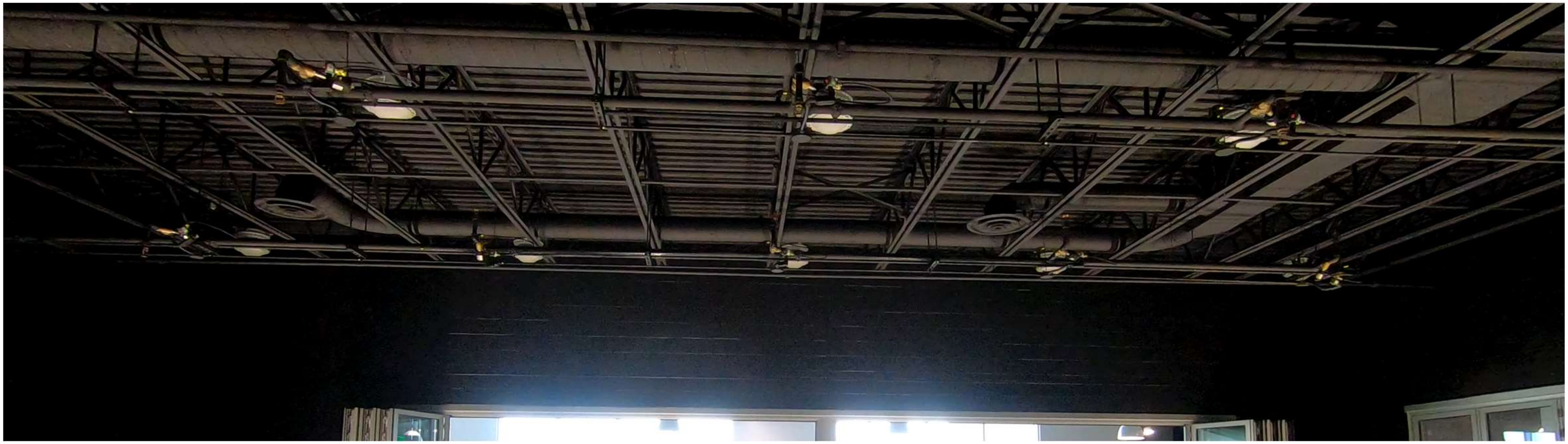
HIP

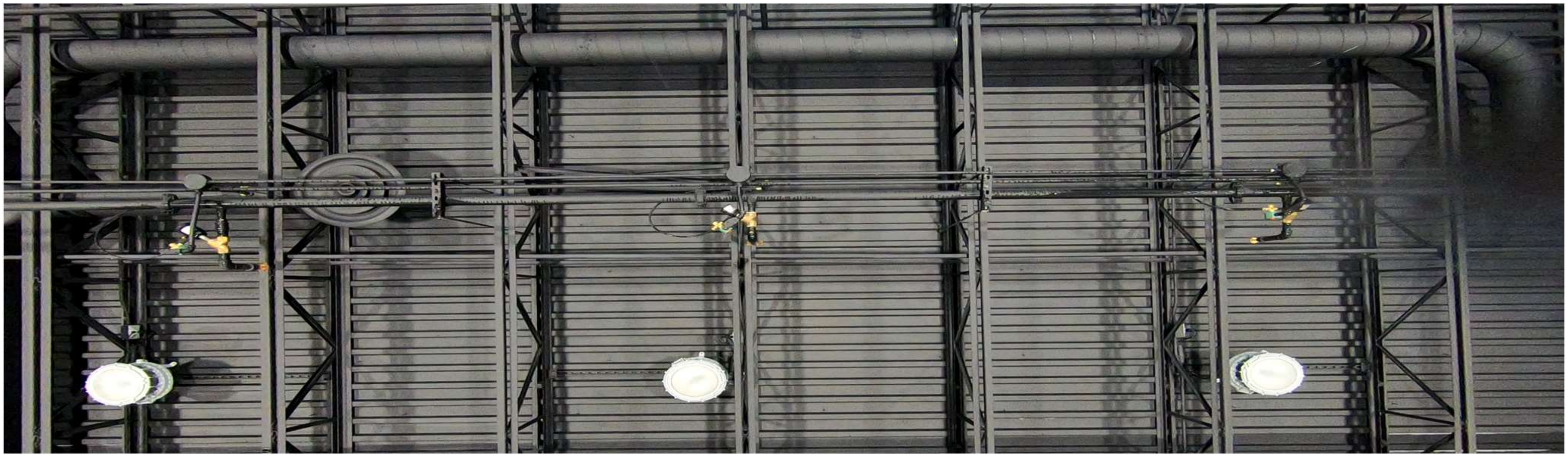
Attic Upright

Special Sprinkler



Special Sprinkler



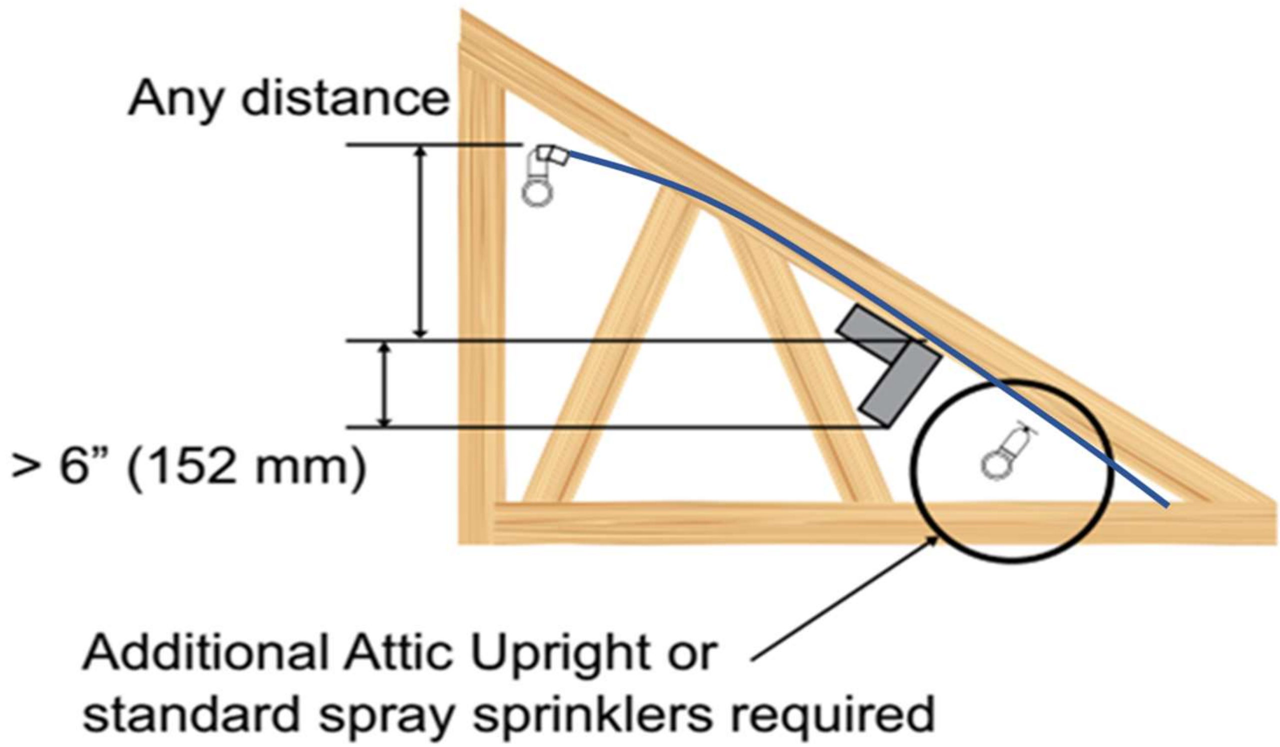


Special Sprinkler

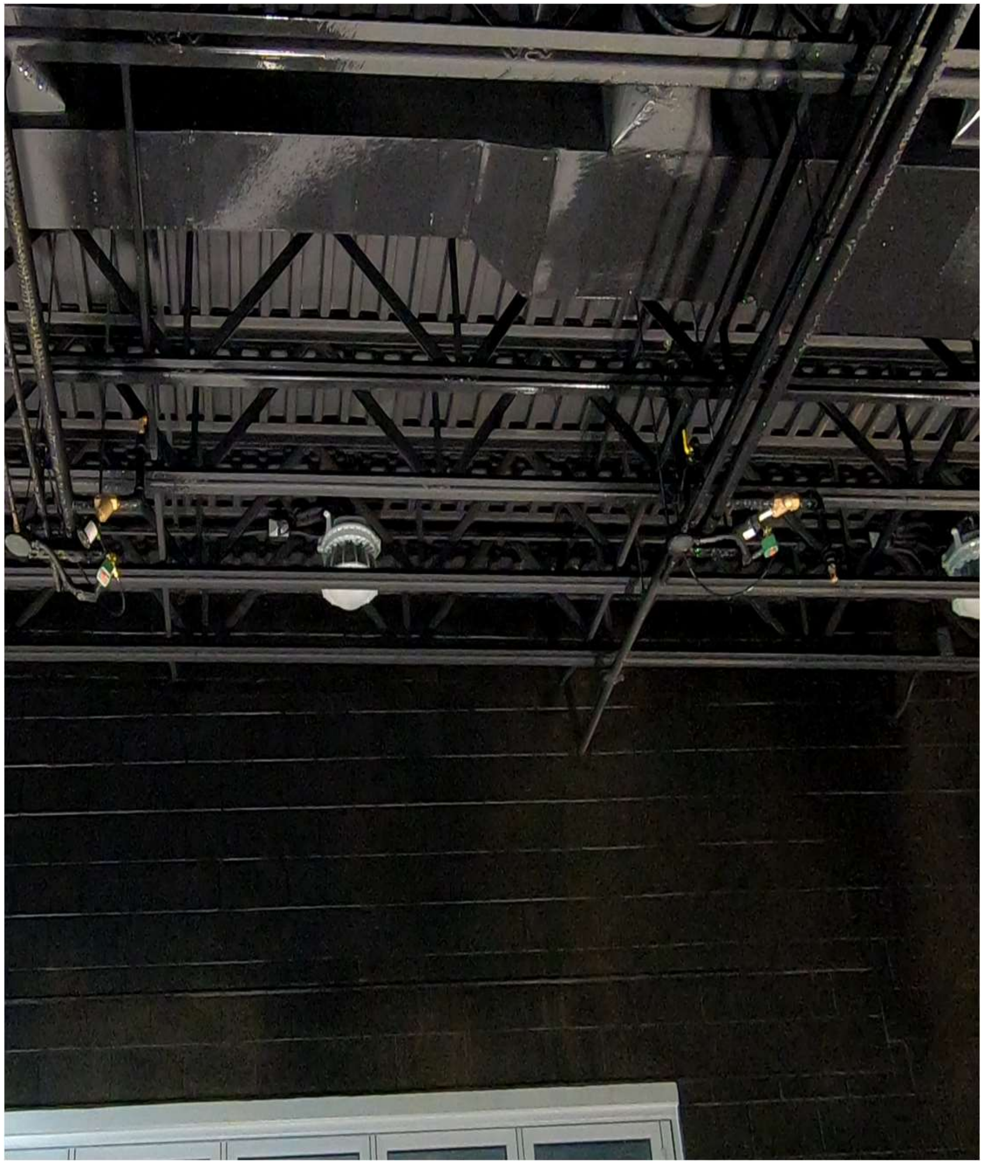
Back-to-Back Attic Sprinkler Deflector Angles

