Public Comment No. 1895-NFPA 70-2021 [Global Input]

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- ***Article 722 - Taking out specific material related to 725, 760 & 770 and putting it back into the original Articles***
- ***Article 722 - Adding Article726 (Class 4) Redundant Material into Article 722***
- ***Article 722 - Adding Article770 (Optical Fiber) Redundant Material into Article 722***
- ***Article 725 - Moving specific Article 725 material in Article 722 back into Article 725***
- ***Article 726 - Removing redundant material from Article 726 and moving it into Article 722***
- ***Article 760 - Moving specific Article 760 material in Article 722 back into Article 760***
- ***Article 770 - Removing redundant material from Article 770 and moving it into Article 722***

Refer to the six Attachments for the text of these changes

Additional Proposed Changes

File Name	Description	Approved
Article_722_Rework_Substantiation.docx	Copy of the substantiation for this Global Comment	
Article_722_-_Taking_out_specific_material_from_725_760_770_Adding_726_Class_4_Redundant_Material.docx	Text of Article 722 showing the additions and deletions in GREEN text.	
Article_725_-_Material_from_722_Put_Back_into_725_Using_FR_Text_.docx	Text of Article 725 showing the additions and deletions in GREEN text.	
Article_760_-_Material_from_722_Put_Back_into_760_Using_FR_Text_.docx	Text of Article 760 showing additions and deletions in GREEN text.	
Article_770_-_Moving_Redundant_Material_into_722.docx	Text of Article 770 showing additions and deletions in GREEN text.	
Article_726_-_Moving_Redundant_Material_into_722.docx	Text of Article 726 showing additions and deletions in GREEN text.	

Statement of Problem and Substantiation for Public Comment

722 Rework Substantiation
References:
FR 9582
FR 9602
FR 9606
Global PI 3671

This Public Comment was developed by a Panel 3 appointed task group to address a Correlating Committee request to restructure the new Article 722 on power limited cables to remove any material that is specific to Class 2, Class 3, PLFA and optical fiber cables and move this material back into Articles 725, 760 and 770. The Panel 3 task group members included TG Chairman Randy Ivans (Panel 3 Principal, Panel 16 Alternate), Robert Jones (Chairman Panel 3), James Conrad, Don Iverson, Jessica Kiefer and Ron Tellas.
At the same time, the redundancies in Articles 725, 760 and 770 that were originally addressed in FR 9582 also appear in the new Article 726 for Class 4 circuits (FR 9606). This Public Comment also removes these redundancies from Article 726 and incorporates Class 4 cables into Article 722.
These changes significantly improve clarity and usability while removing redundant requirements. It is not the intent of these proposals to introduce any technical changes. Some editorial errors were found during this process and fixed within this Comment
Changes from the First Revisions currently in TerraView are in Green Text.
The TG recognizes that there is still some redundant material relating to “Separation from Electric Light, Power, Class 1, Non–Power-Limited Fire Alarm Circuit, and Medium-Power Network-Powered Broadband Communications Cables” and “Installation of Conductors of Different Circuits in the Same Cable, Enclosure, Cable Tray, Raceway, or Cable Routing Assembly” that is now back in the original articles 725, 726, 760 and 770. Consolidation is difficult due to the different combinations of different circuits in each article. It is expected that the consolidation into 722 of this material will be the subject of future public inputs.
Attached are 6 documents as follows:
- Article 722 Rework Substantiation.docx

This document is the text of this substantiation
- Article 722 - Taking out specific material from 725, 760 & 770; Adding 726 Class 4 Redundant Material.docx

This document is a revision of Article 722 that removes any material that is specific to Class 2, Class 3, PLFA and optical fiber cables. The original Parts II, III and IV are eliminated. Part V is renumbered as Part II. There is some relocation of common material into Part I. This document also adds the redundant material from Article 726 into Article 722. The title of Article 722 is revised to accommodate optical fiber cables and the addition of Class 4 cables. Panel 16 pointed out that “Power Limited Cables” does not adequately describe optical fiber cables. Class 4 circuits are technically not power limited in the way that Class 2, Class3 or PLFA circuits are limited although the energy available into a fault is power limited. Therefore a separate designation in the title is needed.
- Article 725 - Material from 722 Put Back into 725 (Using FR Text).docx

This document is a revision of Article 725 that adds the material from Article 722 back in as directed by the Correlating Committee.
- Article 726 - Moving Redundant Material into 722.docx

This document is a revision of Article 726 that removes redundant material now covered by Article 722. Installation criteria that is unique to Class 4 cables remains in Article 726 as directed by the Correlating Committee. Article 722 combines common cabling requirements found in Articles 725, 726, 760, and 770 into a single article. The proposed revisions also removes the redundancy between the text-based requirements and the tabular requirements by including most of the requirements only in tabular form in Article 722. This has been found to be more user-friendly. Some of the text-based requirements do not lend themselves to being represented in tabular form and remain as text in the new Article 722.

- Article 760 - Material from 722 Put Back into 760 (Using FR Text).docx

This document is a revision of Article 760 that adds the material from Article 722 back in as directed by the Correlating Committee. It was found that a lot of material that was supposed to be removed in the First Revision was not removed. Some of this now remains as part of the restructuring. This revision removes the redundant material that is still in Article 722 as a correction to the FR.
- Article 770 - Moving Redundant Material into 722.docx

Panel 16 rejected the original Global PI 3671 that proposed moving redundant material into the new Cables Article 722. This document is a resubmission of the revision of Article 770 that removes redundant material that is now located in Article 722. Installation criteria that is unique to optical fiber cable remains in Article 770 as directed by the Correlating Committee. Article 722 combines common cabling requirements found in Articles 725, 726, 760, and 770 into a single article. The proposed revisions also removes the redundancy between the text-based requirements and the tabular requirements by including most of the requirements only in tabular form in Article 722. This has been found to be more user-friendly. Some of the text-based requirements do not lend themselves to being represented in tabular form and remain as text in the new Article 722.

Related Item

• FR 9582 • FR 9602 • FR 9606 • PI 3671

Submitter Information Verification

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Submittal Date: Wed Aug 18 14:01:25 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: Panel 3 has reviewed the concerns of the Panel 3 appointed Task Group and the CC and have created second revisions where needed throughout Articles under its purview.

Article 722 –Cables for Power-Limited and Fault-Managed Power (Class 4) Circuits and Optical Fiber

Part I. General

722.1 Scope. This article covers the general requirements for the installation of single- and multiple-conductor cables used in Class 2 and Class 3 power-limited circuits, power-limited fire alarm (PLFA) circuits, fault-managed power (Class 4) circuits and optical fiber installations. ~~Parts I and V of this article provide the general cable requirements for power-limited circuit conductors and cables. Part II covers additional cable requirements specifically for Class 2 and Class 3 circuits. Part III covers additional cable requirements specifically for fire alarm systems. Part IV covers additional cable requirements specifically for optical fiber cables.~~

722.2 Definitions. The definitions in this section shall apply only within this article.

Abandoned Cable. Installed ~~Class 2, Class 3, and PLTC~~ cable that is not terminated at equipment and not identified for future use with a tag.

General-Purpose Cables, Cable Routing Assemblies and Raceways. General-purpose cables, cable routing assemblies and raceways are suitable for general purpose applications and are resistant to the spread of fire.

Cables for Limited Use. Cables that are intended to be used with protection such as a raceway or for specific restricted applications.

Plenum Cable, Cable Routing Assemblies and Raceways. Cables, cable routing assemblies and raceways that have adequate fire-resistant and low smoke-producing characteristics and are suitable for use in ducts, plenums, and other spaces used for environmental air.

Riser Cable, Cable Routing Assemblies and Raceways. Cables, cable routing assemblies and raceways that have fire resistant characteristics capable of preventing the carrying of fire from floor to floor and are suitable for use in a vertical run in a shaft or from floor to floor.

Under Carpet Cable. Cables that are intended to be used under carpeting, floor covering, modular tiles, and planks.

722.3 Other Articles. In addition to the requirements of this article, installation of cables shall comply with the articles or sections listed in 722.3(A) through (O). Only those sections of Article 300 referenced in this article shall apply.

(A) Installation of Cables and Conductors in Raceway. The number and size of conductors and cables, as well as raceway sizing, shall comply with 300.17.

(B) Spread of Fire or Products of Combustion. Installation of power-limited circuits shall comply with 300.21.

(C) Ducts, Plenums, and Other Air-Handling Spaces. Power-limited circuits installed in ducts, plenums, or other space used for environmental air shall comply with 300.22.
Exception No. 1: Cables selected in accordance with Table 722.154 and installed in accordance with 722.135(B) and 300.22(B), Exception shall be permitted to be installed in ducts specifically fabricated for environmental air.
Exception No. 2: Cables selected in accordance with Table 722.154 and installed in accordance with 722.135(C) shall be permitted to be installed in other spaces used for environmental air (plenums).

(D) Cables in Ducts for Dust, Loose Stock, or Vapor Removal. Section 300.22(A) for wiring systems shall apply.
Exception: Nonconductive optical fiber cables shall be permitted in ducts used for dust, loose stock, or vapor Removal.

(E) Cable Trays. Cable tray installations shall comply with Parts I and II of Article 392.

(F) Instrumentation Tray Cable. Circuits wired using instrument tray cable shall comply with ~~341.1, 341.10, 341.12, 341.24, 341.80, 341.100 and 341.120~~ 335.1, 335.10, 335.12, 335.24, 335.80, 335.100 and 335.120.

(G) Raceways or Sleeves Exposed to Different Temperatures. Section 300.7(A) shall apply.

(H) Vertical Support for Fire-Resistive Cables and Conductors. Vertical installations of circuit integrity (CI) cables and conductors installed in a raceway or conductors and cables of electrical circuit protective systems and fire resistive-cable systems shall be installed in accordance with 300.19.

(I) Installation of Cables with Other Systems. Section 300.8. shall apply.

(J) Corrosive, Damp, or Wet Locations. The installation of power-limited cables shall comply with the applicable requirements in sections 110.11, 300.5(B), 300.6, 300.9, and 310.10(F) when installed in corrosive, damp, or wet locations.

(K) Cable Routing Assemblies. Cables installed in cable routing assemblies, shall be selected in accordance with Table 800.154(c), listed in accordance with 800.182, and installed in accordance with 800.110(C)(1), 800.110(C)(2) and 800.113

(L) Communications Raceways. Cables communications raceways shall be selected in accordance with Table 800.154(b), listed in accordance with 800.182, and installed in accordance with 800.113 and 362.24 through 362.56, where the requirements applicable to electrical nonmetallic tubing (ENT) apply.

(M) Temperature Limitation of ~~Class 2 and Class 3~~ Cables. The requirements of 310.14(A)(3) on the temperature limitation of conductors shall apply to power-limited circuit cables.

(N) Identification of Equipment Grounding Conductors. Section 250.119 shall apply.
Exception: Conductors with green insulation shall be permitted to be used as ungrounded signal conductors.

(O) Specific Requirements. As appropriate, the installation of wires and cables shall also comply with the requirements of the following:
(1) Class 2 and Class 3 cables - Article 725
(2) Fire alarm cables – Article 760
(3) Optical fiber cables - Article 770

722.12 Uses Not Permitted.
(A) Hazardous Locations. Cables shall not be installed in any hazardous (classified) location, except as permitted by other articles of this Code.

Informational Note: Hazardous locations are covered in Articles 500 through 516 and in Article 517 Part IV.

(B) Other Applications. Class 4 cables shall not be permitted for any applications that are not part of a Class 4 distribution system.

Exception: Use of CL4 cable for other applications shall be permitted if the cable has ~~multiple listings~~been listed as suitable for the other applications.

722.21 Access to Electrical Equipment Behind Panels Designed to Allow Access. Access to electrical equipment shall not be denied by an accumulation of cables that prevents removal of panels, including suspended ceiling panels.

722.24 Mechanical Execution of Work.
(A) General. Cables 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, hangers, cable ties listed and identified for securement and support, or similar fittings, designed and installed so as not to damage the cable. The installation shall conform to 300.4 and 300.11.
A bushing shall be installed where cables emerge from raceway used for mechanical support or protection in accordance with 300.15(C).
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 300.22(C).

Informational Note No. 1: See NFPA 90A-2018, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, for discrete combustible components installed in accordance with 300.22(C).

Informational Note No. 2: Paint, plaster, cleaners, abrasives, corrosive residues, or other contaminants may result in an undetermined alteration of cable properties.

(B) Support of Cables. Cables shall not be strapped, taped, or attached by any means to the exterior of any conduit or other raceway as a means of support.

Exception 1: Class 2 circuit conductors or cables shall be permitted to be installed as permitted by 300.11(C)(2).
Exception 2: Overhead (aerial) spans of optical fiber cables shall be permitted to be attached to the exterior of a raceway-type mast intended for the attachment and support of such cables.

(C) Circuit Integrity (CI) Cable. Circuit integrity (CI) cable shall be supported at a distance not exceeding 610 mm (24 in.). Cable shall be secured to the noncombustible surface of the building structure. Cable supports and fasteners shall be steel.

722.25 Abandoned Cables. The accessible portion of abandoned cables shall be removed. Where cables are identified for future use with a tag, the tag shall be of sufficient durability to withstand the environment involved.

722.31 Safety-Control Equipment. Where damage to power-limited circuits can result in a failure of safety-control equipment that would introduce a direct fire or life hazard, the power limited circuits shall be installed using Class 1 circuit wiring methods in accordance with 7XX.46. All conductors of such circuits shall be installed in rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, electrical metallic tubing, Type MI cable, or Type MC cable, or be otherwise suitably protected from physical damage.

722.135 Installation of Cables. The Installation of cables shall comply with 722.135 (A)~~, or, 722.135(B) or 722.135(C), and 722.135 (D)~~ through (~~G~~J) as applicable for the installation.

(A) Listing. Cables installed in buildings shall be listed.

(B) Cables in Buildings. The **i**nstallation of cables shall comply with Table 722.135(B).

Table 722.135(B) Installation of Listed Cables in Buildings

Applications		Cable Type [Note 1]					
		Plenum	Riser	General-Purpose	Limited Use	Under Carpet	PLTC
In ducts specifically fabricated for environmental air as described in 300.22(B)[Note 2]	Cables in lengths as short as practicable to perform the required function	Y	N	N	N	N	N
	In metal raceway that complies with 300.22(B)	Y	Y	Y	Y	N	Y
In other spaces used for environmental air (plenums) as described in 300.22(C)	Cables in other spaces used for environmental air	Y	N	N	N	N	N
	Cables In metal raceway that complies with 300.22(C)	Y	Y	Y	Y	N	Y
	Cables in plenum communications raceways	Y	N	N	N	N	N
	Cables in plenum cable routing assemblies	Y	N	N	N	N	N
	Cables supported by open metal cable trays	Y	N	N	N	N	N
	Cables, or cables installed in raceways or cable routing assemblies supported by solid bottom metal cable trays with solid metal covers	Y	Y	Y	Y	N	Y
In risers and vertical runs	Cables in vertical runs penetrating one or more floors and in vertical runs in a shaft	Y	Y	N	N	N	N
	Cables in metal raceways	Y	Y	Y	Y	N	Y
	Cables in fireproof shafts	Y	Y	Y	N	N	Y
	Cables in plenum communications raceways	Y	Y	N	N	N	N
	Cables in plenum cable routing assemblies	Y	Y	N	N	N	N
	Cables in riser communications raceways	Y	Y	N	N	N	N
	Cables in riser cable routing assemblies	Y	Y	N	N	N	N
	Cables in one- and two-family dwellings	Y	Y	Y	Y [Note 3]	N	Y

Table 722.135(B) Installation of Listed Cables in Buildings

Applications		Cable Type Note 1 Plenum	Riser	General-Purpose	Limited Use	Under Carpet	PLTC
Cables and innerducts installed in metal raceways in a riser having firestops at each floor Note 2	Cables	Y	Y	Y	Y	N	Y
	Cables in plenum communications raceways (innerduct)	Y	Y	Y	Y	N	Y
	Cables in riser communications raceways (innerduct)	Y	Y	Y	Y	N	Y
	Cables in general purpose communications raceways (innerduct)	Y	Y	Y	Y	N	Y
In fireproof riser shafts having firestops at each floor Note 2	Cables	Y	Y	Y	N	N	Y
	Cables in plenum communications raceways or plenum cable routing assemblies	Y	Y	Y	N	N	Y
	Cables in riser communications raceways or riser cable routing assemblies	Y	Y	Y	N	N	Y
	Cables in general-purpose communications raceways or general-purpose cable routing assemblies	Y	Y	Y	N	N	Y
In cable trays	Outdoors	N	N	N	N	N	Y
	Cables, or cables in plenum, riser or general-purpose communications raceways, installed indoors	Y	Y	Y	N	N	Y
In cross-connect arrays	Cables, and cables in plenum, riser or general purpose communications raceways or cable routing assemblies	Y	Y	Y	N	N	Y

Table 722.135(B) Installation of Listed Cables in Buildings

Applications		Cable Type Note 1					
		Plenum	Riser	General-Purpose	Limited Use	Under Carpet	PLTC
In one-, two-, and multi-family dwellings, and in building locations other than the locations covered above	Cables	Y	Y	Y	Y Note 3	N	Y
	Cables in plenum, riser or general purpose communications raceways or cable routing assemblies, or, raceways recognized in Chapter 3	Y	Y	Y	Y	N	Y
	Cables in non-concealed spaces	Y	Y	Y	Y Note 4	Y	Y
	Under carpet, floor covering, modular flooring, and planks	N	N	N	N	Y	N

Note 1: "N" indicates that the cable type shall not be permitted to be installed in the application. "Y" indicates that the cable type shall be permitted to be installed in the application, subject to any limitations described in this article or the articles described in 722.3(O).

Note 2: In 300.22(B), cables shall be permitted in ducts specifically fabricated for environmental air only if directly associated with the air distribution system.

Note 3: Limited-use cable shall be permitted to be installed only in one-, two-, and multi-family dwellings and only if the cable is smaller in diameter than 0.25 in or 6.35 mm.

Note 4: The exposed length of cable shall not exceed 10 ft or 3.05 m.

Informational Note 1: For information on fire protection of wiring installed in ducts specifically fabricated for environmental air and other spaces used for environmental air (plenums), see 4.3.4 and 4.3.11.3.3 of NFPA 90ANFPA 90A-2021, *Standard for the Installation of Air-Conditioning and Ventilating Systems*.

Informational Note 2: See 300.21 for firestop requirements for floor penetrations.

Informational Note 3: See Chapter 3 for the installation requirements for PLTC cables installed outdoors in cable trays.

Informational Note 4: One way to determine applicable requirements for plenum, riser and general purpose cable routing assemblies and raceways is to refer to UL2024, *Standard for Safety for Cable Routing Assemblies and Communications Raceways*

(C) Industrial Establishments. In industrial establishments where the conditions of maintenance and supervision ensure that only qualified persons service the installation, Type PLTC cable shall be permitted in accordance with either (1) or (2) as follows:

(1) Where the cable is not subject to physical damage, Type PLTC cable that complies with the crush and impact requirements of Type MC cable and is identified as PLTC-ER for such use shall be permitted to be exposed between the cable tray and the utilization equipment or device. The cable shall be continuously supported and protected against physical damage using mechanical protection such as dedicated struts, angles, or channels. The cable shall be supported and secured at intervals not exceeding 1.8 m (6 ft). Where not subject to physical damage, Type PLTC-ER cable shall be permitted to transition between cable trays and between cable trays and utilization equipment or devices for a distance not to exceed 1.8 m (6 ft) without continuous support. The cable shall be mechanically supported where exiting the cable tray to ensure that the minimum bending radius is not exceeded.

(2) Type PLTC cable, with a metallic sheath or armor in accordance with 725.179(E), shall be permitted to be installed exposed. The cable shall be continuously supported and protected against physical damage using mechanical protection such as dedicated struts, angles, or channels. The cable shall be secured at intervals not exceeding 1.8 m (6 ft).

(D) In Hoistways. In hoistways, cables shall be installed in rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit, liquidtight flexible nonmetallic conduit, or electrical metallic tubing. For elevators or similar equipment, these conductors shall be permitted to be installed as provided in 620.21.

(E) Cable Substitutions. The substitutions for cables listed in Table 722.135(E)) shall be permitted. Where substitute cables are installed, the installation requirements of the articles described in 722.3(O) shall also apply. CI cables shall be permitted to be installed to provide 2-hour circuit integrity. See 722.154(B).

Informational Note: For information on Types CMP, CMR, CM, and CMX, see 805.179.

Table 722.135(E) Cable Substitutions

Cable Type	Permitted Substitutions
CL3P	CMP
CL2P	CMP, CL3P
CL3R	CMP, CL3P, CMR

Table 722.135(E) Cable Substitutions

Cable Type	Permitted Substitutions
CL2R	CMP, CL3P, CL2P, CMR, CL3R
PLTC	None
CL3	CMP, CL3P, CMR, CL3R, CMG, CM, PLTC
CL2	CMP, CL3P, CL2P, CMR, CL3R, CL2R, CMG, CM, PLTC, CL3
CL3X	CMP, CL3P, CMR, CL3R, CMG, CM, PLTC, CL3, CMX
CL2X	CMP, CL3P, CL2P, CMR, CL3R, CL2R, CMG, CM, PLTC, CL3, CL2, CMX, CL3X
FPLP	CMP
FPLR	CMP, FPLP, CMR
FPL	CMP, FPLP, CMR, FPLR, CMG, CM
OFNP	None
OFCP	OFNP
OFNR	OFNP
OFCR	OFNP, OFCP, OFNR
OFNG, OFN	OFNP, OFNR
OFCG, OFC	OFNP, OFCP, OFNR, OFCR, OFNG, OFN
CMUC	None

(F) Circuit Integrity (CI) Cable, Fire-Resistive Cable System or Electrical Circuit Protective System. Circuit integrity (CI) cable, a fire resistive cable system or a listed electrical circuit protective system shall be permitted for use in systems that supply critical circuits to ensure survivability for continued circuit operation for a specified time under fire conditions.

(G) Thermocouple Circuits. Conductors in Type PLTC cables used for Class 2 thermocouple circuits shall be permitted to be any of the materials used for thermocouple extension wire.

(H) Bundling of 4-Pair Cables Transmitting Power and Data. 725.144 shall apply to 4-pair cables that are used to transmit power and data to a powered device.

(I) Installation of Circuit Conductors Extending Beyond One Building. ~~Where Class 2 or Class 3~~ Circuit conductors that extend beyond one building and are run so as to be subject to accidental contact with electric light or power conductors operating over 300 volts to ground, or are exposed to lightning on interbuilding circuits on the same premises, ~~the requirements of the following~~ shall ~~also apply:~~ comply with the following:

(1) Sections 800.44, 800.53, 800.100, 805.50, 805.93, 805.170(A), and 805.170(B) for other than coaxial conductors

(2) Sections 820.44, 820.93, and 820.100 for coaxial conductors

(3) ~~Fire Alarm Circuits Extending Beyond One Building. Non- power-limited fire alarm circuits and power-limited fire alarm circuits that extend beyond one building and run outdoors shall meet the installation requirements of Parts II, III, and IV of Article 805 and shall meet~~ The installation requirements of Part I of Article 300.

(J) Raceway Fill for Optical Fiber Cables. Raceway fill for optical fiber cables shall comply with either 722.135(J)(1) or (2).

(1) Without Electric Light or Power Conductors. Where optical fiber cables are installed in raceway without electric light or power conductors, the raceway fill requirements of Chapters 3 and 9 shall not apply.

(2) Nonconductive Optical Fiber Cables with Electric Light or Power Conductors. Where nonconductive optical fiber cables are installed with electric light or power conductors in a raceway, the raceway fill requirements of Chapters 3 and 9 shall apply.

~~**Part II. Class 2 and Class 3 Cables**~~

~~722.140 Wiring Methods and Materials on Load Side of the Class 2 or Class 3 Power Source.~~ **~~Class 2 and Class 3 circuits on the load side of the power source shall be permitted to be installed using wiring methods and materials in accordance with 722.140(A), (B), or a combination of (A) and (B).~~**

~~(A) Class 1 Wiring Methods and Materials.~~ ~~It shall be permitted to use Class 1 wiring methods for Class 2 and Class 3 circuits. Separation from Electric Light, Power, Class 1, Non–Power-Limited Fire Alarm Circuit Conductors, and Medium-Power Network-Powered Broadband Communications Cables shall comply with 722.141.~~

~~Exception No. 1: The ampacity adjustment factors given in 310.15(C)(1) shall not apply.~~

~~(B) Class 2 and Class 3 Wiring Methods and Materials.~~ ~~Cables on the load side of the power source shall be insulated in accordance with 722.179 and shall be installed in accordance with 722.135.~~

~~Exception No. 1: As provided for in 620.21 for elevators and similar equipment.~~

~~Exception No. 2: Other wiring methods and materials installed in accordance with 722.3 shall be permitted to extend or replace the conductors and cables described in 722.179 and permitted by 722.140(B).~~

~~Exception No. 3: Bare Class 2 conductors shall be permitted as part of a listed intrusion protection system where installed in accordance with the listing instructions for the system.~~

~~722.141 Separation from Electric Light, Power, Class 1, Non–Power-Limited Fire Alarm Circuit Conductors, and Medium-Power Network-Powered Broadband Communications Cables.~~

~~(A) General.~~ ~~Cables and conductors of Class 2 and Class 3 circuits shall not be placed in any cable, cable tray, compartment, enclosure, manhole, outlet box, device box, raceway, or similar fitting with conductors of electric light, power, Class 1, non–power-limited fire alarm circuits, and medium-power network-powered broadband communications circuits unless permitted by 722.141(B) through (H).~~

~~**(B) Separated by Barriers.** Class 2 and Class 3 circuits shall be permitted to be installed together with the conductors of electric light, power, Class 1, non- power-limited fire alarm and medium power network-powered broadband communications circuits where they are separated by a barrier.~~

~~**(C) Raceways Within Enclosures.** In enclosures, Class 2 and Class 3 circuits shall be permitted to be installed in a raceway to separate them from Class 1, non- power-limited fire alarm and medium-power network-powered broadband communications circuits.~~

~~**(D) Associated Systems Within Enclosures.** Class 2 and Class 3 circuit conductors in compartments, enclosures, device boxes, outlet boxes, or similar fittings shall be permitted to be installed with electric light, power, Class 1, non- power-limited fire alarm, and medium-power network-powered broadband communications circuits where they are introduced solely to connect the equipment connected to Class 2 and Class 3 circuits, and where (1) or (2) applies:~~

~~(1) The electric light, power, Class 1, non- power-limited fire alarm, and medium-power network-powered broadband communications circuit conductors are routed to maintain a minimum of 6 mm (0.25 in.) separation from the conductors and cables of Class 2 and Class 3 circuits.~~

~~(2) The circuit conductors operate at 150 volts or less to ground and also comply with one of the following:~~

~~(a) The Class 2 and Class 3 circuits are installed using Type CL3, CL3R, or CL3P or permitted substitute cables, provided these Class 3 cable conductors extending beyond the jacket are separated by a minimum of 6 mm (0.25 in.) or by a nonconductive sleeve or nonconductive barrier from all other conductors.~~

~~(b) The Class 2 and Class 3 circuit conductors are installed as a Class 1 circuit in accordance with 725.41.~~

~~**(E) Enclosures with Single Opening.** Class 2 and Class 3 circuit conductors entering compartments, enclosures, device boxes, outlet boxes, or similar fittings shall be permitted to be installed with Class 1, non- power-limited fire alarm and medium-power network-powered broadband communications circuits where they are introduced solely to connect the equipment connected to Class 2 and Class 3 circuits. Where Class 2 and Class 3 circuit conductors must enter an enclosure that is provided with a single opening, they shall be permitted to enter through a single fitting (such as a tee), provided the conductors are separated from the conductors of the other circuits by a continuous and firmly fixed nonconductor, such as flexible tubing.~~

~~**(F) Manholes.** Underground Class 2 and Class 3 circuit conductors in a manhole shall be permitted to be installed with Class 1, non-power-limited fire alarm and medium-power network-powered broadband communications circuits where one of the following conditions is met:~~

~~(1) The electric light, power, Class 1, non-power-limited fire alarm and medium-power network-powered broadband communications circuit conductors are in a metal-enclosed cable or Type UF cable.~~

~~(2) The Class 2 and Class 3 circuit conductors are permanently and effectively separated from the conductors of other circuits by a continuous and firmly fixed nonconductor, such as flexible tubing, in addition to the insulation or covering on the wire.~~

~~(3) The Class 2 and Class 3 circuit conductors are permanently and effectively separated from conductors of the other circuits and securely fastened to racks, insulators, or other approved supports.~~

~~**(G) Cable Trays.** Class 2 and Class 3 circuit conductors shall be permitted to be installed in cable trays, where the conductors of the electric light, Class 1, and non-power-limited fire alarm circuits are separated by a solid fixed barrier of a material compatible with the cable tray or where the Class 2 or Class 3 circuits are installed in Type MC cable.~~

~~**(H) Where Protected.** Class 2 and Class 3 circuits shall be permitted to be installed together with the conductors of electric light, power, Class 1, non-power-limited fire alarm and medium power network-powered broadband communications circuits where they are installed using Class 1 wiring methods in accordance with 725.46 and where they are protected by an approved raceway.~~

~~**(I) Other Applications.** For other applications, conductors of Class 2 and Class 3 circuits shall be separated by at least 50 mm (2 in.) from conductors of any electric light, power, Class 1 non-power-limited fire alarm or medium power network-powered broadband communications circuits unless one of the following conditions is met:~~

~~(1) Either all of the electric light, power, Class 1, non-power-limited fire alarm and medium-power network-powered broadband communications circuit conductors or all of the Class 2 and Class 3 circuit conductors are in a raceway or in metal-sheathed, metal-clad, non-metallic-sheathed, Type TC, or Type UF cables~~

~~(2) All of the electric light, power, Class 1 non-power-limited fire alarm, and medium-power network-powered broadband communications circuit conductors are permanently separated from all of the Class 2 and Class 3 circuit conductors by a continuous and firmly fixed nonconductor, such as porcelain tubes or flexible tubing, in addition to the insulation on the conductors~~

~~722.142 Installation of Conductors of Different Circuits in the Same Cable, Enclosure, Cable Tray, Raceway, or Cable Routing Assembly.~~

~~(A) Two or More Class 2 Circuits.~~ ~~Conductors of two or more Class 2 circuits shall be permitted within the same cable, enclosure, raceway, or cable routing assembly.~~

~~(B) Two or More Class 3 Circuits.~~ ~~Conductors of two or more Class 3 circuits shall be permitted within the same cable, enclosure, raceway, or cable routing assembly.~~

~~(C) Class 2 Circuits with Class 3 Circuits.~~ ~~Conductors of one or more Class 2 circuits shall be permitted within the same cable, enclosure, raceway, or cable routing assembly with conductors of Class 3 circuits, provided that the insulation of the Class 2 circuit conductors in the cable, enclosure, raceway, or cable routing assembly is at least that required for Class 3 circuits.~~

~~(D) Class 2 and Class 3 Circuits with Communications Circuits.~~

~~(1) Communications Cables.~~ ~~Conductors of one or more Class 2 or Class 3 circuits shall be permitted in the same cable with conductors of communications circuits provided the cable is a listed communications cable that shall be installed in accordance with the requirements of Part V of Article 805. The cables shall be listed as communications cables.~~

~~(2) Composite Cables.~~ ~~Cables constructed of individually listed Class 2, Class 3, and communications cables under a common jacket shall be permitted to be classified as communications cables. The fire resistance rating of the composite cable shall be determined by the performance of the composite cable.~~

~~(E) Class 2 or Class 3 Cables with Other Circuit Cables.~~ ~~Jacketed cables of Class 2 or Class 3 circuits shall be permitted in the same enclosure, cable tray, raceway, or cable routing assembly with jacketed cables of any of the following:~~

~~(1) Power-limited fire alarm systems in compliance with Parts I and III of Article 760~~

~~(2) Nonconductive and conductive optical fiber cables in compliance with Parts I and IV of Article 770~~

~~(3) Communications circuits in compliance with Parts I and IV of Article 805~~

~~(4) Community antenna television and radio distribution systems in compliance with Parts I and IV of Article 820~~

~~(5) Low-power, network-powered broadband communications in compliance with Parts I and IV of Article 830~~

~~**(F) Class 2 or Class 3 Conductors or Cables and Audio System Circuits.** Audio system circuits described in 640.9(C), and installed using Class 2 or Class 3 wiring methods in compliance with 725.133 and 725.154, shall not be permitted to be installed in the same cable, raceway, or cable routing assembly with Class 2 or Class 3 conductors or cables.~~