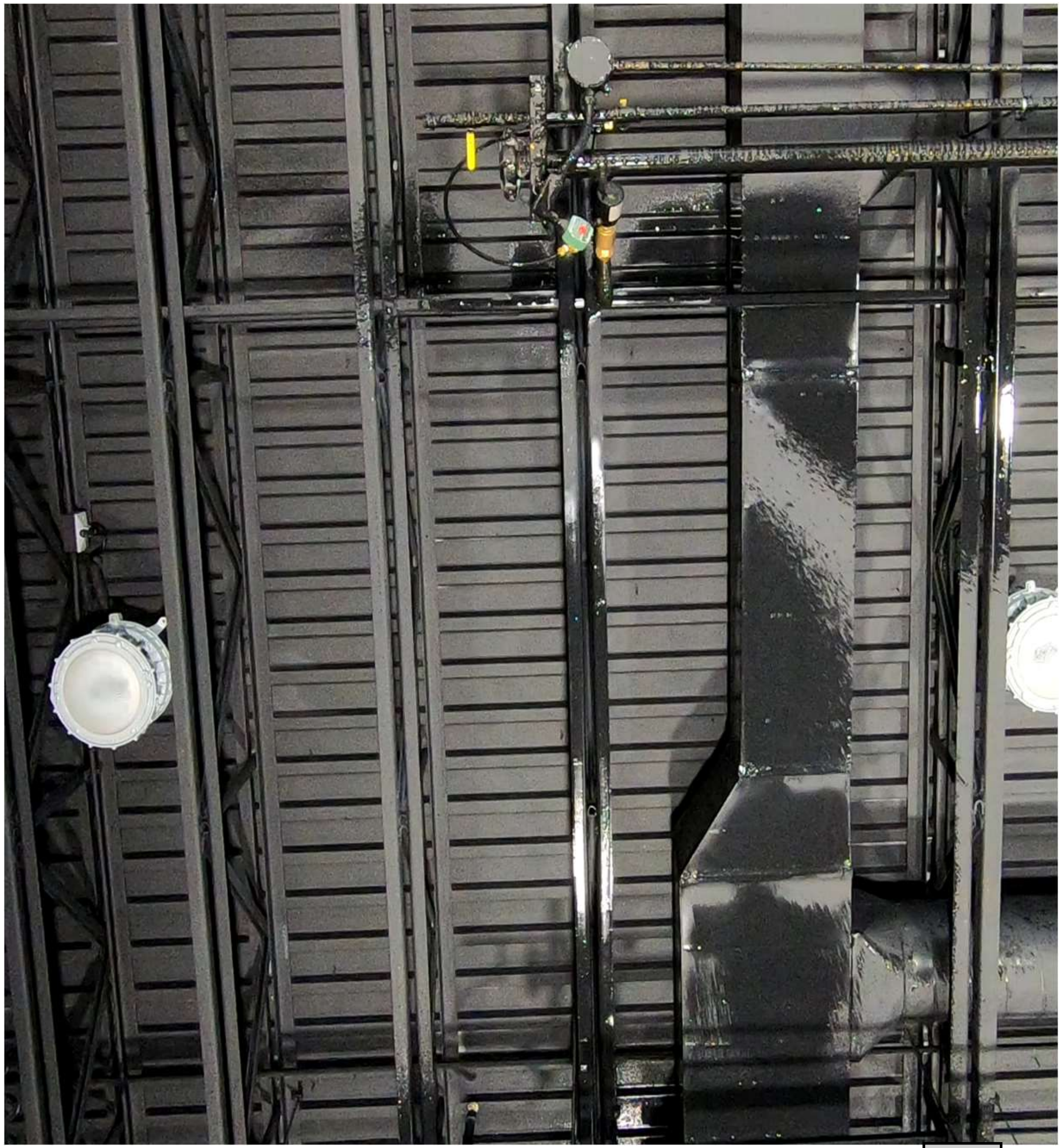
Special Sprinkler

Single Directional Attic Sprinklers

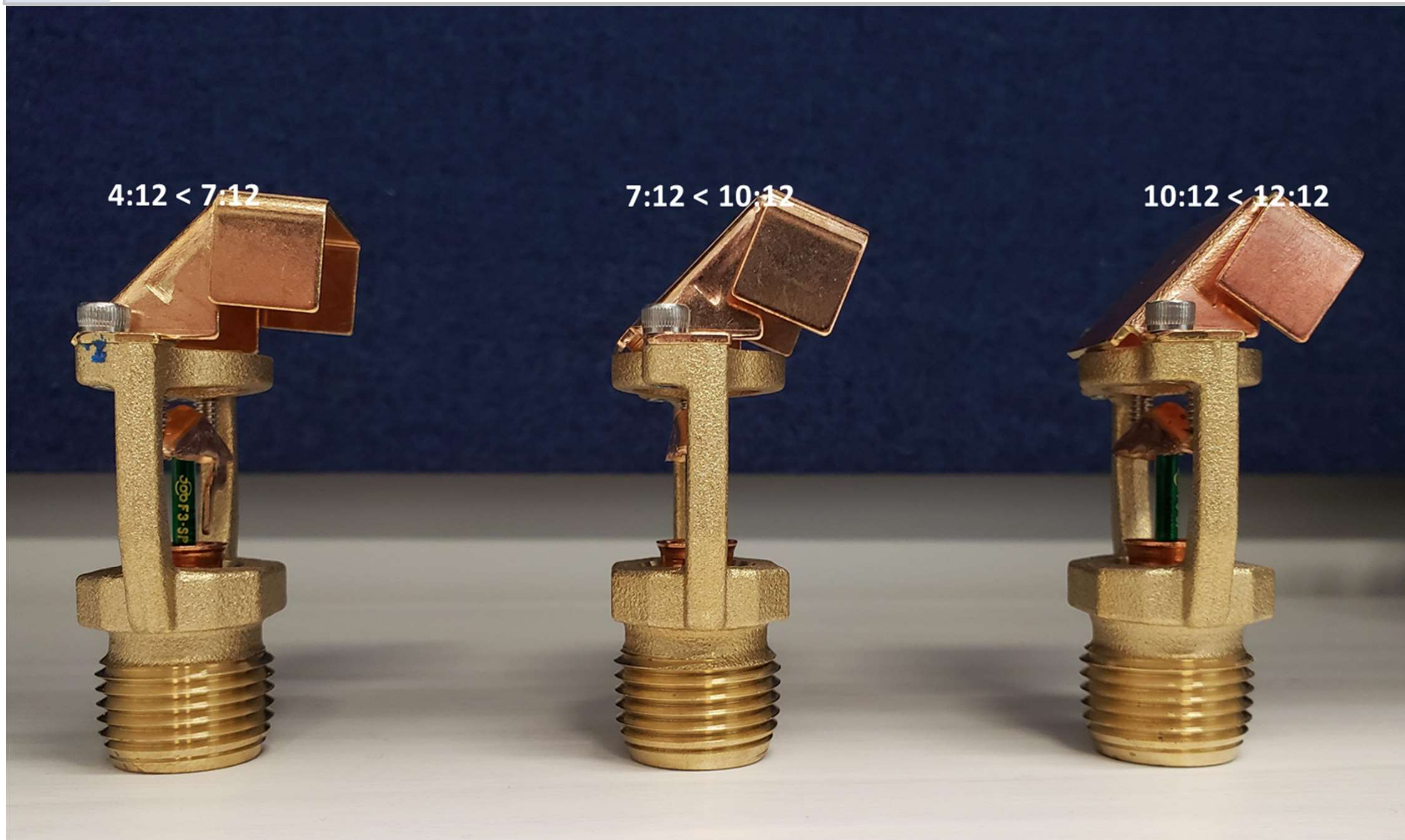


Special Sprinkler



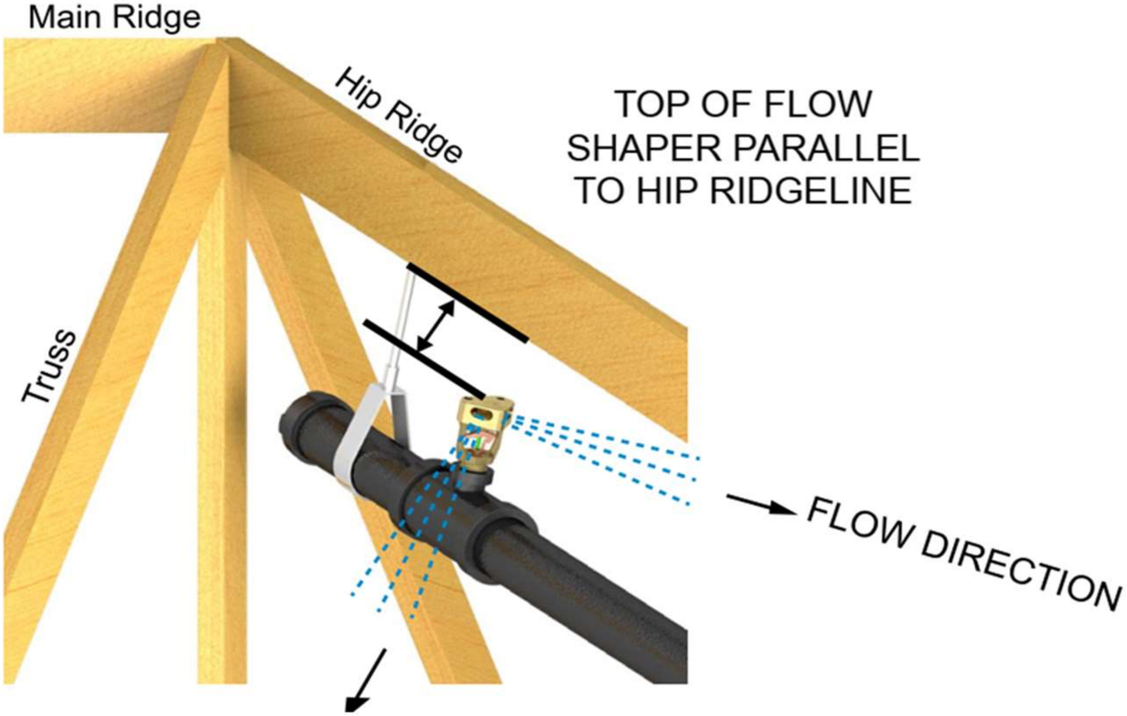


Special Sprinkler



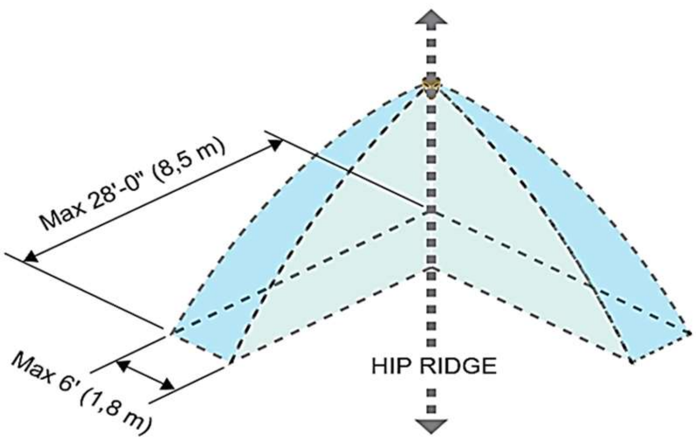
Special Sprinkler

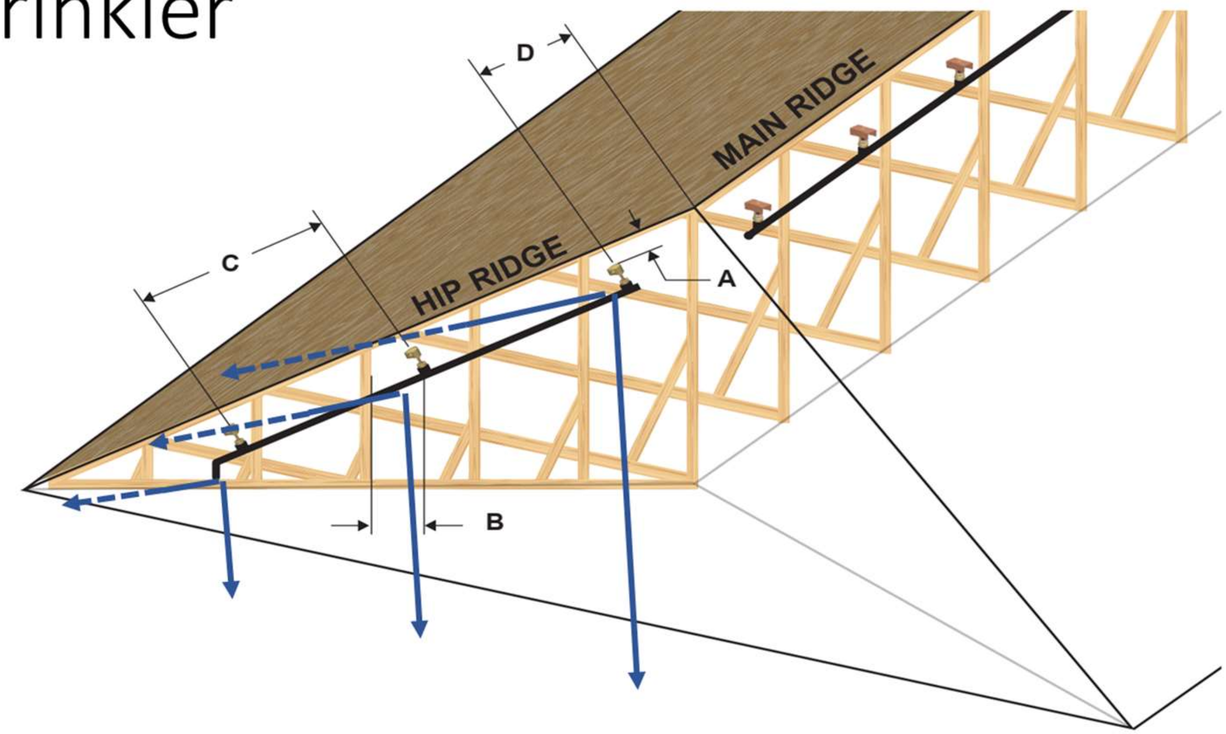
HIP Ridge Attic Sprinkler



Special Sprinkler

HIP Ridge Attic Sprinkler





Special Sprinkler

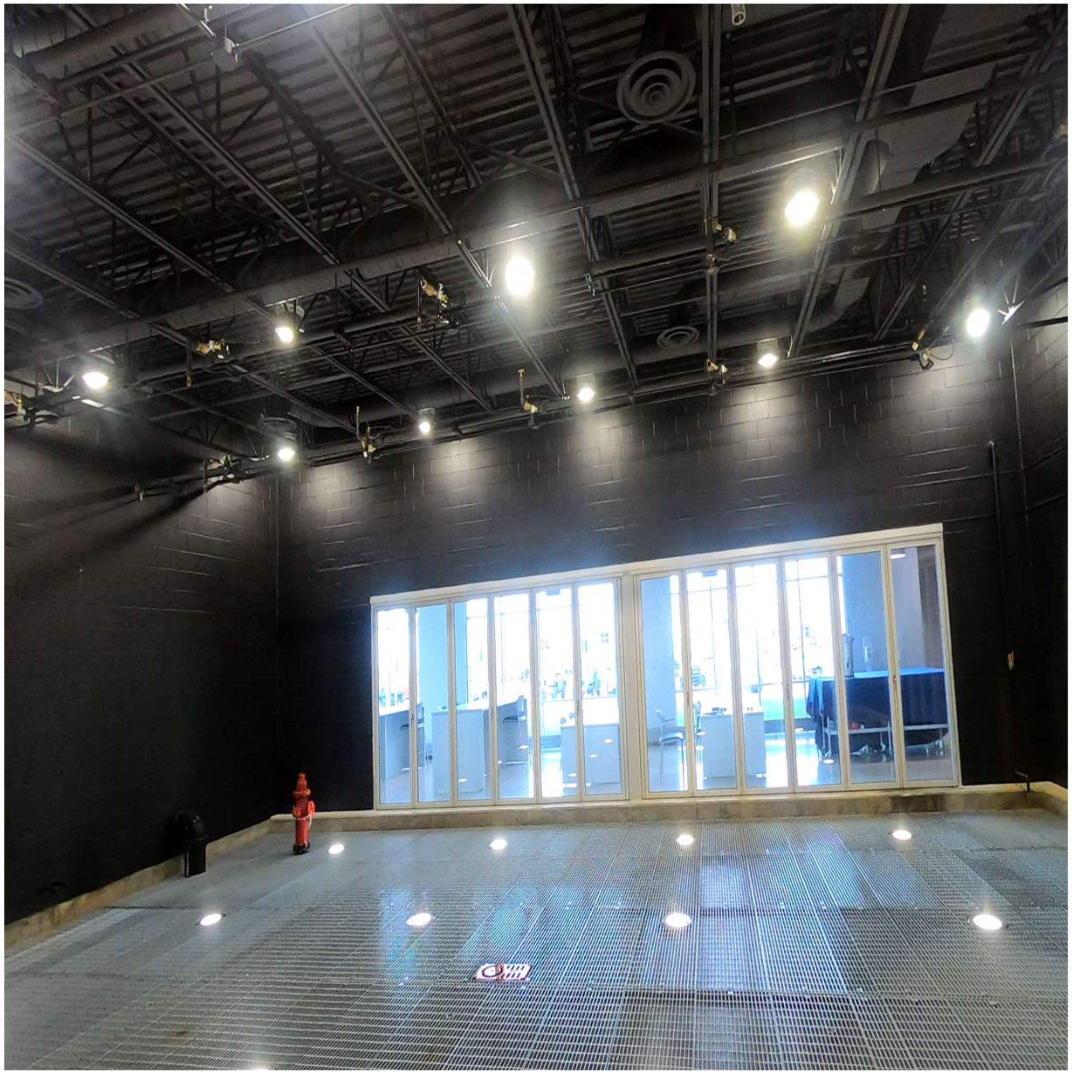
Special Sprinkler

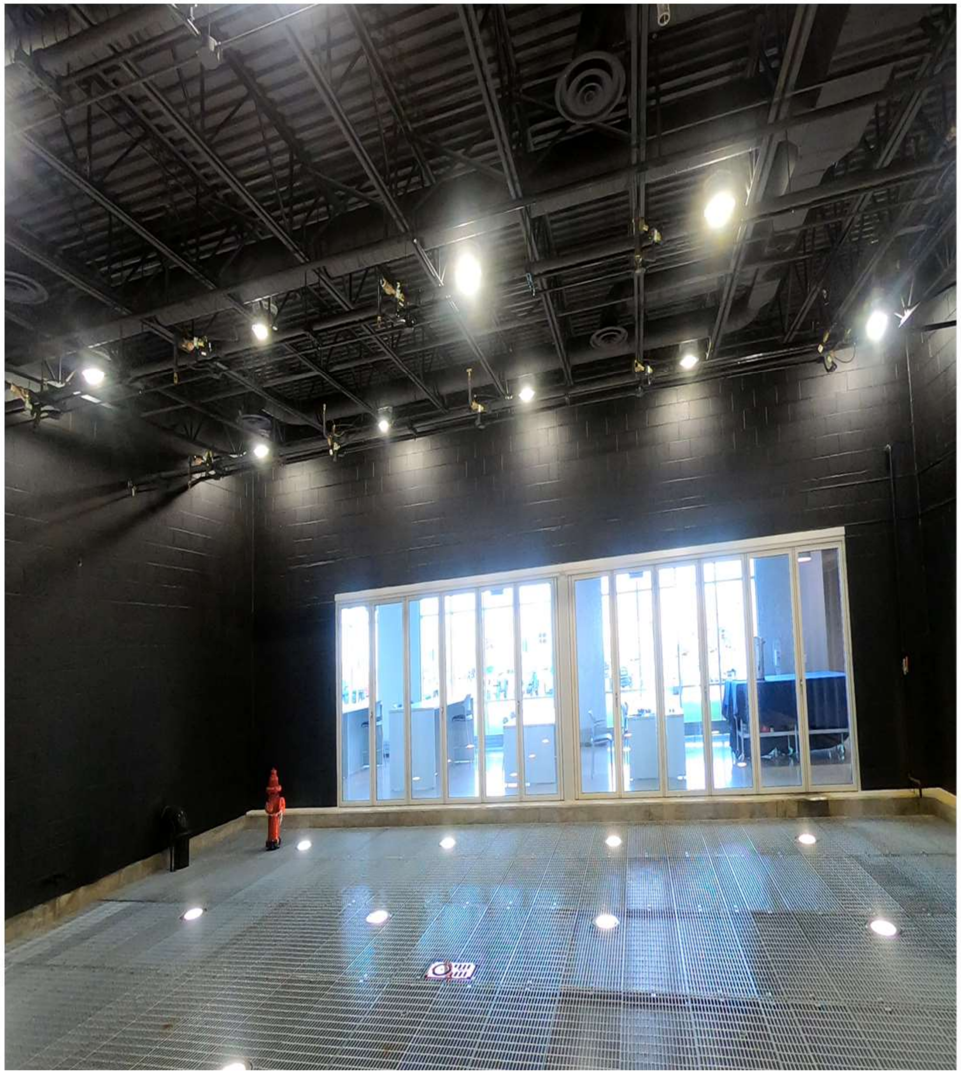
SD EP

SD EP

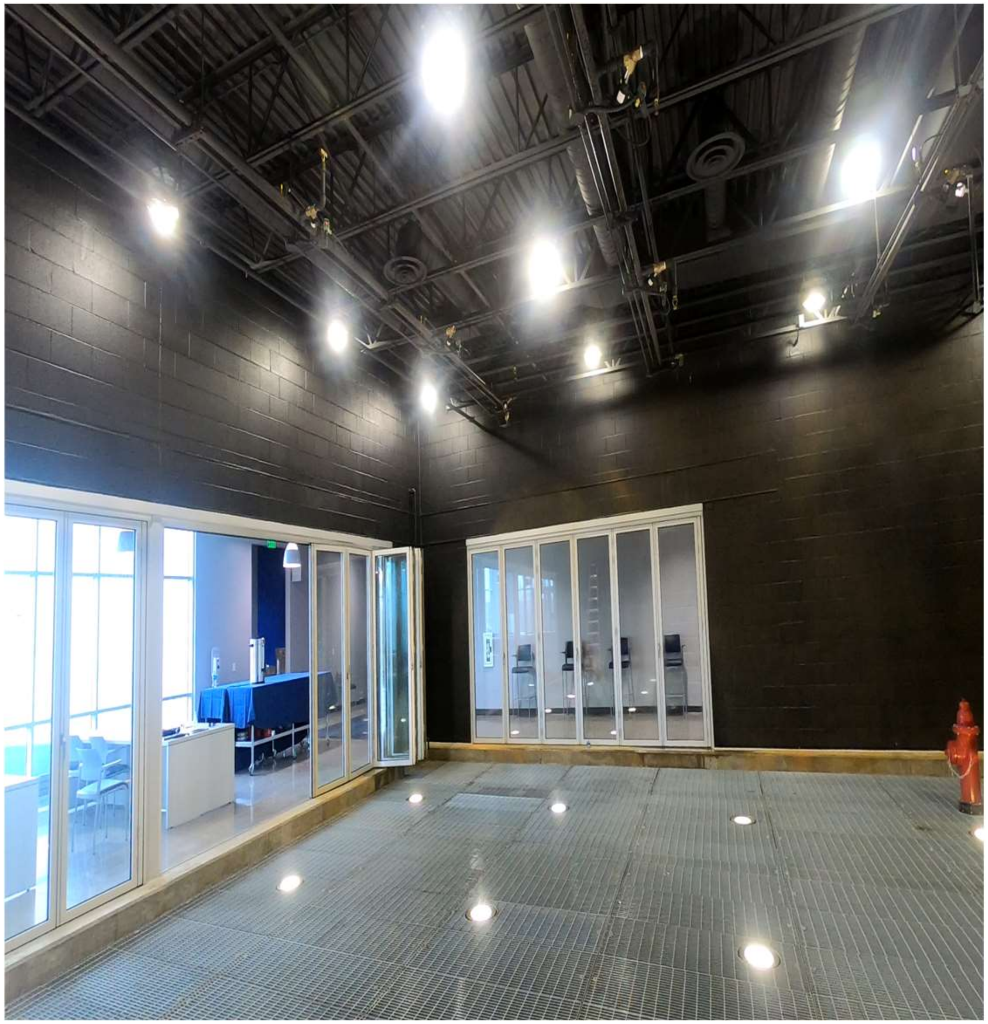
Special Sprinkler