~~**722.143 Class 2 and Class 3 Cable Voltage and Temperature Ratings.** Class 2 cables shall have a voltage rating of not less than 150 volts. Class 3 cables shall have a voltage rating of not less than 300 volts. Class 2 and Class 3 cables shall have a temperature rating of not less than 60°C (140°F).~~

Commented [IR1]: Relocated to 722.179

~~**722.144 Bundling of 4-Pair Cables Transmitting Power and Data.** 725.144 shall apply to 4-pair cables that are used to transmit power and data to a powered device.~~

Commented [IR2]: Relocated to 722.135(H)

~~**722.145 Installation of Circuit Conductors Extending Beyond One Building.** Where Class 2 or Class 3 circuit conductors extend beyond one building and are run so as to be subject to accidental contact with electric light or power conductors operating over 300 volts to ground, or are exposed to lightning on interbuilding circuits on the same premises, the requirements of the following shall also apply:~~

Commented [IR3]: Relocated to 722.135(I)

~~(1) Sections 800.44, 800.53, 800.100, 805.50, 805.93, 805.170(A), and 805.170(B) for other than coaxial conductors~~

~~(2) Sections 820.44, 820.93, and 820.100 for coaxial conductors~~

~~Part III. PLFA Cables~~

~~**722.150 Wiring Methods and Materials on Load Side of the PLFA Power Source.** Fire alarm circuits on the load side of the power source shall be permitted to be installed using wiring methods and materials in accordance with 722.150(A), (B), or a combination of (A) and (B).~~

~~**(A) NPLFA Wiring Methods and Materials.** It shall be permitted to use NPLFA wiring methods in accordance with 760.46, 760.49, or 760.53 for PLFA circuits. Conductors shall be solid or stranded copper. Separation from electric light, power, Class 1, non-power-limited fire alarm circuit conductors and medium-power network-powered broadband communications cables shall comply with 760.136.~~

~~*Exception: The ampacity adjustment factors given in 310.15(C)(1) shall not apply.*~~

~~**(B) PLFA Wiring Methods and Materials.** Power-limited fire alarm conductors and cables described in 722.179 shall be installed as detailed in 722.150(B)(1), 722.150(B)(2), or 722.135. Devices shall be installed in accordance with 110.3(B), 300.11(A), and 300.15.~~

~~**(1) In Raceways, Exposed on Ceilings or Sidewalls, or Fished in Concealed Spaces.** Cable splices or terminations shall be made in listed fittings, boxes, enclosures, fire alarm devices, or utilization equipment. Where installed exposed, cables shall be adequately supported and installed in such a way that maximum protection against physical damage is afforded by building construction such as baseboards, door frames, ledges, and so forth. Where located within 2.1 m (7 ft) of the floor, cables shall be securely fastened in an approved manner at intervals of not more than 450 mm (18 in.).~~

~~**(2) Passing Through a Floor or Wall.** Cables shall be installed in metal raceways or rigid nonmetallic conduit where passing through a floor or wall to a height of 2.1 m (7 ft) above the floor, unless adequate protection can be afforded by building construction such as detailed in 760.130(B)(1), or unless an equivalent solid guard is provided.~~

~~**760.151 Separation from Electric Light, Power, Class 1, NPLFA, and Medium-Power Network-Powered Broadband Communications Circuit Conductors.**~~

~~**(A) General.** Power-limited fire alarm circuit cables and conductors shall not be placed in any cable, cable tray, compartment, enclosure, manhole, outlet box, device box, raceway, or similar fitting with conductors of electric light, power, Class 1, non- power-limited fire alarm circuits, and medium-power network-powered broadband communications circuits unless permitted by 760.151(B) through (F).~~

~~**(B) Separated by Barriers.** Power-limited fire alarm circuit cables shall be permitted to be installed together with Class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuits where they are separated by a barrier.~~

~~**(C) Raceways Within Enclosures.** In enclosures, power-limited fire alarm circuits shall be permitted to be installed in a raceway within the enclosure to separate them from Class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuits.~~

~~**(D) Associated Systems Within Enclosures.** Power-limited fire alarm conductors in compartments, enclosures, device boxes, outlet boxes, or similar fittings shall be permitted to be installed with electric light, power, Class 1, non-power-limited fire alarm, and medium power network-powered broadband communications circuits where they are introduced solely to connect the equipment connected to power-limited fire alarm circuits, and comply with either of the following conditions:~~

~~(1) The electric light, power, Class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuit conductors are routed to maintain a minimum of 6 mm (0.25 in.) separation from the conductors and cables of power-limited fire alarm circuits.~~

~~(2) The circuit conductors operate at 150 volts or less to ground and also comply with one of the following:~~

~~(a) The fire alarm power-limited circuits are installed using Type FPL, FPLR, FPLP, or permitted substitute cables, provided these power-limited cable conductors extending beyond the jacket are separated by a minimum of 6 mm (0.25 in.) or by a nonconductive sleeve or nonconductive barrier from all other conductors.~~

~~(b) The power-limited fire alarm circuit conductors are installed as non-power-limited circuits in accordance with 760.46.~~

~~**(E) Enclosures with Single Opening.** Power-limited fire alarm circuit conductors entering compartments, enclosures, device boxes, outlet boxes, or similar fittings shall be permitted to be installed with electric light, power, Class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuits where they are introduced solely to connect the equipment connected to power-limited fire alarm circuits or to other circuits controlled by the fire alarm system to which the other conductors in the enclosure are connected. Where power-limited fire alarm circuit conductors must enter an enclosure that is provided with a single opening, they shall be permitted to enter through a single fitting (such as a tee), provided the conductors are separated from the conductors of the other circuits by a continuous and firmly fixed nonconductor, such as flexible tubing.~~

~~**(F) Where Protected.** PLFA circuits shall be permitted to be installed together with the conductors of electric light, power, Class 1, non-power-limited fire alarm and medium-power network-powered broadband communications circuits where they are installed using NPLFA wiring methods and materials in accordance with Part II of Article 760 and where they are protected by an approved method.~~

~~**(G) Other Applications.** For other applications, power-limited fire alarm circuit conductors shall be separated by at least 50 mm (2 in.) from conductors of any electric light, power, Class 1, non- power-limited fire alarm, or medium-power network-powered broadband communications circuits unless one of the following conditions is met:~~

~~(1) Either (a) all of the electric light, power, Class 1, non- power-limited fire alarm, and medium-power network-powered broadband communications circuit conductors or (b) all of the power-limited fire alarm circuit conductors are in a raceway or in metal-sheathed, metal-clad, nonmetallic-sheathed, or Type UF cables.~~

~~(2) All of the electric light, power, Class 1, non- power-limited fire alarm, and medium-power network-powered broadband communications circuit conductors are permanently separated from all of the power-limited fire alarm circuit conductors by a continuous and firmly fixed nonconductor, such as porcelain tubes or flexible tubing, in addition to the insulation on the conductors.~~

~~**722.152 Installation of Conductors of Different PLFA Circuits, Class 2, Class 3, and Communications Circuits in the Same Cable, Enclosure, Cable Tray, Raceway, or Cable Routing Assembly.**~~

~~**(A) Two or More PLFA Circuits.** Cable and conductors of two or more power-limited fire alarm circuits shall be permitted within the same cable, enclosure, cable tray, raceway, or cable routing assembly.~~

~~**(B) Class 2 Circuits with PLFA Circuits.** Conductors of one or more Class 2 circuits shall be permitted within the same cable, enclosure, cable tray, raceway, or cable routing assembly with conductors of power-limited fire alarm circuits, provided that the insulation of the Class 2 circuit conductors in the cable, enclosure, raceway, or cable routing assembly is at least that required by the power-limited fire alarm circuits.~~

~~**C) Class 3 and Communication Circuits with PLFA Circuits.** Cable and conductors of Class 3 and communications circuits shall be permitted within the same cable, enclosure, cable tray, raceway, or cable routing assembly with cables and conductors of power-limited fire alarm circuits.~~

~~**(D) Low-Power Network-Powered Broadband Communications Cables and PLFA Cables.** Low-power network-powered broadband communications circuits shall be permitted in the same enclosure, cable tray, raceway, or cable routing assembly with PLFA cables.~~

~~**(E) Audio System Circuits and PLFA Circuits.** Audio system circuits described in 640.9(C) and installed using Class 2 or Class 3 wiring methods in compliance with 722.135 shall not be permitted to be installed in the same cable, cable tray, raceway, or cable routing assembly with power-limited conductors or cables.~~

~~**722.153 Cables.** Cables shall comply with 722.153(A) through (D).~~

Commented [IR4]: Rerlocated to 722.179

~~**(A) Conductor Materials.** Conductors for cables, other than coaxial cables, shall be solid or stranded copper. Coaxial cables shall be permitted to use 30 percent conductivity copper-covered steel center conductor wire.~~

~~**(B) Conductor Size.** The size of conductors in a multiconductor cable shall not be smaller than 26 AWG. Single conductors shall not be smaller than 18 AWG. Conductors of 26 AWG shall be permitted only where spliced with a connector listed as suitable for 26 AWG to 24 AWG or larger conductors that are terminated on equipment or where the 26 AWG conductors are terminated on equipment listed as suitable for 26 AWG conductors.~~

~~**(C) Voltage Ratings.** The cable shall have a voltage rating of not less than 300 volts.~~

~~**(D) Temperature Ratings.** The cable shall have a temperature rating of not less than 60°C (140°F).~~

~~**722.154 Installation of PLFA Cables in Buildings.** Installation of power-limited fire alarm cables in buildings shall be in accordance with 722.135, and 722.154 (A) and (B).~~

~~**(A) Nonconcealed Spaces.** Cables specified in Chapter 3 and meeting the requirements of 760.179(A) and (B) shall be permitted to be installed in nonconcealed spaces where the exposed length of cable does not exceed 3 m (10 ft).~~

~~**(B) Portable Fire Alarm System.** A portable fire alarm system provided to protect a stage or set when not in use shall be permitted to use wiring methods in accordance with 530.12.~~

~~**722.155 Fire Alarm Circuits Extending Beyond One Building.** Non- power-limited fire alarm circuits and power-limited fire alarm circuits that extend beyond one building and run outdoors shall meet the installation requirements of Parts II, III, and IV of Article 805 and shall meet the installation requirements of Part I of Article 300.~~

Commented [IR5]: Relocated to 722.135(I)

~~Part IV. Optical Fiber Cables - Installation Methods Within Buildings~~

~~**722.160 Raceways, Cable Routing Assemblies, and Cable Trays for Optical Fiber Cables.**~~

~~**(A) Types of Raceways.** Optical fiber cables shall be permitted to be installed in any raceway that complies with either 722.160(A)(1), (2) or (3).~~

~~**(1) Raceways Recognized in Chapter 3.** Optical fiber cables shall be permitted to be installed in any raceway included in Chapter 3. The raceways shall be installed in accordance with the requirements of Chapter 3.~~

Commented [IR6]: Covered by Table 722.135(B)

~~**(2) Communications Raceways.** Optical fiber cables shall be permitted to be installed in listed communications raceways selected in accordance with Table 800.154(b).~~

Commented [IR7]: Covered by Table 722.135(B)

~~**(3) Innerduct for Optical Fiber Cables.** Listed plenum communications raceway, listed riser communications raceway, and listed general-purpose communications raceway selected in accordance with Table 800.154(b) shall be permitted to be installed as innerduct in any type of listed raceway permitted in Chapter 3.~~

Commented [IR8]: InnerDuct requirement. Not a cable requirement.Leave in 770.

~~**(B) Raceway Fill for Optical Fiber Cables.** Raceway fill for optical fiber cables shall comply with either 722.160(B)(1) or (2).~~

Commented [IR9]: Moved to 722.135(J)

~~**(1) Without Electric Light or Power Conductors.** Where optical fiber cables are installed in raceway without electric light or power conductors, the raceway fill requirements of Chapters 3 and 9 shall not apply.~~

~~**(2) Nonconductive Optical Fiber Cables with Electric Light or Power Conductors.** Where nonconductive optical fiber cables are installed with electric light or power conductors in a raceway, the raceway fill requirements of Chapters 3 and 9 shall apply.~~

~~**(C) Cable Routing Assemblies.** Optical fiber cables shall be permitted to be installed in listed cable routing assemblies selected in accordance with Table 800.154(c)~~

Commented [IR10]: Covered by Table 722.135(B)

~~**(D) Cable Trays.** Optical fiber cables shall be permitted to be installed in metal or listed nonmetallic cable tray systems.~~

~~**722.161 Grounding.** Non-current-carrying conductive members of optical fiber cables shall be bonded to a grounded equipment rack or enclosure, or grounded in accordance with the grounding methods specified by 770.100(B)(2).~~

~~**722.162 Installation of Optical Fibers and Electrical Conductors.**~~

~~**(A) In Cable Trays and Raceways.** Conductive optical fiber cables contained in an armored or metal-clad-type sheath and nonconductive optical fiber cables shall be permitted to occupy the same cable tray or raceway with conductors for electric light, power, Class 1, non-power-limited fire alarm, Type ITC, or medium-power network-powered broadband communications circuits operating at 1000 volts or less. Conductive optical fiber cables without an armored or metal-clad-type sheath shall not be permitted to occupy the same cable tray or raceway with conductors for electric light, power, Class 1, non-power-limited fire alarm, Type ITC, or medium-power network-powered broadband communications circuits, unless all of the conductors of electric light, power, Class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuits are separated from all of the optical fiber cables by a permanent barrier or listed divider.~~

~~**(B) In Cabinets, Outlet Boxes, and Similar Enclosures.** Nonconductive optical fiber cables shall not be permitted to occupy the same cabinet, outlet box, panel, or similar enclosure housing the electrical terminations of an electric light, power, Class 1, non-power-limited fire alarm, or medium-power network-powered broadband communications circuit unless one or more of the following conditions exist:~~

~~(1) The nonconductive optical fiber cables are functionally associated with the electric light, power, Class 1, non-power-limited fire alarm, or medium-power network-powered broadband communications circuit.~~

~~(2) The conductors for electric light, power, Class 1, non-power-limited fire alarm, Type ITC, or medium-power network-powered broadband communications circuits operate at 1000 volts or less.~~

~~(3) The nonconductive optical fiber cables and the electrical terminations of electric light, power, Class 1, non-power-limited fire alarm, or medium-power network-powered broadband communications circuit are installed in factory- or field-assembled control centers.~~

~~(4) The nonconductive optical fiber cables are installed in an industrial establishment where conditions of maintenance and supervision ensure that only qualified persons service the installation.~~

Commented [IR11]: Covered by Table 722.135(B)

Commented [IR12]: Leave in 770.

Commented [IR13]: Leave in 770.

~~When optical fibers are within the same composite cable for electric light, power, Class 1, non-power-limited fire alarm, or medium-power network-powered broadband communications circuits operating at 1000 volts or less, they shall be permitted to be installed only where the functions of the optical fibers and the electrical conductors are associated.~~
~~Optical fibers in composite optical fiber cables containing only current-carrying conductors for electric light, power, or Class 1 circuits rated 1000 volts or less shall be permitted to occupy the same cabinet, cable tray, outlet box, panel, raceway, or other termination enclosure with conductors for electric light, power, or Class 1 circuits operating at 1000 volts or less.~~
~~Optical fibers in composite optical fiber cables containing current-carrying conductors for electric light, power, or Class 1 circuits rated over 1000 volts shall be permitted to occupy the same cabinet, cable tray, outlet box, panel, raceway, or other termination enclosure with conductors for electric light, power, or Class 1 circuits in industrial establishments, where conditions of maintenance and supervision ensure that only qualified persons service the installation.~~

~~**(C) With Other Circuits.** Optical fibers shall be permitted in the same cable, and conductive and nonconductive optical fiber cables shall be permitted in the same raceway, cable tray, box, enclosure, or cable routing assembly, with conductors of any of the following:~~

~~(1) Class 2 and Class 3 remote-control, signaling, and power-limited circuits in compliance with Article 645 or Parts I and III of Article 725~~

~~(2) Power-limited fire alarm systems in compliance with Parts I and III of Article 760~~

~~(3) Communications circuits in compliance with Parts I and V of Article 805~~

~~(4) Community antenna television and radio distribution systems in compliance with Parts I and V of Article 820~~

~~(5) Low-power network-powered broadband communications circuits in compliance with Parts I and V of Article 830~~

Part ~~V~~II. Listing Requirements

722.179 Listing and Marking of Cables. Cables installed in buildings shall be listed in accordance with 722.179(A), marked in accordance with 722.179(B) and shall be permitted to be marked in accordance with 722.179(C).
Exception: Optical fiber cables that are installed in compliance with 770.48 shall not be required to be listed.

(A) Listing of Cables. Cables, installed as wiring methods within buildings, shall be listed as resistant to the spread of fire and other criteria in accordance with 722.179(A)(1) through 722.179(A)(~~12~~16).

Informational Note 1: See UL 13, *Standard for Power-Limited Circuit Cables,* for applicable requirements for listing of Class 2 and, Class 3 cable and Power-limited Tray Cable (PLTC).

Informational Note 2: See UL 1424, *Cables for Power-Limited Fire-Alarm Circuits,* for applicable requirements for listing of power-limited fire alarm cable.

Informational Note 3: See UL 1651, *Optical Fiber Cable,* for applicable requirements for listing of optical fiber cable.

Informational Note 4: See UL 1400-2, *Standard for Fault-Managed Power Distribution Technologies - Part 2: Requirements for Class 4 Cables*, for applicable requirements for listing of Class 4 cable.

(1) Plenum Cable. Plenum cable shall be listed as suitable for use in ducts, plenums, and other space for environmental air and shall be listed as having adequate fire-resistant and low-smoke producing characteristics. Refer to Table 722.XX for plenum cable types.

Informational Note: One method of defining a cable that is low-smoke producing and fire resistant is that the cable exhibits a maximum peak optical density of 0.50 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.52 m (5 ft) or less when tested in accordance with NFPA 262-2019, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*.

(2) Riser Cable. Riser cable shall be listed as suitable for use in a vertical run in a shaft or from floor to floor and shall be listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor.

Informational Note: One method of defining fire-resistant characteristics capable of preventing the carrying of fire from floor to floor is that the cables pass the requirements of ANSI/UL 1666-2012, *Test for Flame Propagation Height of Electrical and Optical-Fiber Cable Installed Vertically in Shafts*.

(3) General-Purpose Cable. General-Purpose cable shall be listed as suitable for general-purpose use, with the exception of risers, ducts, plenums, and other space used for environmental air, and shall be listed as resistant to the spread of fire.

Informational Note: One method of defining resistant to the spread of fire is that the cables do not spread fire to the top of the tray in the UL flame exposure, vertical tray flame test in ANSI/UL 1685-2010, *Standard for Safety for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*. The smoke measurements in the test method are not applicable.

Another method of defining resistant to the spread of fire is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the CSA vertical flame test for cables in cable trays, as described in CSA C22.2 No. 0.3-M-2001, *Test Methods for Electrical Wires and Cables*.

(4) Alternative General-Purpose Cable. Alternative general-purpose optical fiber cable shall be listed as suitable for general-purpose use, with the exception of risers and plenums, and shall also be resistant to the spread of fire.

Informational Note: One method of defining resistant to the spread of fire is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the CSA vertical flame test — cables in cable trays, as described in CSA C22.2 No. 0.3-M-2001, *Test Methods for Electrical Wires and Cables*.

5) Limited-Use Cable. Limited-use cable shall be listed as suitable for use in dwellings and raceways and shall be listed as resistant to flame spread.

Informational Note: One method of determining that cable is resistant to flame spread is by testing the cable to the FV-2/VW-1 flame test in ANSI/UL 2556, *Standard for Wire and Cable Test Methods*.

(6) Type PLTC. Type PLTC nonmetallic-sheathed, power-limited tray cable shall be listed as being suitable for cable trays, resistant to the spread of fire, and, sunlight- and moisture-resistant. Type PLTC cable used in a wet location shall be listed for use in wet locations and marked “wet” or “wet location.

Informational Note: One method of defining resistant to the spread of fire is that the cables do not spread fire to the top of the tray in the UL flame exposure, vertical tray flame test in ANSI/UL 1685-2010, *Standard for Safety for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.* The smoke measurements in the test method are not applicable.
Another method of defining resistant to the spread of fire is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the CSA vertical tray flame test for cables in cable trays, as described in CSA C22.2 No. 0.3-M-2001, *Test Methods for Electrical Wires and Cables*.

(7) Circuit Integrity (CI) Cable, Fire-Resistive Cable System or Electrical Circuit Protective System. Cables that are used for survivability of critical circuits under fire conditions shall meet either 722.179(A)(7)(a), (b) or (c) .

Informational Note: Fire alarm circuit integrity (CI) cable, fire-resistive cable systems or electrical circuit protective systems may be used for fire alarm circuits to comply with the survivability requirements of NFPA 72-2019, *National Fire Alarm and Signaling Code*, 12.4.3 and 12.4.4, that the circuit maintain its electrical function during fire conditions for a defined period of time.

(a) Circuit Integrity (CI) Cables.
Circuit integrity (CI) cables, of the types specified in 722.179(A)(1), (2), (3), (4), and (6), and used for survivability of critical circuits, shall be marked with the additional classification using the suffix “CI.” In order to maintain its listed fire-resistive rating, circuit integrity (CI) cable shall only be installed in free air in accordance with 722.24(B). Circuit integrity (CI) cables shall only be permitted to be installed in a raceway where specifically listed and marked as part of a fire-resistive cable system as covered in 722.179(A)(7)(b).

Informational Note: One method of defining circuit integrity (CI) cable is by establishing a rating when tested in accordance with UL 2196, *Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables* as specified in UL 1425, *Cables for Non–Power-Limited Fire-Alarm Circuits*. UL Guide Information for Nonpower-limited Fire Alarm Circuits (HNHT) contains information to identify the cable and its installation limitations to maintain the fire-resistive rating.

(b) Fire-resistive cables of the types specified in 722.179(A)(1), (2), (3), (4), (6), and 722.179(A)(7)(a), which are part of a fire-resistive cable system, shall be identified with the system identifier and hourly rating marked on the protectant or the smallest unit container and installed in accordance with the listing of the system.

Informational Note: One method of defining a fire-resistive cable system is by establishing a rating when tested in accordance with UL 2196*, Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables*. UL Guide Information for *Electrical Circuit Integrity Systems* (FHIT) contains information to identify the system and its installation limitations to maintain a minimum fire-resistive rating.

(c) Electrical Circuit Protective System.
Protectants for cables of the types specified in 722.179(A)(1), (2), (3), (4), and (6) which are part of an electrical circuit protective system, shall be identified with the protective system identifier and hourly rating marked on the protectant or the smallest unit container and installed in accordance with the listing of the protective system.

Informational Note: One method of defining an electrical circuit protective system is by establishing a rating when tested in accordance with UL 1724, *Fire Tests for Electrical Circuit Protective Systems* . UL Guide Information for *Electrical Circuit Integrity Systems* (FHIT) contains information to identify the system and its installation limitations to maintain the fire-resistive rating.

<u>(8)</u> Class 3 Single Conductors. Class 3 single conductors used as other wiring within buildings shall be listed Type CL3 and shall not be smaller than 18 AWG.

Informational Note: One method of defining resistant to the spread of fire is that the cables do not spread fire to the top of the tray in the UL flame exposure, vertical tray flame test in ANSI/UL 1685-2010, *Standard for Safety for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*. The smoke measurements in the test method are not applicable. Another method of defining resistant to the spread of fire is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the CSA vertical tray flame test for cables in cable trays, as described in CSA C22.2 No. 0.3-M-2001, *Test Methods for Electrical Wires and Cables*.

<u>(9)</u> Limited Power (LP) Cable. Class 2 and Class 3 limited power (-LP) cables shall be listed as suitable for carrying power and data up to a specified current limit for each conductor without exceeding the temperature rating of the cable where the cable is installed in cable bundles in free air or installed within a raceway, cable tray, or cable routing assembly. The cables shall be marked with the suffix “-LP (XXA)” where XXA designates the current limit is in amperes per conductor.

Informational Note: An example of the marking on a Class 2 cable with an LP rating is “CL2-LP (75°C) 23 AWG 4-pair,” which indicates that it is a 4-pair plenum cable with 23 AWG conductors, a temperature rating of 75°C, and a current limit of 0.6 amperes per conductor (0.6 A).

(10) Undercarpet Cables. Undercarpet cable shall be listed as suitable for use under carpet, floor covering, modular tiles, and planks.

Informational Note: One method of determining the suitability of cable for undercarpet use is with the compressive loading test in UL 444, *Standard for Safety for Communications Cables*.

(11) Wet locations. Cable used in a wet location shall be listed for use in wet locations and be marked “wet” or “wet location”, or have a moisture-impervious metal sheath.

(12) Field-Assembled Optical Fiber Cables. Field-assembled optical fiber cable shall comply with 722.179(A)(12)(a) through (d).

(a) The specific combination of jacket and optical fibers intended to be installed as a field-assembled optical fiber cable shall be one of the types in 722.179(A)(1), (2) or (3) and shall be marked in accordance with Table 179(B)(1).

(b) The jacket of a field-assembled optical fiber cable shall have a surface marking indicating the specific optical fibers with which it is identified for use.

(c) The optical fibers shall have a permanent marking, such as a marker tape, indicating the jacket with which they are identified for use.
(d) The jacket without fibers shall meet the listing requirements for communications raceways in 800.182(A), (B), or (C) in accordance with the cable marking.

(13) Cables Containing Optical Fibers. Composite optical fiber cables shall be listed as electrical cables based on the type of electrical conductors.

(14) Class 2 and Class 3 Cable Voltage and Temperature Ratings. Class 2 cables shall have a voltage rating of not less than 150 volts. Class 3 cables shall have a voltage rating of not less than 300 volts. Class 2 and Class 3 cables shall have a temperature rating of not less than 60°C (140°F).

(15) Power Limited Fire Alarm (PLFA) Cables. PFLA cables shall comply with 722.179(A)(15)(a) through 722.179(A)(15)(d).

(a) Conductors for cables, other than coaxial cables, shall be solid or stranded copper. Coaxial cables shall be permitted to use 30 percent conductivity copper-covered steel center conductor wire.

(b) The size of conductors in a multiconductor cable shall not be smaller than 26 AWG. Single conductors shall not be smaller than 18 AWG. Conductors of 26 AWG shall be permitted only where spliced with a connector listed as suitable for 26 AWG to 24 AWG or larger conductors that are terminated on equipment or where the 26 AWG conductors are terminated on equipment listed as suitable for 26 AWG conductors.

(c) The cable shall have a voltage rating of not less than 300 volts.

(d) The cable shall have a temperature rating of not less than 60°C (140°F).

(16) Class 4 Cable Construction.
(1) Sizes.
Conductors of sizes not smaller than 24 AWG shall be permitted to be used.
(2) Insulation.

Insulation on conductors shall be rated not less than 450 volts dc.
(3) Voltage Rating.
Cables shall have a voltage rating of not less than 450 volts dc. Voltage ratings shall not be marked on the cables.
(4) Temperature Rating.
Cables shall have a temperature rating of not less than 60°C (140°F).
(5) Cabling.
Cables shall comply with any requirements provided in the listing of the system.
Informational Note: Excessive cable lengths can result in higher capacitance which could affect the safety of the circuit. See UL 1400-1, *Standard for Fault-Managed Power Distribution Technologies – Part 1: General Requirements*, for information on determining applicable requirements for the listing of Class 4 power systems.
(F) Marking.
All cables shall be marked to indicate the following information using the applicable method described in 310.8(B):

1. The cable type as described in 726.179 (A) through (D)
2. The manufacturer's name, trademark, or other distinctive marking by which the organization responsible for the product can be readily identified
3. The AWG size or circular mil area
4. Number of conductors, if more than two
5. The temperature rating of Class 4 cables that have a rating exceeding 60°C (140°F)

(B) Marking. Cables shall be durably marked on the surface in accordance with 722.179(B)(1) through(##). The AWG size or circular mil area shall be repeated at intervals not exceeding 610 mm (24 in.). All other markings shall be repeated at intervals not exceeding 1.0 m (40 in.).

(1) The proper type designation for the type of cable in accordance with Table 179(B)(1).

(2) The manufacturer's name, trademark, or other distinctive marking by which the organization responsible for the product can be readily identified.

(3) The AWG size or circular mil area.

Informational Note: See Chapter 9, Table 8, Conductor Properties, for conductor area expressed in SI units for conductor sizes specified in AWG or circular mil area.

(4) The temperature rating for a temperature rating exceeding 60°C (140°F).

Informational Note: A minimum temperature rating of 60°C is assumed for cables not marked with a temperature rating

(5) Voltage ratings shall not be marked on the cables.

Exception: Voltage markings shall be permitted where the cable has multiple listings and a voltage marking is required for one or more of the listings.

Informational Note: Voltage markings on cables may be misinterpreted to suggest that the cables may be suitable for Class 1 electric light and power applications.

(6) Class 4 cables shall be marked using the applicable method described in 310.8(B). The marking shall include the number of conductors, if more than two.

Table 722.179(B)(1) Cable Type Markings

Cable Type	Cable Marking
Class 4 Plenum Cable	CL4P
Class 3 Plenum Cable	CL3P
Class 2 Plenum Cable	CL2P
Power Limited Fire Alarm Plenum Cable	FPLP
Nonconductive Optical Fiber Plenum Cable	OFNP
Conductive Optical Fiber Plenum Cable	OFCP
Class 4 Riser Cable	CL4R
Class 3 Riser Cable	CL3R
Class 2 Riser Cable	CL2R
Power Limited Fire Alarm Riser Cable	FPLR
Nonconductive Optical Fiber Riser Cable	OFNR
Conductive Optical Fiber Riser Cable	OFCR
Class 4 General-Purpose Cable	CL4
Class 3 General-Purpose Cable	CL3
Class 2 General-Purpose Cable	CL2
Power Limited Fire Alarm Cable	FPL
Nonconductive General-Purpose Optical Fiber Cable	OFN
Conductive General-Purpose Optical Fiber Cable	OFC
Alternative Nonconductive General-Purpose Optical Fiber Cable	OFNG
Alternative Conductive General-Purpose Optical Fiber Cable	OFCG
Class 3 Cable – Limited Use	CL3X
Class 2 Cable – Limited Use~~s~~	CL2X
Under Carpet Cable	CMUC

Note: All types of CL2, CL3 and FPL cables containing optical fibers are provided with the suffix "-OF".

Informational Note: Informational Note: Cable types are listed in descending order of fire resistance rating.

(C) Optional Markings. Cables shall be permitted to be surface marked to indicate special characteristics of the cable materials.

Informational Note No. 1: These markings include, but are not limited to, markings for limited smoke, halogen free, low smoke and halogen free, and sunlight resistant.

Informational Note No. 2: Some examples of optional markings are ST1 to indicate limited smoke characteristics in accordance with UL 2556, *Wire and Cable Test Methods*; HF to indicate halogen free as described in UL 2885, *Outline of Investigation for Acid Gas, Acidity and Conductivity of Combusted Materials*; and LSHF to indicate halogen free and low smoke characteristics in accordance with IEC 61034-2, *Measurement of smoke density of cables burning under defined conditions — Part 2: Test procedure and requirements.*

Article 725 Class 2 and Class 3 Power-Limited Circuits

Part I. General

725.1 Scope.
This article covers power-limited circuits, including power-limited remote control and signaling circuits, that are not an integral part of a device or of utilization equipment.
Informational Note: The circuits described herein are characterized by usage and electrical power limitations that differentiate them from electric light and power circuits; therefore, alternative requirements to those of Chapters 1 through 4 are given with regard to minimum wire sizes, ampacity adjustment and correction factors, overcurrent protection, insulation requirements, and wiring methods and materials.

725.3 Other Articles.
In addition to the requirements of this article, circuits and equipment shall comply with the articles or sections listed in 725.3(A) through (E). Only those sections of Article 300 referenced in this article shall apply to Class 2 and Class 3 circuits.

(A) Spread of Fire or Products of Combustion.
Installation of Class 2 and Class 3 circuits shall comply with 300.21.

(B) Ducts, Plenums, and Other Air-Handling Spaces.
Class 2 and Class 3 circuits installed in ducts, plenums, or other space used for environmental air shall comply with 300.22.

(C) Motor Control Circuits.
Motor control circuits tapped from the load side of the motor branch-circuit protective device(s) as specified in 430.72(A) shall comply with Part IV of Article 430.

(D) Identification of Equipment Grounding Conductors.
Equipment grounding conductors shall be identified in accordance with 250.119.