Eave Protection & Single Directional



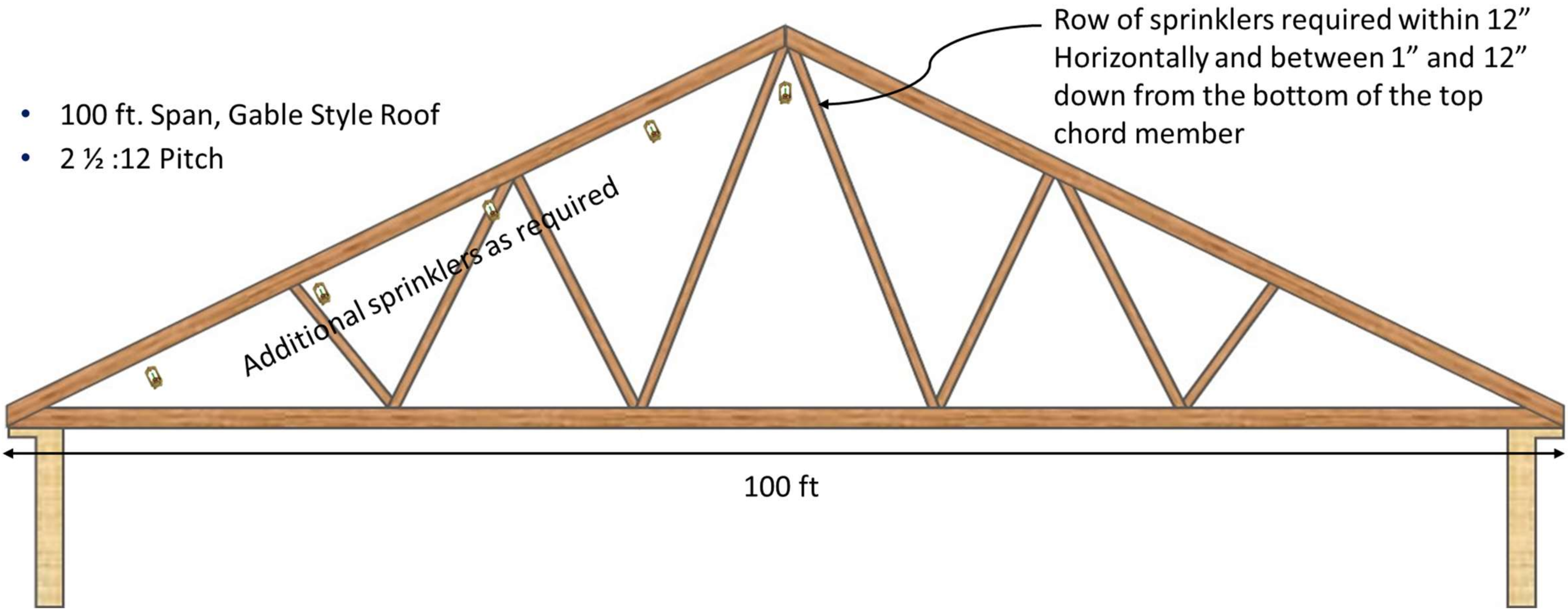


Special Sprinkler

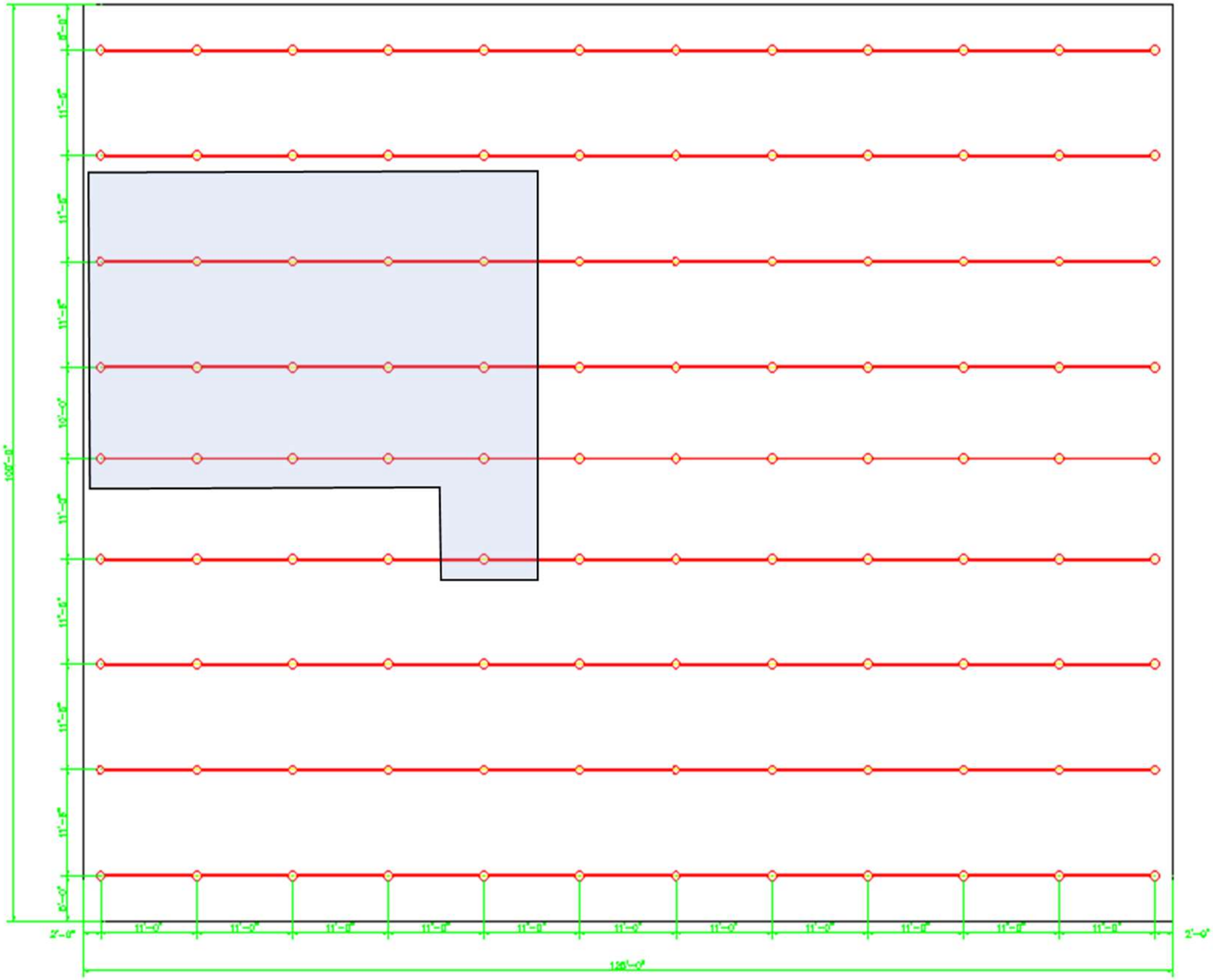


Special Sprinkler

- 100 ft. Span, Gable Style Roof
- 2 ½ :12 Pitch



Special Sprinkler

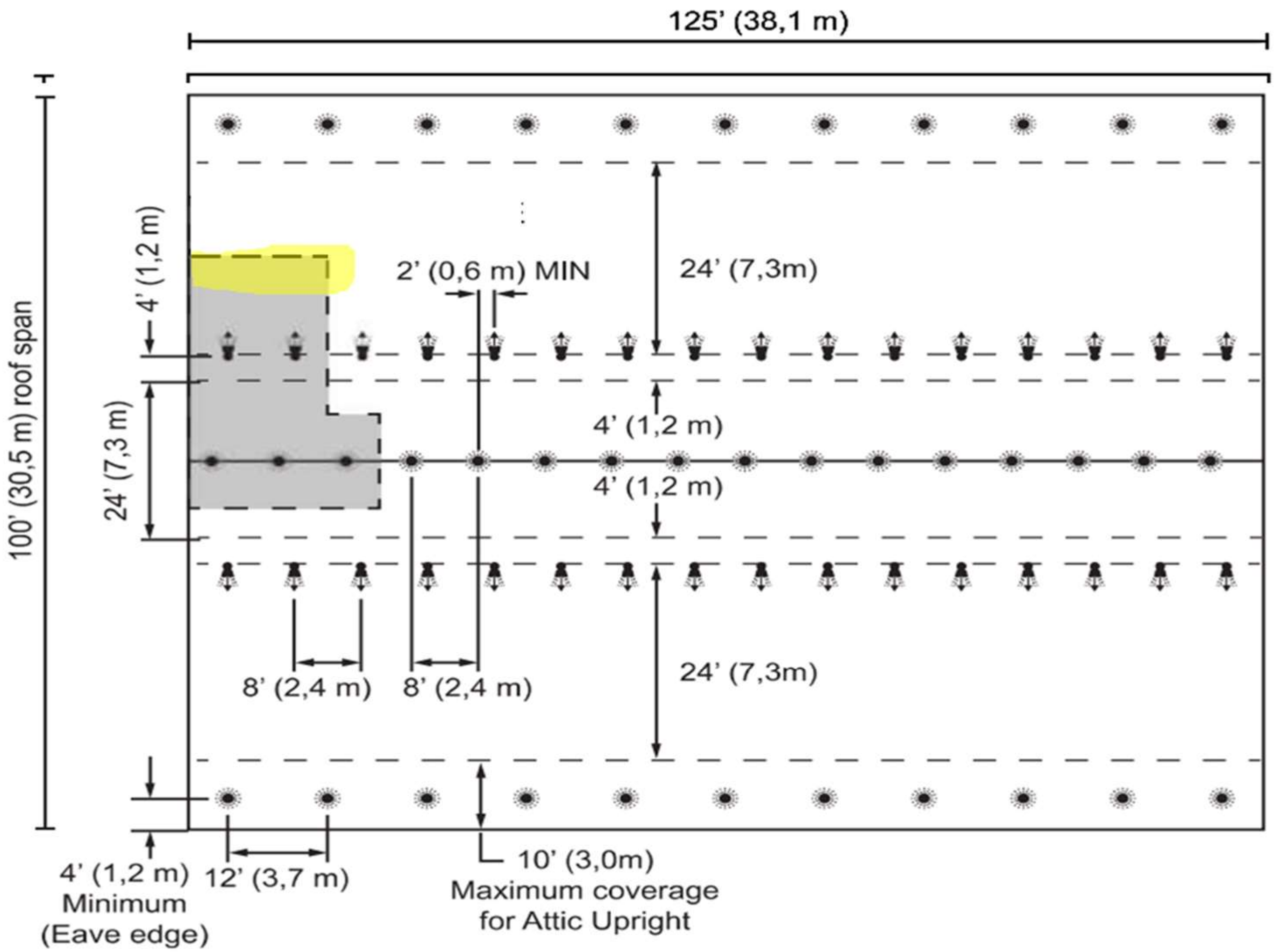


Design area: 1,950 sq. ft.

Design sprinklers: 16 @ 14.8 gpm

Design flow: 237 gpm

Special Sprinkler



Design area: Ridge

Design sprinklers: 5 @ 20 gpm

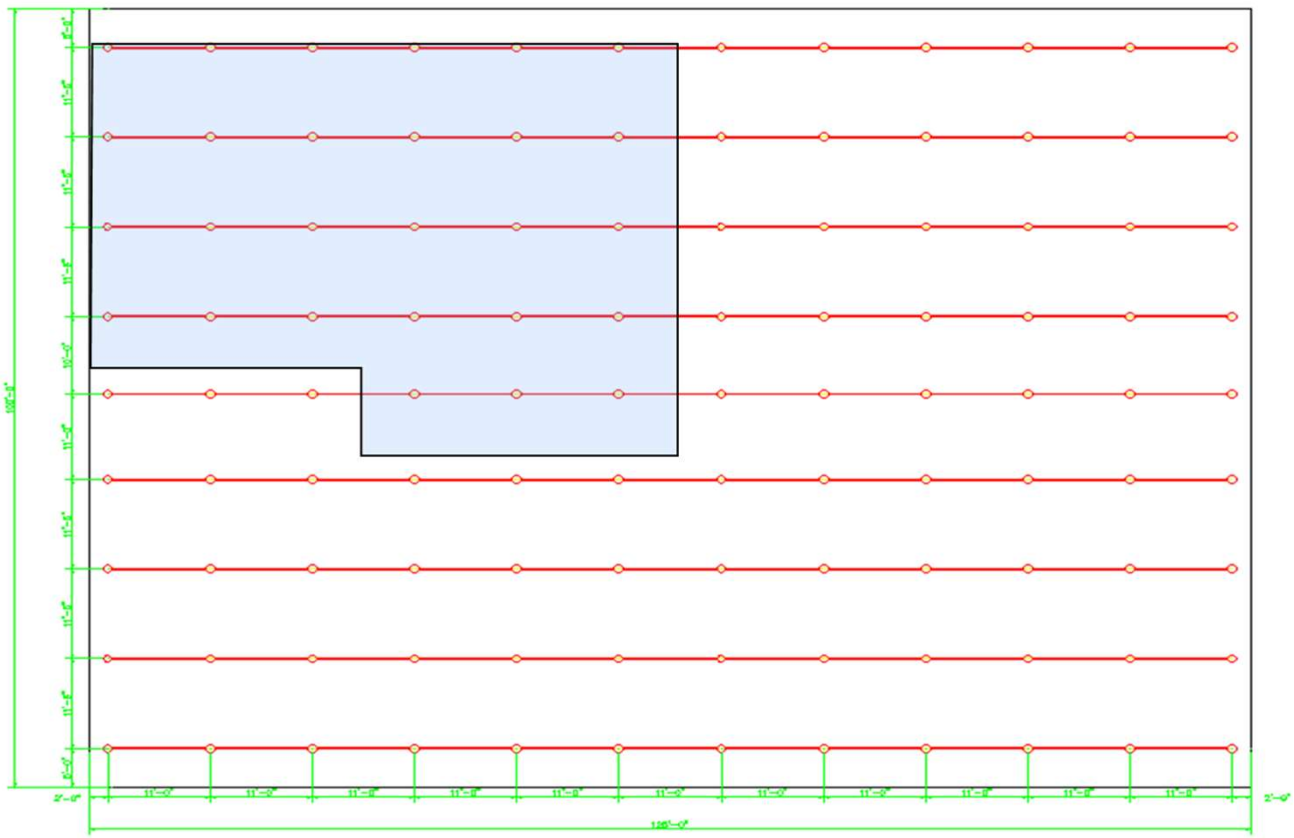
Design flow: 100 gpm

Design area: Ridge & Slope

Design sprinklers: 3 @ 20 gpm
2 @ 23 gpm

Design flow: 106 gpm

Special Sprinkler

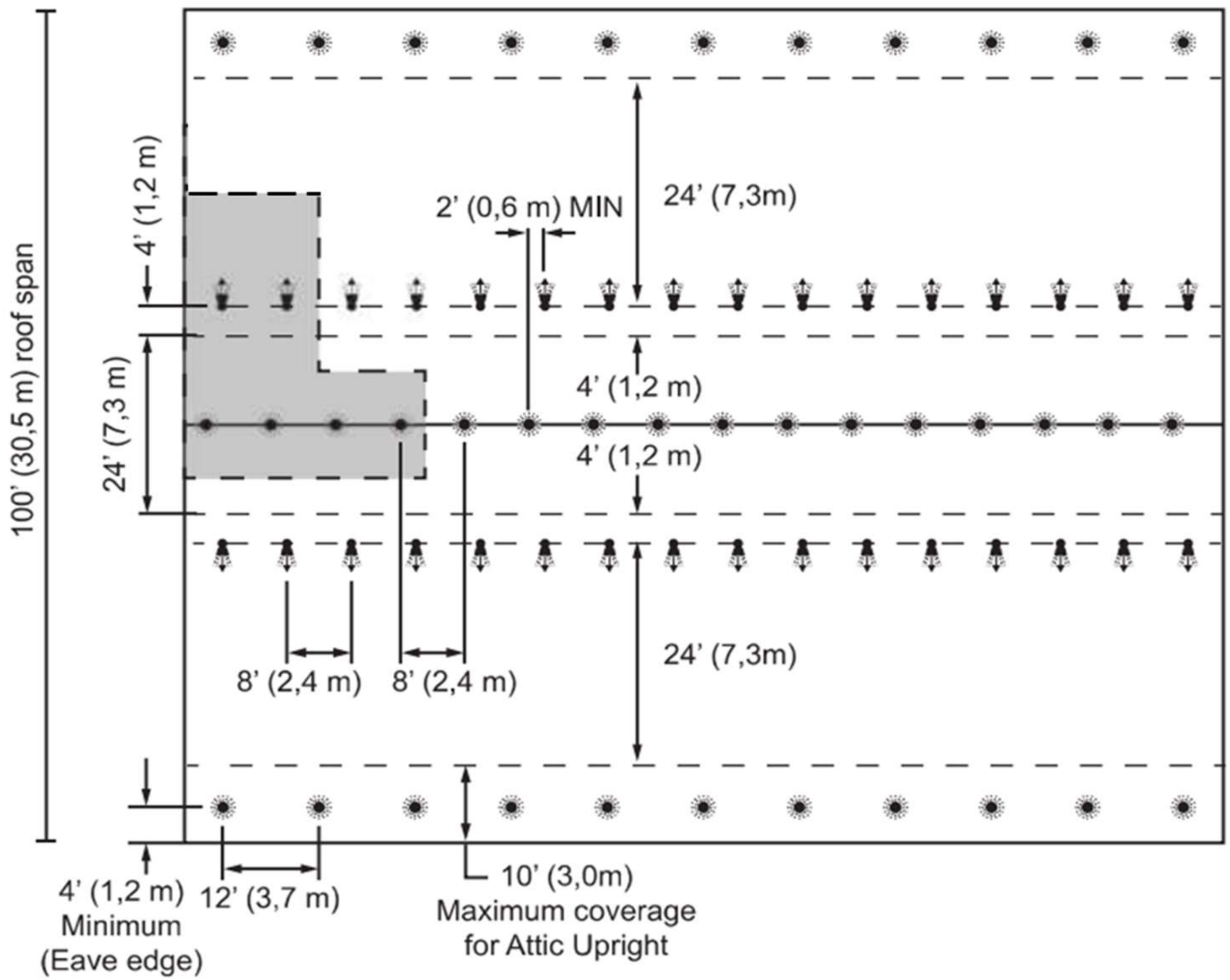


Design area: 2,535 sq. ft.

Design sprinklers: 21 @ 14.8 gpm

Design flow: 311.1 gpm

Special Sprinkler



Design area: Ridge

Design sprinklers: 6 @ 20 gpm

Design flow: 120 gpm

Ridge

Design area: Ridge & Slope

Design sprinklers: 4 @ 20 gpm
2 @ 23 gpm

Design flow: 126 gpm

Special Sprinkler

- **Standard Spray Sprinklers (NFPA 13)**
- Wet System
- Design Area: 1950 sq.ft.
- Sprinklers/Flow per: 16/14.8gpm
- Total Demand: 238gpm

- **Dry System**
- Design Area: 2535 sq.ft.
- Sprinklers/Flow per: 21/14.8gpm
- Total Demand: 311gpm

Attic Sprinklers

Wet System

Design Area: Ridge

Sprinklers/Flow per: 5/20gpm

Total Demand: 100 gpm & 106gpm

Dry System

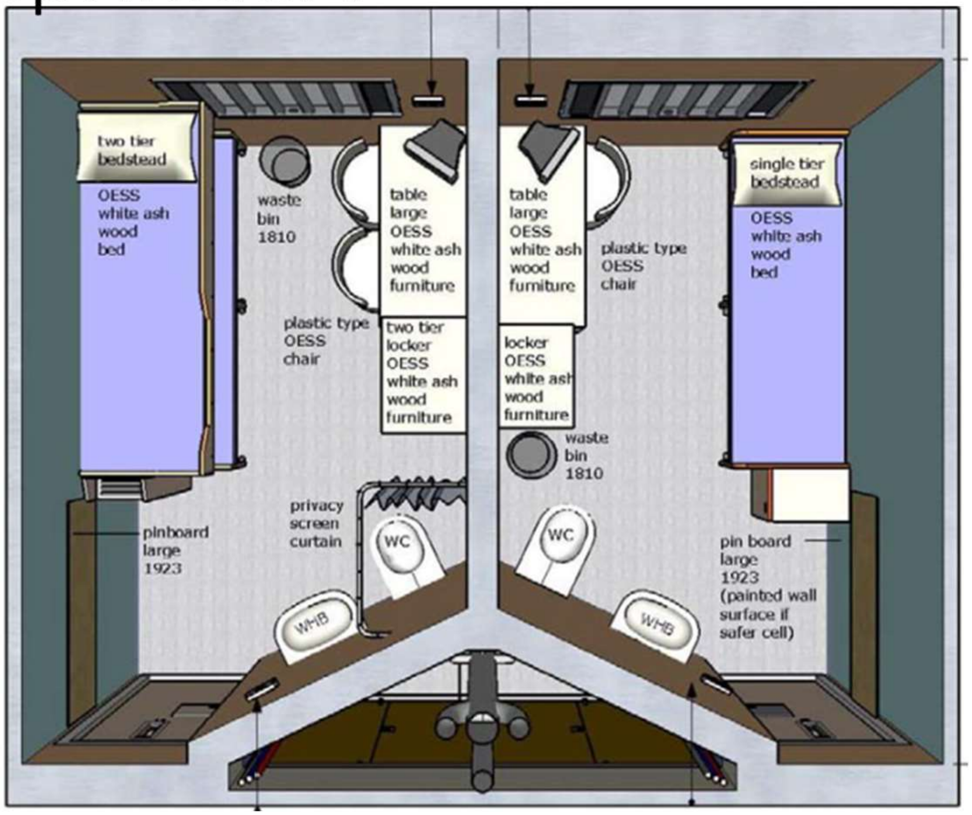
Design Area: Ridge

Sprinklers/Flow per: 6/20gpm

Total Demand: 120 gpm & 126gpm

Special Sprinkler

What is an Institutional Sprinkler?

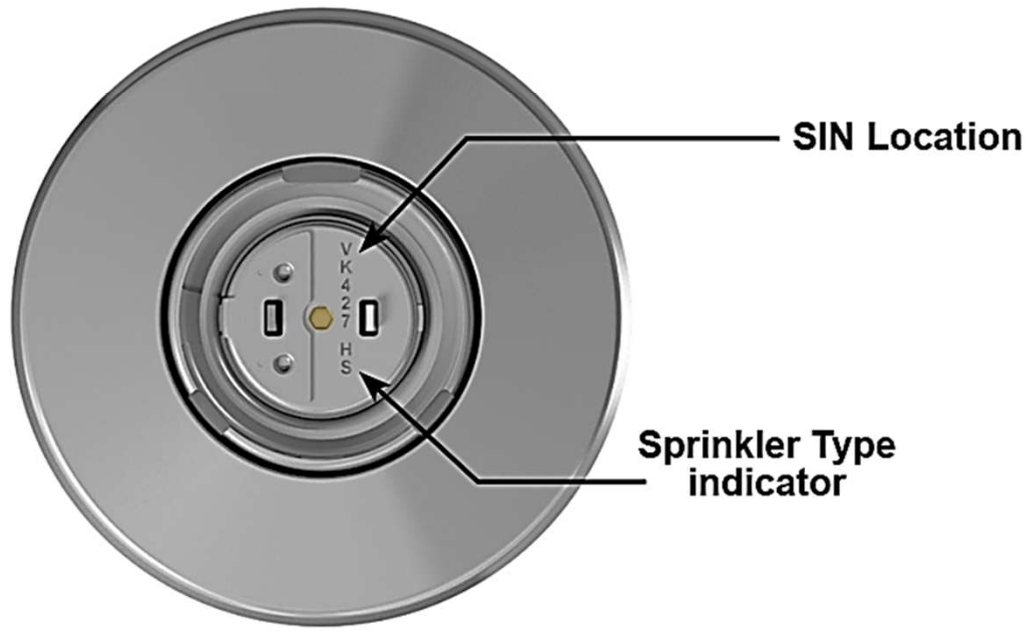


Special Sprinkler

Why Institutional Sprinklers?