(E) Cables for Class 2 and Class 3 Circuits.
The listing and installation of cables for Class 2 and Class 3 circuits shall comply with Article 722, Parts I~~,~~ and II~~, and V~~.

725.12 Uses Not Permitted.
Cables and equipment shall not be installed in any hazardous (classified) location, except as permitted by other articles of this *Code*.
Informational Note: Hazardous locations are covered in Articles 500 through 516 and in Article 517, Part IV.

725.21 Access to Electrical Equipment Behind Panels Designed to Allow Access.
Access to electrical equipment shall not be denied by an accumulation of wires and cables that prevents removal of panels, including suspended ceiling panels.

725.24 Mechanical Execution of Work.
(A) General.

Class 2 and Class 3 ~~circuits~~ equipment shall be installed in a neat and workmanlike manner. ~~Cables and conductors 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 supported by straps, staples, hangers, cable ties listed and identified for securement and support, or similar fittings designed and installed so as not to damage the cable.~~ The installation shall also comply with 300.4 and 300.11.

Informational Note: Paint, plaster, cleaners, abrasives, corrosive residues, or other contaminants can result in an undetermined alteration of Class 2, Class 3, and PLTC cable properties.

(B) Circuit Integrity (CI) Cable.

Circuit integrity (CI) cable shall be supported at a distance not exceeding 610 mm (24 in.). Cable shall be secured to the noncombustible surface of the building structure. Cable supports and fasteners shall be steel.

~~Informational Note: Paint, plaster, cleaners, abrasives, corrosive residues, or other contaminants can result in an undetermined alteration of Class 2, Class 3, and PLTC cable properties.~~

725.30 Class 2 and Class 3 Circuit Identification.

Class 2 and Class 3 circuits shall be identified at terminal and junction locations in a manner that prevents unintentional interference with other circuits during testing and servicing.

725.31 Safety-Control Equipment.

Where damage to power-limited circuits can result in a failure of safety-control equipment that would introduce a direct fire or life hazard, the power-limited circuits shall be installed in accordance with 724.31. Room thermostats, water temperature regulating devices, and similar controls used in conjunction with electrically controlled household heating and air conditioning shall not be considered safety-control equipment.

Part II. Class 2 and Class 3 Circuits

725.60 Power Sources for Class 2 and Class 3 Circuits.

(A) Power Source.

The power source for a Class 2 or a Class 3 circuit shall be as follows:

Informational Note No. 1: Informational Note Figure 725.60 illustrates the relationships between Class 2 or Class 3 power sources, their supply, and the Class 2 or Class 3 circuits.

Informational Note No. 2: Table 11(A) and Table 11(B) in Chapter 9 provide the requirements for listed Class 2 and Class 3 power sources.

1. A listed Class 2 or Class 3 transformer
2. A listed Class 2 or Class 3 power supply
3. Other listed equipment marked to identify the Class 2 or Class 3 power source

   Exception No. 1 to (3): Thermocouples shall not require listing as a Class 2 power source.

   Exception No. 2 to (3): Limited power circuits of listed equipment where these circuits have energy levels rated at or below the limits established in Chapter 9, Table 11(A) and Table 11(B).

   Informational Note No. 3: Examples of other listed equipment are as follows:

1. A circuit card listed for use as a Class 2 or Class 3 power source where used as part of a listed assembly
2. A current-limiting impedance, listed for the purpose, or part of a listed product, used in conjunction with a non-power-limited transformer or a stored energy source, for example, storage battery, to limit the output current
3. A thermocouple
4. Limited voltage/current or limited impedance secondary communications circuits of listed industrial control equipment

4. Listed audio/video, information technology (computer), communications, and industrial equipment limited-power circuits

   Informational Note No. 4: One way to determine applicable requirements for listing of information technology (computer) equipment is to refer to UL 60950-1-2011, *Standard for Safety of Information Technology Equipment*. Another way to determine applicable requirements for listing of audio/video, information technology, and communications equipment is to refer to UL 62368-1-2014, *Safety of audio/video, information and communication technology equipment*. Typically such circuits are used to interconnect data circuits for the purpose of exchanging information data. One way to determine applicable requirements for listing of industrial equipment is to refer to UL 61010-2-201, *Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 2-201: Particular requirements for control equipment*, and/or UL 61800-5-1, *Adjustable speed electrical power drive systems — Part 5-1: Safety requirements — Electrical, thermal and energy.*

5. A battery source or battery source system that is listed and identified as Class 2

(B) Interconnection of Power Sources.
Class 2 or Class 3 power sources shall not have the output connections paralleled or otherwise interconnected unless listed for such interconnection.
Figure Informational Note Figure 725.60 Class 2 and Class 3 Circuits.

(C) Marking.
The equipment supplying the circuits shall be durably marked where plainly visible to indicate each circuit that is a Class 2 or Class 3 circuit. The power sources for limited power circuits in 725.60(A)(3), limited power circuits for listed audio/video equipment, listed information technology equipment, listed communications equipment, and listed industrial equipment in 725.60(A)(4) shall have a label indicating the maximum voltage and rated current output per conductor for each connection point on the power source. Where multiple connection points have the same rating, a single label shall be permitted to be used.
Informational Note No. 1: Rated current for power sources covered in 725.144 is the output current per conductor the power source is designed to deliver to an operational load at normal operating conditions, as declared by the manufacturer.
Informational Note No. 2: An example of a label is “52V @ 0.433A, 57V MAX” for an IEEE 802.3 compliant Class 8 power source.

725.127 Wiring Methods on Supply Side of the Class 2 or Class 3 Power Source.
Conductors and equipment on the supply side of the power source shall be installed in accordance with the appropriate requirements of Chapters 1 through 4.
Exception: The input leads of a transformer or other power source supplying Class 2 and Class 3 circuits shall be permitted to be smaller than 14 AWG but not smaller than 18 AWG if they are protected by an overcurrent device rated not over 20 amperes, are not over 305 mm (12 in.) long, and have insulation that complies with 724.49(B).

725.130 Wiring Methods and Materials on Load Side of the Class 2 or Class 3 Power Source.

~~Parts I, II, and V of Article 722 shall apply to wiring methods and materials on the load side of the Class 2 or Class 3 power source.~~
Class 2 and Class 3 circuits on the load side of the power source shall be permitted to be installed using wiring methods and materials in accordance with 725.130(A), (B), or a combination of (A) and (B). Parts I and II of Article 722 shall apply.

(A) Class 1 Wiring Methods and Materials.
It shall be permitted to use Class 1 wiring methods for Class 2 and Class 3 circuits. Separation from electric light, power, Class 1, non-power-limited fire alarm circuit conductors, and medium-power network-powered broadband communications cables shall comply with 725.136 ~~722.141~~.
Exception: The ampacity adjustment factors given in 310.15(C)(1) shall not apply.

(B) Class 2 and Class 3 Wiring Methods and Materials.
Conductors on the load side of the power source shall be insulated in accordance with ~~722.143~~722.179 and shall be installed in accordance with 722.135 and 725.136 through 722.144.
Exception No. 1: As provided for in 620.21 for elevators and similar equipment.
Exception No. 2: Other wiring methods and materials installed in accordance with 725.3 shall be permitted to extend or replace the conductors and cables described in 725.179 and permitted by 725.130(B).
Exception No. 3: Bare Class 2 conductors shall be permitted as part of a listed intrusion protection system where installed in accordance with the listing instructions for the system.

725.136 Separation from Electric Light, Power, Class 1, Non–Power-Limited Fire Alarm Circuit Conductors, and Medium-Power Network-Powered Broadband Communications Cables.

(A) General. Cables and conductors of Class 2 and Class 3 circuits shall not be placed in any cable, cable tray, compartment, enclosure, manhole, outlet box, device box, raceway, or similar fitting with conductors of electric light, power, Class 1, non–power-limited fire alarm circuits, and medium-power network-powered broadband communications circuits unless permitted by 722.141(B) through (H).

(B) Separated by Barriers. Class 2 and Class 3 circuits shall be permitted to be installed together with the conductors of electric light, power, Class 1, non–power-limited fire alarm and medium power network-powered broadband communications circuits where they are separated by a barrier.

(C) Raceways Within Enclosures. In enclosures, Class 2 and Class 3 circuits shall be permitted to be installed in a raceway to separate them from Class 1, non–power-limited fire alarm and medium-power network-powered broadband communications circuits.

(D) Associated Systems Within Enclosures. Class 2 and Class 3 circuit conductors in compartments, enclosures, device boxes, outlet boxes, or similar fittings shall be permitted to be installed with electric light, power, Class 1, non–power-limited fire alarm, and medium-power network-powered broadband communications circuits where they are introduced solely to connect the equipment connected to Class 2 and Class 3 circuits, and where (1) or (2) applies:

(1) The electric light, power, Class 1, non–power-limited fire alarm, and medium-power network-powered broadband communications circuit conductors are routed to maintain a minimum of 6 mm (0.25 in.) separation from the conductors and cables of Class 2 and Class 3 circuits.

(2) The circuit conductors operate at 150 volts or less to ground and also comply with one of the following:

(a) The Class 2 and Class 3 circuits are installed using Type CL3, CL3R, or CL3P or permitted substitute cables, provided these Class 3 cable conductors extending beyond the jacket are separated by a minimum of 6 mm (0.25 in.) or by a nonconductive sleeve or nonconductive barrier from all other conductors.

(b) The Class 2 and Class 3 circuit conductors are installed as a Class 1 circuit in accordance with 725.41.

(E) Enclosures with Single Opening. Class 2 and Class 3 circuit conductors entering compartments, enclosures, device boxes, outlet boxes, or similar fittings shall be permitted to be installed with Class 1, non–power-limited fire alarm and medium-power network-powered broadband communications circuits where they are introduced solely to connect the equipment connected to Class 2 and Class 3 circuits. Where Class 2 and Class 3 circuit conductors must enter an enclosure that is provided with a single opening, they shall be permitted to enter through a single fitting (such as a tee), provided the conductors are separated from the conductors of the other circuits by a continuous and firmly fixed nonconductor, such as flexible tubing.

(F) Manholes. Underground Class 2 and Class 3 circuit conductors in a manhole shall be permitted to be installed with Class 1, non–power-limited fire alarm and medium-power network-powered broadband communications circuits where one of the following conditions is met:

(1) The electric light, power, Class 1, non–power-limited fire alarm and medium-power network-powered broadband communications circuit conductors are in a metal-enclosed cable or Type UF cable.

(2) The Class 2 and Class 3 circuit conductors are permanently and effectively separated from the conductors of other circuits by a continuous and firmly fixed nonconductor, such as flexible tubing, in addition to the insulation or covering on the wire.

(3) The Class 2 and Class 3 circuit conductors are permanently and effectively separated from conductors of the other circuits and securely fastened to racks, insulators, or other approved supports.

(G) Cable Trays. Class 2 and Class 3 circuit conductors shall be permitted to be installed in cable trays, where the conductors of the electric light, Class 1, and non–power-limited fire alarm circuits are separated by a solid fixed barrier of a material compatible with the cable tray or where the Class 2 or Class 3 circuits are installed in Type MC cable.

(H) Where Protected. Class 2 and Class 3 circuits shall be permitted to be installed together with the conductors of electric light, power, Class 1, non–power-limited fire alarm and medium power network-powered broadband communications circuits where they are installed using Class 1 wiring methods in accordance with 724.46 and where they are protected by an approved raceway.

(I) Other Applications. For other applications, conductors of Class 2 and Class 3 circuits shall be separated by at least 50 mm (2 in.) from conductors of any electric light, power, Class 1 non–power-limited fire alarm or medium power network-powered broadband communications circuits unless one of the following conditions is met:

(1) Either all of the electric light, power, Class 1, non–power-limited fire alarm and medium-power network-powered broadband communications circuit conductors or all of the Class 2 and Class 3 circuit conductors are in a raceway or in metal-sheathed, metal-clad, non–metallic-sheathed, Type TC, or Type UF cables

(2) All of the electric light, power, Class 1 non–power-limited fire alarm, and medium-power network-powered broadband communications circuit conductors are permanently separated from all of the Class 2 and Class 3 circuit conductors by a continuous and firmly fixed nonconductor, such as porcelain tubes or flexible tubing, in addition to the insulation on the conductors.

722.139 Installation of Conductors of Different Circuits in the Same Cable, Enclosure, Cable Tray, Raceway, or Cable Routing Assembly.

(A) Two or More Class 2 Circuits. Conductors of two or more Class 2 circuits shall be permitted within the same cable, enclosure, raceway, or cable routing assembly.

(B) Two or More Class 3 Circuits. Conductors of two or more Class 3 circuits shall be permitted within the same cable, enclosure, raceway, or cable routing assembly.

(C) Class 2 Circuits with Class 3 Circuits. Conductors of one or more Class 2 circuits shall be permitted within the same cable, enclosure, raceway, or cable routing assembly with conductors of Class 3 circuits, provided that the insulation of the Class 2 circuit conductors in the cable, enclosure, raceway, or cable routing assembly is at least that required for Class 3 circuits.

(D) Class 2 and Class 3 Circuits with Communications Circuits.

(1) Communications Cables. Conductors of one or more Class 2 or Class 3 circuits shall be permitted in the same cable with conductors of communications circuits provided the cable is a listed communications cable that shall be installed in accordance with the requirements of Part V of Article 805. The cables shall be listed as communications cables.

(2) Composite Cables. Cables constructed of individually listed Class 2, Class 3, and communications cables under a common jacket shall be permitted to be classified as communications cables. The fire resistance rating of the composite cable shall be determined by the performance of the composite cable.

(E) Class 2 or Class 3 Cables with Other Circuit Cables. Jacketed cables of Class 2 or Class 3 circuits shall be permitted in the same enclosure, cable tray, raceway, or cable routing assembly with jacketed cables of any of the following:

(1) Power-limited fire alarm systems in compliance with Parts I and III of Article 760

(2) Nonconductive and conductive optical fiber cables in compliance with Parts I and IV of Article 770

(3) Communications circuits in compliance with Parts I and IV of Article 805

(4) Community antenna television and radio distribution systems in compliance with Parts I and IV of Article 820

(5) Low-power, network-powered broadband communications in compliance with Parts I and IV of Article 830

(F) Class 2 or Class 3 Conductors or Cables and Audio System Circuits. Audio system circuits described in 640.9(C), and installed using Class 2 or Class 3 wiring methods in compliance with 725.133 and 725.154, shall not be permitted to be installed in the same cable, raceway, or cable routing assembly with Class 2 or Class 3 conductors or cables.

725.144 Bundling of 4-Pair Cables Transmitting Power and Data.
Sections 725.144(A) and (B) shall apply to Class 2 and Class 3 circuits that transmit power and data to a powered device over listed 4-pair (8 conductor) cabling. Section 300.11 and Parts I and III of Article 725 shall apply to Class 2 and Class 3 circuits that transmit power and data. The conductors that carry power for the data circuits shall be copper. The current in the power circuit shall not exceed the current limitation of the connectors.

Informational Note No. 1: One example of the use of cables that transmit power and data is the connection of closed-circuit TV cameras (CCTV).

Informational Note No. 2: The 8P8C connector is in widespread use with powered communications systems. IEC 60603-7-2008, *Connectors for electronic equipment — Part 7-1: Detail specification for 8-way, unshielded, free and fixed connectors,* specifies these connectors to have a current-carrying capacity per contact of 1.0 amperes maximum at 60°C (149°F). See IEC 60603-7 for more information on current-carrying capacity at higher and lower temperatures.

Informational Note No. 3: The requirements of Table 725.144 were derived for carrying power and data over 4-pair copper balanced twisted pair cabling. This type of cabling is described in ANSI/TIA 568-C.2-2009, *Commercial Building Telecommunications Cabling Standard — Part 2: Balanced Twisted-Pair Telecommunications Cabling and Components*.

Informational Note No. 4: See TIA-TSB-184-A-2017, *Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling*, for information on installation and management of balanced twisted pair cabling supporting power delivery.

Informational Note No. 5: See ANSI/NEMA C137.3-2017, *American National Standard for Lighting Systems — Minimum Requirements for Installation of Energy Efficient Power over Ethernet (PoE) Lighting Systems*, for information on installation of cables for PoE lighting systems.

Informational Note No. 6: Rated current for power sources covered in 725.144 is the output current per conductor the power source is designed to deliver to an operational load at normal operating conditions, as declared by the manufacturer. In the design of these systems, the actual current in a given conductor might vary from the rated current per conductor by as much as 20 percent. An increase in current in one conductor is offset by a corresponding decrease in current in one or more conductors of the same cable.

(A) Use of Class 2 or Class 3 Cables to Transmit Power and Data.
Where Types CL3P, CL2P, CL3R, CL2R, CL3, or CL2 transmit power and data, the rated current per conductor of the power source shall not exceed the ampacities in Table 725.144 at an ambient temperature of 30°C (86°F). For ambient temperatures above 30°C (86°F), the correction factors in Table 310.15(B)(1)(1) or in Equation 310.15(B) shall apply.
Exception: Compliance with Table 725.144 shall not be required for installations where conductors are 24 AWG or larger and the rated current per conductor of the power source does not exceed 0.3 amperes.
Informational Note: One example of the use of Class 2 cables is a network of closed-circuit TV cameras using 24 AWG, 60°C rated, Type CL2R, Category 5e balanced twisted-pair cabling.

(B) Use of Class 2-LP or Class 3-LP Cables to Transmit Power and Data.
Types CL3P-LP, CL2P-LP, CL3R-LP, CL2R-LP, CL3-LP, or CL2-LP shall be permitted to supply power to equipment from a power source with a rated current per conductor up to the marked current limit located immediately following the suffix "-LP" and shall be permitted to transmit data to the equipment. Where the number of bundled LP cables is 192 or less and the selected ampacity of the cables in accordance with Table 725.144 exceeds the marked current limit of the cable, the ampacity determined from the table shall be permitted to be used. For ambient temperatures above 30°C (86°F), the correction factors of Table 310.15(B)(1)(1) or Equation 310.15(B) shall apply. The Class 2-LP and Class 3-LP cables shall comply with the following, as applicable:

1. Cables with the suffix "-LP" shall be permitted to be installed in bundles, raceways, cable trays, communications raceways, and cable routing assemblies.
2. Cables with the suffix "-LP" and a marked current limit shall follow the substitution hierarchy of 722.135(E) for the cable type without the suffix "-LP" and without the marked current limit.
3. System design shall be permitted by qualified persons under engineering supervision.

Informational Note: An example of the marking on a 23 AWG, 4-pair, Class 2 cable rated 75°C with an LP current rating of 0.6 amperes per conductor is "CL2-LP(0.6A) 75°C AWG 4-pair". See 722.179(A)(9).

Table 725.144 Ampacities of Each Conductor in Amperes in 4-Pair Class 2 or Class 3 Balanced Twisted-Pair Cables Based on Copper Conductors at an Ambient Temperature of 30°C (86°F) with All Conductors in All Cables Carrying Current, 60°C (140°F), 75°C (167°F), and 90°C (194°F) Rated Cables

	Number of 4-Pair Cables in a Bundle																	
	1–7			**8–19**			**20–37**			**38–61**			**62–91**			**92–192**		
	Temperature Rating			**Temperature Rating**			**Temperature Rating**			**Temperature Rating**			**Temperature Rating**			**Temperature Rating**		
AWG	**60°C**	**75°C**	**90°C**	**60°C**	**75°C**	**90°C**	**60°C**	**75°C**	**90°C**	**60°C**	**75°C**	**90°C**	**60°C**	**75°C**	**90°C**	**60°C**	**75°C**	**90°C**
26	1.00	1.23	1.42	0.71	0.87	1.02	0.55	0.68	0.78	0.46	0.57	0.67	0.45	0.55	0.64	NA	NA	NA
24	1.19	1.46	1.69	0.81	1.01	1.17	0.63	0.78	0.91	0.55	0.67	0.78	0.46	0.56	0.65	0.40	0.48	0.55
23	1.24	1.53	1.78	0.89	1.11	1.28	0.77	0.95	1.10	0.66	0.80	0.93	0.58	0.71	0.82	0.45	0.55	0.63
22	1.50	1.86	2.16	1.04	1.28	1.49	0.77	0.95	1.11	0.66	0.82	0.96	0.62	0.77	0.89	0.53	0.63	0.72

Notes:
1. For bundle sizes over 192 cables, or for conductor sizes smaller than 26 AWG, ampacities shall be permitted to be determined by qualified personnel under engineering supervision.
2. Where only half of the conductors in each cable are carrying current, the values in the table shall be permitted to be increased by a factor of 1.4.
Informational Note No. 1: Elevated cable temperatures can reduce a cable's data transmission performance. For information on practices for 4-pair balanced twisted pair cabling, see TIA-TSB-184-A and 6.4.7, 6.6.3, and Annex G of ANSI/TIA-568-C.2, which provide guidance on adjustments for operating temperatures between 20°C and 60°C.
Informational Note No. 2: The per-contact current rating of connectors can limit the maximum allowable current below the ampacity shown in Table 725.144.

Part IV. Listing Requirements

725.160 Listing and Marking of Equipment for Power and Data Transmission.

The listed power source for circuits intended to provide power and data over Class 2 cables to remote equipment shall be as specified in 725.60(A)(1), (A)(2), (A)(3), or (A)(4). In accordance with 725.60(B), the power sources shall not have the output connections paralleled or otherwise interconnected, unless listed for such interconnection. Powered devices connected to a circuit supplying data and power shall be listed. Marking of equipment output connections shall be in accordance with 725.60(C).

725.179 Listing and Marking of Limited Power (LP) Cables.

LP cables shall be listed as suitable for carrying power and data up to a specified current limit for each conductor without exceeding the temperature rating of the cable. The cables shall be marked with the suffix “-LP (XXA)” where XXA designates the current limit in amperes per conductor.
Informational Note: An example of the marking on a 23 AWG, 4-pair, Class 2 cable rated 75°C with an LP current rating of 0.6 amperes per conductor is “CL2-LP(0.6A) 75°C 23 AWG 4-pair.”

Article 760 Fire Alarm Systems
Part I. General
760.1 Scope.
This article covers the installation of wiring and equipment of fire alarm systems, including all circuits controlled and powered by the fire alarm system.
Informational Note No. 1: Fire alarm systems include fire detection and alarm notification, guard's tour, sprinkler waterflow, and sprinkler supervisory systems. Circuits controlled and powered by the fire alarm system include circuits for the control of building systems safety functions, elevator capture, elevator shutdown, door release, smoke doors and damper control, fire doors and damper control, and fan shutdown, but only where these circuits are powered by and controlled by the fire alarm system. See *NFPA 72*-2019, *National Fire Alarm and Signaling Code*, for further information on the installation and monitoring for integrity requirements for fire alarm systems.
Informational Note No. 2: Class 1, 2, and 3 circuits are defined in Articles 724 and 725.

760.3 Other Articles.
Circuits and equipment shall comply with 760.3(A) through (O). Only those sections of Article 300 referenced in this article shall apply to fire alarm systems.
(A) Spread of Fire or Products of Combustion.
Installation of fire alarm circuits shall comply with 300.21.
(B) Ducts, Plenums, and Other Air-Handling Spaces.
Power-limited and non-power-limited fire alarm cables installed in ducts, plenums, or other spaces used for environmental air shall comply with 300.22.
Exception No. 1: Power-limited fire alarm cables selected in accordance with Table 760.154 and installed in accordance with 760.135(B) and 300.22(B), Exception shall be permitted to be installed in ducts specifically fabricated for environmental air.
Exception No. 2: Power-limited fire alarm cables selected in accordance with Table 760.154 and installed in accordance with 760.135© shall be permitted to be installed in other spaces used for environmental air (plenums).
~~© Hazardous (Classified) Locations.~~
~~Articles 500 through 516 and Article 517, Part IV, where installed in hazardous (classified) locations.~~
(~~D~~C) Corrosive, Damp, or Wet Locations.
Fire alarm circuits and equipment installed in corrosive, damp, or wet locations shall comply with 110.11, 300.5(B), 300.6, 300.9, and 310.10(F).
~~©~~ (D) Building Control Circuits.
Article 725, where building control circuits (e.g., elevator capture, fan shutdown) are associated with the fire alarm system.
(~~F~~E) Optical Fiber Cables.
Where optical fiber cables are utilized for fire alarm circuits, the cables shall be installed in accordance with Article 770.
(~~G~~F) Installation of Conductors with Other Systems.
Installations shall comply with 300.8.
(~~H~~G) Raceways or Sleeves Exposed to Different Temperatures.
Installations shall comply with 300.7(A).
(~~I~~H) Vertical Support for Fire-Resistive Cables and Conductors.
Vertical installations of circuit integrity (CI) cables and conductors installed in a raceway or conductors and cables of fire-resistive cable systems shall be installed in accordance with 300.19.
(~~J~~I) Installation of Cables and Conductors in Raceway.

Commented [IR1]: Changes in 760.3 are corrections based on Panel 3 FR Report

The number and size of cables and conductors shall comply with 300.17.
(~~K~~J) Bushing.
A bushing shall be installed where cables emerge from raceway used for mechanical support or protection in accordance with 300.15©.
(~~L~~K) Cable Routing Assemblies.
Power-limited fire alarm cables shall be permitted to be installed in plenum cable routing assemblies, riser cable routing assemblies, and general-purpose cable routing assemblies selected in accordance with Table 800.154(C), listed in accordance with 800.182, and installed in accordance with 800.110(C) and 800.113.
(~~M~~L) Communications Raceways.
Power-limited fire alarm cables shall be permitted to be installed in plenum communications raceways, riser communications raceways, and general-purpose communications raceways selected in accordance with Table 800.154(b), listed in accordance with 800.182, and installed in accordance with 800.113 and 362.24 through 362.56, where the requirements applicable to electrical nonmetallic tubing apply.
(~~N~~M) Temperature Limitations of Power-Limited and Non–Power-Limited Fire Alarm Cables.
The requirements of 310.14(A)(3) on the temperature limitation of conductors shall apply to power-limited fire alarm cables and non–power-limited fire alarms cables.
(~~O~~N) Identification of Equipment Grounding Conductors.
Equipment grounding conductors shall be identified in accordance with 250.119.
Exception: Conductors with green insulation shall be permitted to be used as ungrounded signal conductors for Types FPLP, FPLR, FPL, and substitute cables installed in accordance with 760.154(A).
(O) Cables for Power-limited Fire Alarm (PLFA) Circuits.
The listing and installation of cables for power limited fire alarm circuits shall comply with Part III and Article 7XX Parts I~~, III~~ and II~~V~~.

760.12 Uses Not Permitted. Cables and equipment shall not be installed in any hazardous (classified) location, except as permitted by other articles of this Code.

Informational Note: Hazardous locations are covered in Articles 500 through 516 and in Article 517 Part IV.

760.21 Access to Electrical Equipment Behind Panels Designed to Allow Access.
Access to electrical equipment shall not be denied by an accumulation of conductors and cables that prevents removal of panels, including suspended ceiling panels.

760.24 Mechanical Execution of Work.
(A) General.
Fire alarm circuits shall be installed in a neat workmanlike manner. Cables and conductors 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 supported by hardware, including straps, staples, hangers, cable ties listed and identified for securement and support, or similar fittings designed and installed so as not to damage the cable. The installation shall also comply with 300.4 and 300.11.
Informational Note: Paint, plaster, cleaners, abrasives, corrosive residues, or other contaminants might result in an undetermined alteration of PLFA and NPLFA cable properties.

(B) Circuit Integrity (CI) Cable.
Circuit integrity (CI) cables shall be supported at a distance not exceeding 610 mm (24 in.). Where located within 2.1 m (7 ft) of the floor in accordance with 760.53(A)(1) and 760.130(B)(1), as applicable, the cable shall be fastened in an approved manner at intervals of not more than 450 mm (18 in.). Cable supports and fasteners shall be steel.

760.25 Abandoned Cables.
The accessible portion of abandoned fire alarm cables shall be removed. Where cables are identified for future use with a tag, the tag shall be of sufficient durability to withstand the environment involved.

760.30 Fire Alarm Circuit Identification.
Fire alarm circuits shall be identified at terminal and junction locations in a manner that helps to prevent unintentional signals on fire alarm system circuit(s) during testing and servicing of other systems.

760.32 Fire Alarm Circuits Extending Beyond One Building.
Non–power-limited fire alarm circuits and power-limited fire alarm circuits that extend beyond one building and run outdoors shall meet the installation requirements of Parts II, III, and IV of Article 805 and shall meet the installation requirements of Part I of Article 300.

760.33 Supply-Side Overvoltage Protection.
A listed surge-protective device (SPD) shall be installed on the supply side of a fire alarm control panel in accordance with Part II of Article 242.

760.35 Fire Alarm Circuit Requirements.
Fire alarm circuits shall comply with 760.35(A) and (B).
(A) Non–Power-Limited Fire Alarm (NPLFA) Circuits.
See Parts I and II.
(B) Power-Limited Fire Alarm (PLFA) Circuits.
See Parts I and III.

Part II. Non–Power-Limited Fire Alarm (NPLFA) Circuits

760.41 NPLFA Circuit Power Source Requirements.
(A) Power Source.
The power source of non–power-limited fire alarm circuits shall comply with Chapters 1 through 4, and the output voltage shall be not more than 600 volts, nominal. The fire alarm circuit disconnect shall be permitted to be secured in the "on" position.
(B) Branch Circuit.
The branch circuit supplying the fire alarm equipment(s) shall supply no other loads. The location of the branch-circuit overcurrent protective device shall be permanently identified at the fire alarm control unit. The circuit disconnecting means shall have red identification, shall be accessible only to qualified personnel, and shall be identified as "FIRE ALARM CIRCUIT." The red identification shall not damage the overcurrent protective devices or obscure the

manufacturer's markings. This branch circuit shall not be supplied through ground-fault circuit interrupters or arc-fault circuit-interrupters.
Informational Note: See 210.8(A)(5), Exception, for receptacles in dwelling-unit unfinished basements that supply power for fire alarm systems.

760.43 NPLFA Circuit Overcurrent Protection.
Overcurrent protection for conductors 14 AWG and larger shall be provided in accordance with the conductor ampacity without applying the ampacity adjustment and correction factors of 310.14 to the ampacity calculation. Overcurrent protection shall not exceed 7 amperes for 18 AWG conductors and 10 amperes for 16 AWG conductors.
Exception: Where other articles of this Code permit or require other overcurrent protection.

760.45 NPLFA Circuit Overcurrent Device Location.
Overcurrent devices shall be located at the point where the conductor to be protected receives its supply.
Exception No. 1: Where the overcurrent device protecting the larger conductor also protects the smaller conductor.
Exception No. 2: Transformer secondary conductors. Non–power-limited fire alarm circuit conductors supplied by the secondary of a single-phase transformer that has only a 2-wire (single-voltage) secondary shall be permitted to be protected by overcurrent protection provided by the primary (supply) side of the transformer, provided the protection is in accordance with 450.3 and does not exceed the value determined by multiplying the secondary conductor ampacity by the secondary-to-primary transformer voltage ratio. Transformer secondary conductors other than 2-wire shall not be considered to be protected by the primary overcurrent protection.
Exception No. 3: Electronic power source output conductors. Non–power-limited circuit conductors supplied by the output of a single-phase, listed electronic power source, other than a transformer, having only a 2-wire (single-voltage) output for connection to non–power-limited circuits shall be permitted to be protected by overcurrent protection provided on the input side of the electronic power source, provided this protection does not exceed the value determined by multiplying the non–power-limited circuit conductor ampacity by the output-to-input voltage ratio. Electronic power source outputs, other than 2-wire (single voltage), connected to non–power-limited circuits shall not be considered to be protected by overcurrent protection on the input of the electronic power source.
Informational Note: A single-phase, listed electronic power supply whose output supplies a 2-wire (single-voltage) circuit is an example of a non–power-limited power source that meets the requirements of 760.41.

760.46 NPLFA Circuit Wiring.
Installation of non–power-limited fire alarm circuits shall be in accordance with 110.3(B), 300.7, 300.11, 300.15, 300.17, 300.19(B), and other appropriate articles of Chapter 3.
Exception No. 1: As provided in 760.48 through 760.53.
Exception No. 2: Where other articles of this Code require other methods.
760.48 Conductors of Different Circuits in Same Cable, Enclosure, or Raceway.
(A) Class 1 with NPLFA Circuits.
Class 1 and non–power-limited fire alarm circuits shall be permitted to occupy the same cable, enclosure, or raceway without regard to whether the individual circuits are alternating current or

direct current, provided all conductors are insulated for the maximum voltage of any conductor in the enclosure or raceway.

(B) Fire Alarm with Power-Supply Circuits.

Power-supply and fire alarm circuit conductors shall be permitted in the same cable, enclosure, or raceway only where connected to the same equipment.