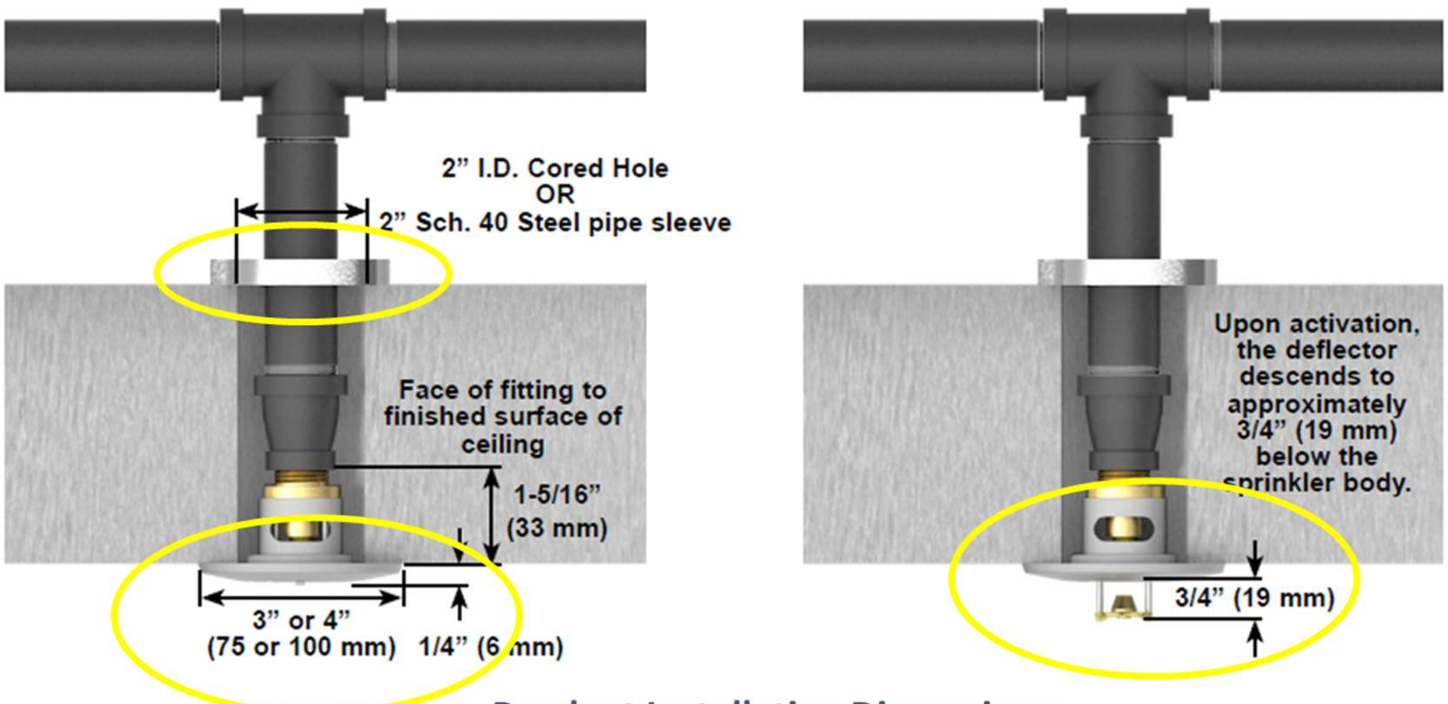
Special Sprinkler

Institutional Sprinklers



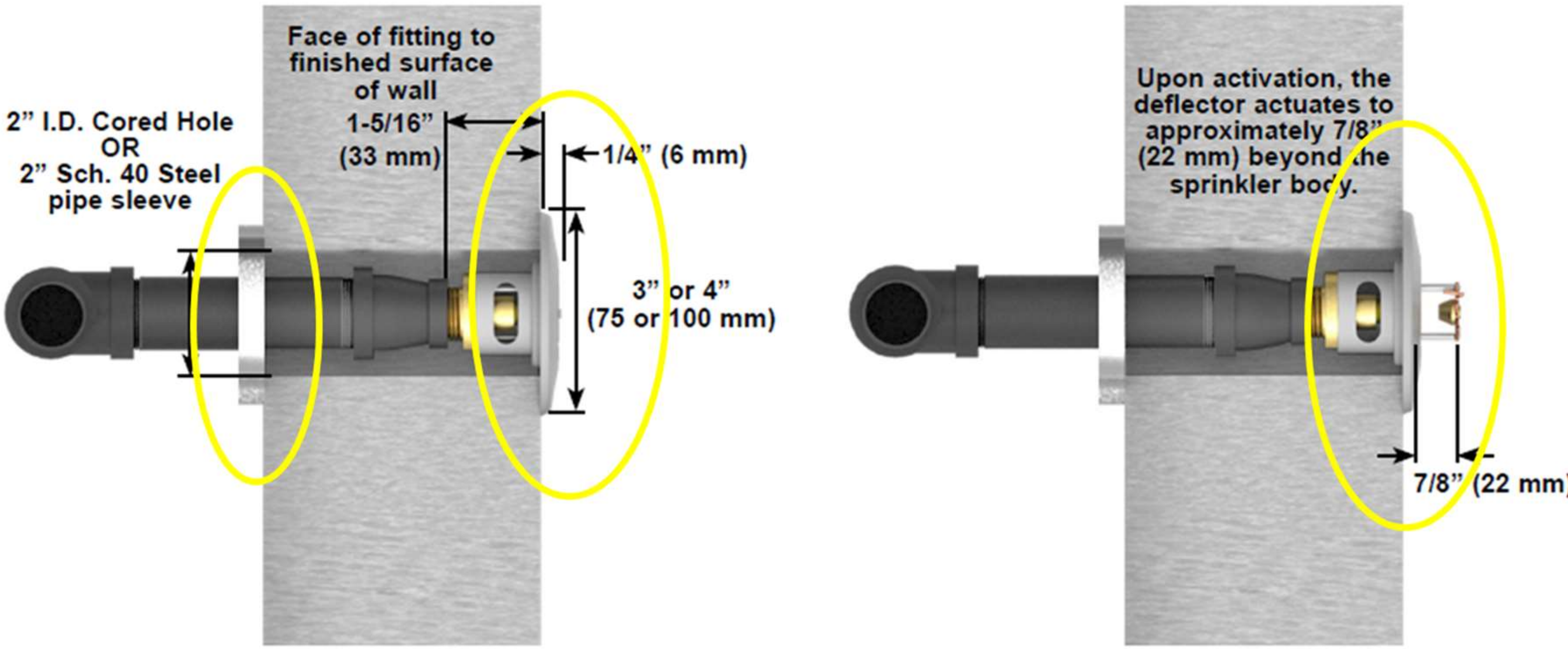
Special Sprinkler

Institutional Sprinklers - Installation



Pendent Installation Dimensions

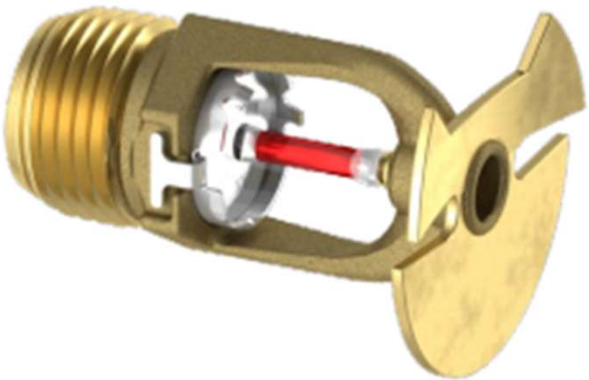
Institutional Sprinklers - Installation

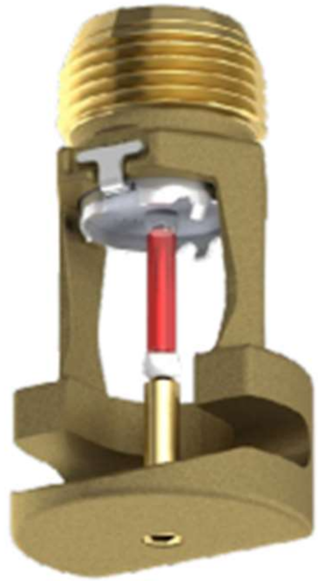


Sidewall Installation Dimensions

Special Sprinkler

Window Sprinklers





Special Sprinkler

Why Window Sprinklers?

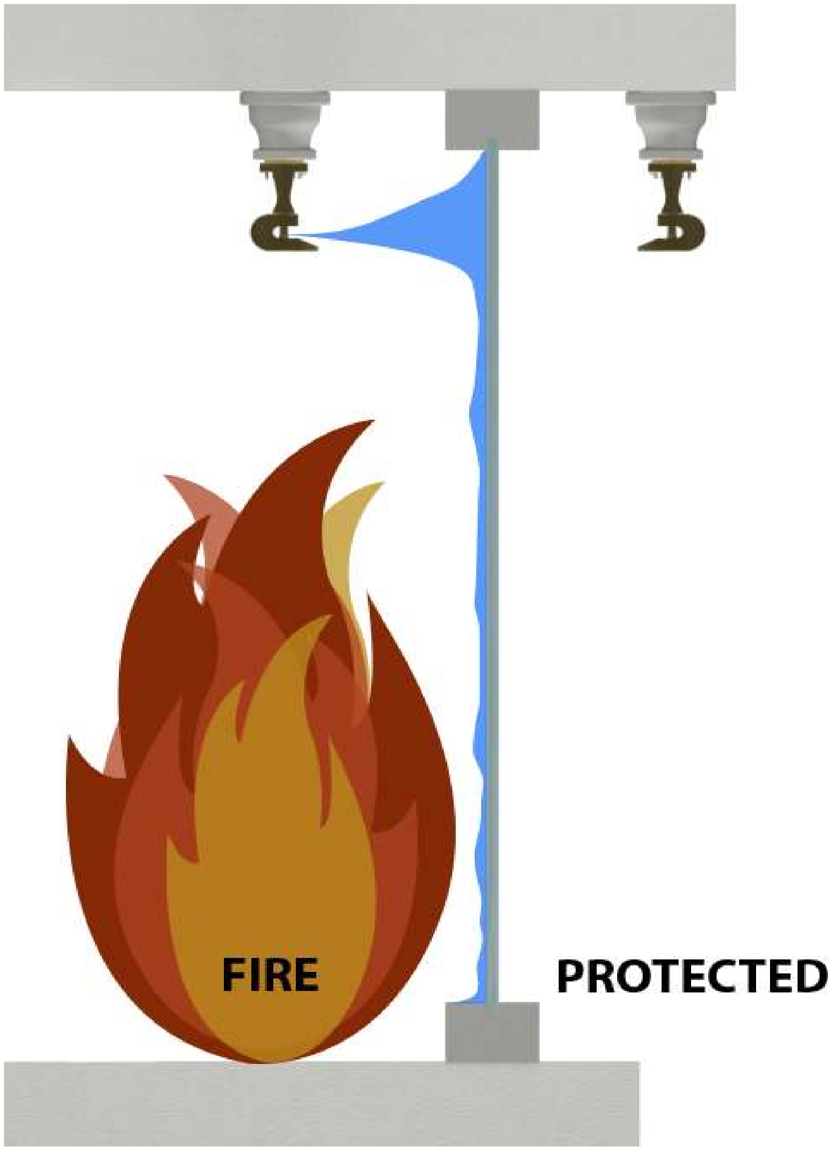
ICC INTERNATIONAL CODE COUNCIL®

NFPA®

Special Sprinkler

Where Window Sprinklers?