760.49 NPLFA Circuit Conductors.

(A) Sizes and Use.

Only copper conductors shall be permitted to be used for fire alarm systems. Size 18 AWG and 16 AWG conductors shall be permitted to be used, provided they supply loads that do not exceed the ampacities given in Table 402.5 and are installed in a raceway, an approved enclosure, or a listed cable. Conductors larger than 16 AWG shall not supply loads greater than the ampacities given in 310.14, as applicable.

(B) Insulation.

Insulation on conductors shall be rated for the system voltage and not less than 600 volts. Conductors larger than 16 AWG shall comply with Article 310. Conductors 18 AWG and 16 AWG shall be Type KF-2, KFF-2, PAFF, PTFF, PF, PFF, PGF, PGFF, RFH-2, RFHH-2, RFHH-3, SF-2, SFF-2, TF, TFF, TFN, TFFN, ZF, or ZFF. Conductors with other types and thickness of insulation shall be permitted if listed for non–power-limited fire alarm circuit use.

Informational Note: For application provisions, see Table 402.3.

(C) Conductor Materials.

Conductors shall be solid or stranded copper.

Exception to (B) and (C): Wire Types PAF and PTF shall be permitted only for high-temperature applications between 90°C (194°F) and 250°C (482°F).

760.51 Number of Conductors in Cable Trays and Raceways, and Ampacity Adjustment Factors.

(A) NPLFA Circuits and Class 1 Circuits.

Where only non-power-limited fire alarm circuit and Class 1 circuit conductors are in a raceway, the number of conductors shall be determined in accordance with 300.17. The ampacity adjustment factors given in 310.15(C)(1) shall apply if such conductors carry continuous load in excess of 10 percent of the ampacity of each conductor.

(B) Power-Supply Conductors and NPLFA Circuit Conductors.

Where power-supply conductors and non-power-limited fire alarm circuit conductors are permitted in a raceway in accordance with 760.48, the number of conductors shall be determined in accordance with 300.17. The ampacity adjustment factors given in 310.15(C)(1) shall apply as follows:

1. To all conductors where the fire alarm circuit conductors carry continuous loads in excess of 10 percent of the ampacity of each conductor and where the total number of conductors is more than three
2. To the power-supply conductors only, where the fire alarm circuit conductors do not carry continuous loads in excess of 10 percent of the ampacity of each conductor and where the number of power-supply conductors is more than three

(C) Cable Trays.
Where fire alarm circuit conductors are installed in cable trays, they shall comply with 392.22 and 392.80(A).

760.53 Multiconductor NPLFA Cables.
Multiconductor non-power-limited fire alarm cables that meet the requirements of 760.176 shall be permitted to be used on fire alarm circuits operating at 150 volts or less and shall be installed in accordance with 760.53(A) and (B).
(A) NPLFA Wiring Method.
Multiconductor non-power-limited fire alarm circuit cables shall be installed in accordance with 760.53(A)(1), (A)(2), and (A)(3).

(1) In Raceways, Exposed on Ceilings or Sidewalls, or Fished in Concealed Spaces.
Cable splices or terminations shall be made in listed fittings, boxes, enclosures, fire alarm devices, or utilization equipment. Where installed exposed, cables shall be adequately supported and installed in such a way that maximum protection against physical damage is afforded by building construction such as baseboards, door frames, ledges, and so forth. Where located within 2.1 m (7 ft) of the floor, cables shall be securely fastened in an approved manner at intervals of not more than 450 mm (18 in.).

(2) Passing Through a Floor or Wall.
Cables shall be installed in metal raceway or rigid nonmetallic conduit where passing through a floor or wall to a height of 2.1 m (7 ft) above the floor, unless adequate protection can be afforded by building construction such as detailed in 760.53(A)(1), or unless an equivalent solid guard is provided.

(3) In Hoistways.
Cables shall be installed in rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit, liquidtight flexible nonmetallic conduit, or electrical metallic tubing where installed in hoistways.
Exception: As provided for in 620.21 for elevators and similar equipment.

(B) Applications of Listed NPLFA Cables.
The use of non–power-limited fire alarm circuit cables shall comply with 760.53(B)(1) through (B)(4).

(1) Ducts Specifically Fabricated for Environmental Air.
Multiconductor non–power-limited fire alarm circuit cables, Types NPLFP, NPLFR, and NPLF, shall not be installed exposed in ducts specifically fabricated for environmental air.
Informational Note: See 300.22(B).

(2) Other Spaces Used for Environmental Air (Plenums).
Cables installed in other spaces used for environmental air shall be Type NPLFP.
Exception No. 1: Types NPLFR and NPLF cables installed in compliance with 300.22©.
Exception No. 2: Other wiring methods in accordance with 300.22© and conductors in compliance with 760.49©.

Exception No. 3: Type NPLFP-CI cable shall be permitted to be installed to provide a 2-hour circuit integrity rated cable.

(3) Riser.
Cables installed in vertical runs and penetrating one or more floors, or cables installed in vertical runs in a shaft, shall be Type NPLFR. Floor penetrations requiring Type NPLFR shall contain only cables suitable for riser or plenum use.
Exception No. 1: Type NPLF or other cables that are specified in Chapter 3 and are in compliance with 760.49(C) and encased in metal raceway.
Exception No. 2: Type NPLF cables located in a fireproof shaft having firestops at each floor.
Informational Note: See 300.21 for firestop requirements for floor penetrations.
Exception No. 3: Type NPLF-CI cable shall be permitted to be installed to provide a 2-hour circuit integrity rated cable.

(4) Other Wiring Within Buildings.
Cables installed in building locations other than the locations covered in 760.53(B)(1), (B)(2), and (B)(3) shall be Type NPLF.
Exception No. 1: Chapter 3 wiring methods with conductors in compliance with 760.49(C).
Exception No. 2: Type NPLFP or Type NPLFR cables shall be permitted.
Exception No. 3: Type NPLFR-CI cable shall be permitted to be installed to provide a 2-hour circuit integrity rated cable.

Part III. Power-Limited Fire Alarm (PLFA) Circuits

760.121 Power Sources for PLFA Circuits.
(A) Power Source.
The power source for a power-limited fire alarm circuit shall be as specified in the following:
Informational Note No. 1: Tables 12(A) and 12(B) in Chapter 9 provide the listing requirements for power-limited fire alarm circuit sources.
Informational Note No. 2: See 210.8(A)(5), Exception, for receptacles in dwelling-unit unfinished basements that supply power for fire alarm systems.

1. A listed PLFA or Class 3 transformer
2. A listed PLFA or Class 3 power supply
3. Listed equipment marked to identify the PLFA power source

Informational Note No. 3: Examples of listed equipment are a fire alarm control panel with integral power source; a circuit card listed for use as a PLFA source, where used as part of a listed assembly; a current-limiting impedance, listed for the purpose or part of a listed product, used in conjunction with a non-power-limited transformer or a stored energy source, for example, storage battery, to limit the output current.

(B) Branch Circuit.
The branch circuit supplying the fire alarm equipment(s) shall comply with the following requirements:

1. The branch circuit shall supply no other loads.
2. The branch circuit shall not be supplied through ground-fault circuit interrupters or arc-fault circuit interrupters.

3. The location of the branch-circuit overcurrent protective device shall be permanently identified at the fire alarm control unit.
4. The circuit disconnecting means shall have red identification, shall be accessible only to qualified personnel, and shall be identified with the following words: "FIRE ALARM CIRCUIT." The red identification shall not damage the overcurrent protective devices or obscure the manufacturer's markings.
5. The fire alarm branch-circuit disconnecting means shall be permitted to be secured in the "on" position.

Informational Note: See 210.8(A)(5), Exception, for requirements on receptacles in dwelling-unit unfinished basements that supply power for fire alarm systems.

760.124 Circuit Marking.
The equipment supplying PLFA circuits shall be durably marked where plainly visible to indicate each circuit that is a power-limited fire alarm circuit.
Informational Note: See 760.130(A), Exception No. 3, where a power-limited circuit is to be reclassified as a non–power-limited circuit.

760.127 Wiring Methods on Supply Side of the PLFA Power Source.
Conductors and equipment on the supply side of the power source shall be installed in accordance with the appropriate requirements of Part II and Chapters 1 through 4. Transformers or other devices supplied from power-supply conductors shall be protected by an overcurrent device rated not over 20 amperes.
Exception: The input leads of a transformer or other power source supplying power-limited fire alarm circuits shall be permitted to be smaller than 14 AWG, but not smaller than 18 AWG, if they are not over 300 mm (12 in.) long and if they have insulation that complies with 760.49(B).

760.130 Wiring Methods and Materials on Load Side of the PLFA Power Source.
Fire alarm circuits on the load side of the power source shall be permitted to be installed using wiring methods and materials in accordance with 760.130(A), (B), or a combination of (A) and (B). Parts I and II of Article 722 shall apply.

(A) NPLFA Wiring Methods and Materials.
~~The~~ It shall be permitted to use of NPLFA wiring methods in accordance with 760.46, 760.49, or 760.53 for PLFA circuits ~~shall be permitted~~. Conductors shall be solid or stranded copper. Separation from electric light, power, Class 1, non-power-limited fire alarm circuit conductors, and medium-power network-powered broadband communications cables shall comply with 760.136.
Exception: The ampacity adjustment factors specified in 310.15(C)(1) shall not apply.

(B) PLFA Wiring Methods and Materials.
Power-limited fire alarm conductors and cables described in ~~760.179~~722.179 shall be installed as detailed in 722.135, 760.130(B)(1) through ~~,~~ ~~(B)(2), or~~ 760.130(B)(~~3~~4) ~~of this section and 300.7~~. Devices shall be installed in accordance with 110.3(B), 300.11(A), and 300.15.

(1) In Raceways, Exposed on Ceilings or Sidewalls, or Fished in Concealed Spaces.

Cable splices or terminations shall be made in listed fittings, boxes, enclosures, fire alarm devices, or utilization equipment. Where installed exposed, cables shall be adequately supported and installed in such a way that maximum protection against physical damage is afforded by building construction such as baseboards, door frames, ledges, and so forth. Where located within 2.1 m (7 ft) of the floor, cables shall be securely fastened in an approved manner at intervals of not more than 450 mm (18 in.).

(2) Passing Through a Floor or Wall.
Cables shall be installed in metal raceways or rigid nonmetallic conduit where passing through a floor or wall to a height of 2.1 m (7 ft) above the floor, unless adequate protection can be afforded by building construction such as detailed in 760.130(B)(1), or unless an equivalent solid guard is provided.

(3) Nonconcealed Spaces. Cables specified in Chapter 3 and meeting the requirements of 760.179(A) and (B) shall be permitted to be installed in nonconcealed spaces where the exposed length of cable does not exceed 3 m (10 ft).

(4) Portable Fire Alarm System. A portable fire alarm system provided to protect a stage or set when not in use shall be permitted to use wiring methods in accordance with 530.12.

~~(3) In Hoistways.~~
~~Cables shall be installed in rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit, or electrical metallic tubing where installed in hoistways.~~
~~*Exception: As provided for in 620.21 for elevators and similar equipment.*~~

760.133 Installation of Conductors and Equipment in Cables, Compartments, Cable Trays, Enclosures, Manholes, Outlet Boxes, Device Boxes, Raceways, and Cable Routing Assemblies for Power-Limited Fire Alarm Circuits.
Conductors and equipment for power-limited fire alarm circuits shall be installed in accordance with Article 722 Parts I and II, and 760.13~~5~~6 through 760.143.

~~**760.135 Installation of PLFA Cables in Buildings.**~~
~~Installation of power-limited fire alarm cables in buildings shall comply with 760.135(A) through (J).~~
~~(A) Listing.~~
~~PLFA cables installed in buildings shall be listed.~~
~~(B) Ducts Specifically Fabricated for Environmental Air.~~
~~The following cables shall be permitted in ducts specifically fabricated for environmental air as described in 300.22(B) if they are directly associated with the air distribution system:~~

1. ~~Type FPLP and Type FPLP-CI cables in lengths as short as practicable to perform the required function~~
2. ~~Type FPLP, Type FPLP-CI, Type FPLR, Type FPLR-CI, Type FPL, and Type FPL-CI cables installed in raceways that are installed in compliance with 300.22(B)~~

Commented [IR2]: This strikeout was in the Panel 3 FR Report

~~Informational Note: See NFPA 90A-2021, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 4.3.4.1 for information on fire protection of wiring installed in fabricated ducts.~~

~~(C) Other Spaces Used For Environmental Air (Plenums).~~
~~The following cables shall be permitted in other spaces used for environmental air as described in 300.22(C):~~

1. ~~Type FPLP cables~~
2. ~~Type FPLP cables installed in plenum communications raceways~~
3. ~~Type FPLP cables installed in plenum routing assemblies~~
4. ~~Type FPLP and Type FPLP-CI cables supported by open metallic cable trays or cable tray systems~~
5. ~~Type FPLP, Type FPLR, and Type FPL cables installed in raceways that are installed in compliance with 300.22(C)~~
6. ~~Type FPLP, Type FPLR, and Type FPL cables supported by solid bottom metal cable trays with solid metal covers in other spaces used for environmental air (plenums) as described in 300.22(C)~~
7. ~~Type FPLP, Type FPLR, and Type FPL cables installed in plenum communications raceways, riser communications raceways, or general-purpose communications raceways supported by solid bottom metal cable trays with solid metal covers in other spaces used for environmental air (plenums) as described in 300.22(C)~~

~~Informational Note: See 4.3.11.3.3 of NFPA 90A-2021, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, for information on fire protection of wiring installed in other spaces used for environmental air (plenums).~~
~~(D) Risers — Cables in Vertical Runs.~~
~~The following cables shall be permitted in vertical runs penetrating one or more floors and in vertical runs in a shaft:~~

1. ~~Types FPLP and FPLR cables~~
2. ~~Types FPLP and FPLR cables installed in the following:~~
    1. ~~Plenum communications raceways~~
    2. ~~Plenum cable routing assemblies~~
    3. ~~Riser communications raceways~~
    4. ~~Riser cable routing assemblies~~

~~Informational Note: See 300.21 for firestop requirements for floor penetrations.~~

~~(E) Risers — Cables in Metal Raceways.~~
~~The following cables shall be permitted in metal raceways in a riser having firestops at each floor:~~

1. ~~Types FPLP, FPLR, and FPL cables~~
2. ~~Types FPLP, FPLR, and FPL cables installed in the following:~~
    1. ~~Plenum communications raceways~~

    2. ~~Riser communications raceways~~
    3. ~~General-purpose communications raceways~~

~~Informational Note: See 300.21 for firestop requirements for floor penetrations.~~

~~(F) Risers — Cables in Fireproof Shafts.~~
~~The following cables shall be permitted to be installed in fireproof riser shafts having firestops at each floor:~~

1. ~~Types FPLP, FPLR, and FPL cables~~
2. ~~Types FPLP, FPLR, and FPL cables installed in the following:~~
    1. ~~Plenum communications raceways~~
    2. ~~Plenum cable routing assemblies~~
    3. ~~Riser communications raceways~~
    4. ~~Riser cable routing assemblies~~
    5. ~~General-purpose communications raceways~~
    6. ~~General-purpose cable routing assemblies~~

~~Informational Note: See 300.21 for firestop requirements for floor penetrations.~~

~~(G) Risers — One- and Two-Family Dwellings.~~
~~The following cables shall be permitted in one- and two-family dwellings:~~

1. ~~Types FPLP, FPLR, and FPL cables~~
2. ~~Types FPLP, FPLR, and FPL cables installed in the following:~~
    1. ~~Plenum communications raceways~~
    2. ~~Plenum cable routing assemblies~~
    3. ~~Riser communications raceways~~
    4. ~~Riser cable routing assemblies~~
    5. ~~General-purpose communications raceways~~
    6. ~~General-purpose cable routing assemblies~~

~~(H) Other Building Locations.~~
~~The following cables shall be permitted to be installed in building locations other than the locations covered in 770.113(B) through (H):~~

1. ~~Types FPLP, FPLR, and FPL cables~~
2. ~~Types FPLP, FPLR, and FPL cables installed in the following:~~
    1. ~~Plenum communications raceways~~
    2. ~~Plenum cable routing assemblies~~
    3. ~~Riser communications raceways~~
    4. ~~Riser cable routing assemblies~~
    5. ~~General-purpose communications raceways~~
    6. ~~General-purpose cable routing assemblies~~
3. ~~Types FPLP, FPLR, and FPL cables installed in a raceway of a type recognized in Chapter 3~~

~~(I) Nonconcealed Spaces.~~
~~Cables specified in Chapter 3 and meeting the requirements of 760.179(A) and (B) shall be permitted to be installed in nonconcealed spaces where the exposed length of cable does not exceed 3 m (10 ft).~~
~~(J) Portable Fire Alarm System.~~
~~A portable fire alarm system provided to protect a stage or set when not in use shall be permitted to use wiring methods in accordance with 530.22.~~

760.136 Separation from Electric Light, Power, Class 1, NPLFA, and Medium-Power Network-Powered Broadband Communications Circuit Conductors.

Commented [IR3]: Based on the Panel 3 FR report this section was supposed to be moved to Article 722. However, it is now supposed to be moved back here so it remains as is.

(A) General.
Power-limited fire alarm circuit cables and conductors shall not be placed in any cable, cable tray, compartment, enclosure, manhole, outlet box, device box, raceway, or similar fitting with conductors of electric light, power, Class 1, non–power-limited fire alarm circuits, and medium-power network-powered broadband communications circuits unless permitted by 760.136(B) through (G).

(B) Separated by Barriers.
Power-limited fire alarm circuit cables shall be permitted to be installed together with Class 1, non–power-limited fire alarm, and medium-power network-powered broadband communications circuits where they are separated by a barrier.

(C) Raceways Within Enclosures.
In enclosures, power-limited fire alarm circuits shall be permitted to be installed in a raceway within the enclosure to separate them from Class 1, non–power-limited fire alarm, and medium-power network-powered broadband communications circuits.

(D) Associated Systems Within Enclosures.
Power-limited fire alarm conductors in compartments, enclosures, device boxes, outlet boxes, or similar fittings shall be permitted to be installed with electric light, power, Class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuits where they are introduced solely to connect the equipment connected to power-limited fire alarm circuits, and shall comply with either of the following conditions:

1. The electric light, power, Class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuit conductors are routed to maintain a minimum of 6 mm (1⁄4 in.) separation from the conductors and cables of power-limited fire alarm circuits.
2. The circuit conductors operate at 150 volts or less to ground and also comply with one of the following conditions:
   a) The fire alarm power-limited circuits are installed using Type FPL, Type FPLR, Type FPLP, or permitted substitute cables if these power-limited cable conductors extending beyond the jacket are separated by a minimum of 6 mm (1⁄4 in.) or by a nonconductive sleeve or nonconductive barrier from all other conductors.

b) The power-limited fire alarm circuit conductors are installed as non-power-limited circuits in accordance with 760.46.

(E) Enclosures with Single Opening.
Power-limited fire alarm circuit conductors entering compartments, enclosures, device boxes, outlet boxes, or similar fittings shall be permitted to be installed with electric light, power, Class 1, non–power-limited fire alarm, and medium-power network-powered broadband communications circuits where they are introduced solely to connect the equipment connected to power-limited fire alarm circuits or to other circuits controlled by the fire alarm system to which the other conductors in the enclosure are connected. Where power-limited fire alarm circuit conductors must enter an enclosure that is provided with a single opening, they shall be permitted to enter through a single fitting (such as a tee), provided the conductors are separated from the conductors of the other circuits by a continuous and firmly fixed nonconductor, such as flexible tubing.

~~**(F) In Hoistways.**~~
~~In hoistways, power-limited fire alarm circuit conductors shall be installed in rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit, liquidtight flexible nonmetallic conduit, or electrical metallic tubing. For elevators or similar equipment, these conductors shall be permitted to be installed as provided in 620.21.~~

Commented [IR4]: This strikeout was in the Panel 3 FR Report

(~~G~~F) Where Protected.
PLFA circuits shall be permitted to be installed together with the conductors of electric light, power, Class 1, non–power-limited fire alarm, and medium-power network-powered broadband communications circuits where they are installed using NPFLA wiring methods and materials in accordance with Part II of Article 760 and are protected by an approved method.

(~~H~~G) Other Applications.
For other applications, power-limited fire alarm circuit conductors shall be separated by at least 50 mm (2 in.) from conductors of any electric light, power, Class 1, non–power-limited fire alarm, or medium-power network-powered broadband communications circuits unless one of the following conditions is met:

1. Either (a) all of the electric light, power, Class 1, non–power-limited fire alarm, and medium-power network-powered broadband communications circuit conductors or (b) all of the power-limited fire alarm circuit conductors are in a raceway or in metal-sheathed, metal-clad, nonmetallic-sheathed, or Type UF cables.
2. All of the electric light, power, Class 1, non–power-limited fire alarm, and medium-power network-powered broadband communications circuit conductors are permanently separated from all of the power-limited fire alarm circuit conductors by a continuous and firmly fixed nonconductor, such as porcelain tubes or flexible tubing, in addition to the insulation on the conductors.

760.139 Installation of Conductors of Different PLFA Circuits, Class 2, Class 3, and Communications Circuits in the Same Cable, Enclosure, Cable Tray, Raceway, or Cable Routing Assembly.

Commented [IR5]: Based on the Panel 3 FR report this section was supposed to be moved to Article 722. However, it is now supposed to be moved back here so it remains as is.

(A) Two or More PLFA Circuits.
Cable and conductors of two or more power-limited fire alarm circuits shall be permitted within the same cable, enclosure, cable tray, raceway, or cable routing assembly.

(B) Class 2 Circuits with PLFA Circuits.
Conductors of one or more Class 2 circuits shall be permitted within the same cable, enclosure, cable tray, raceway, or cable routing assembly with conductors of power-limited fire alarm circuits if the insulation of the Class 2 circuit conductors in the cable, enclosure, raceway, or cable routing assembly is at least that required by the power-limited fire alarm circuits.

(C) Class 3 and Communications Circuits with PLFA Circuits.
Cable and conductors of Class 3 and communications circuits shall be permitted within the same cable, enclosure, cable tray, raceway, or cable routing assembly with cables and conductors of power-limited fire alarm circuits.

(D) Low-Power Network-Powered Broadband Communications Cables and PLFA Cables.
Low-power network-powered broadband communications circuits shall be permitted in the same enclosure, cable tray, raceway, or cable routing assembly with PLFA cables.

(E) Audio System Circuits and PLFA Circuits.
Audio system circuits described in 640.9(C) and installed using Class 2 or Class 3 wiring methods in compliance with 725.133 and 725.154 shall not be permitted to be installed in the same cable, cable tray, raceway, or cable routing assembly with power-limited conductors or cables.

~~**760.142 Conductor Size.**~~
~~Conductors of 26 AWG shall be permitted only where spliced with a connector listed as suitable for 26 AWG to 24 AWG or larger conductors that are terminated on equipment or where the 26 AWG conductors are terminated on equipment listed as suitable for 26 AWG conductors. Single conductors shall not be smaller than 18 AWG.~~

Commented [IR6]: This strikeout was in the Panel 3 FR Report

~~760.143 Support of Conductors.~~
~~Power-limited fire alarm circuit conductors shall not be strapped, taped, or attached by any means to the exterior of any conduit or other raceway as a means of support.~~

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760.145 Current-Carrying Continuous Line-Type Fire Detectors.

(A) Application.
Listed continuous line-type fire detectors, including insulated copper tubing of pneumatically operated detectors, employed for both detection and carrying signaling currents shall be permitted to be used in power-limited circuits.

(B) Installation.
Continuous line-type fire detectors shall be installed in accordance with 760.124 through 760.130 and 760.133.

~~760.154 Applications of Listed PLFA Cables.~~

~~PLFA cables shall comply with the requirements described in Table 760.154 or where cable substitutions are made as shown in 760.154(A). Where substitute cables are installed, the wiring requirements of Article 760, Parts I and III, shall apply. Types FPLP-CI, FPLR-CI, and FPL-CI cables shall be permitted to be installed to provide 2-hour circuit integrity rated cables.~~

~~Table 760.154 Applications of Listed PLFA Cables in Buildings~~

~~Applications~~		~~Cable Type~~		
		~~FPLP & FPLP-CI~~	~~FPLR & FPLR-CI~~	~~FPL & FPL-CI~~
~~In fabricated ducts as described in 300.22(B)~~	~~In fabricated ducts~~	~~Y*~~	~~N~~	~~N~~
	~~In metal raceway that complies with 300.22(B)~~	~~Y*~~	~~Y*~~	~~Y*~~
~~In other spaces used for environmental air as described in 300.22(C)~~	~~In other spaces used for environmental air~~	~~Y*~~	~~N~~	~~N~~
	~~In metal raceway that complies with 300.22(C)~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In plenum communications raceways~~	~~Y*~~	~~N~~	~~N~~
	~~In plenum cable routing assemblies~~	~~Y*~~	~~N~~	~~N~~
	~~Supported by open metal cable trays~~	~~Y*~~	~~N~~	~~N~~
	~~Supported by solid bottom metal cable trays with solid metal covers~~	~~Y*~~	~~Y*~~	~~Y*~~
~~In risers~~	~~In vertical runs~~	~~Y*~~	~~Y*~~	~~N~~
	~~In metal raceways~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In fireproof shafts~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In plenum communications raceways~~	~~Y*~~	~~Y*~~	~~N~~
	~~In plenum cable routing assemblies~~	~~Y*~~	~~Y*~~	~~N~~
	~~In riser communications raceways~~	~~Y*~~	~~Y*~~	~~N~~
	~~In riser cable routing assemblies~~	~~Y*~~	~~Y*~~	~~N~~
	~~In one- and two-family dwellings~~	~~Y*~~	~~Y*~~	~~Y*~~
~~Within buildings in other than air-handling spaces and risers~~	~~General~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~Supported by cable trays~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In any raceway recognized in Chapter 3~~	~~Y*~~	~~Y*~~	~~Y*~~

Commented [IR8]: This strikeout was in the Panel 3 FR Report

~~Applications~~		~~Cable Type~~		
		~~FPLP & FPLP-CI~~	~~FPLR & FPLR-CI~~	~~FPL & FPL-CI~~
	~~In plenum communications raceway~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In plenum cable routing assemblies~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In riser communications raceways~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In riser cable routing assemblies~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In general-purpose communications raceways~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In general-purpose cable routing assemblies~~	~~Y*~~	~~Y*~~	~~Y*~~

~~Note:~~
~~"N" indicates that the cable type shall not be permitted to be installed in the application.~~
~~"Y*" indicates that the cable type shall be permitted to be installed in the application subject to the limitations described in 760.130 through 760.145.~~

~~**(A) Fire Alarm Cable Substitutions.**~~
~~The substitutions for fire alarm cables listed in Table 760.154(A) and illustrated in Figure 760.154(A) shall be permitted. Where substitute cables are installed, the wiring requirements of Article 760, Parts I and III, shall apply.~~
~~Informational Note: For information on communications cables (CMP, CMR, CMG, CM), see 805.179.~~

~~**Figure 760.154(A) Cable Substitution Hierarchy.**~~

~~**Table 760.154(A) Cable Substitutions**~~

~~Cable Type~~	~~Permitted Substitutions~~
~~FPLP~~	~~CMP~~
~~FPLR~~	~~CMP, FPLP, CMR~~
~~FPL~~	~~CMP, FPLP, CMR, FPLR, CMG, CM~~

Part IV. Listing Requirements

760.176 Listing and Marking of NPLFA Cables.
Non-power-limited fire alarm cables installed as wiring within buildings shall be listed in accordance with 760.176(A) and (B) and as being resistant to the spread of fire in accordance with 760.176(C) through (F), and shall be marked in accordance with 760.176(G). Cable used in a wet location shall be listed for use in wet locations or have a moisture-impervious metal sheath. Non-power-limited fire alarm cables shall have a temperature rating of not less than 60°C (140°F). Non-power-limited fire alarm cables shall be permitted to contain optical fibers.
Informational Note: See UL 1425, *Standard for Cables for Non-Power-Limited Fire-Alarm Circuits*, for information on non-power-limited fire alarm cables.

(A) NPLFA Conductor Materials.
Conductors shall be 18 AWG or larger solid or stranded copper.

(B) Insulated Conductors.
Insulation on conductors shall be rated for the system voltage and not less than 600 V. Insulated conductors 14 AWG and larger shall be one of the types listed in Table 310.4(1) or one that is identified for this use. Insulated conductors 18 AWG and 16 AWG shall be in accordance with 760.49.

(C) Type NPLFP.
Type NPLFP non-power-limited fire alarm cable for use in other space used for environmental air shall be listed as being suitable for use in other space used for environmental air as described in 300.22(C) and shall also be listed as having adequate fire-resistant and low smoke–producing characteristics.
Informational Note: One method of defining a cable that is low-smoke producing cable and fire-resistant cable is that the cable exhibits a maximum peak optical density of 0.50 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.52 m (5 ft) or less when tested in accordance with NFPA 262-2019, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*.

(D) Type NPLFR.
Type NPLFR non–power-limited fire alarm riser cable shall be listed as being suitable for use in a vertical run in a shaft or from floor to floor and shall also be listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor.
Informational Note: One method of defining fire-resistant characteristics capable of preventing the carrying of fire from floor to floor is that the cables pass ANSI/UL 1666-2012, *Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts*.

(E) Type NPLF.
Type NPLF non–power-limited fire alarm cable shall be listed as being suitable for general-purpose fire alarm use, with the exception of risers, ducts, plenums, and other space used for environmental air, and shall also be listed as being resistant to the spread of fire.
Informational Note: One method of defining *resistant to the spread of fire* is that the cables do not spread fire to the top of the tray in the "UL Flame Exposure, Vertical Tray Flame Test" in ANSI/UL 1685-2010, *Standard for Safety for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*. The smoke measurements in the test method are not applicable.
Another method of defining *resistant to the spread of fire* is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the CSA "Vertical Flame Test — Cables in Cable Trays," as described in CSA C22.2 No. 0.3-M-2001, *Test Methods for Electrical Wires and Cables*.

(F) Fire Alarm Circuit Integrity (CI) Cable, Fire-Resistive Cable System, or Electrical Circuit Protective System.
Cables that are used for survivability of critical circuits under fire conditions shall be listed and meet the requirements of 760.176(F)(1), (F)(2), or (F)(3).
Informational Note: See 12.4.3 and 12.4.4 of *NFPA 72*-2019, *National Fire Alarm and Signaling Code*, for fire alarm circuit integrity (CI) cable, fire-resistive cable systems, or electrical circuit protective systems that might be used for fire alarm circuits to comply with the survivability requirements to maintain the circuit's electrical function during fire conditions for a defined period of time.

(1) Circuit Integrity (CI) Cables.
Circuit integrity (CI) cables specified in 760.176(C), (D), and (E) and used for survivability of critical circuits shall be marked for an additional classification using the suffix "-CI." In order to

maintain its listed fire-resistive rating, CI cables shall only be installed in free air in accordance with 760.24(B). CI cables shall only be permitted to be installed in a raceway where specifically listed and marked as part of an electrical circuit protective fire-resistive cable system as covered in 760.176(F)(2). CI cables shall only be permitted to be installed in a raceway where specifically listed and marked as part of an electrical circuit protective system as covered in 760.176(F)(2). Circuit Integrity (CI) cables shall only be permitted to be installed in a raceway where specifically listed and marked as part of a fire-resistive cable system as covered in 760.176(F)(2).

Commented [IR9]: This was in the Panel 3 FR Report.

Informational Note: One method of defining CI cable is by establishing a rating when tested in accordance with UL 2196, *Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables*, as specified in UL 1425, *Cables for Non-Power-Limited Fire-Alarm Circuits*. UL guide information for non-power-limited fire alarm circuits (HNHT) contains information for identifying the cable and its installation limitations to maintain the fire-resistive rating.

(2) Fire-Resistive Cable Systems.

Cables specified in 760.176(C), (D), (E), and (F)(1) that are part of a fire-resistive cable system shall be identified with the system identifier and hourly rating marked on the protectant or the smallest unit container and installed in accordance with the listing of the system.

Informational Note: One method of defining a fire-resistive cable system is by establishing a rating when tested in accordance with UL 2196, *Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables*. UL guide information for electrical circuit integrity systems (FHIT) contains information for identifying the system and its installation limitations to maintain a minimum fire-resistive rating.

(3) Electrical Circuit Protective System.

Protectants for cables specified in 760.176(C), (D), and (E) that are part of an electrical circuit protective system shall be identified with the protective system identifier and hourly rating marked on the protectant or the smallest unit container and installed in accordance with the listing of the protective system.