Special Sprinkler

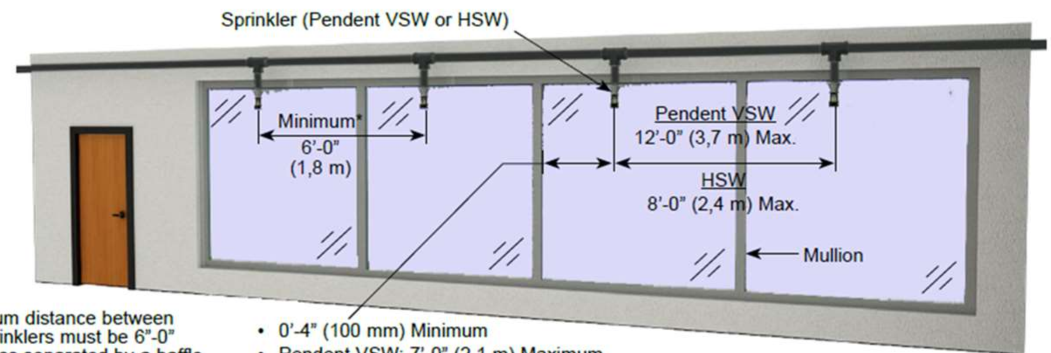


Special Sprinkler

Window and Glass Requirements

- Glass
- Glass size
- Glass frames
- Horizontal mullions
- Operability
- Openings and penetrations

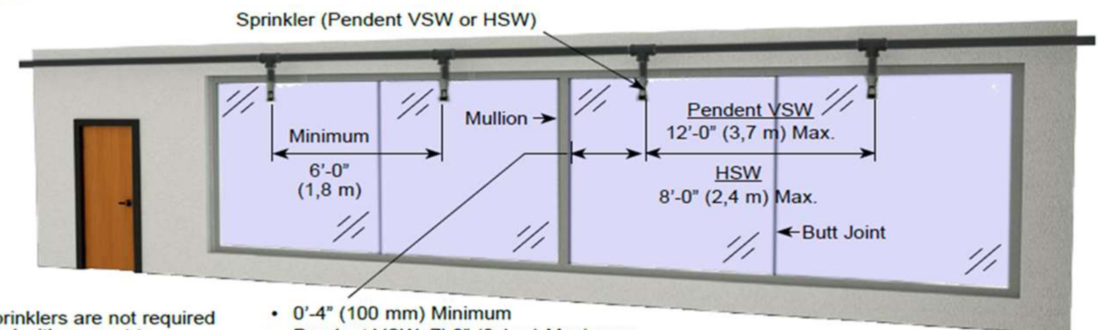
Special Sprinkler



*The minimum distance between Window Sprinklers must be 6"-0" (1,8 m) unless separated by a baffle or mullion of adequate depth to act as a baffle.

- 0'-4" (100 mm) Minimum
- Pendent VSW: 7'-0" (2,1 m) Maximum
- HSW: 5'-0" (1,5 m) Maximum

Figure 4A: Multiple Windows Separated by Mullions



Window Sprinklers are not required to be located with respect to horizontal or vertical butt joints.

- 0'-4" (100 mm) Minimum
- Pendent VSW: 7'-0" (2,1 m) Maximum
- HSW: 5'-0" (1,5 m) Maximum

Figure 4B: Multiple Windows Separated by Butt Joints

Special Sprinkler

Figure 5A: Vertical Sidewall Pendent

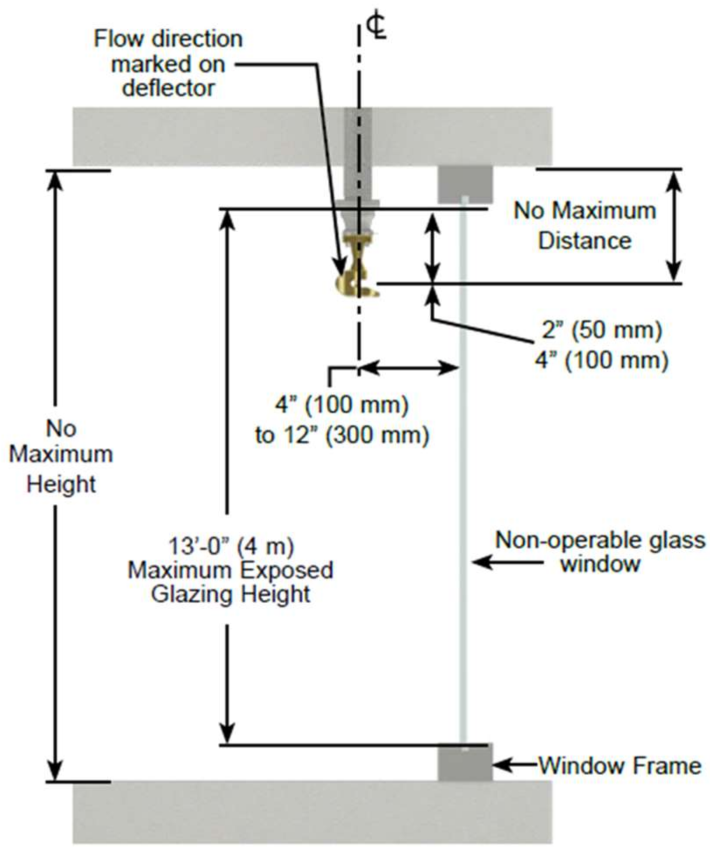
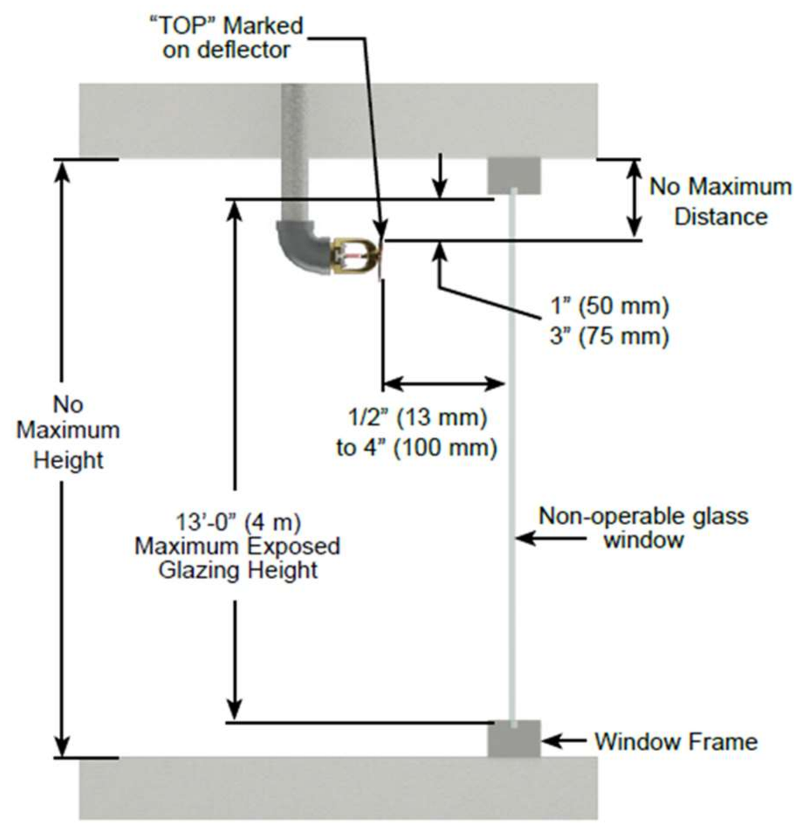


Figure 5B: Horizontal Sidewall



Special Sprinkler

Special Sprinkler

The Big K's

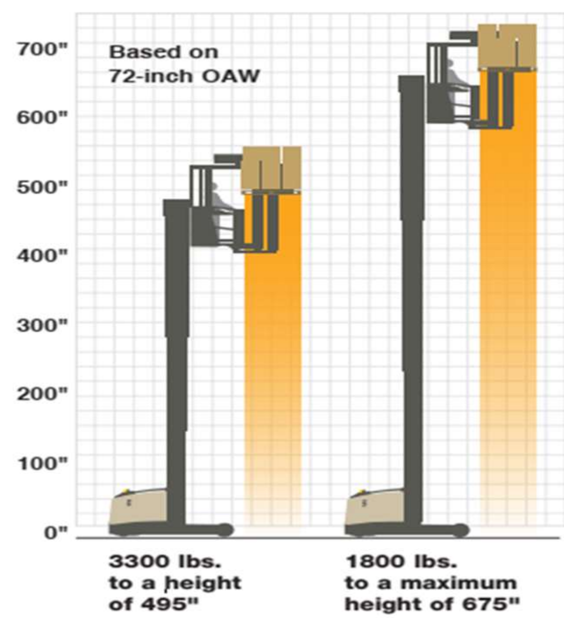
K28.0

K33.6

Special Sprinkler

Special Sprinkler

Special Sprinkler



More Height

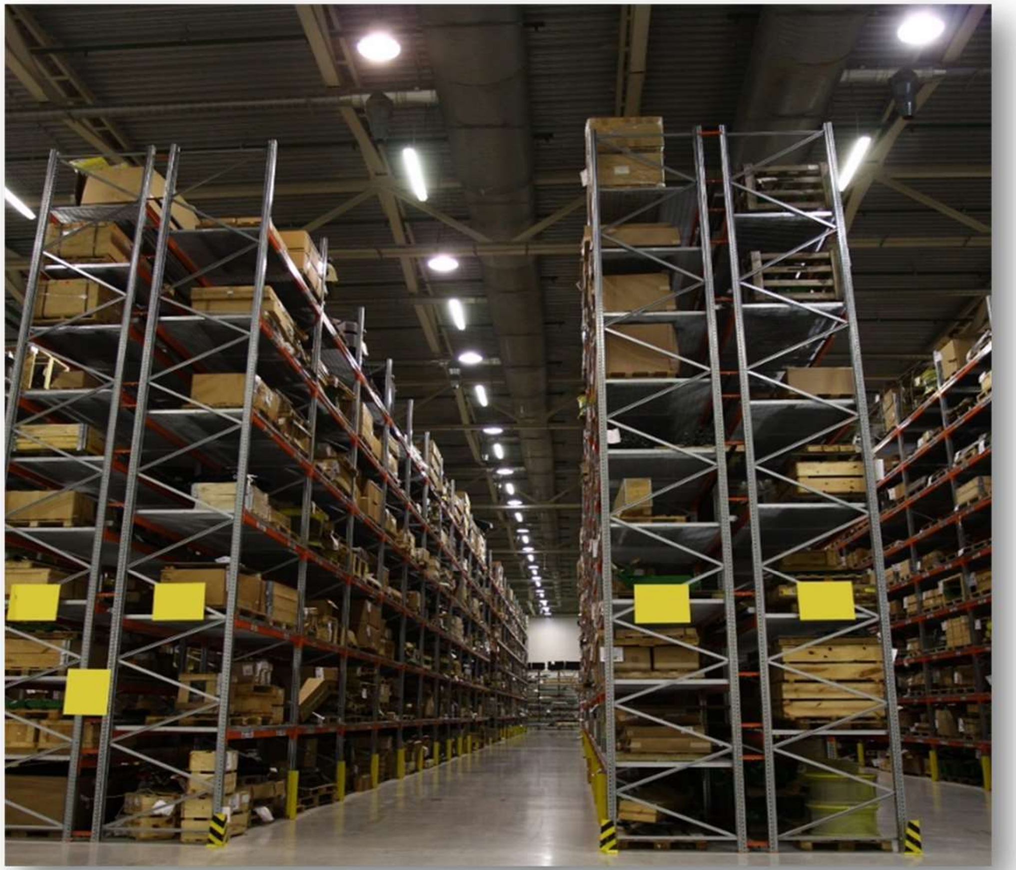
675"

With operators and loads up to 675" or six stories in the air, stability is key. Crown's MonoLift mast does the job so your operators can focus on theirs.