Informational Note: One method of defining an electrical circuit protective system is by establishing a rating when tested in accordance with UL 1724, *Fire Tests for Electrical Circuit Protective Systems*. UL guide information for electrical circuit integrity systems (FHIT) contains information for identifying the system and its installation limitations to maintain the fire-resistive rating.

(G) NPLFA Cable Markings.

Multiconductor non–power-limited fire alarm cables shall be marked in accordance with Table 760.176(G). Non–power-limited fire alarm circuit cables shall be permitted to be marked with a maximum usage voltage rating of 150 volts. Cables that are listed for circuit integrity shall be identified with the suffix "-CI" as defined in 760.176(F). The temperature rating shall be marked on the jacket of NPLFA cables that have a temperature rating exceeding 60°C (140°F). The jacket of NPLFA cables shall be marked with the conductor size.

Informational Note: Cable types are listed in descending order of fire performance.

Table 760.176(G) NPLFA Cable Markings

Cable Marking	Type	Reference
NPLFP	Non–power-limited fire alarm circuit cable for use in "other space used for environmental air"	760.176(C) and (G)
NPLFR	Non–power-limited fire alarm circuit riser cable	760.176(D) and (G)
NPLF	Non–power-limited fire alarm circuit cable	760.176(E) and (G)

Note 1: Cables identified in 760.176(C), (D), and (E) and meeting the requirements for circuit integrity shall have the additional classification using the suffix "-CI" (for example, NPLFP-CI, NPLFR-CI, and NPLF-CI).
Note 2: Cables containing optical fibers shall be provided with the suffix "-OF".

Commented [IR10]: This was in the Panel FR Report.

760.179 Listing and Marking of PLFA Cables and Insulated Continuous Line-Type Fire Detectors.

Commented [IR11]: Changes to this section were part of the Panel 3 FR Report.

~~PLFA cables installed as wiring within buildings shall be listed as being resistant to the spread of fire and other criteria in accordance with 760.179(A) through (I) and shall be marked in accordance with 760.179(J).~~ Insulated continuous line-type fire detectors shall be listed in accordance with 760.179(~~K~~A) through (D). Cable used in a wet location shall be listed for use in wet locations or have a moisture-impervious metal sheath.

~~Informational Note: See UL 1424, *Cables for Power-Limited Fire-Alarm Circuits*, for applicable requirements for listing of power-limited fire alarm cable.~~

(A) The cable shall be listed as being resistant to the spread of fire in accordance with 722.179(A)(1), (2) and (3)

(B) The cable shall have a voltage rating of not less than 300 volts. The cable shall have a temperature rating of not less than 60°C (140°F).

(C) The cable shall be marked with a fire resistance type FPLP, FPLR or FPL in accordance with 722.179(B). The voltage rating shall not be marked on the cable. The temperature rating shall be marked on the jacket that have a temperature rating exceeding 60°C (140°F). The jacket of PLFA cables shall be marked with the conductor size.

Informational Note: Voltage ratings on cables may be misinterpreted to suggest that the cables may be suitable for Class 1, electric light, and power applications.

Exception: Voltage markings shall be permitted where the cable has multiple listings and voltage marking is required for one or more of the listings.

(D) The cable jacket compound shall have a high degree of abrasion resistance.

~~(A) Conductor Materials.~~
~~Conductors shall be solid or stranded copper.~~
~~(B) Conductor Size.~~

~~The size of conductors in a multiconductor cable shall not be smaller than 26 AWG. Single conductors shall not be smaller than 18 AWG.~~

~~(C) Voltage and Temperature Ratings.~~

~~The cable shall have a voltage rating of not less than 300 volts. The cable shall have a temperature rating of not less than 60°C (140°F).~~

~~(D) Type FPLP.~~

~~Type FPLP power-limited fire alarm plenum cable shall be listed as being suitable for use in ducts, plenums, and other space used for environmental air and shall also be listed as having adequate fire-resistant and low smoke-producing characteristics.~~

~~Informational Note: One method of defining a cable that is low-smoke producing cable and fire-resistant cable is that the cable exhibits a maximum peak optical density of 0.50 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.52 m (5 ft) or less when tested in accordance with NFPA 262-2019, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*.~~

~~(E) Type FPLR.~~

~~Type FPLR power-limited fire alarm riser cable shall be listed as being suitable for use in a vertical run in a shaft or from floor to floor and shall also be listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor.~~

~~Informational Note: One method of defining fire-resistant characteristics capable of preventing the carrying of fire from floor to floor is that the cables pass the requirements of ANSI/UL 1666-2012, *Standard Test for Flame Propagation Height of Electrical and Optical-Fiber Cable Installed Vertically in Shafts*.~~

~~(F) Type FPL.~~

~~Type FPL power-limited fire alarm cable shall be listed as being suitable for general-purpose fire alarm use, with the exception of risers, ducts, plenums, and other spaces used for environmental air, and shall also be listed as being resistant to the spread of fire.~~

~~Informational Note: One method of defining *resistant to the spread of fire* is that the cables do not spread fire to the top of the tray in the "UL Flame Exposure, Vertical Tray Flame Test" in ANSI/UL 1685-2012, *Standard for Safety for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*. The smoke measurements in the test method are not applicable.~~

~~Another method of defining *resistant to the spread of fire* is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the CSA "Vertical Flame Test — Cables in Cable Trays," as described in CSA C22.2 No. 0.3-M-2001, *Test Methods for Electrical Wires and Cables*.~~

~~(G) Fire Alarm Circuit Integrity (CI) Cable, Fire-Resistive Cable System, or Electrical Circuit Protective System.~~

~~Cables that are used for survivability of critical circuits under fire conditions shall be listed and meet the requirements of 760.179(G)(1), (G)(2), or (G)(3).~~

~~Informational Note: See 12.4.3 and 12.4.4 of *NFPA 72-2019*, *National Fire Alarm and Signaling Code*, for fire alarm circuit integrity (CI) cable, fire-resistive cable systems, or electrical circuit protective systems that might be used for fire alarm circuits to comply with the survivability requirements to maintain the circuit's electrical function during fire conditions for a defined period of time.~~

~~(1) Circuit Integrity (CI) Cables.~~

~~Circuit integrity (CI) cables specified in 760.179(D), (E), (F), and (H) and used for survivability of critical circuits shall have an additional classification using the suffix "-CI." CI cables shall only be permitted to be installed in a raceway where specifically listed and marked as part of a fire-resistive system as covered in 760.179(G)(2).~~

~~(2) Electrical Circuit Protective System.~~

~~Cables specified in 760.179(D), (E), (F), (H), and (G)(1) that are part of an electrical circuit protective system shall be identified with the protective system number and hourly rating printed on the outer jacket of the cable and installed in accordance with the listing of the protective system.~~

~~(H) Coaxial Cables.~~

~~Coaxial cables shall be permitted to use 30 percent conductivity copper-covered steel center conductor wire and shall be listed as Type FPLP, FPLR, or FPL cable.~~

~~(I) Cables Containing Optical Fibers.~~

~~Composite optical fiber cables shall be listed as electrical cables based on the type of electrical conductors.~~

~~(J) Cable Marking.~~

~~The cable shall be marked in accordance with Table 760.179(J). The voltage rating shall not be marked on the cable. Cables that are listed for circuit integrity shall be identified with the suffix "-CI" as defined in 760.179(G). The temperature rating shall be marked on the jacket of PLFA cables that have a temperature rating exceeding 60°C (140°F). The jacket of PLFA cables shall be marked with the conductor size.~~

~~Informational Note No. 1: Voltage ratings on cables might be misinterpreted to suggest that the cables might be suitable for Class 1, electric light, and power applications.~~

~~Exception: Voltage markings shall be permitted where the cable has multiple listings and voltage marking is required for one or more of the listings.~~

~~Table 760.179(J) Cable Markings~~

~~**Cable Marking**~~	~~**Type**~~
~~FPLP~~	~~Power-limited fire alarm plenum cable~~
~~FPLR~~	~~Power-limited fire alarm riser cable~~
~~FPL~~	~~Power-limited fire alarm cable~~

~~Notes:~~

~~1. Cables identified in 760.179(D), (E), and (F) as meeting the requirements for circuit integrity shall have the additional classification using the suffix "-CI" (for example, FPLP-CI, FPLR-CI, and FPL-CI).~~

~~2. Cables containing optical fibers shall be provided with the suffix "-OF".~~

~~Informational Note No. 2: Cable types are listed in descending order of fire performance.~~

~~(K) Insulated Continuous Line-Type Fire Detectors.~~

~~Insulated continuous line-type fire detectors shall be rated in accordance with 760.179(C), listed as being resistant to the spread of fire in accordance with 760.179(D) through (F), and marked in accordance with 760.179(J), and the jacket compound shall have a high degree of abrasion resistance.~~

Article 770 Optical Fiber Cables
Part I. General
770.1 Scope.
This article covers the installation of optical fiber cables. This article does not cover the construction of optical fiber cables.
770.3 Other Articles.
Installations of optical fiber cables shall comply with 770.3(A) through (D). Only those sections of Chapter 2 and Article 300 referenced in this article shall apply to optical fiber cables.
~~(A) Hazardous (Classified) Locations.~~
~~Listed optical fiber cables shall be permitted to be installed in hazardous (classified) locations. The cables shall be sealed in accordance with 501.15, 502.15, 505.16, or 506.16, as applicable.~~
(~~B~~A) Cables in Ducts for Dust, Loose Stock, or Vapor Removal.
The requirements of 300.22(A) for wiring systems shall apply to conductive optical fiber cables.
(~~C~~B) Hybrid Cables.
Hybrid optical fiber cables shall be classified as electrical cables in accordance with the type of electrical conductors. They shall be constructed, listed, and marked in accordance with the appropriate article for each type of electrical cable.

(C) Optical Fiber Cables within Buildings. The listing and installation of optical fiber cables within buildings shall comply with Part V and Article 722 Parts I and II.

(D) Vertical Support for Fire-Resistive Cables.
Vertical installations of circuit integrity (CI) cables installed in a raceway or cables of fire-resistive cable systems shall be installed in accordance with their listing.

7XX.12 Uses Not Permitted. Cables shall not be installed in any hazardous (classified) location, except as permitted by other articles of this Code.

Informational Note: Hazardous locations are covered in Articles 500 through 516 and in Article 517 Part IV.

770.21 Access to Electrical Equipment Behind Panels Designed to Allow Access.
Access to electrical equipment shall not be denied by an accumulation of optical fiber cables that prevents removal of panels, including suspended ceiling panels.

770.24 Mechanical Execution of Work.
(A) General.
Optical fiber cables 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 listed and identified for securement and support, hangers, or similar fittings, designed and installed so as not to damage the cable. The installation shall also conform to 300.4 and 300.11. Plenum 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.
Informational Note No. 1: See ANSI/NECA/FOA 301-2016, *Standard for Installing and Testing Fiber Optic Cables*, ANSI/TIA-568.0-D-2015, *Generic Telecommunications Cabling for*

Customer Premises, and ANSI/TIA 568.3-D-2016, *Optical Fiber Cabling and Components Standard*, for accepted industry practices.

Informational Note No. 2: See NFPA 90A-2021, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, for discrete combustible components installed in accordance with 300.22(C).

Informational Note No. 3: Paint, plaster, cleaners, abrasives, corrosive residues, or other contaminants may result in an undetermined alteration of optical fiber cable properties.

(B) Circuit Integrity (CI) Cable.

Circuit integrity (CI) cable shall be supported at a distance not exceeding 610 mm (24 in.).Cable shall be secured to the noncombustible surface of the building structure. Cable supports and fasteners shall be steel.

770.25 Abandoned Cables.

The accessible portion of abandoned optical fiber cables shall be removed. Where cables are identified for future use with a tag, the tag shall be of sufficient durability to withstand the environment involved.

770.26 Spread of Fire or Products of Combustion.

Installations of optical fiber cables and communications raceways in hollow spaces, vertical shafts, and ventilation or air-handling ducts shall be made so that the possible spread of fire or products of combustion will not be substantially increased. Openings around penetrations of optical fiber cables and communications raceways through fire-resistant–rated walls, partitions, floors, or ceilings shall be firestopped using approved methods to maintain the fire resistance rating.

Informational Note: Directories of electrical construction materials published by qualified testing laboratories contain many listing installation restrictions necessary to maintain the fire-resistive rating of assemblies where penetrations or openings are made. Building codes also contain restrictions on membrane penetrations on opposite sides of a fire resistance–rated wall assembly. An example is the 600-mm (24-in.) minimum horizontal separation that usually applies between boxes installed on opposite sides of the wall. Assistance in complying with 770.26 can be found in building codes, fire resistance directories, and product listings.

770.27 Temperature Limitation of Optical Fiber Cables.

No optical fiber cable shall be used in such a manner that its operating temperature exceeds that of its rating.

Part II. Cables Outside and Entering Buildings

770.44 Overhead (Aerial) Optical Fiber Cables.

Overhead optical fiber cables containing a non–current-carrying metallic member entering buildings shall comply with 800.44(A) and (B).

(A) On Poles and In-Span.

Where outside plant optical fiber cables and electric light or power conductors are supported by the same pole or are run parallel to each other in-span, the conditions described in 770.44(A)(1) through (A)(4) shall be met.

(1) Relative Location.

Where practicable, the outside plant optical fiber cables shall be located below the electric light or power conductors.

(2) Attachment to Cross-Arms.

Attachment of outside plant optical fiber cables to a cross-arm that carries electric light or power conductors shall not be permitted.

(3) Climbing Space.
The climbing space through outside plant optical fiber cables shall comply with the requirements of 225.14(D).
(4) Clearance.
Supply service drops and sets of overhead service conductors of 0 to 750 volts running above and parallel to optical fiber cable service drops shall have a minimum separation of 300 mm (12 in.) at any point in the span, including the point of their attachment to the building. Clearance of not less than 1.0 m (40 in.) shall be maintained between the two services at the pole.
(B) Above Roofs.
Outside plant optical fiber cables shall have a vertical clearance of not less than 2.5 m (8 ft) from all points of roofs above which they pass.
Exception No. 1: The requirement of 770.44(B) shall not apply to auxiliary buildings such as garages and the like.
Exception No. 2: A reduction in clearance above only the overhanging portion of the roof to not less than 450 mm (18 in.) shall be permitted if (1) not more than 1.2 m (4 ft) of optical fiber cable service drop cable passes above the roof overhang, and (2) the cable is terminated at a through- or above-the-roof raceway or approved support.
Exception No. 3: Where the roof has a slope of not less than 100 mm in 300 mm (4 in. in 12 in.), a reduction in clearance to not less than 900 mm (3 ft) shall be permitted.
Informational Note: See ANSI/IEEE C2-2017, *National Electric Safety Code, Part 2, Safety Rules for Overhead Lines*, for additional information regarding overhead wires and cables.
770.47 Underground Optical Fiber Cables Entering Buildings.
Underground optical fiber cables entering buildings shall comply with 770.47(A) and (B).
(A) Underground Systems with Electric Light, Power, Class 1, or Non–Power-Limited Fire Alarm Circuit Conductors.
Underground conductive optical fiber cables entering buildings with electric light, power, Class 1, or non–power-limited fire alarm circuit conductors in a raceway, handhole enclosure, or manhole shall be located in a section separated from such conductors by means of brick, concrete, or tile partitions or by means of a suitable barrier.
(B) Direct-Buried Cables and Raceways.
Direct-buried conductive optical fiber cables shall be separated by at least 300 mm (12 in.) from conductors of any electric light, power, non-power-limited fire alarm circuit conductors, or Class 1 circuit.
Exception No. 1: Separation shall not be required where the electric service conductors are installed in raceways or have metal cable armor.
Exception No. 2: Separation shall not be required where electric light or power branch-circuit or feeder conductors, non-power-limited fire alarm circuit conductors, or Class 1 circuit conductors are installed in a raceway or in metal-sheathed, metal-clad, or Type UF or Type USE cables.
770.48 Unlisted Cables Entering Buildings.
(A) Conductive and Nonconductive Cables.
Unlisted conductive and nonconductive outside plant optical fiber cables shall be permitted to be installed in building spaces, other than risers, ducts used for environmental air, plenums used for environmental air, and other spaces used for environmental air, where the length of the cable within the building, measured from its point of entrance, does not exceed 15 m (50 ft) and the cable enters the building from the outside and is terminated in an enclosure.

The point of entrance shall be permitted to be extended from the penetration of the external wall or floor slab by continuously enclosing the entrance optical fiber cables in rigid metal conduit (RMC) or intermediate metal conduit (IMC) to the point of emergence.
Informational Note: Splice cases or terminal boxes, both metallic and plastic types, typically are used as enclosures for splicing or terminating optical fiber cables.
(B) Nonconductive Cables in Raceway.
Unlisted nonconductive outside plant optical fiber cables shall be permitted to enter the building from the outside and shall be permitted to be installed in any of the following raceways:

1. Intermediate metal conduit (IMC)
2. Rigid metal conduit (RMC)
3. Rigid polyvinyl chloride conduit (PVC)
4. Electrical metallic tubing (EMT)

Unlisted nonconductive outside plant cables installed in rigid polyvinyl chloride conduit (PVC) or electrical metallic tubing (EMT) shall not be permitted to be installed in risers, ducts used for environmental air, plenums used for environmental air, and other spaces used for environmental air.
770.49 Metal Entrance Conduit Grounding.
Metal conduit containing optical fiber entrance cable shall be connected by a bonding conductor or grounding electrode conductor to a grounding electrode or, where present, the building grounding electrode system in accordance with 770.100(B).
Part III. Protection
770.93 Grounding, Bonding, or Interruption of Non–Current-Carrying Metallic Members of Optical Fiber Cables.
Optical fiber cables entering the building or terminating on the outside of the building shall comply with 770.93(A) or (B).
(A) Entering Buildings.
In installations where an optical fiber cable is exposed to contact with electric light or power conductors and the cable enters the building, the non–current-carrying metallic members shall be either grounded or bonded as specified in 770.100 or interrupted by an insulating joint or equivalent device. The grounding or interruption shall be as close as practicable to the point of entrance.
(B) Terminating on the Outside of Buildings.
In installations where an optical fiber cable is exposed to contact with electric light or power conductors and the cable is terminated on the outside of the building, the non–current-carrying metallic members shall be either grounded or bonded as specified in 770.100 or interrupted by an insulating joint or equivalent device. The grounding, bonding, or interruption shall be as close as practicable to the point of termination of the cable.
Part IV. Grounding Methods
770.100 Entrance Cable Bonding and Grounding.
If required, the non-current-carrying metallic members of optical fiber cables entering buildings shall be bonded or grounded as specified in 770.100(A) through (D).
(A) Bonding Conductor or Grounding Electrode Conductor.
(1) Insulation.

The bonding conductor or grounding electrode conductor shall be listed and shall be permitted to be insulated, covered, or bare.

(2) Material.

The bonding conductor or grounding electrode conductor shall be copper or other corrosion-resistant conductive material, stranded or solid.

(3) Size.

The bonding conductor or grounding electrode conductor shall not be smaller than 14 AWG. It shall have a current-carrying capacity not less than that of the grounded metallic member(s). The bonding conductor or grounding electrode conductor shall not be required to exceed 6 AWG.

(4) Length.

The bonding conductor or grounding electrode conductor shall be as short as practicable. In one- and two-family dwellings, the bonding conductor or grounding electrode conductor shall be as short as practicable not to exceed 6.0 m (20 ft) in length.

Informational Note: Similar bonding conductor or grounding electrode conductor length limitations applied at apartment buildings and commercial buildings help to reduce voltages that may develop between the building's power and communications systems during lightning events.

Exception: In one- and two-family dwellings if it is not practicable to achieve an overall maximum bonding conductor or grounding electrode conductor length of 6.0 m (20 ft), a separate ground rod meeting the minimum dimensional criteria of 770.100(B)(3)(2) shall be driven, the grounding electrode conductor shall be connected to the separate ground rod in accordance with 770.100(C), and the separate ground rod shall be bonded to the power grounding electrode system in accordance with 770.100(D).

(5) Run in Straight Line.

The bonding conductor or grounding electrode conductor shall be run in as straight a line as practicable.

(6) Physical Protection.

Bonding conductors and grounding electrode conductors shall be protected where exposed to physical damage. Where the bonding conductor or grounding electrode conductor is installed in a metal raceway, both ends of the raceway shall be bonded to the contained conductor or to the same terminal or electrode to which the bonding conductor or grounding electrode conductor is connected.

(B) Electrode.

The bonding conductor and grounding electrode conductor shall be connected in accordance with 770.100(B)(1), (B)(2), or (B)(3).

(1) In Buildings or Structures with an Intersystem Bonding Termination.

If the building or structure served has an intersystem bonding termination as required by 250.94, the bonding conductor shall be connected to the intersystem bonding termination.

Informational Note: See Informational Note Figure 800.100(B)(1) for an illustration of the application of the bonding conductor in buildings or structures equipped with an intersystem bonding termination.

(2) In Buildings or Structures with Grounding Means.

If an intersystem bonding termination is established, 250.94(A) shall apply.

If the building or structure served has no intersystem bonding termination, the bonding conductor or grounding electrode conductor shall be connected to the nearest accessible location on one of the following:

1. The building or structure grounding electrode system as covered in 250.50
2. The power service accessible means external to enclosures using the options identified in 250.94(A), Exception
3. The nonflexible metal power service raceway
4. The service equipment enclosure
5. The grounding electrode conductor or the grounding electrode conductor metal enclosure of the power service
6. The grounding electrode conductor or the grounding electrode of a building or structure disconnecting means that is connected to a grounding electrode as covered in 250.32
7. The grounded interior metal water piping system, within 1.5 m (5 ft) from its point of entrance to the building, as covered in 250.52

Informational Note: See Informational Note Figure 800.100(B)(2) for an illustration of the application of the bonding conductor in buildings or structures not equipped with an intersystem bonding termination or terminal block providing access to the building grounding electrode system.
(3) In Buildings or Structures Without Intersystem Bonding Termination or Grounding Means.
If the building or structure served has no intersystem bonding termination or grounding means, as described in 770.100(B)(2), the grounding electrode conductor shall be connected to either of the following:

1. To any one of the individual grounding electrodes described in 250.52(A)(1), (A)(2), (A)(3), or (A)(4).
2. If the building or structure served has no grounding means, as described in 770.100(B)(2) or (B)(3)(1), to any one of the individual grounding electrodes described in 250.52(A)(7) and (A)(8) or to a ground rod or pipe not less than 1.5 m (5 ft) in length and 12.7 mm (1⁄2 in.) in diameter, driven, where practicable, into permanently damp earth and separated from lightning protection system conductors as covered in 805.53 and at least 1.8 m (6 ft) from electrodes of other systems. Steam, hot water pipes, or lightning protection system conductors shall not be employed as electrodes for non–current-carrying metallic members.

(C) Electrode Connection.
Connections to grounding electrodes shall comply with 250.70.
(D) Bonding of Electrodes.
A bonding jumper not smaller than 6 AWG copper or equivalent shall be connected between the grounding electrode and power grounding electrode system at the building or structure served where separate electrodes are used.
Exception: At mobile homes as covered in 770.106.
Informational Note No. 1: See 250.60 for connection to a lightning protection system.
Informational Note No. 2: Bonding together of all separate electrodes limits potential differences between them and between their associated wiring systems.
770.106 Grounding and Bonding of Entrance Cables at Mobile Homes.
(A) Grounding.
Grounding shall comply with 770.106(A)(1) and (A)(2).
(1) Installations Without Mobile Home Service Equipment.

If there is no mobile home service equipment located within 9.0 m (30 ft) of the exterior wall of the mobile home it serves, the non-current-carrying metallic members of optical fiber cables entering the mobile home shall be grounded in accordance with 770.100(B)(3).
(2) Installations Without Mobile Home Disconnecting Means.
If there is no mobile home disconnecting means grounded in accordance with 250.32 and located within 9.0 m (30 ft) of the exterior wall of the mobile home it serves, the non-current-carrying metallic members of optical fiber cables entering the mobile home shall be grounded in accordance with 770.100(B)(3).
(B) Bonding.
The grounding electrode shall be bonded to the metal frame or available grounding terminal of the mobile home with a copper conductor or other equivalent corrosion-resistant material not smaller than 12 AWG under either of the following conditions:

1. If there is no mobile home service equipment or disconnecting means as in 770.106(A)
2. If the mobile home is supplied by cord and plug

Part V. Installation Methods Within Buildings

770.110 ~~Raceways, Cable Routing Assemblies, and Cable Trays for Optical Fiber Cables.~~ In addition to this Part V, Parts I and II of Article 7XX shall apply to wiring methods and materials for optical fiber cable used within buildings.
~~(A) Types of Raceways.~~
~~Optical fiber cables shall be permitted to be installed in any raceway that complies with either 770.110(A)(1) or (A)(2).~~
~~(1) Raceways Recognized in Chapter 3.~~
~~Optical fiber cables shall be permitted to be installed in any raceway included in Chapter 3. The raceways shall be installed in accordance with Chapter 3.~~
~~(2) Communications Raceways.~~
~~Optical fiber cables shall be permitted to be installed in listed communications raceways selected in accordance with Table 800.154(b).~~
~~(3)~~ 770.111 Innerduct for Optical Fiber Cables.
Listed plenum communications raceways, listed riser communications raceways, and listed general-purpose communications raceways selected in accordance with Table 800.154(b) shall be permitted to be installed as innerduct in any type of listed raceway permitted in Chapter 3.
~~(B) Raceway Fill for Optical Fiber Cables.~~
~~Raceway fill for optical fiber cables shall comply with either 770.110(B)(1) or (B)(2).~~
~~(1) Without Electric Light or Power Conductors.~~
~~Where optical fiber cables are installed in raceway without electric light or power conductors, the raceway fill requirements of Chapters 3 and 9 shall not apply.~~
~~(2) Nonconductive Optical Fiber Cables with Electric Light or Power Conductors.~~
~~Where nonconductive optical fiber cables are installed with electric light or power conductors in a raceway, the raceway fill requirements of Chapters 3 and 9 shall apply.~~
~~(C) Cable Routing Assemblies.~~
~~Optical fiber cables shall be permitted to be installed in listed cable routing assemblies selected in accordance with Table 800.154(c)~~
~~(D) Cable Trays.~~

~~Optical fiber cables shall be permitted to be installed in metal or listed nonmetallic cable tray systems.~~

~~770.113 Installation of Optical Fiber Cables.~~

~~Installation of optical fiber cables shall comply with 770.113(A) through (J). Installation of raceways and cable routing assemblies shall comply with 770.110.~~

~~(A) Listing.~~

~~Optical fiber cables installed in buildings shall be listed in accordance with 770.179 and installed in accordance with the limitations of the listing.~~

~~Exception: Optical fiber cables that are installed in compliance with 770.48 shall not be required to be listed.~~

~~(B) Ducts Specifically Fabricated for Environmental Air.~~

~~Installations of optical fiber cables in ducts specifically fabricated for environmental air shall be in accordance with 770.113(B)(1) and (B)(2).~~

~~(1) Uses Permitted.~~

~~The following cables shall be permitted in ducts specifically fabricated for environmental air as described in 300.22(B) if they are directly associated with the air distribution system:~~

1. ~~Up to 1.22 m (4 ft) of Types OFNP and OFCP~~
2. ~~Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC installed in raceways that are installed in compliance with 300.22(B)~~

~~Informational Note: For information on fire protection of wiring installed in fabricated ducts, see NFPA 90A-2018, *Standard for the Installation of Air-Conditioning and Ventilating Systems*.~~

~~(2) Uses Not Permitted.~~

~~Types OFNR, OFCR, OFNG, OFCG, OFN, and OFC shall not be permitted to be installed in ducts specifically fabricated for environmental air as described in 300.22(B).~~

~~Informational Note: See NFPA 90A-2021, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, for information on fire protection of wiring installed in fabricated ducts.~~

~~(C) Other Spaces Used for Environmental Air (Plenums).~~

~~Installations of optical fiber cables in other spaces used for environmental air shall be in accordance with 770.13(C)(1) and (C)(2).~~

~~(1) Uses Permitted.~~

~~The following cables shall be permitted in other spaces used for environmental air as described in 300.22(C):~~

1. ~~Types OFNP and OFCP~~
2. ~~Types OFNP and OFCP installed in plenum communications raceways~~
3. ~~Types OFNP and OFCP installed in plenum cable routing assemblies~~
4. ~~Types OFNP and OFCP supported by open metal cable tray systems~~
5. ~~Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC installed in raceways that are installed in compliance with 300.22(C)~~
6. ~~Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC supported by solid bottom metal cable trays with solid metal covers in other spaces used for environmental air (plenums), as described in 300.22(C)~~
7. ~~Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC installed in plenum, riser, and general-purpose communications raceways supported by solid bottom metal~~

~~cable trays with solid metal covers in other spaces used for environmental air (plenums), as described in 300.22(C)~~

~~(2) Uses Not Permitted.~~
~~Types OFNR, OFCR, OFNG, OFCG, OFN, and OFC shall not be permitted to be installed in other spaces used for environmental air (plenums).~~
~~Informational Note: See NFPA 90A-2018, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, for information on fire protection of wiring installed in other spaces used for environmental air.~~
~~(D) Risers — Cables in Vertical Runs.~~
~~Installations of optical fiber cables in vertical runs shall be in accordance with 770.113(D)(1) and (D)(2).~~
~~(1) Uses Permitted.~~
~~The following cables shall be permitted in vertical runs penetrating one or more floors and in vertical runs in a shaft:~~

1. ~~Types OFNP, OFCP, OFNR, and OFCR~~
2. ~~Types OFNP, OFCP, OFNR, and OFCR installed in the following:~~
    1. ~~Plenum communications raceways~~
    2. ~~Plenum cable routing assemblies~~
    3. ~~Riser communications raceways~~
    4. ~~Riser cable routing assemblies~~

~~(2) Uses Not Permitted.~~
~~Types OFNG, OFCG, OFN, and OFC shall not be permitted to be installed in vertical runs.~~
~~Informational Note: See 770.26 for firestop requirements for floor penetrations.~~
~~(E) Risers — Cables Permitted in Metal Raceways.~~
~~The following cables shall be permitted in metal raceways in a riser having firestops at each floor:~~

1. ~~Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC~~
2. ~~Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC installed in the following:~~
    1. ~~Plenum communications raceways (innerduct)~~
    2. ~~Riser communications raceways (innerduct)~~
    3. ~~General-purpose communications raceways (innerduct)~~

~~Informational Note: See 770.26 for firestop requirements for floor penetrations.~~
~~(F) Risers — Cables Permitted in Fireproof Shafts.~~
~~The following cables shall be permitted to be installed in fireproof riser shafts having firestops at each floor:~~

1. ~~Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC~~
2. ~~Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC installed in the following:~~
    1. ~~Plenum communications raceways~~

    2. ~~Plenum cable routing assemblies~~
    3. ~~Riser communications raceways~~
    4. ~~Riser cable routing assemblies~~
    5. ~~General-purpose communications raceways~~
    6. ~~General-purpose cable routing assemblies~~

~~Informational Note: See 770.26 for firestop requirements for floor penetrations.~~
~~(G) Risers — Cables Permitted in One- and Two-Family Dwellings.~~
~~The following cables shall be permitted in one- and two-family dwellings:~~

1. ~~Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC~~
2. ~~Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC installed in the following:~~
    1. ~~Plenum communications raceways~~
    2. ~~Plenum cable routing assemblies~~
    3. ~~Riser communications raceways~~
    4. ~~Riser cable routing assemblies~~
    5. ~~General-purpose communications raceways~~
    6. ~~General-purpose cable routing assemblies~~

~~(H) Cable Trays — Cables Permitted.~~
~~The following cables shall be permitted to be supported by cable trays:~~

1. ~~Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC~~
2. ~~Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC installed in the following:~~
    1. ~~Plenum communications raceways~~
    2. ~~Riser communications raceways~~
    3. ~~General-purpose communications raceways~~

~~(I) Distributing Frames and Cross-Connect Arrays — Cables Permitted.~~
~~The following cables shall be permitted to be installed in distributing frames and cross-connect arrays:~~

1. ~~Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC~~
2. ~~Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC installed in the following:~~
    1. ~~Plenum communications raceways~~
    2. ~~Plenum cable routing assemblies~~
    3. ~~Riser communications raceways~~
    4. ~~Riser cable routing assemblies~~
    5. ~~General-purpose communications raceways~~
    6. ~~General-purpose cable routing assemblies~~

~~(J) Other Building Locations — Cables Permitted.~~

~~The following cables shall be permitted to be installed in building locations other than the locations covered in 770.113(B) through (I):~~

1. ~~Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC~~
2. ~~Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC installed in the following:~~
    1. ~~Plenum communications raceways~~
    2. ~~Plenum cable routing assemblies~~
    3. ~~Riser communications raceways~~
    4. ~~Riser cable routing assemblies~~
    5. ~~General-purpose communications raceways~~
    6. ~~General-purpose cable routing assemblies~~
3. ~~Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC installed in a raceway of a type recognized in Chapter 3~~

770.114 Grounding.
Non-current-carrying conductive members of optical fiber cables shall be bonded to a grounded equipment rack or enclosure, or grounded in accordance with the grounding methods specified by 770.100(B) using a conductor specified in 770.100(A).