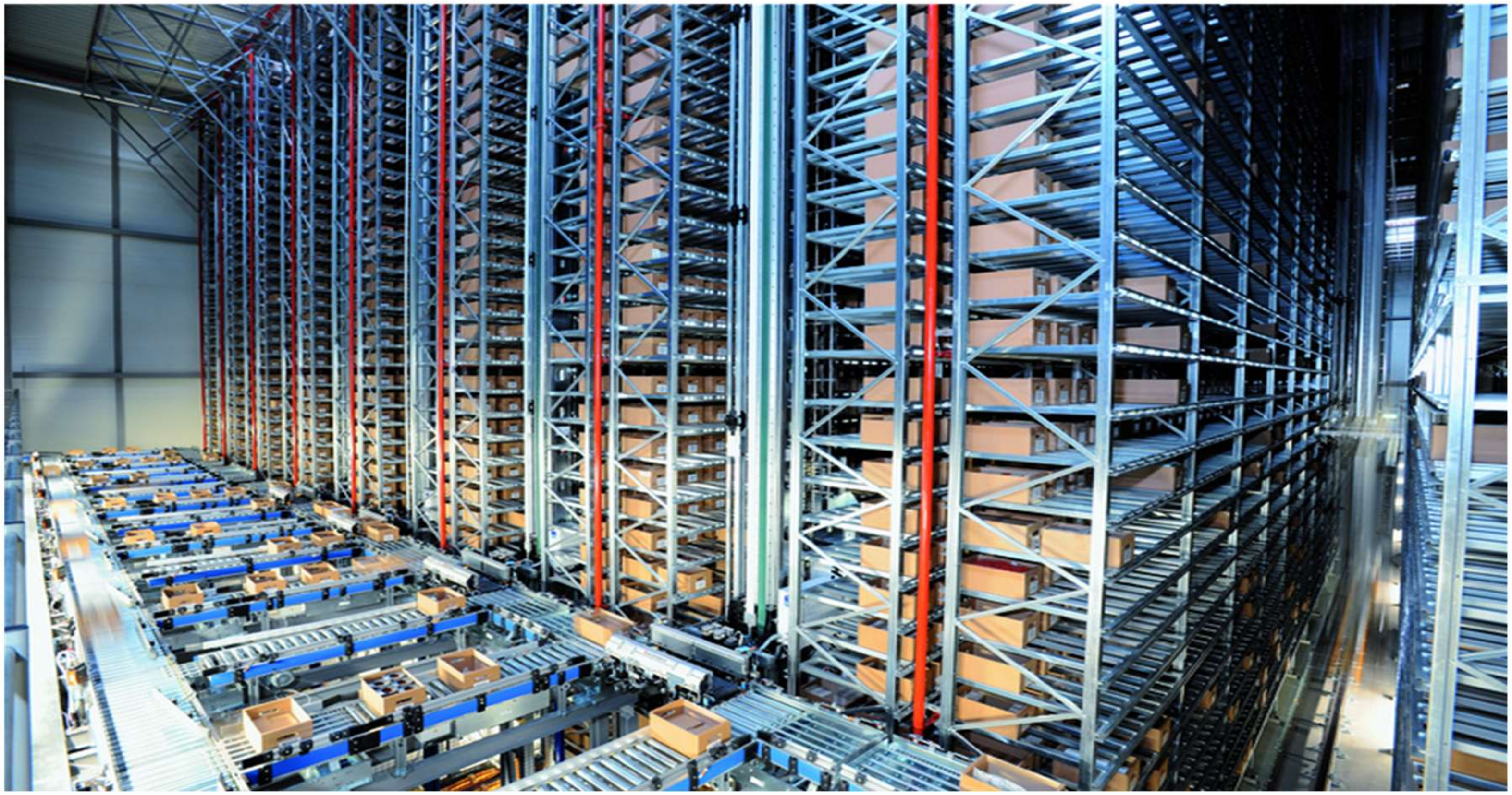
56.25 ft

More Capacity at Height
Lift more weight to greater heights than ever before with the TSP Series. Imagine the throughput gains and flexibility in your warehouse when you have fewer capacity constraints—slotting heavier loads nearly anywhere in your operation.

Special Sprinkler



Special Sprinkler



Special Sprinkler

Special Sprinkler

Special Sprinkler

Special Sprinkler

Special Sprinkler

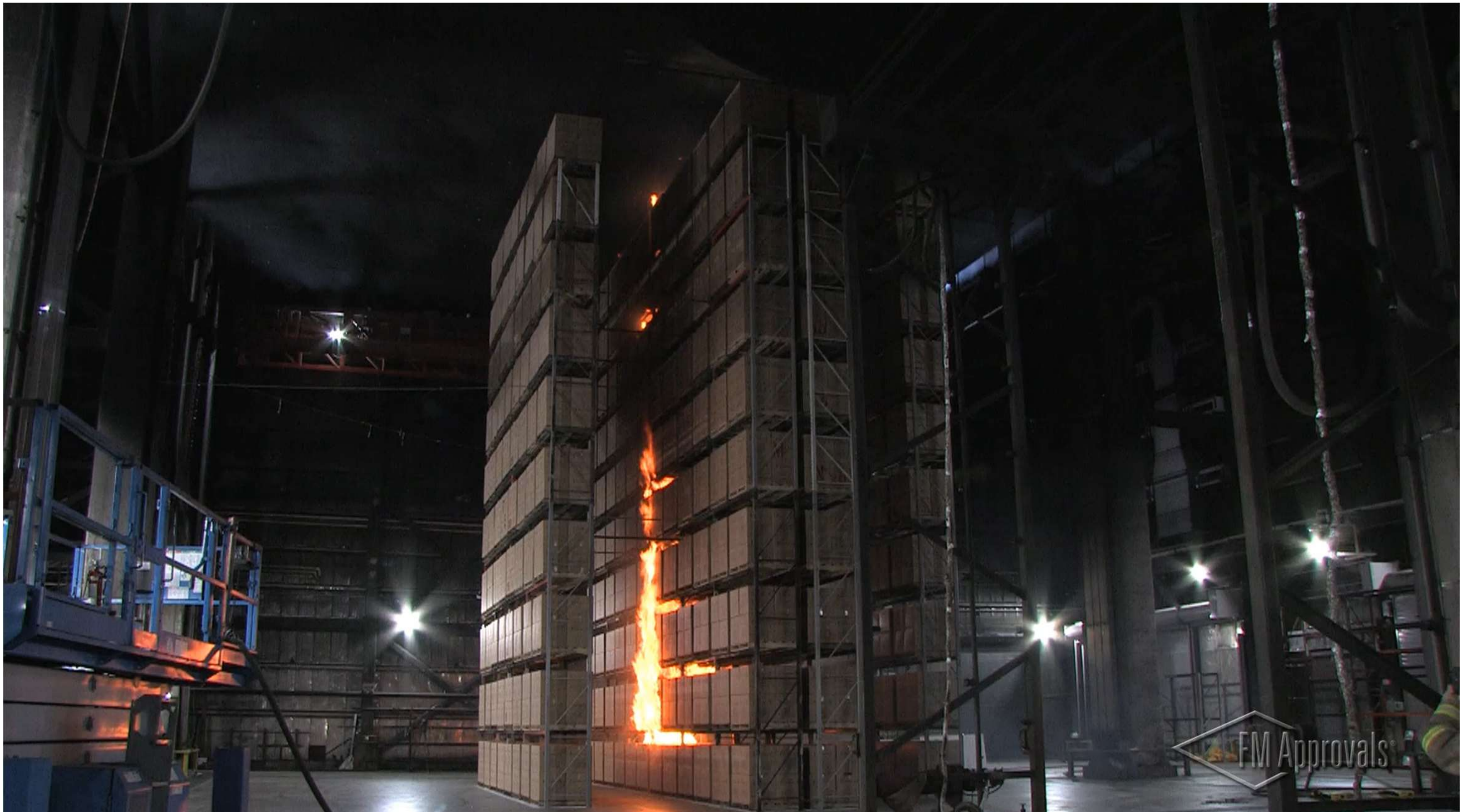
Table 23.6.1 ESFR Protection of Rack Storage of Group A Plastic Commodities

Storage Arrangement	Commodity	Maximum Storage Height ft	Maximum Storage Height m	Maximum Ceiling/ Roof Height ft	Maximum Ceiling/ Roof Height m	Nominal K-Factor	Orientation	Minimum Operating Pressure psi	Minimum Operating Pressure bar
Single-, double-, and multiple-row racks (no open-top containers)	Cartoned nonexpanded	30	9.1	35	11	14 (200)	Upright/pendent	75	5.2
						16.8 (240)	Upright/pendent	52	3.6
						22.4 (320)	Pendent	35	2.4
						25.2 (360)	Pendent	20	1.4
				40	12	16.8 (240)	Pendent	52	3.6
						22.4 (320)	Pendent*	40	2.7
						25.2 (360)	Pendent*	25	1.7
				45	14	14 (200)	Pendent*	NA	NA
						16.8 (240)	Pendent*	NA	NA
						22.4 (320)	Pendent	40	2.7
						25.2 (360)	Pendent	40	2.7
		35	11	40	12	16.8 (240)	Pendent	52	3.6
						25.2 (360)	Pendent	25	1.7
				45	14	14 (200)	Pendent*	NA	NA
						16.8 (240)	Pendent*	NA	NA
						22.4 (320)	Pendent	40	2.7
						25.2 (360)	Pendent	40	2.7
		40	12	45	14	14 (200)	Pendent*	NA	NA
						16.8 (240)	Pendent*	NA	NA
						22.4 (320)	Pendent	40	2.7
						25.2 (360)	Pendent	40	2.7

Special Sprinkler

- 1) Add a level or levels of in-rack sprinklers to maintain your ceiling design with ESFR sprinklers.
- 2) Add a false ceiling or lower the ceiling.
- Neither of these ideas appeal to the builder or the owner.

Special Sprinkler



Special Sprinkler

Table 17b. Quick Response, 160°F (70°C) Nominally Rated, Standard-Coverage pendent Storage Sprinkler
Ceiling Only Designs for Ceiling Heights Over 40ft (12.0m)

Storage Arrancgement	Commodity	Maximum Storage Height ft (m)	Maximum Ceiling Height ft (m)	Ceiling Sprinkler K-Factor	Maximum Vertical Distance from Ceiling to Sprinkler's Thermal Element, in. (mm)	Minimum Aisle Width ft (m)	*Sprinkler System Design* Ceiling Sprinkler System No. of AS @ psi (bar)	*Sprinkler System Design* Hose Demand, gpm (L/min)	*Sprinkler System Design* System Duration min	Ceiling Sprinkler System Demand gpm (L/min)
Solid-Piled, Palletized, Bin-Box, Shelf,and Open-Frame Racks*	Class 1, 2, 3, 4 and Cartoned Unexpanded Plastics	45 (13.7)	50 (15.2	22.4 (320)	13 (325)	6 (1.8)	10@63 (4.3)	250 (950)	60	1778 (6756)
				25.2 (360)	13 (325)	6 (1.8)	10@50 (3.5)			1782 (6772)
					17 (425)	6 (1.8)	10@75 (5.2)			2182 (8260)
				28.0** (400)**	13 (325)	6 (1.8)	10@40 (2.8)			1771 (6704)
				33.6 (480)	17 (425)	6 (1.8)	9@55 (3.8)			2242 (8467)
		50 (15.2)	55 (16.8)	28.0 (400)	13 (325)	8 (2.4)	9@80 (5.5)			2254 (8532)
				33.6 (480)	17 (425)	6 (1.8)	9@55 (3.8)			2242 (8467)

* See the definition of Open-Frame Rack Storage in Appendix A to confirm that any multiple-row racks being protected in accordance with this table meet the requirements to be considered open-frame

** The design of 10 AS @ 40 psi (2.8 bar) can be reduced to 9 AS @ 40 psi (2.8 bar) when the water supply can also provide a minimum pressure of 80 psi (5.5 bar) from the most remote 4 sprinklers (2 sprinklers on 2 lines) — 1594 (6034)

Special Sprinkler

Learning Outcomes

- 1. Explain the advantages of using attic sprinklers over standard spray sprinkler designs
- 2. Discuss the challenges of combustible interstitial space fires and how to provide protection
- 3. Explain the necessity of using institutional sprinklers
- 4. Describe how using window sprinklers allows for architectural freedom in building design.
- 5. Detail the challenges of ever increasing storage heights and the sprinklers that address them.

Thank You

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