770.133 Installation of Optical Fibers and Electrical Conductors.
(A) In Cable Trays and Raceways.
Conductive optical fiber cables contained in an armored or metal-clad-type sheath and nonconductive optical fiber cables shall be permitted to occupy the same cable tray or raceway with conductors for electric light, power, Class 1, non-power-limited fire alarm, Type ITC, or medium-power network-powered broadband communications circuits operating at 1000 volts or less. Conductive optical fiber cables without an armored or metal-clad-type sheath shall not be permitted to occupy the same cable tray or raceway with conductors for electric light, power, Class 1, non-power-limited fire alarm, Type ITC, or medium-power network-powered broadband communications circuits, unless all of the conductors of electric light, power, Class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuits are separated from all of the optical fiber cables by a permanent barrier or listed divider.
(B) In Cabinets, Outlet Boxes, and Similar Enclosures.
Nonconductive optical fiber cables shall not be permitted to occupy the same cabinet, outlet box, panel, or similar enclosure housing the electrical terminations of an electric light, power, Class 1, non-power-limited fire alarm, or medium-power network-powered broadband communications circuit unless one or more of the following conditions exist:

1. The nonconductive optical fiber cables are functionally associated with the electric light, power, Class 1, non-power-limited fire alarm, or medium-power network-powered broadband communications circuit.
2. The conductors for electric light, power, Class 1, non-power-limited fire alarm, Type ITC, or medium-power network-powered broadband communications circuits operate at 1000 volts or less.

3. The nonconductive optical fiber cables and the electrical terminations of electric light, power, Class 1, non-power-limited fire alarm, or medium-power network-powered broadband communications circuit are installed in factory- or field-assembled control centers.
4. The nonconductive optical fiber cables are installed in an industrial establishment where conditions of maintenance and supervision ensure that only qualified persons service the installation.

When optical fibers are within the same hybrid cable for electric light, power, Class 1, non-power-limited fire alarm, or medium-power network-powered broadband communications circuits operating at 1000 volts or less, they shall be permitted to be installed only where the functions of the optical fibers and the electrical conductors are associated.
Optical fibers in hybrid optical fiber cables containing only current-carrying conductors for electric light, power, or Class 1 circuits rated 1000 volts or less shall be permitted to occupy the same cabinet, cable tray, outlet box, panel, raceway, or other termination enclosure with conductors for electric light, power, or Class 1 circuits operating at 1000 volts or less.
Optical fibers in hybrid optical fiber cables containing current-carrying conductors for electric light, power, or Class 1 circuits rated over 1000 volts shall be permitted to occupy the same cabinet, cable tray, outlet box, panel, raceway, or other termination enclosure with conductors for electric light, power, or Class 1 circuits in industrial establishments, where conditions of maintenance and supervision ensure that only qualified persons service the installation.
(C) With Other Circuits.
Conductive and nonconductive optical fiber cables shall be permitted in the same raceway, cable tray, box, enclosure, or cable routing assembly, with conductors of any of the following:

1. Class 2 and Class 3 remote-control, signaling, and power-limited circuits in compliance with Article 645 or Parts I and III of Article 725
2. Power-limited fire alarm systems in compliance with Parts I and III of Article 760
3. Communications circuits in compliance with Parts I and V of Article 805
4. Community antenna television and radio distribution systems in compliance with Parts I and V of Article 820
5. Low-power network-powered broadband communications circuits in compliance with Parts I and V of Article 830

(D) Support of Optical Fiber Cables.
Raceways shall be used for their intended purpose. Optical fiber cables shall not be strapped, taped, or attached by any means to the exterior of any conduit or raceway as a means of support.
Exception: Overhead (aerial) spans of optical fiber cables shall be permitted to be attached to the exterior of a raceway-type mast intended for the attachment and support of such cables.

~~770.154 Applications of Listed Optical Fiber Cables.~~
~~Permitted and nonpermitted applications of listed optical fiber cables shall be as indicated in Table 770.154(a). The permitted applications shall be subject to the installation requirements of 770.110 and 770.113. The substitutions for optical fiber cables in Table 770.154(b) and illustrated in Figure 770.154 shall be permitted.~~

~~Table 770.154(a) Applications of Listed Optical Fiber Cables in Buildings~~

~~Applications~~		~~Listed Optical Fiber Cable Type~~		
		~~OFNP, OFCP~~	~~OFNR, OFCR~~	~~OFNG, OFCG, OFN, OFC~~
~~In ducts specifically fabricated for environmental air as described in 300.22(B)~~	~~In fabricated ducts~~	~~Y*~~	~~N~~	~~N~~
	~~In metal raceway that complies with 300.22(B)~~	~~Y*~~	~~Y*~~	~~Y*~~
~~In other spaces used for environmental air (plenums) as described in 300.22(C)~~	~~In other spaces used for environmental air~~	~~Y*~~	~~N~~	~~N~~
	~~In metal raceway that complies with 300.22(C)~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In plenum communications raceways~~	~~Y*~~	~~N~~	~~N~~
	~~In plenum cable routing assemblies~~	~~Y*~~	~~N~~	~~N~~
	~~Supported by open metal cable trays~~	~~Y*~~	~~N~~	~~N~~
	~~Supported by solid bottom metal cable trays with solid metal covers~~	~~Y*~~	~~Y*~~	~~Y*~~
~~In risers~~	~~In vertical runs~~	~~Y*~~	~~Y*~~	~~N~~
	~~In metal raceways~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In fireproof shafts~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In plenum communications raceways~~	~~Y*~~	~~Y*~~	~~N~~
	~~In plenum cable routing assemblies~~	~~Y*~~	~~Y*~~	~~N~~
	~~In riser communications raceways~~	~~Y*~~	~~Y*~~	~~N~~
	~~In riser cable routing assemblies~~	~~Y*~~	~~Y*~~	~~N~~
	~~In one- and two-family dwellings~~	~~Y*~~	~~Y*~~	~~Y*~~
~~Within buildings in other than air-handling spaces and risers~~	~~General~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~Supported by cable trays~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In distributing frames and cross-connect arrays~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In any raceway recognized in Chapter 3~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In plenum communications raceways~~	~~Y*~~	~~Y*~~	~~Y*~~

~~Applications~~		~~Listed Optical Fiber Cable Type~~		
		~~OFNP, OFCP~~	~~OFNR, OFCR~~	~~OFNG, OFCG, OFN, OFC~~
	~~In plenum cable routing assemblies~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In riser communications raceways~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In riser cable routing assemblies~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In general-purpose communications raceways~~	~~Y*~~	~~Y*~~	~~Y*~~
	~~In general-purpose cable routing assemblies~~	~~Y*~~	~~Y*~~	~~Y*~~

~~Note: "N" indicates that the cable type shall not be permitted to be installed in the application. "Y*" indicates that the cable type shall be permitted to be installed in the application subject to the limitations described in 770.110 and 770.113.~~

~~Informational Note No. 1: Part V of Article 770 covers installation methods within buildings. This table covers the applications of listed optical fiber cables in buildings. The definition of *Point of Entrance* is in 770.2.~~

~~Informational Note No. 2: For information on the restrictions to the installation of optical fiber cables in ducts specifically fabricated for environmental air, see 770.113(B).~~

~~Table 770.154(b) Cable Substitutions~~

~~Cable Type~~	~~Permitted Substitutions~~
~~OFNP~~	~~None~~
~~OFCP~~	~~OFNP~~
~~OFNR~~	~~OFNP~~
~~OFCR~~	~~OFNP, OFCP, OFNR~~
~~OFNG, OFN~~	~~OFNP, OFNR~~
~~OFCG, OFC~~	~~OFNP, OFCP, OFNR, OFCR, OFNG, OFN~~

~~Figure 770.154 Cable Substitution Hierarchy.~~

Part VI. Listing Requirements

770.179 Optical Fiber Cables.

Optical fiber cables shall be listed and identified in accordance with 722.179. ~~770.179(A) through (G) and shall be marked in accordance with Table 770.179. Optical fiber cables shall have a temperature rating of not less than 60°C (140°F). The temperature rating shall be marked on the jacket of optical fiber cables that have a temperature rating exceeding 60°C (140°F).~~

~~Informational Note: See UL 1651-2015, *Standard for Optical Fiber Cable*, for information on optical fiber cables.~~

~~Table 770.179 Cable Markings~~

~~Cable Marking~~	~~Type~~
~~OFNP~~	~~Nonconductive optical fiber plenum cable~~
~~OFCP~~	~~Conductive optical fiber plenum cable~~
~~OFNR~~	~~Nonconductive optical fiber riser cable~~
~~OFCR~~	~~Conductive optical fiber riser cable~~
~~OFNG~~	~~Nonconductive optical fiber general-purpose cable~~
~~OFCG~~	~~Conductive optical fiber general-purpose cable~~
~~OFN~~	~~Nonconductive optical fiber general-purpose cable~~
~~OFC~~	~~Conductive optical fiber general-purpose cable~~

~~(A) Types OFNP and OFCP.~~

~~Types OFNP and OFCP nonconductive and conductive optical fiber plenum cables shall be suitable for use in ducts, plenums, and other space used for environmental air and shall also have adequate fire-resistant and low-smoke-producing characteristics.~~

~~Informational Note: See NFPA 262-2019, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*, for one method of defining that a cable has adequate fire-resistant and low-smoke-producing characteristics where the cable exhibits a maximum peak optical density of 0.50 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.52 m (5 ft) or less.~~

~~(B) Types OFNR and OFCR.~~

~~Types OFNR and OFCR nonconductive and conductive optical fiber riser cables shall be suitable for use in a vertical run in a shaft or from floor to floor and shall also have the fire-resistant characteristics capable of preventing the carrying of fire from floor to floor.~~

~~Informational Note: See ANSI/UL 1666-2017, *Standard Test for Flame Propagation Height of Electrical and Optical-Fiber Cable Installed Vertically in Shafts*, for one method of defining fire-resistant characteristics capable of preventing the carrying of fire from floor to floor.~~

~~(C) Types OFNG and OFCG.~~

~~Types OFNG and OFCG nonconductive and conductive general-purpose optical fiber cables shall be suitable for general-purpose use, with the exception of risers and plenums, and shall also be resistant to the spread of fire.~~

~~Informational Note No 1: See CSA Vertical Flame Test — Cables in Cable Trays, as described in CSA C22.2 No. 0.3-2009 (R2019), *Test Methods for Electrical Wires and Cables*, for one method of defining *resistant to the spread of fire* for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the test.~~

~~Informational Note No. 2: See ANSI/UL 1685-2015, *Standard for Safety for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*, for another method of defining resistant to the spread of fire where the cables do not spread fire to the top of the tray in the UL flame exposure, vertical tray flame test. The smoke measurements in the test method are not applicable.~~

~~(D) Types OFN and OFC.~~

~~Types OFN and OFC nonconductive and conductive optical fiber cables shall be suitable for general-purpose use, with the exception of risers, plenums, and other spaces used for environmental air, and shall also be resistant to the spread of fire.~~

~~Informational Note No. 1: See ANSI/UL 1685-2015, *Standard for Safety for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*, for one method of defining resistant to the spread of fire where the cables do not spread fire to the top of the tray in~~

~~the UL flame exposure, vertical tray flame test. The smoke measurements in the test method are not applicable.~~

~~Informational Note No. 2: See CSA Vertical Flame Test — Cables in Cables Trays, as described in CSA C22.2 No. 0.3-2009 (R2019), *Test Methods for Electrical Wires and Cables*, for another method of defining *resistant to the spread of fire* where the damage (char length) does not exceed 1.5 m (4 ft 11 in.).~~

~~Informational Note No. 3: Cable types are listed in descending order of fire resistance rating. Within each fire resistance rating, nonconductive cable is listed first because it is often substituted for conductive cable.~~

~~(E) Circuit Integrity (CI), Fire-Resistive Cable System, or Electrical Circuit Protective System.~~

~~Cables that are used for survivability of critical circuits under fire conditions shall meet either 770.179(E)(1), (E)(2), or (E)(3).~~

~~(1) Circuit Integrity (CI) Cables.~~

~~Cables specified in 770.179(A) through (D), and used for survivability of critical circuits, shall be marked with the additional classification using the suffix "CI." In order to maintain its listed fire rating, CI cable shall only be installed in free air in accordance with 770.24. CI cables shall only be permitted to be installed in a raceway where specifically listed and marked as part of a fire-resistive cable system as covered in 770.179(E)(2).~~

~~Informational Note: See UL 2196, *Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables*, for one method of defining CI cable for establishing a minimum 2-hour fire resistance rating for the cable as specified in UL 1651, *Optical Fiber Cable*. UL *Guide Information for Optical Cable Fiber (QAYK)* contains information to identify the cable and its installation limitations to maintain the fire-resistive rating.~~

~~(2) Fire-Resistive Cables.~~

~~Cables specified in 770.179(A) through (D) and 770.179(E)(1) that are part of an electrical circuit protective system shall be fire-resistive cable and identified with the protective system number on the product or on the smallest unit container in which the product is packaged and installed in accordance with the listing of the protective system.~~

~~Informational Note: See UL 2196, *Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables,* for one method of defining an electrical circuit protective system for establishing a rating for the system. UL *Guide Information for Electrical Circuit Integrity Systems (FHIT)* contains information to identify the system and its installation limitations to maintain a minimum fire-resistive rating.~~

~~(F) Field-Assembled Optical Fiber Cables.~~

~~Field-assembled optical fiber cable shall comply with the following:~~

1. ~~The specific combination of jacket and optical fibers intended to be installed as a field-assembled optical fiber cable shall be one of the types in 770.179(A), (B), or (D) and shall be marked in accordance with Table 770.179.~~
2. ~~The jacket of a field-assembled optical fiber cable shall have a surface marking indicating the specific optical fibers with which it is identified for use.~~
3. ~~The optical fibers shall have a permanent marking, such as a marker tape, indicating the jacket with which they are identified for use.~~
4. ~~The jacket without fibers shall meet the listing requirements for communications raceways in 800.182(A), (B), or (C) in accordance with the cable marking.~~

~~(G) Optional Markings.~~

~~Cables shall be permitted to be surface marked to indicate special characteristics of the cable materials.~~

~~Informational Note: These markings can include, but are not limited to, markings for limited-smoke, halogen-free, low-smoke halogen-free, and sunlight resistance.~~

770.180 Grounding Devices.

Where bonding or grounding is required, devices used to connect a shield, a sheath, or non–current-carrying metallic members of a cable to a bonding conductor or grounding electrode conductor shall be listed or be part of listed equipment.

Article 726 Class 4 (CL4) Power Systems

Part I. General

726.1 Scope.

This article covers the installation of wiring and equipment of fault-managed power (FMP) systems, including utilization equipment incorporating parts of these systems.

Informational Note No. 1: See Article 100 for definitions related to this section.

Informational Note No. 2: Class 4 power systems consist of a Class 4 power transmitter and a Class 4 power receiver connected by a cabling system. These systems are characterized by monitoring the circuit for faults and controlling the power transmitted to ensure the energy and power delivered into any fault is limited. Class 4 systems differ from Class 1, Class 2, and Class 3 systems in that they are not limited for power delivered to an appropriate load. They are power limited with respect to risk of shock and fire between the Class 4 transmitter and Class 4 receiver.

Informational Note No. 3: The circuits described in this article are characterized by monitoring and control systems that differentiate them from electric light and power circuits; therefore, alternative requirements to those of Chapters 1 through 4 are given regarding minimum wire sizes, ampacity adjustment and correction factors, overcurrent protection, insulation requirements, and wiring methods and materials.

Part II. Class 4 Circuits

726.121 Power Sources for Class 4 Circuits.

The power source shall be a listed Class 4 power transmitter or listed Class 4 power transmitter/receiver system and shall provide the protections in accordance with 726.121(A) and (B). Class 4 circuits shall be supplied from a power source (transmitter) that has a peak voltage output of not more than 450 volts dc line to line or 225 volts dc line to ground.

Informational Note No. 1: Informational Note Figure 726.121 illustrates the relationships between Class 4 power transmitters (power sources), Class 4 power transmitters (power sources) supplies, Class 4 circuits, Class 4 power receivers, and utilization equipment.

Informational Note No. 2: See UL ###-1, *Standard for Class 4 Power Systems*, for information on determining applicable requirements for the listing of Class 4 power systems.

Figure Informational Note Figure 726.121 Class 4 Circuits.

(A) Fault Energy and Power Limitations.

For listing purposes, under the conditions specified in 726.121(B), the energy available into a fault shall be limited according to the requirements of the following:

1. A Class 4 power source shall provide protection of personnel against the risk of electric shock by de-energizing the circuit or a portion thereof, or limiting the current, within an established period of time.

   Informational Note No. 1: This time requirement provides an equivalent level of protection from electric shock as Class 2 circuits.

2. The maximum power that can be delivered into a fault between conductors or between any conductor and ground shall not exceed 100 volt-amperes, measured after 5 seconds.

Informational Note No. 2: This requirement reduces the risk of fire due to resistive heating.

3. A Class 4 power source shall provide protection from the effects of arc faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc fault is detected.

   Informational Note No. 3: This requirement reduces the risk of fire due to arcing.

(B) Fault Management.
A listed transmitter shall interrupt an energized circuit within the limits of 726.121(A) when any of the following conditions occur:

1. An abnormal condition such as abnormal voltage, current, waveform, or load condition is identified in the system
2. A short circuit occurs
3. Human skin contacts energized parts
4. A ground-fault condition exists
5. An overcurrent condition exists
6. Intentional shorting of the line at the receiving or transmitting end to force de-energization for purposes of maintenance or repair occurs
7. A malfunction of the monitoring or control system occurs

726.122 Class 4 Loads.
Outputs of a Class 4 receiver and power outputs of Class 4 utilization equipment shall be considered a separately derived system and shall be subject to requirements in Chapters 1 through 4.
Informational Note: Class 4 utilization equipment that does not provide power outputs is not subject to these requirements.
Exception: A Class 4 receiver with limited-power circuit outputs shall be permitted to meet the requirements of Parts I thru IV of Article 725.
726.124 Class 4 Marking.
(A) Class 4 Transmitter Marking.
The equipment supplying the Class 4 circuits shall be durably marked where plainly visible to indicate each circuit that is a Class 4 circuit. The marking shall also include the maximum voltage and current output for each connection point. Where multiple connection points have the same rating, a single label shall be permitted to be used.
Informational Note: An example of marking is “Class 4: +/–190V, 5A” for a Class 4 transmitter capable of delivering 1.9 kW from 380 volts line to line.
(B) Class 4 Receiver Marking.
A Class 4 receiver or Class 4 utilization equipment shall be durably marked where plainly visible to indicate each circuit that is a Class 4 circuit. The marking shall also include the maximum input voltage and current for each connection point. Where the Class 4 receiver or Class 4 utilization equipment has user-accessible outputs, each output shall be durably marked where plainly visible. The marking shall also include the maximum output voltage and current for each

connection point. Where multiple connection points have the same rating, a single label shall be permitted to be used.

726.228 Noninterchangeability. Receptacles, cord connectors, and attachment plugs used on Class 4 distribution systems shall be constructed so that they are not interchangeable with other receptacles, cord connectors, and attachment plugs.

726.233 Guarding. Any junctions and mating connectors shall be constructed and installed to guard against inadvertent contact with live parts by persons.

Part III. Listing Requirements

726.170 Listing of Equipment for Class 4 Systems.
The active components of a Class 4 system shall be listed as a Class 4 device. The Class 4 transmitter and Class 4 receiver combination or Class 4 transmitter and Class 4 utilization equipment combination shall be listed as a system to confirm interoperability.
Informational Note: See UL 1400-1~~###-1~~, *Standard for* *for Fault-Managed Power Distribution Technologies - Part 1: General Requirements* ~~*Class 4 Power Systems*~~, for information on determining applicable requirements for the listing of Class 4 power systems.

Part IV. Installation

~~726.203 Other Articles.~~
~~In addition to the requirements of this article, circuits and equipment shall comply with the requirements in 726.3(A) through (N). Only those sections of Article 300 referenced in this article shall apply to Class 4 power systems.~~
~~(A) Number and Size of Conductors in Raceway.~~
~~The number and size of conductors shall comply with the requirements of 300.17.~~
~~(B) Spread of Fire or Products of Combustion.~~
~~Installation of Class 4 circuits shall comply with the requirements of 300.21.~~
~~(C) Ducts, Plenums, and Other Air-Handling Spaces.~~
~~Class 4 circuits installed in ducts, plenums, and other spaces used for environmental air shall comply with the requirements of 300.22.~~
~~(D) Cable Trays.~~
~~Cable tray installations shall comply with the requirements of Parts I and II of Article 392.~~
~~(E) Instrumentation Tray Cable.~~
~~Instrumentation tray cable (Type ITC) installations shall comply with the requirements of 727.1 and 727.4 through 727.9.~~
~~(F) Raceways Exposed to Different Temperatures.~~
~~Installations shall comply with the requirements of 300.7(A).~~
~~(G) Bushing.~~
~~Bushings shall be installed where cables emerge from raceways used for mechanical support or protection in accordance with 300.15(C).~~

~~(H) Installation of Conductors With Other Systems.~~
~~Installation of conductors with other systems shall comply with the requirements of 300.8.~~
~~(I) Corrosive, Damp, or Wet Locations.~~
~~Class 4 cables installed in corrosive, damp, or wet locations shall comply with the applicable requirements of 110.11, 300.5(B), 300.6, 300.9, and 310.10(F).~~
~~(J) Cable Routing Assemblies.~~
~~Class 4 and Type CL4TC cables shall be permitted to be installed in plenum cable routing assemblies, riser cable routing assemblies, and general-purpose cable routing assemblies selected in accordance with Table 800.154(c), listed in accordance with 800.182, and installed in accordance with 800.110(C) and 800.113.~~
~~(K) Communications Raceways.~~
~~Where the requirements applicable to electrical nonmetallic tubing (ENT) apply, Class 4 and Type CL4TC cables shall be permitted to be installed in plenum communications raceways, riser communications raceways, and general-purpose communications raceways selected in accordance with Table 800.154(b), listed in accordance with 800.182, and installed in accordance with 800.113 and 362.24 through 362.56.~~
~~(L) Temperature Limitation of Class 4 Cables.~~
~~The requirements of 310.14(A)(3) on the temperature limitation of conductors shall apply to Class 4 cables.~~
~~(M) Identification of Equipment Grounding Conductors.~~
~~Equipment grounding conductors shall be identified in accordance with 250.119.~~
~~Exception: Class 4 cables that do not contain an equipment grounding conductor shall be permitted to use a conductor with green or green with one or more yellow stripes insulation for other than equipment grounding purposes.~~
~~726.212 Uses Not Permitted.~~
~~(A) Hazardous (Classified) Locations.~~
~~Cables shall not be installed in any hazardous (classified) location, except as permitted by other articles of this *Code*.~~
~~Informational Note: Hazardous locations are covered in Articles 500 through 516 and in Part IV of Article 517.~~
~~(B) Other Applications.~~
~~Class 4 cables shall not be permitted for any applications that are not part of a Class 4 distribution system.~~
~~Exception: Use of CL4 cable for other applications shall be permitted if the cable has multiple listings.~~
~~726.221 Access to Electrical Equipment Behind Panels Designed to Allow Access.~~
~~Access to electrical equipment shall not be denied by an accumulation of wires and cables preventing the removal of panels, including suspended ceiling panels.~~
~~726.224 Mechanical Execution of Work.~~
~~CL4 cables shall be installed in a neat and workmanlike manner. Cables and conductors installed exposed on the surfaces of ceilings and sidewalls shall be supported by the building structure such that the cable will not be damaged by normal building use. Such cables shall be supported by straps, staples, hangers, cable ties, or similar fittings that are designed and installed to not damage the cable. The installation shall also comply with the requirements of 300.4 and 300.11.~~
~~Informational Note: Paint, plaster, cleaners, abrasives, corrosive residues, or other contaminants can result in an undetermined alteration of CL4 cable properties.~~

~~726.225 Abandoned Cables.~~

~~The accessible portion of abandoned Class 4 and CL4TC cables shall be removed. Where cables are identified for future use with a tag, the tag shall be of sufficient durability to withstand the environment involved.~~

~~726.228 Noninterchangeability.~~

~~Receptacles, cord connectors, and attachment plugs used on Class 4 distribution systems shall be constructed so that they are not interchangeable with other receptacles, cord connectors, and attachment plugs.~~

~~726.233 Guarding.~~

~~Any junctions and mating connectors shall be constructed and installed to guard against inadvertent contact with live parts by persons.~~

~~726.335 Installation of CL4 Cables.~~

~~Installation of CL4 and CL4TC cables shall comply with the requirements of 726.135(A) through (L) and shall be listed for the application.~~

~~(A) Ducts Specifically Fabricated for Environmental Air.~~

~~The following cables shall be permitted in ducts specifically fabricated for environmental air as described in 300.22(B) if directly associated with the air distribution system:~~

1. ~~Type CL4 cables in lengths as short as practicable to perform the required function~~
2. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables installed in raceways that are installed in compliance with 300.22(B)~~

~~Informational Note: See 4.3.4.1 and 4.3.11.3.3 of NFPA 90A-2018, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, for information on fire protection of wiring installed in fabricated ducts.~~

~~(B) Other Spaces Used for Environmental Air (Plenums).~~

~~The following cables shall be permitted in other spaces used for environmental air as described in 300.22(C):~~

1. ~~Type CL4P cables~~
2. ~~Type CL4P cables installed in plenum communications raceways~~
3. ~~Type CL4P cables installed in plenum cable routing assemblies~~
4. ~~Type CL4P cables and plenum communications raceways supported by open metallic cable trays or cable tray systems~~
5. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables installed in raceways that are installed in compliance with 300.22(C)~~
6. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables supported by solid bottom metal cable trays with solid metal covers in other spaces used for environmental air (plenums) as described in 300.22(C)~~
7. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables installed in plenum communications raceways, riser communications raceways, and general-purpose communications raceways supported by solid bottom metal cable trays with solid metal covers in other spaces used for environmental air (plenums) as described in 300.22(C)~~

~~(C) Risers — Cables in Vertical Runs.~~

~~The following cables shall be permitted in vertical runs penetrating one or more floors and in vertical runs in a shaft:~~

1. ~~Type CL4R and Type CL4P cables~~
2. ~~Type CL4R and Type CL4P cables installed in the following:~~
    1. ~~Plenum communications raceways~~
    2. ~~Plenum cable routing assemblies~~
    3. ~~Riser communications raceways~~
    4. ~~Riser cable routing assemblies~~

~~Informational Note: See 300.21 for firestop requirements for floor penetrations.~~
~~(D) Risers — Cables and Innerducts in Metal Raceways.~~
~~The following cables shall be permitted in metal raceways in a riser having firestops at each floor:~~

1. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables~~
2. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables installed in the following:~~
    1. ~~Plenum communications raceways (innerduct)~~
    2. ~~Riser communications raceways (innerduct)~~
    3. ~~General-purpose communications raceways (innerduct)~~

~~Informational Note: See 300.21 for firestop requirements for floor penetrations.~~
~~(E) Risers — Cables in Fireproof Shafts.~~
~~The following shall be permitted to be installed in fireproof riser shafts having firestops at each floor:~~

1. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables~~
2. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables installed in the following:~~
    1. ~~Plenum communications raceways~~
    2. ~~Plenum cable routing assemblies~~
    3. ~~Riser communications raceways~~
    4. ~~Riser cable routing assemblies~~
    5. ~~General-purpose communications raceways~~
    6. ~~General-purpose cable routing assemblies~~

~~Informational Note: See 300.21 for firestop requirements for floor penetrations.~~
~~(F) Risers — One- and Two-Family Dwellings.~~
~~The following cables shall be permitted in one- and two-family dwellings:~~

1. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables~~
2. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables installed in the following:~~
    1. ~~Plenum communications raceways~~
    2. ~~Plenum cable routing assemblies~~
    3. ~~Riser communications raceways~~
    4. ~~Riser cable routing assemblies~~
    5. ~~General-purpose communications raceways~~

6. ~~General-purpose cable routing assemblies~~

~~(G) Cable Trays.~~
~~Cables installed in cable trays outdoors shall be Type CL4TC. The following cables shall be permitted to be supported by cable trays in buildings:~~

1. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables~~
2. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables installed in the following:~~
    1. ~~Plenum communications raceways~~
    2. ~~Riser communications raceways~~
    3. ~~General-purpose communications raceways~~

~~(H) Cross-Connect Arrays.~~
~~The following cables shall be permitted to be installed in cross-connect arrays:~~

1. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables~~
2. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables installed in the following:~~
    1. ~~Plenum communications raceways~~
    2. ~~Plenum cable routing assemblies~~
    3. ~~Riser communications raceways~~
    4. ~~Riser cable routing assemblies~~
    5. ~~General-purpose communications raceways~~
    6. ~~General-purpose cable routing assemblies~~

~~(I) Industrial Establishments.~~
~~In industrial establishments where the conditions of maintenance and supervision ensure that only qualified persons service the installation, Type CL4TC cables shall be permitted in accordance with either 726.335(I)(1) or (I)(2).~~
~~(1) Type CL4 TC-ER.~~
~~Where the cable is not subject to physical damage, Type CL4TC cable that complies with the crush and impact requirements of Type MC cable and is identified as Type CL4TC-ER for such use shall be permitted to be exposed between the cable tray and the Class 4 receiver or Class 4 utilization equipment. The cable shall be continuously supported and protected against physical damage using mechanical protection such as dedicated struts, angles, or channels. The cable shall be supported and secured at intervals not exceeding 1.8 m (6 ft). Where not subject to physical damage, Type CL4TC-ER cable shall be permitted to transition between cable trays and between cable trays and the Class 4 receiver or Class 4 utilization equipment for a distance not to exceed 1.8 m (6 ft) without continuous support. The cable shall be mechanically supported where exiting the cable tray to ensure that the minimum bending radius is not exceeded.~~
~~(2) Type CL4 TC.~~
~~Type CL4TC cable, with a metallic sheath or armor in accordance with 725.179(E), shall be permitted to be installed exposed. The cable shall be continuously supported and protected against physical damage using mechanical protection such as dedicated struts, angles, or channels. The cable shall be secured at intervals not exceeding 1.8 m (6 ft).~~
~~(J) Other Building Locations.~~

~~The following cables shall be permitted to be installed in building locations other than those covered in 726.135(B) through (I):~~

1. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables~~
2. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables installed in the following:~~
    1. ~~Plenum communications raceways~~
    2. ~~Plenum cable routing assemblies~~
    3. ~~Riser communications raceways~~
    4. ~~Riser cable routing assemblies~~
    5. ~~General-purpose communications raceways~~
    6. ~~General-purpose cable routing assemblies~~
3. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables installed in raceways recognized in Chapter 3~~

~~(K) Multifamily Dwellings.~~
~~The following cables shall be permitted to be installed in multifamily dwellings in locations other than those covered in 726.135(B) through (I):~~

1. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables~~
2. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables installed in the following:~~
    1. ~~Plenum communications raceways~~
    2. ~~Plenum cable routing assemblies~~
    3. ~~Riser communications raceways~~
    4. ~~Riser cable routing assemblies~~
    5. ~~General-purpose communications raceways~~
    6. ~~General-purpose cable routing assemblies~~
3. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC wires and cables installed in raceways recognized in Chapter 3~~

~~(L)~~ **~~One- and Two-Family Dwellings.~~**
~~The following cables shall be permitted to be installed in one- and two-family dwellings in locations other than those covered in 726.135(B) through (I):~~

1. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables~~
2. ~~Types Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables installed in the following:~~
    1. ~~Plenum communications raceways~~
    2. ~~Plenum cable routing assemblies~~
    3. ~~Riser communications raceways~~
    4. ~~Riser cable routing assemblies~~
    5. ~~General-purpose communications raceways~~
    6. ~~General-purpose cable routing assemblies~~
3. ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables installed in raceways recognized in Chapter 3~~

726.336 Separation from Electric Light, Power, Class 1, Non–Power-Limited Fire Alarm Circuit, and Medium-Power Network-Powered Broadband Communications Cables.

(A) General.

Cables and conductors of CL4 circuits shall not be placed in any cable, cable tray, compartment, enclosure, manhole, outlet box, device box, raceway, or similar fitting with conductors of electric light, power, Class 1, non–power-limited fire alarm, and medium-power network-powered broadband communications circuits unless permitted by 726.136(B) through (I).

(B) Separated by Barriers.

Class 4 circuits shall be permitted to be installed together with the conductors of electric light, power, Class 1, non–power-limited fire alarm, and medium-power network-powered broadband communications circuits where they are separated by a barrier.

(C) Raceways Within Enclosures.

In enclosures, Class 4 circuits shall be permitted to be installed in a raceway to separate them from Class 1, non–power-limited fire alarm, and medium-power network-powered broadband communications circuits.

(D) Associated Systems Within Enclosures.

Class 4 circuit conductors in compartments, enclosures, device boxes, outlet boxes, or similar fittings shall be permitted to be installed with electric light, power, Class 1, non–power-limited fire alarm, and medium-power network-powered broadband communications circuits where they are introduced solely to connect the equipment connected to Class 4 circuits, and where either of the following applies:

1. The electric light, power, Class 1, non–power-limited fire alarm, and medium-power network-powered broadband communications circuit conductors are routed to maintain a minimum of 6 mm (0.25 in.) separation from the conductors and cables of Class 4 circuits.
2. The non–Class 4 circuit conductors operate at 150 volts or less to ground and the Class 4 circuits are installed using Type CL4, Type CL4R, or Type CL4P cables if any CL4 cable conductors extending beyond the jacket are separated by a minimum of 6 mm (0.25 in.) or by a nonconductive sleeve or nonconductive barrier from all other conductors.

(E) Enclosures with Single Openings.

Class 4 circuit conductors entering compartments, enclosures, device boxes, outlet boxes, or similar fittings shall be permitted to be installed with Class 1, non–power-limited fire alarm, and medium-power network-powered broadband communications circuits where they are introduced solely to connect the equipment connected to Class 4 circuits. Where Class 4 circuit conductors must enter an enclosure that is provided with a single opening, they shall be permitted to enter through a single fitting (such as a tee) if the conductors are separated from the conductors of the other circuits by a continuous and firmly fixed nonconductor, such as flexible tubing.

(F) Manholes.

Underground Class 4 circuit conductors in a manhole shall be permitted to be installed with Class 1, non–power-limited fire alarm, and medium-power network-powered broadband communications circuits where one of the following conditions is met:

1. The electric light, power, Class 1, non–power-limited fire alarm, and medium-power network-powered broadband communications circuit conductors are in a metal-enclosed cable or Type UF cable.
2. The Class 4 circuit conductors are permanently and effectively separated from the conductors of other circuits by a continuous and firmly fixed nonconductor, such as flexible tubing, in addition to the insulation or covering on the wire.
3. The Class 4 circuit conductors are permanently and effectively separated from conductors of the other circuits and securely fastened to racks, insulators, or other approved supports.

(G) Cable Trays.
Class 4 circuit conductors shall be permitted to be installed in cable trays where the conductors of the electric light, Class 1, and non–power-limited fire alarm circuits are separated by a solid fixed barrier of a material compatible with the cable tray or where the Class 4 circuits are installed in Type MC cable.
~~(H) In Hoistways.~~
~~In hoistways, Class 4 circuit conductors shall be installed in rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit, liquidtight flexible nonmetallic conduit, or electrical metallic tubing. For elevators or similar equipment, these conductors shall be permitted to be installed in accordance with 620.21.~~
(I) Other Applications.
For other applications, conductors of Class 4 circuits shall be separated by at least 50 mm (2 in.) from conductors of any electric light, power, Class 1, non–power-limited fire alarm, or medium-power network-powered broadband communications circuits unless one of the following conditions is met:

1. Either all of the electric light, power, Class 1, non–power-limited fire alarm, and medium-power network-powered broadband communications circuit conductors or all of the Class 4 circuit conductors are in a raceway or in metal-sheathed, metal-clad, non–metallic-sheathed, Type TC, or Type UF cables
2. All of the electric light, power, Class 1, non–power-limited fire alarm, and medium-power network-powered broadband communications circuit conductors are permanently separated from all of the Class 4 circuit conductors by a continuous and firmly fixed nonconductor, such as porcelain tubes or flexible tubing, in addition to the insulation on the conductors

726.339 Installation of Conductors of Different Circuits in the Same Cable, Enclosure, Cable Tray, Raceway, or Cable Routing Assembly.
(A) Two or More Class 4 Circuits.
Conductors of two or more Class 4 circuits shall be permitted within the same cable, enclosure, raceway, or cable routing assembly.
(B) Class 4 Circuits With Class 2, Class 3, or Communications Circuits.
Conductors of one or more Class 4 circuits shall be permitted within the same cable, enclosure, raceway, or cable routing assembly as conductors of Class 2, Class 3, or communications circuits if the insulation of the Class 2, Class 3, or communications circuit conductors in the cable, enclosure, raceway, or cable routing assembly is at least that required for Class 4 circuits.
(C) Class 4 Cables With Other Circuit Cables.

Jacketed cables of Class 4 circuits shall be permitted in the same enclosure, cable tray, raceway, or cable routing assembly with jacketed cables of any of the following:

1. Power-limited fire alarm systems in compliance with Parts I and III of Article 760
2. Nonconductive and conductive optical fiber cables in compliance with Parts I and IV of Article 770
3. Communications circuits in compliance with Parts I and IV of Article 805
4. Community antenna television and radio distribution systems in compliance with Parts I and IV of Article 820
5. Low-power, network-powered broadband communications in compliance with Parts I and IV of Article 830

~~726.341 Installation of Circuit Conductors Extending Beyond One Building.~~
~~Where Class 4 circuit conductors extend beyond one building and are run such that they are subject to accidental contact with electric light or power conductors operating over 300 volts to ground, or are exposed to lightning on interbuilding circuits on the same premises, the requirements of the following shall also apply:~~

1. ~~Sections 800.44, 800.53, 800.100, 805.50, 805.93, and 805.170(A) and (B) for other than coaxial conductors~~
2. ~~Sections 820.44, 820.93, and 820.100 for coaxial conductors~~

~~726.343 Support of Conductors.~~
~~Class 4 circuit conductors shall not be strapped, taped, or attached by any means to the exterior of any conduit or other raceway as a means of support. These conductors shall be permitted to be installed as permitted by 300.11(C)(2).~~
~~726.379 Listing and Marking of Class 4 Cables.~~
~~Cables for Class 4 power systems shall be Type CL4, Type CL4R, or Type CL4P and shall be listed for Class 4 distribution system use. CL4 cables installed as wiring methods within buildings shall be listed as resistant to the spread of fire and other criteria in accordance with 726.179(A) through (D), shall be constructed in accordance with 726.179(E), shall be marked in accordance with 726.179(F), and shall be permitted to be marked in accordance with 726.179(G).~~
~~Informational Note: See UL ###-2, *Standard for Class 4 Power Systems*, for information on determining applicable requirements for the listing of Class 4 power systems.~~
~~(A) Type CL4P.~~
~~Type CL4P plenum cable shall be marked as Type CL4P and shall be listed as suitable for use in ducts, plenums, and other spaces for environmental air and shall be listed as having adequate fire-resistant and low-smoke producing characteristics.~~
~~Informational Note: One method of defining a cable that is low-smoke producing and fire resistant is that the cable exhibits a maximum peak optical density of 0.50 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.52 m (5 ft) or less when tested in accordance with NFPA 262-2019, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*.~~
~~(B) Type CL4R.~~

~~Type CL4R riser cable shall be marked as Type CL4R and be listed as suitable for use in a vertical run in a shaft or from floor to floor and shall be listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor.~~

~~Informational Note: One method of defining fire-resistant characteristics capable of preventing the carrying of fire from floor to floor is that the cables pass the requirements of ANSI/UL 1666-2012, *Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts*.~~

~~(C) Type CL4.~~

~~Type CL4 cables shall be marked as Type CL4 and be listed as suitable for general-purpose use, with the exception of risers, ducts, plenums, and other spaces used for environmental air, and shall be listed as resistant to the spread of fire.~~

~~Informational Note No. 1: One method of defining *resistant to the spread of fire* is that the cables do not spread fire to the top of the tray in the UL flame exposure, vertical tray flame test in ANSI/UL 1685-2010, *Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*. The smoke measurements in the test method are not applicable.~~

~~Informational Note No. 2: Another method of defining *resistant to the spread of fire* is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the CSA vertical flame test for cables in cable trays, as described in CSA C22.2 No. 0.3-M-2001, *Test Methods for Electrical Wires and Cables*.~~

~~(D) Type CL4TC.~~

~~Type CL4TC nonmetallic-sheathed tray cable shall be marked as Type CL4TC, shall be listed as being suitable for cable trays, and shall consist of a factory assembly of two or more insulated conductors under a nonmetallic jacket. The insulated conductors shall be at least 24 AWG copper (solid or stranded). Insulation on conductors shall be rated for 450 volts dc. The cable core shall be two or more parallel conductors, one or more group assemblies of twisted or parallel conductors, or a combination of both. A metallic shield or a metallized foil shield with drain wire(s) shall be permitted to be applied over the cable core, over groups of conductors, or both. The cable shall be listed as resistant to the spread of fire. The outer jacket shall be a sunlight- and moisture-resistant nonmetallic material. Type CL4TC cable used in a wet location shall be listed for use in wet locations or have a moisture-impervious metal sheath.~~

~~Exception: Where a smooth metallic sheath, continuous corrugated metallic sheath, or nonmetallic jacket with interlocking tape armor is provided, an overall nonmetallic jacket shall not be required. On metallic-sheathed cable without an overall nonmetallic jacket, the information required in 310.8 shall be located on the nonmetallic jacket under the sheath.~~

~~Informational Note No. 1: One method of defining *resistant to the spread of fire* is that the cables do not spread fire to the top of the tray in the UL flame exposure, vertical tray flame test in ANSI/UL 1685-2010, *Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*. The smoke measurements in the test method are not applicable.~~

~~Informational Note No. 2: Another method of defining *resistant to the spread of fire* is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the CSA vertical tray flame test for cables in cable trays, as described in CSA C22.2 No. 0.3-M-2001, *Test Methods for Electrical Wires and Cables*.~~

~~(E) Cable Construction.~~

~~(1) Sizes.~~

~~Conductors of sizes not smaller than 24 AWG shall be permitted to be used.~~

~~(2) Insulation.~~

~~Insulation on conductors shall be rated not less than 450 volts dc.~~

~~(3) Voltage Rating.~~

~~Cables shall have a voltage rating of not less than 450 volts dc. Voltage ratings shall not be marked on the cables.~~

~~(4) Temperature Rating.~~

~~Cables shall have a temperature rating of not less than 60°C (140°F).~~

~~(5) Cabling.~~

~~Cables shall comply with any requirements provided in the listing of the system.~~

~~Informational Note: Excessive cable lengths can result in higher capacitance which could affect the safety of the circuit. See UL ###-2, *Standard for Class 4 Power Systems*, for information on determining applicable requirements for the listing of Class 4 power systems.~~

~~(F) Marking.~~

~~All cables shall be marked to indicate the following information using the applicable method described in 310.8(B):~~

1. ~~The cable type as described in 726.179 (A) through (D)~~
2. ~~The manufacturer's name, trademark, or other distinctive marking by which the organization responsible for the product can be readily identified~~
3. ~~The AWG size or circular mil area~~
4. ~~Number of conductors, if more than two~~
5. ~~The temperature rating of Class 4 cables that have a rating exceeding 60°C (140°F)~~

~~(G) Optional Markings.~~

~~Cables shall be permitted to be surface marked to indicate special characteristics of the cable materials.~~

~~Informational Note No. 1: These markings include, but are not limited to, markings for limited smoke, halogen free, low-smoke and halogen free, and sunlight resistant.~~

~~Informational Note No. 2: Some examples of optional markings are "ST1" to indicate limited-smoke characteristics in accordance with UL 2556, *Wire and Cable Test Methods*; "HF" to indicate halogen-free as described in UL 2885, *Outline of Investigation for Acid Gas, Acidity and Conductivity of Combusted Materials and Assessment of Halogens*; and "LSHF" to indicate halogen-free and low-smoke characteristics in accordance with IEC 61034-2, *Measurement of smoke density of cables burning under defined conditions — Part 2: Test procedure and requirements*.~~

722 Rework Substantiation

References:
FR 9582
FR 9602
FR 9606
Global PI 3671

This Public Comment was developed by a Panel 3 appointed task group to address a Correlating Committee request to restructure the new Article 722 on power limited cables to remove any material that is specific to Class 2, Class 3, PLFA and optical fiber cables and move this material back into Articles 725, 760 and 770. The Panel 3 task group members included TG Chairman Randy Ivans (Panel 3 Principal, Panel 16 Alternate), Robert Jones (Chairman Panel 3), James Conrad, Don Iverson, Jessica Kiefer and Ron Tellas.

At the same time, the redundancies in Articles 725, 760 and 770 that were originally addressed in FR 9582 also appear in the new Article 726 for Class 4 circuits (FR 9606). This Public Comment also removes these redundancies from Article 726 and incorporates Class 4 cables into Article 722.

These changes significantly improve clarity and usability while removing redundant requirements. It is not the intent of these proposals to introduce any technical changes. Some editorial errors were found during this process and fixed within this Comment

Changes from the First Revisions currently in TerraView are in Green Text.

The TG recognizes that there is still some redundant material relating to “Separation from Electric Light, Power, Class 1, Non–Power-Limited Fire Alarm Circuit, and Medium-Power Network-Powered Broadband Communications Cables” and “Installation of Conductors of Different Circuits in the Same Cable, Enclosure, Cable Tray, Raceway, or Cable Routing Assembly” that is now back in the original articles 725, 726, 760 and 770. Consolidation is difficult due to the different combinations of different circuits in each article. It is expected that the consolidation into 722 of this material will be the subject of future public inputs.

Attached are 6 documents as follows:

- *Article 722 Rework Substantiation.docx*

This document is the text of this substantiation

- *Article 722 - Taking out specific material from 725, 760 & 770; Adding 726 Class 4 Redundant Material.docx*

This document is a revision of Article 722 that removes any material that is specific to Class 2, Class 3, PLFA and optical fiber cables. The original Parts II, III and IV are eliminated. Part V is renumbered as Part II. There is some relocation of common material into Part I. This document also adds the redundant material from Article 726 into Article 722. The title of Article 722 is revised to accommodate optical fiber cables and the addition of Class 4 cables. Panel 16 pointed out that “Power Limited Cables” does not adequately describe optical fiber cables. Class 4 circuits are technically not power limited in the way that Class 2, Class3 or PLFA circuits are limited although the energy available into a fault is power limited. Therefore a separate designation in the title is needed.

- *Article 725 - Material from 722 Put Back into 725 (Using FR Text).docx*

This document is a revision of Article 725 that adds the material from Article 722 back in as directed by the Correlating Committee.

- *Article 726 - Moving Redundant Material into 722.docx*

This document is a revision of Article 726 that removes redundant material now covered by Article 722. Installation criteria that is unique to Class 4 cables remains in Article 726 as directed by the Correlating Committee. Article 722 combines common cabling requirements found in Articles 725, 726, 760, and 770 into a single article. The proposed revisions also removes the redundancy between the text-based requirements and the tabular requirements by including most of the requirements only in tabular form in Article 722. This has been found to be more user-friendly. Some of the text-based requirements do not lend themselves to being represented in tabular form and remain as text in the new Article 722.

- *Article 760 - Material from 722 Put Back into 760 (Using FR Text).docx*

This document is a revision of Article 760 that adds the material from Article 722 back in as directed by the Correlating Committee. It was found that a lot of material that was supposed to be removed in the First Revision was not removed. Some of this now remains as part of the restructuring. This revision removes the redundant material that is still in Article 722 as a correction to the FR.

- *Article 770 - Moving Redundant Material into 722.docx*

Panel 16 rejected the original Global PI 3671 that proposed moving redundant material into the new Cables Article 722. This document is a resubmission of the revision of Article 770 that removes redundant material that is now located in Article 722. Installation criteria that is unique to optical fiber cable remains in Article 770 as directed by the Correlating Committee. Article 722 combines common cabling requirements found in Articles 725, 726, 760, and 770 into a single article. The proposed revisions also removes the redundancy between the text-based requirements and the tabular requirements by including most of the requirements only in tabular form in Article 722. This has been found to be more user-friendly. Some of the text-based requirements do not lend themselves to being represented in tabular form and remain as text in the new Article 722.

Public Comment No. 1962-NFPA 70-2021 [Global Input]

The Correlating Committee directs CMP-3 to review the structure of all informational notes to comply with the NEC Style Manual, 3.1.3.1, 4.1.3 and 4.1.4.

Additional Proposed Changes

File Name	Description	Approved
CN_383_Global.pdf	70_CN383	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 383 appeared in the First Draft Report.

The Correlating Committee directs CMP-3 to review the structure of all informational notes to comply with the NEC Style Manual, 3.1.3.1, 4.1.3 and 4.1.4.

Related Item

- Correlating Note No. 383

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 18 20:39:30 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: Panel 3 has reviewed the concerns of the Panel 3 appointed Task Group and the CC and have created second revisions where needed throughout Articles under its purview.

Public Comment No. 53-NFPA 70-2021 [Global Input]

Article 720 should be saved,

It provides guidance for wiring a remote off grid dwelling unit, and provides relief from the dwelling unit requirements in 210 for remote cabins and dwellings without AC grid power.
The branch circuit requirements in 210 are intended for grid connected dwellings with ample power supplied by a utility.
Without 720 an AHJ may require all re-requirements of 210 to a rural cabin or 'off grid' dwelling that uses 12, 24,32,or 48 volt nominal systems.
As long as there is wilderness there will be remote cabins that are powered off a simple battery or 12V source.

Statement of Problem and Substantiation for Public Comment

Without 720 an AHJ may require all re-requirements of 210 to a rural cabin or 'off grid' dwelling that uses 12, 24,32,or 48 volt nominal systems.

Related Item

• 2440-NFPA 70-2020

Submitter Information Verification

Submitter Full Name: Stephen Schmiechen
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jul 01 00:33:37 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: Article 710, "Stand-Alone Systems", is the proper Article to address the premise wiring for a remote off grid dwelling unit, see Section 710.15. There is nothing in Article 720 that provides relief from the requirements of Article 210. Section 720.4 which requires #12 AWG copper or equivalent minimum conductors is more restrictive than Article 210. Article 720 was intended for a specific power supply that has not been used since the end of World War II.

Public Comment No. 592-NFPA 70-2021 [Global Input]

The Correlating Committee directs the Chair of CMP-3 to assign a task group to review all the definitions under their purview for compliance with the NEC Style Manual and to review definitions identified by the Correlating Committee that may contain correlation issues. The attachment includes a list of those definitions identified that need to be reviewed.

Additional Proposed Changes

File Name	Description	Approved
3_CN_353_Global.pdf	70_CN353	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 353 appeared in the First Draft Report on First Revisions No. 9620.

The Correlating Committee directs the Chair of CMP-3 to assign a task group to review all the definitions under their purview for compliance with the NEC Style Manual and to review definitions identified by the Correlating Committee that may contain correlation issues. The attachment includes a list of those definitions identified that need to be reviewed.

Related Item

- First Revision No. 9620

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 02 10:25:00 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: A CMP-3 Task Group was assigned and reviewed the definitions under its purview creating second revisions where necessary to comply with the NEC Style Manual.

Correlating Committee Note No. 353-NFPA 70-2021 [Global Input]

Supplemental Information

File Name	Description	Approved
NEC_P03_Definitions_TG_Attachment_CN353.docx		

Submitter Information Verification

Committee: NEC-P03

Submittal Date: Thu May 06 22:35:59 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs the Chair of CMP-3 to assign a task group to review all the definitions under their purview for compliance with the NEC Style Manual and to review definitions identified by the Correlating Committee that may contain correlation issues. The attachment includes a list of those definitions identified that need to be reviewed.

First Revision No. 9620-NFPA 70-2021 [Global Input]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
0 Not Returned
12 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Johnston, Michael J.
Kendall, David H.
Kovacik, John R.
Manche, Alan
McDaniel, Roger D.
Porter, Christine T.
Williams, David A.

Correlating Committee Definitions Task Group
CMP-3 - Definitions

CMP-3 Definitions	Correlating Committee Comments
	The Correlating Committee directs the Chair of CMP-3 to assign a task group to review all the definitions under their purview for compliance with the NEC Style Manual and to review definitions identified by the Correlating Committee that may contain correlation issues. The attachment includes a list of those definitions identified that need to be reviewed.
Under Carpet Cable. Cables that are intended to be used under carpeting, floor covering, modular tiles and planks. (722) (CMP-3)	Need to Correlate with CMP-6 (Article 324) Regarding this wiring method Use of Under Carpet Cables
Abandoned Cable. Installed Class 2, Class 3, and PLTC cable that is not terminated at equipment and not identified for future use with a tag. (722) (CMP-3)	Task Group 2 Cable Issues 2.2.2.3 Base Term. [Cable, Abandoned] 2.2.2.4 Multiple Terms
Abandoned Class 2, Class 3, and PLTC Cable. Installed Class 2, Class 3, and PLTC cable that is not terminated at equipment and not identified for future use with a tag. (CMP-3)	Task Group 2 Cable Issues
Abandoned Fire Alarm Cable. Installed fire alarm cable that is not terminated at equipment other than a connector and not identified for future use with a tag. (CMP-3)	Task Group 2 Cable Issues
Cable Bundle. A group of cables that are tied together or in contact with one another in a closely packed configuration for at least 1.0 m (40 in.). (CMP-3) Informational Note: Random or loose installation of individual cables can result in less heating. Combing of the cables can result in less heat dissipation and more signal cross talk between cables.	Task Group 2 Cable Issues
Cables for Limited Use. Cables that are intended to be used with protection such as a raceway or for specific restricted applications. (722) (CMP-3)	Task Group 2 Cable Issues
Circuit Integrity (CI) Cable. Cable(s) marked with the suffix (-CI) used for remote-control, signaling, power-limited, fire alarm, optical fiber, or communications systems that supply critical circuits to ensure survivability for continued circuit operation for a specified time under fire conditions. (CMP-3)	Task Group 2 Cable Issues

Informational Note: See 728.4 for power circuits installed for survivability.	
Fire Alarm Circuit Integrity (CI) Cable. Cable used in fire alarm systems to ensure continued operation of critical circuits during a specified time under fire conditions. (CMP-3)	Task Group 2 Cable Issues
Fire-Resistive Cable System. A cable and components used to ensure survivability of critical circuits for a specified time under fire conditions. (CMP-3)	Task Group 2 Cable Issues
General-Purpose Cables, Cable Routing Assemblies, and Raceways. General-purpose cables, cable routing assemblies, and raceways are suitable for general purpose applications and are resistant to the spread of fire. (722) (CMP-3)	Task Group 2 Cable Issues 2.2.2.2 Term in Definition
Plenum Cable, Cable Routing Assemblies, and Raceways. Cables, cable routing assemblies, and raceways that have adequate fire-resistant and low smoke-producing characteristics and are suitable for use in ducts, plenums, and other spaces used for environmental air. (722) (CMP-3)	Task Group 2 Cable Issues 2.2.2.2 Term in Definition
Riser Cable, Cable Routing Assemblies, and Raceways. Cables, cable routing assemblies, and raceways that have fire-resistant characteristics capable of preventing the carrying of fire from floor to floor and are suitable for use in a vertical run in a shaft or from floor to floor. (722) (CMP-3)	Task Group 2 Cable Issues 2.2.2.2 Term in Definition
The Definitions in Articles 305 and 722 will to be relocated to Article 100.	2.2.2 Relocate all definitions to Article 100
Class 4 Transmitter. A device that sources Class 4 power, monitors the line for faults, ceases power transmission if a fault is sensed, and limits the energy and power into a fault to the levels described in 726.121(A). (CMP-3)	2.2.2.2 Requirement in Definition (726.121(A)
Fault-Managed Power (FMP). A powering system that monitors for faults and controls power delivered to ensure fault energy is limited. The monitoring and control systems differentiate them from electric light and power circuits; therefore, alternative requirements to those of Chapters 1 through 4 are given regarding minimum wire sizes, ampacity adjustment and correction factors, overcurrent protection, insulation requirements, and wiring methods and materials. (CMP-3)	3.1.3 Interpretation in Definition Consider the last sentence as an Informational Note
Instrumentation Tray Cable (Type ITC). A factory assembly of two or more insulated conductors, with or without an equipment grounding conductor(s), enclosed in a nonmetallic sheath. (CMP-3)	2.2.2.3 Base Term Group by Cable

Non–Power-Limited Fire Alarm Circuit (NPLFA). A fire alarm circuit powered by a source that complies with the requirements of 760.41 and 760.43. (CMP-3)	2.2.2.2 Requirement in Definition 4.2 References to Requirements Fire Alarm Circuit, Non-Power Limited
Power-Limited Fire Alarm Circuit (PLFA). A fire alarm circuit powered by a source that complies with the requirements of 760.121. (CMP- 3)	2.2.2.2 Requirement in Definition 4.2 References to Requirements
Power-Limited Tray Cable (PLTC). A factory assembly of two or more insulated conductors rated at 300 volts, with or without associated bare or insulated equipment grounding conductors, under a nonmetallic jacket. (CMP- 3)	2.2.2.3 Base Term. Group by Cable
Remote-Control Circuit, Branch Circuit. A branch circuit that controls any other branch circuit through a relay or an equivalent device. (CMP-3)	Review the use of the term in the code 2.2.2.3.1 Searchable Title
Remote-Control Circuit, Power-Limited. Any power-limited electrical circuit that controls any other circuit through a relay or an equivalent device. (CMP-3)	Review the use of the term in the code 2.2.2.3.1 Searchable Title Suggest: (Power-Limited Circuit)
Signaling Circuit, Branch Circuit. Any branch circuit that energizes signaling equipment. (CMP-3)	Review the use of the term in the code 2.2.2.3.1 Searchable Title Suggest: (Signaling Circuit)
Signaling Circuit, Power-Limited. Any power-limited electrical circuit that energizes signaling equipment. (CMP-3)	Review the use of the term in the code 2.2.2.3.1 Searchable Title Suggest: (Power-Limited Signaling Circuit)

Public Comment No. 666-NFPA 70-2021 [Global Input]

The Correlating Committee directs the panel to review the reference to Article 450 in 724.40(A) for compliance in accordance with section 4.1.1 of the NEC Style Manual. It is not necessary to repeat requirements in Chapter 4.

The Correlating Committee directs the panel to review references to entire "Articles" and revise in accordance with section 4.1.4 of the NEC Style Manual.

The Correlating Committee directs the panel to reconsider the deleted text in 725.41 (B) for correlation with 300.3(C)(1) and the impact on these circuits occupying the same enclosure or raceway.

The Correlating Committee directs that FR-9591 be sent to CMP-3, CMP-11, CMP-9, CMP-12, CMP-13, CMP-18 for information.

The Correlating Committee directs that the Panel review the elimination of 725.41 (B) as it appears to have eliminated the ability to mix full voltage remote control and signaling circuits with Class 1.

The Correlating Committee further requests clarity with regard to the use and application of the terms remote-control, branch circuit and signaling circuit, branch circuit as it applies to the revisions in this new article that were formerly located in Part II of Article 725.

Additional Proposed Changes

File Name	Description	Approved
3_CN_368_Global.pdf	3 CN368	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 368 appeared in the First Draft Report on First Revision No. 9591.

The Correlating Committee directs the panel to review the reference to Article 450 in 724.40(A) for compliance in accordance with section 4.1.1 of the NEC Style Manual. It is not necessary to repeat requirements in Chapter 4.

The Correlating Committee directs the panel to review references to entire "Articles" and revise in accordance with section 4.1.4 of the NEC Style Manual.

The Correlating Committee directs the panel to reconsider the deleted text in 725.41 (B) for correlation with 300.3(C)(1) and the impact on these circuits occupying the same enclosure or raceway.

The Correlating Committee directs that FR-9591 be sent to CMP-3, CMP-11, CMP-9, CMP-12, CMP-13, CMP-18 for information.

The Correlating Committee directs that the Panel review the elimination of 725.41 (B) as it appears to have eliminated the ability to mix full voltage remote control and signaling circuits with Class 1.

The Correlating Committee further requests clarity with regard to the use and application of the terms remote-control, branch circuit and signaling circuit, branch circuit as it applies to the revisions in this new article that were formerly located in Part II of Article 725.

Related Item

• First Revision No. 9591

Submitter Information Verification

Submitter Full Name:	CC on NEC-AAC
Organization:	NEC Correlating Committee
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 03 09:02:36 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	Panel 3 has reviewed the concerns of the Panel 3 appointed Task Group and the CC and have created second revisions where needed throughout Articles under its purview.

Public Comment No. 666-NFPA 70-2021 [Global Input]

The Correlating Committee directs the panel to review the reference to Article 450 in 724.40(A) for compliance in accordance with section 4.1.1 of the NEC Style Manual. It is not necessary to repeat requirements in Chapter 4.

The Correlating Committee directs the panel to review references to entire "Articles" and revise in accordance with section 4.1.4 of the NEC Style Manual.

The Correlating Committee directs the panel to reconsider the deleted text in 725.41 (B) for correlation with 300.3(C)(1) and the impact on these circuits occupying the same enclosure or raceway.

The Correlating Committee directs that FR-9591 be sent to CMP-3, CMP-11, CMP-9, CMP-12, CMP-13, CMP-18 for information.

The Correlating Committee directs that the Panel review the elimination of 725.41 (B) as it appears to have eliminated the ability to mix full voltage remote control and signaling circuits with Class 1.

The Correlating Committee further requests clarity with regard to the use and application of the terms remote-control, branch circuit and signaling circuit, branch circuit as it applies to the revisions in this new article that were formerly located in Part II of Article 725.

Additional Proposed Changes

File Name	Description	Approved
3_CN_368_Global.pdf	3 CN368	✓

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 368 appeared in the First Draft Report on First Revision No. 9591.

The Correlating Committee directs the panel to review the reference to Article 450 in 724.40(A) for compliance in accordance with section 4.1.1 of the NEC Style Manual. It is not necessary to repeat requirements in Chapter 4.

The Correlating Committee directs the panel to review references to entire "Articles" and revise in accordance with section 4.1.4 of the NEC Style Manual.

The Correlating Committee directs the panel to reconsider the deleted text in 725.41 (B) for correlation with 300.3(C)(1) and the impact on these circuits occupying the same enclosure or raceway.

The Correlating Committee directs that FR-9591 be sent to CMP-3, CMP-11, CMP-9, CMP-12, CMP-13, CMP-18 for information.

The Correlating Committee directs that the Panel review the elimination of 725.41 (B) as it appears to have eliminated the ability to mix full voltage remote control and signaling circuits with Class 1.

The Correlating Committee further requests clarity with regard to the use and application of the terms remote-control, branch circuit and signaling circuit, branch circuit as it applies to the revisions in this new article that were formerly located in Part II of Article 725.

Related Item

• First Revision No. 9591

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 03 09:02:36 EDT 2021
Committee: NEC-P03

that I have full power and authority to enter into this copyright assignment.

☑ By checking this box I affirm that I am CC on NEC-AAC, and I agree to be legally bound by the above Copyright Assignment and the terms and conditions contained therein. I understand and intend that, by checking this box, I am creating an electronic signature that will, upon my submission of this form, have the same legal force and effect as a handwritten signature

Public Comment No. 706-NFPA 70-2021 [Global Input]

The Correlating Committee advises that article scope statements and location are the responsibility of the Correlating Committee and the Correlating Committee accepts the panel action to create Article 722 and the scope statement.

The Correlating Committee directs the panel to review references to entire "Articles" and revise in accordance with section 4.1.4 of the NEC Style Manual.

The Correlating Committee requests that the panel review and revise Article 722 to correlate with the structure of Articles 31 0 and 311 and provide all general requirements for conductors and cables of limited energy.

The Correlating Committee directs that this first revision be referred to CMP-16 for reconsideration of PI 4138 to correlate Article 770 and Article 722 by removing the material in NEC 770 that has been moved to Article 722.

Additional Proposed Changes

File Name	Description	Approved
3_CN_374_Global.pdf	3 CN374	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 374 appeared in the First Draft Report on First Revision No. 9582

The Correlating Committee advises that article scope statements and location are the responsibility of the Correlating Committee and the Correlating Committee accepts the panel action to create Article 722 and the scope statement.

The Correlating Committee directs the panel to review references to entire "Articles" and revise in accordance with section 4.1.4 of the NEC Style Manual.

The Correlating Committee requests that the panel review and revise Article 722 to correlate with the structure of Articles 31 0 and 311 and provide all general requirements for conductors and cables of limited energy.

The Correlating Committee directs that this first revision be referred to CMP-16 for reconsideration of PI 4138 to correlate Article 770 and Article 722 by removing the material in NEC 770 that has been moved to Article 722.

Related Item

- First Revision No. 9582

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 03 13:01:32 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution:	Panel 3 has reviewed the concerns of the Panel 3 appointed Task Group and the CC and have created second revisions where needed throughout Articles under its purview.

Correlating Committee Note No. 374-NFPA 70-2021 [Global Input]

Submitter Information Verification

Committee: NEC-P03

Submittal Date: Fri May 07 11:10:39 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee advises that article scope statements and location are the responsibility of the Correlating Committee and the Correlating Committee accepts the panel action to create Article 722 and the scope statement.

The Correlating Committee directs the panel to review references to entire "Articles" and revise in accordance with section 4.1.4 of the NEC Style Manual.

The Correlating Committee requests that the panel review and revise Article 722 to correlate with the structure of Articles 310 and 311 and provide all general requirements for conductors and cables of limited energy.

The Correlating Committee directs that this first revision be referred to CMP-16 for reconsideration of PI 4138 to correlate Article 770 and Article 722 by removing the material in NEC 770 that has been moved to Article 722.

The Correlating Committee directs that the panel relocated definitions to Article 100 and identified that the definitions only apply to Article 722 in accordance with section 2.2.2 of the NEC Style Manual.

The Correlating Committee directs the Panel to consider relocating all ampacity values for limited energy cables to Article 722.

The Correlating Committee requests the panel review and consider relocation of the cable requirements unique to a specific article as follows: 1) All special cable requirements such as those in 722.154 for fire alarm systems to be relocated to Article 760. 2) All special cable requirements for Class 2 and Class 3 circuits to be relocated to Article 725. 3) All fire resistive cable requirements to be relocated to Article 728. 4) All optical fiber cable requirements should be relocated to Article 770.

First Revision No. 9582-NFPA 70-2021 [Global Input]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
0 Not Returned
12 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Johnston, Michael J.
Kendall, David H.
Kovacik, John R.
Manche, Alan
McDaniel, Roger D.
Porter, Christine T.
Williams, David A.

Public Comment No. 709-NFPA 70-2021 [Global Input]

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and the Correlating Committee accepts the panel action to create Miele 726 and the scope statement. The Correlating Committee requests the panel to review the need and location of Information Notes within the Scope of the article.

The Correlating Committee directs the panel to review references to an entire "Article" and revise in accordance with section 4.1.4 of the NEC® Style Manual.

The Correlating Committee directs the panel to identify the UL Standard shown in Information Note "No. 2" of 726.121 and to identify the Section Numbers in Figure 726.121.

The Correlating Committee directs the panel to review and identify the UL Standard shown in the Information Note for 726.170.

Additional Proposed Changes

File Name	Description	Approved
3_CN_376_Global.pdf	3 CN376	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 376 appeared in the First Draft Report on First Revision No. 9606.

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and the Correlating Committee accepts the panel action to create Miele 726 and the scope statement. The Correlating Committee requests the panel to review the need and location of Information Notes within the Scope of the article.

The Correlating Committee directs the panel to review references to an entire "Article" and revise in accordance with section 4.1.4 of the NEC® Style Manual.

The Correlating Committee directs the panel to identify the UL Standard shown in Information Note "No. 2" of 726.121 and to identify the
Section Numbers in Figure 726.121.

The Correlating Committee directs the panel to review and identify the UL Standard shown in the Information Note for 726.170.

Related Item

- First Revision No. 9606

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 03 13:06:11 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution:	Panel 3 has reviewed the concerns of the Panel 3 appointed Task Group and the CC and have created second revisions where needed throughout Articles under its purview.

Correlating Committee Note No. 376-NFPA 70-2021 [Global Input]

Submitter Information Verification

Committee: NEC-P03

Submittal Date: Fri May 07 11:24:45 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and the Correlating Committee accepts the panel action to create Article 726 and the scope statement. The Correlating Committee requests the panel to review the need and location of Information Notes within the Scope of the article.

The Correlating Committee directs the panel to review references to an entire “Article” and revise in accordance with section 4.1.4 of the NEC® Style Manual.

The Correlating Committee directs the panel to identify the UL Standard shown in Information Note “No. 2” of 726.121 and to identify the Section Numbers in Figure 726.121.

The Correlating Committee directs the panel to review and identify the UL Standard shown in the Information Note for 726.170.

First Revision No. 9606-NFPA 70-2021 [Global Input]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
0 Not Returned
12 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Johnston, Michael J.

Kendall, David H.

Kovacik, John R.

Manche, Alan

McDaniel, Roger D.

Porter, Christine T.

Williams, David A.

Public Comment No. 716-NFPA 70-2021 [Global Input]

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and the Correlating Committee accepts the panel action to delete Article 720.

Additional Proposed Changes

File Name	Description	Approved
3_CN_373.pdf	3 CN373	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 373 appeared in the First Draft Report on First Revision No. 9580

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and the Correlating Committee accepts the panel action to delete Article 720.

Related Item

- First Revision No. 9580

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 03 13:35:04 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected
Resolution: The Panel was not required to take any action.

Correlating Committee Note No. 373-NFPA 70-2021 [Article 720]

Submitter Information Verification

Committee: NEC-P03
Submittal Date: Fri May 07 11:08:54 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and the Correlating Committee accepts the panel action to delete Article 720.

First Revision No. 9580-NFPA 70-2021 [Article 720]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
0 Not Returned
12 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Johnston, Michael J.
Kendall, David H.
Kovacik, John R.
Manche, Alan
McDaniel, Roger D.
Porter, Christine T.
Williams, David A.

Public Comment No. 732-NFPA 70-2021 [Global Input]

The Correlating Committee notes there are more than one related term or similar terms for the various Cable Definitions. Section 2.2.2.4 of the NEC Style Manual states a task group shall be formed to work on the development of a single acceptable definition. There are also correlation issues with other terms regarding cable wiring methods and installations. The Correlating Committee establishes a Task Group with representation from CMPs 1, 3, 12, 15 and 16 to review the following terms to group them by a base term and to consider a single definition where applicable. Each panel is assigned to revise the definitions under their purview to comply with the NEC Style Manual.

Abandoned Cable. (CMP-3) 9620.

Abandoned Class2, Class 3, and PLTC Cable (CMP-3) 9620.

Bundled Cable. (CMP-15)

Cable, Abandoned (CMP-16) 9570.

Cable, Bundle. (CMP-3) 9620.

Cable, Circuit Integrity. (CMP-3) 9555.

Cable, Communications, Circuit Integrity. (CMP-16)

Cable Routing Assembly. (CMP-16)

Cable Sheath. (CMP-16) 9571.

Cable Sheath, Optical Fiber. (CMP-16) 9574.

Cables for Limited Use. (CMP-3) 9620.

Fire Alarm, Circuit Integrity (CI) Cable. (CMP-3) 9620.

Grouped. (CMP-15)

Point of Entrance. (CMP-16) 9572.

Point of Entrance (Point of Entrance Optical Fiber Cable). (CMP-16) 9572.

Additional Proposed Changes

File Name	Description	Approved
3_CN_392_Global.pdf	3 CN392	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 392 appeared in the First Draft Report on First Revision Nos. 9620, 9570, 9555, 9571, 9574 and 9572.

The Correlating Committee notes there are more than one related term or similar terms for the various Cable Definitions. Section 2.2.2.4 of the NEC Style Manual states a task group shall be formed to work on the development of a single acceptable definition. There are also correlation issues with other terms regarding cable wiring methods and installations. The Correlating Committee establishes a Task Group with representation from CMPs 1, 3, 12, 15 and 16 to review the following terms to group them by a base term and to consider a single definition where applicable. Each panel is assigned to revise the definitions under their purview to comply with the NEC Style Manual.

Abandoned Cable. (CMP-3) 9620.

Abandoned Class2, Class 3, and PLTC Cable (CMP-3) 9620.

Bundled Cable. (CMP-15)

Cable, Abandoned (CMP-16) 9570.

Cable, Bundle. (CMP-3) 9620.

Cable, Circuit Integrity. (CMP-3) 9555.

Cable, Communications, Circuit Integrity. (CMP-16)

Cable Routing Assembly. (CMP-16)

Cable Sheath. (CMP-16) 9571.

Cable Sheath, Optical Fiber. (CMP-16) 9574.

Cables for Limited Use. (CMP-3) 9620.

Fire Alarm, Circuit Integrity (CI) Cable. (CMP-3) 9620.

Grouped. (CMP-15)

Point of Entrance. (CMP-16) 9572.

Point of Entrance (Point of Entrance Optical Fiber Cable). (CMP-16) 9572.

Related Item

- First Revision No. 9620
- First Revision No. 9570
- First Revision No. 9555
- First Revision No. 9571
- First Revision No. 9574
- First Revision No. 9572

Submitter Information Verification

Submitter Full Name:	CC on NEC-AAC
Organization:	NEC Correlating Committee
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 03 14:22:30 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	Panel 3 has reviewed the concerns of the CC and have created second revisions addressing definitions under its purview.

Correlating Committee Note No. 392-NFPA 70-2021 [Global Input]

Submitter Information Verification

Committee: NEC-P03

Submittal Date: Fri May 07 16:10:57 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee notes there are more than one related term or similar terms for the various Cable Definitions. Section 2.2.2.4 of the NEC Style Manual states a task group shall be formed to work on the development of a single acceptable definition. There are also correlation issues with other terms regarding cable wiring methods and installations. The Correlating Committee establishes a Task Group with representation from CMPs 1, 3, 12, 15 and 16 to review the following terms to group them by a base term and to consider a single definition where applicable. Each panel is assigned to revise the definitions under their purview to comply with the NEC Style Manual.

Abandoned Cable. (CMP-3) 9620.

Abandoned Class2, Class 3, and PLTC Cable (CMP-3) 9620.

Bundled Cable. (CMP-15)

Cable, Abandoned (CMP-16) 9570.

Cable, Bundle. (CMP-3) 9620.

Cable, Circuit Integrity. (CMP-3) 9555.

Cable, Communications, Circuit Integrity. (CMP-16)

Cable Routing Assembly. (CMP-16)

Cable Sheath. (CMP-16) 9571.

Cable Sheath, Optical Fiber. (CMP-16) 9574.

Cables for Limited Use. (CMP-3) 9620.

Fire Alarm, Circuit Integrity (CI) Cable. (CMP-3) 9620.

Grouped. (CMP-15)

Point of Entrance. (CMP-16) 9572.

Point of Entrance (Point of Entrance Optical Fiber Cable). (CMP-16) 9572.

First Revision No. 9620-NFPA 70-2021 [Global Input]

First Revision No. 9570-NFPA 70-2021 [Definition: Abandoned Cable.]

First Revision No. 9555-NFPA 70-2021 [Definition: Circuit Integrity (CI) Cable.]

First Revision No. 9571-NFPA 70-2021 [Definition: Cable Sheath.]

First Revision No. 9574-NFPA 70-2021 [Definition: Cable Sheath.]

First Revision No. 9572-NFPA 70-2021 [Definition: Point of Entrance.]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
0 Not Returned
12 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Johnston, Michael J.
Kendall, David H.
Kovacik, John R.
Manche, Alan
McDaniel, Roger D.
Porter, Christine T.
Williams, David A.

Public Comment No. 734-NFPA 70-2021 [Global Input]

The Correlating Committee directs this definition be correlated with the Article 324 and refer this first revision to Code Making Panel 6 for correlation.

Additional Proposed Changes

File Name	Description	Approved
3_CN_407_Global.pdf	3 CN407	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 407 appeared in the First Draft Report on First Revision No. 9582.

The Correlating Committee directs this definition be correlated with the Article 324 and refer this first revision to Code Making Panel 6 for correlation.

Related Item

• First Revision No. 9582

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 03 14:29:26 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: Panel 3 has reviewed the concerns of the CC and have created second revisions addressing definitions under its purview.

Public Comment No. 734-NFPA 70-2021 [Global Input]

The Correlating Committee directs this definition be correlated with the Article 324 and refer this first revision to Code Making Panel 6 for correlation.

Additional Proposed Changes

File Name	Description	Approved
3_CN_407_Global.pdf	3 CN407	✓

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 407 appeared in the First Draft Report on First Revision No. 9582.

The Correlating Committee directs this definition be correlated with the Article 324 and refer this first revision to Code Making Panel 6 for correlation.

Related Item

- First Revision No. 9582

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 03 14:29:26 EDT 2021
Committee: NEC-P06

Public Comment No. 897-NFPA 70-2021 [Global Input]

The Correlating Committee requests that Panels 3, 7, 8, 9, 12, 13, 15, 16 and 18 reconsider the text "shall not be permitted to be" for clarification and ease of use. Simplifying the text to state "shall not be" is suggested as an alternative.

Additional Proposed Changes

File Name	Description	Approved
CN_260_Global.pdf	70_CN260	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 26 appeared in the First Draft Report.

The Correlating Committee requests that Panels 3, 7, 8, 9, 12, 13, 15, 16 and 18 reconsider the text "shall not be permitted to be" for clarification and ease of use. Simplifying the text to state "shall not be" is suggested as an alternative.

Related Item

- Correlating Note No. 260

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 04 15:47:24 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: Panel 3 has reviewed the concerns of the Panel 3 appointed Task Group and the CC and have created second revisions where needed throughout Articles under its purview.

Public Comment No. 897-NFPA 70-2021 [Global Input]

The Correlating Committee requests that Panels 3, 7, 8, 9, 12, 13, 15, 16 and 18 reconsider the text "shall not be permitted to be" for clarification and ease of use. Simplifying the text to state "shall not be" is suggested as an alternative.

Additional Proposed Changes

File Name	Description	Approved
CN_260_Global.pdf	70_CN260	✓

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 26 appeared in the First Draft Report.

The Correlating Committee requests that Panels 3, 7, 8, 9, 12, 13, 15, 16 and 18 reconsider the text "shall not be permitted to be" for clarification and ease of use. Simplifying the text to state "shall not be" is suggested as an alternative.

Related Item

- Correlating Note No. 260

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC

Organization: NEC Correlating Committee

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 04 15:47:24 EDT 2021

Committee: NEC-P03

Public Comment No. 665-NFPA 70-2021 [New Article after 100]

TITLE OF NEW CONTENT

Type your content here ...Threads, field-cut

~~Field-cut threads are those threads that are cut in conduit, elbows, or nipples anywhere other than at the factory where the product is listed.[Stet]~~

Statement of Problem and Substantiation for Public Comment

Strikeout not intended in text. "After Article 100" not intended, but rather IN Article 100. This definition is presently found in an I.N. to 300.6. There is an argument in favor of keeping all definitions near the text that they explain, but that is not the way the NEC has moved. An I.N. is not the best place for a definition, so if this definition is necessary, it should live in Article 100.

Related Item

- PI 2438

Submitter Information Verification

Submitter Full Name:	David Shapiro
Organization:	Safety First Electrical
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 03 09:01:18 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	Definition for “field-cut threads” is not necessary, this is a well-known term within the electrical construction industry. Refer to PC 664 for more information about changes to 300.6(A).

Public Comment No. 196-NFPA 70-2021 [Definition: Abandoned Class 2, Class 3, and PLTC Cable.]

Cable, Abandoned Class2, Class3 and PLTC (Abandoned Class 2, Class 3, and PLTC Cable) .

Installed Class 2, Class 3, and PLTC cable that is not terminated at equipment and not identified for future use with a tag. (CMP-3)

Statement of Problem and Substantiation for Public Comment

Starting the definition with the word "cable" will move the definition adjacent to all the other abandoned cable definitions.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 197-NFPA 70-2021 [Definition: Abandoned Fire Alarm Cable.]	
Public Comment No. 198-NFPA 70-2021 [Definition: Circuit Integrity (CI) Cable.]	
Public Comment No. 200-NFPA 70-2021 [Definition: Fire Alarm Circuit Integrity (CI) Cable.]	
Public Comment No. 197-NFPA 70-2021 [Definition: Abandoned Fire Alarm Cable.]	
Public Comment No. 198-NFPA 70-2021 [Definition: Circuit Integrity (CI) Cable.]	
Public Comment No. 200-NFPA 70-2021 [Definition: Fire Alarm Circuit Integrity (CI) Cable.]	

Related Item

- FR-9620

Submitter Information Verification

Submitter Full Name:	Stanley Kaufman
Organization:	CableSafe, Inc./OFS
Affiliation:	PLASTICS (Plastics Industry Association)
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sun Jul 11 09:37:56 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8621-NFPA 70-2021
Statement:	In accordance with section 2.2.2.4 of the NEC Style Manual a CC task group was formed to work on a single definition for “abandoned cable”. This CC task group consisted of CMPs 3, 12, and 16 members. CMP 3 has accepted the recommendation of this task group to delete the definition for “abandoned Class 2, Class 3, and PLTC Cable.”

Public Comment No. 197-NFPA 70-2021 [Definition: Abandoned Fire Alarm Cable.]

Cable, Abandoned Fire Alarm, (Abandoned Fire Alarm Cable) .

Installed fire alarm cable that is not terminated at equipment other than a connector and not identified for future use with a tag. (CMP-3)

Statement of Problem and Substantiation for Public Comment

Starting the definition with the word "cable" will move the definition adjacent to all the other abandoned cable definitions.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 196-NFPA 70-2021 [Definition: Abandoned Class 2, Class 3, and PLTC Cable.]	
Public Comment No. 198-NFPA 70-2021 [Definition: Circuit Integrity (CI) Cable.]	
Public Comment No. 200-NFPA 70-2021 [Definition: Fire Alarm Circuit Integrity (CI) Cable.]	
Public Comment No. 196-NFPA 70-2021 [Definition: Abandoned Class 2, Class 3, and PLTC Cable.]	
Public Comment No. 198-NFPA 70-2021 [Definition: Circuit Integrity (CI) Cable.]	
Public Comment No. 200-NFPA 70-2021 [Definition: Fire Alarm Circuit Integrity (CI) Cable.]	

Related Item

- FR-9620

Submitter Information Verification

Submitter Full Name: Stanley Kaufman
Organization: CableSafe, Inc./OFS
Affiliation: PLASTICS (Plastics Industry Association)
Street Address:
City:
State:
Zip:
Submittal Date: Sun Jul 11 09:46:01 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8622-NFPA 70-2021

Statement: In accordance with section 2.2.2.4 of the NEC Style Manual a CC task group was formed to work on a single definition for “abandoned cable”. This CC task group consisted of CMPs 3, 12, and 16 members. CMP 3 has accepted the recommendation of this task group to delete the definition for “abandoned fire alarm cable.”

Public Comment No. 198-NFPA 70-2021 [Definition: Circuit Integrity (CI) Cable.]

Cable, Circuit Integrity (CI), (Circuit Integrity (CI) Cable) .

Cable(s) marked with the suffix "-CI" used for remote-control, signaling, power-limited, fire alarm, optical fiber, or communications systems that supply critical circuits to ensure survivability for continued circuit operation for a specified time under fire conditions. (CMP-3)

Informational Note: See 728.4 for power circuits installed for survivability.

Statement of Problem and Substantiation for Public Comment

Starting the definition with the word "cable" will move the definition adjacent to all the other cable definitions.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 196-NFPA 70-2021 [Definition: Abandoned Class 2, Class 3, and PLTC Cable.]	
Public Comment No. 197-NFPA 70-2021 [Definition: Abandoned Fire Alarm Cable.]	
Public Comment No. 200-NFPA 70-2021 [Definition: Fire Alarm Circuit Integrity (CI) Cable.]	
Public Comment No. 196-NFPA 70-2021 [Definition: Abandoned Class 2, Class 3, and PLTC Cable.]	
Public Comment No. 197-NFPA 70-2021 [Definition: Abandoned Fire Alarm Cable.]	
Public Comment No. 200-NFPA 70-2021 [Definition: Fire Alarm Circuit Integrity (CI) Cable.]	

Related Item

- FR-9620

Submitter Information Verification

Submitter Full Name:	Stanley Kaufman
Organization:	CableSafe, Inc./OFS
Affiliation:	PLASTICS (Plastics Industry Association)
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sun Jul 11 09:58:26 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Accepted
Resolution:	SR-8624-NFPA 70-2021
Statement:	Starting the definition with the word "cable" will move the definition adjacent to all other cable definitions and complying with section 2.2.2.3.1 of the NEC Style Manual will assist in electronic searching.

Public Comment No. 1725-NFPA 70-2021 [Definition: Class 4 Circuit.]

Class 4 Circuit.

The portion of the wiring system between the load side of a Class 4 transmitter and the Class 4 receiver or Class 4 utilization equipment, as appropriate. Due to the active monitoring and control of the ~~power transmitted~~ voltage and current provided , a Class 4 circuit ~~is not considered a possible ignition source, and it minimizes the risk of~~ considers safety from a fire initiation standpoint and provides acceptable protection from electric shock. (CMP-3)

Statement of Problem and Substantiation for Public Comment

The Class 4 Circuit definition has been harmonized to closely mirror the Class 2 Circuit definition. The words that are being replaced also apply to Class 2 Circuits but the Class 2 Circuit definition didn't feel the need to make those claims in its definition. The Class 2 Circuit definition has been legally vetted, I fear the Class 4 Circuit definition may expose liability due to absolute claims of safety; "is not considered a possible ignition source"...

Related Item

- PI 3740

Submitter Information Verification

Submitter Full Name: Chad Jones
Organization: Cisco Systems
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 17 15:14:06 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR
Resolution: SR-8626-NFPA 70-2021
Statement: The Class 4 Circuit definition has been harmonized with the Class 2 Circuit definition.

Public Comment No. 1728-NFPA 70-2021 [Definition: Class 4 Transmitter.]

Class 4 Transmitter.

A device that sources Class 4 power, monitors the line for faults, ceases power transmission if a fault is sensed, and limits the ~~energy and power~~ current into a fault to the levels described in 726.121(A). (CMP-3)

Statement of Problem and Substantiation for Public Comment

This definition was written with an assumption on how these systems work. Subsequent work on the listing standard reveals that the current is the defining factor for all faults, hence it is proper to change this from 'energy and power' to current.

Related Item

- PI 3740

Submitter Information Verification

Submitter Full Name:	Chad Jones
Organization:	Cisco Systems
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 17 15:19:42 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8700-NFPA 70-2021
Statement:	The definition has been modified to conform to the style manual by removing requirements in the definition and moving them to an informational note.

Public Comment No. 1724-NFPA 70-2021 [Definition: Fault-Managed Power (FMP).]

Fault-Managed Power (FMP).

A powering system that monitors for faults and controls ~~power~~ current delivered to ensure fault energy is limited. The monitoring and control systems differentiate them from electric light and power circuits; therefore, alternative requirements to those of Chapters 1 through 4 are given regarding minimum wire sizes, ampacity adjustment and correction factors, overcurrent protection, insulation requirements, and wiring methods and materials. (CMP-3)

Statement of Problem and Substantiation for Public Comment

This definition was written with an assumption on how these systems work. Subsequent work on the listing standard reveals that the current is the defining factor for all faults, hence it is proper to change this from power to current.

Related Item

• PI 3740

Submitter Information Verification

Submitter Full Name:	Chad Jones
Organization:	Cisco Systems
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 17 14:56:56 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8638-NFPA 70-2021
Statement:	The listing standard defines current/time requirements and therefore it is not appropriate to refer to the power but instead to the current and/or energy. The definition has been modified to conform to the style manual by removing requirements in the definition and moving them to an informational note.

Public Comment No. 200-NFPA 70-2021 [Definition: Fire Alarm Circuit Integrity (CI) Cable.]

Cable, Fire Alarm Circuit Integrity (CI), (Fire Alarm Circuit Integrity (CI) Cable) .

Cable used in fire alarm systems to ensure continued operation of critical circuits during a specified time under fire conditions. (CMP-3)

Statement of Problem and Substantiation for Public Comment

Starting the definition with the word "cable" will move the definition adjacent to all the other cable definitions.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 196-NFPA 70-2021 [Definition: Abandoned Class 2, Class 3, and PLTC Cable.]	
Public Comment No. 197-NFPA 70-2021 [Definition: Abandoned Fire Alarm Cable.]	
Public Comment No. 198-NFPA 70-2021 [Definition: Circuit Integrity (CI) Cable.]	
Public Comment No. 196-NFPA 70-2021 [Definition: Abandoned Class 2, Class 3, and PLTC Cable.]	
Public Comment No. 197-NFPA 70-2021 [Definition: Abandoned Fire Alarm Cable.]	
Public Comment No. 198-NFPA 70-2021 [Definition: Circuit Integrity (CI) Cable.]	

Related Item

- FR-9620

Submitter Information Verification

Submitter Full Name:	Stanley Kaufman
Organization:	CableSafe, Inc./OFS
Affiliation:	PLASTICS (Plastics Industry Association)
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sun Jul 11 13:05:19 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Accepted
Resolution:	SR-8625-NFPA 70-2021
Statement:	Starting the definition with the word “cable” will move the definition adjacent to all other cable definitions and complying with section 2.2.2.3.1 of the NEC Style Manual will assist in electronic searching.

Public Comment No. 2200-NFPA 70-2021 [Definitions (100): Class 2 Cir... to Class 3 Cir...]

Definitions (100): Class 2 Cir... to Class 3 Cir...

Class 2 Circuit.

The portion of the wiring system between the load side of a Class 2 power source and the connected equipment. Due to its power limitations, a Class 2 circuit considers safety from a fire initiation standpoint and provides acceptable protection from electric shock. (CMP-3)

Class 2 Circuit, Bundle Limited (Bundle-limited Class 2 Circuit).

A Class 2 circuit subject to bundle size restrictions as defined in Table 725.144. (CMP-3)

Class 3 Circuit.

The portion of the wiring system between the load side of a Class 3 power source and the connected equipment. Due to its power limitations, a Class 3 circuit considers safety from a fire initiation standpoint. Since higher levels of voltage and current than for Class 2 are permitted, additional safeguards are specified to provide protection from an electric shock hazard that could be encountered. (CMP-3)

Class 3 Circuit, Bundle Limited (Bundle-limited Class 3 Circuit).

A Class 3 circuit subject to bundle size restrictions as defined in Table 725.144. (CMP-3)

Statement of Problem and Substantiation for Public Comment

Some Authorities Having Jurisdiction have identified Table 725.144 compliance as the key differentiator between 4-pair cable installations that require permitting and inspection versus those legacy types that have traditionally been exempt. The lack of a defined term for circuits that are subject to a bundle limit in the NEC makes setting corresponding policies in local regulations cumbersome. The NFPA defining a term here would help with education, inspection, and adoption of the code.

Terra Misbehavior Note: Terra marked the basic Class 3 Circuit definition as changed, but I did not change this definition.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 2192-NFPA 70-2021 [Section No. 725.144(A)]	Code language using the definition.
Public Comment No. 2192-NFPA 70-2021 [Section No. 725.144(A)]	

Related Item

• PI 4683-NFPA 70-2020 • PI 4695-NFPA 70-2020

Submitter Information Verification

Submitter Full Name:	Jason Potterf
Organization:	Cisco
Affiliation:	Entertainment Services and Technology Association (ESTA)
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Aug 19 16:26:27 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	Requirements in a definition is a violation of section 2.2.2.2 of the NEC Style Manual. The panel acknowledges there was no intended change to the definition of Class 3 Circuit.

Public Comment No. 1878-NFPA 70-2021 [Section No. 300.2]

300.2 Limitations.

(A) Voltage.

~~With the exception of those~~ Wiring methods specified in ~~Article 305, wiring methods specified in~~ Chapter 3 shall be used for 1000 volts ~~ac, 1500 volts dc,~~ nominal, or less ~~. Wiring methods shall~~ where not specifically limited in some section of Chapter 3. They shall be permitted for over ~~1000 volts ac, 1500 volts dc, nominal, where specified in Article 305~~ 1000 volts nominal, where specifically permitted elsewhere in this Code .

(B) Temperature.

Temperature limitation of conductors shall be in accordance with 310.14(A)(3).

Statement of Problem and Substantiation for Public Comment

The proposed revisions refer to proposed Article 305 that includes multiple errors and is missing multiple parts. All later parts of the proposed Article have been restored to their respective articles based on Correlating Committee direction. This leaves proposed Table 305.7 incomplete and inaccurate leaving the text in 300.2(A) incorrect. This is just scratching the surface on numerous issues related to the creation of a new Article 305. This disruption is unnecessary and unsubstantiated.

Related Item

- FR 9609

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz
Organization: NECA
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 18 13:27:15 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8615-NFPA 70-2021

Statement: The text in 300.2 was reverted to closely match what was in the 2020 code and only modified to add “1500 volts dc” in two spots and a reference to 305.1.

Public Comment No. 19-NFPA 70-2021 [New Section after 300.4]

300.4 Bored holes

This public input is intended to have petition NFPA 7020 regarding 300.4 revisited. It was originally Resolved at the first draft meeting by code making panel 3. The reason for resolving was the submitter did not present substantial evidence to justify the changing of the section of code 300.4. Since this time we did submit public input with full substantial justification for the second draft meeting. However We are not sure that the information submitted has appeared on this website since we recently recieved an e-mail stating the input was drafted but ot submitted. Because of thsi we are submitting all the information again here id possible

Type your content here ...

Additional Proposed Changes

File Name	Description	Approved
A.01_300.4_Mark-up_Final.pdf	Final Markup of 300.4	
EXHIBIT_A_CODE_PETITION_SUMMARY.pdf	EXHIBIT A CODE PETITION SUMMARY	
EXHIBIT_B_NFPA_Home_Electrical_Fires_Full_Report_2012-2016.pdf	EXHIBIT B NFPA Home Electrical Fires Full Report 2012-2016	
EXHIBIT_C_NFPA_Home_Electrical_Fires_Supporting_Tables_2012_-_2016.pdf	EXHIBIT C NFPA Home Electrical Fires Supporting Tables 2012-2016	
EXHIBIT_D_Effectiveness_of_Circuit_Breakers_in_Mitigation_of_Arc_Faults_UL_2011.pdf	EXHIBIT D Effectiveness of Circuit Breakers in Mitigation of Arc Faults UL 2011	
EXHIBIT_E_Causes_of_Electrical_Fires_The_hidden_dangers_of_arc_fault_Siemens_2018.pdf	EXHIBIT E Causes of Electrical Fires The Hidden dangers of Arc faults Siemens 2018	
EXHIBIT_F_Arc_Faults_The_Hidden_Fire_Risk_Revealed_Schneider_Electric_2020.pdf	EXHIBIT F Arc Faults The hidden Risk Revealed Schneider Electric 2020	

EXHIBIT_G_Typical_TV_and_Monitor_Monitor_Mount_Kits_Instructions_2021.pdf	EXHIBIT G Typical TV and Monitor Mount Kits Instructions 2021

Statement of Problem and Substantiation for Public Comment

This public Input / comment is focused on minimizing the penetration of wires during and after installation by screws, nails, and drills, as well as minimizing scraping of wires during installation.
It is the petitioner's conclusion that NEC 300.4 does not provide adequate damage protection of wires passing through a structural wood frame member. Extensive research of multiple sources will prove justification for the conclusion drawn. It is documented that Electrical wiring in homes can be damaged during and after installation through over-stapling, crushing, bending, scraping, or PENETRATION by SCREWS, NAILS or DRILLS. Over time, damaged cabling degrades due to exposure to elevated temperatures or humidity, eventually leading to arc faults and ignition of combustible materials in proximity.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 20-NFPA 70-2021 [Section No. 300.4(A)]	

Related Item

• Addresses same issue

Submitter Information Verification

Submitter Full Name:	Glenn Liubakka
Organization:	EZ Electrical
Affiliation:	EZ Electrical System Solutions, LLC
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Jun 29 14:17:32 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	While wiring in homes can be damaged as indicated in the "Code Petition Summary", workmanship as cited in the report can be an issue also; and is outside the scope of the NEC. As stated in the panel's statement to resolve the original PI's associated with this public comment, cables installed less than 1 ¼ inches from the nearest edge require protection. Section 110.2 requires conductors and equipment to be acceptable if approved. If the authority having jurisdiction feels that the cable or raceway type wiring method is subject to physical damage, they may require additional protection. Protection of circuitry has increased over time with the creation, and increased use of, AFCI protection. AFCI protection detects and protects against issues raised by this public comment.

Code Petition Summary

NFPA 70 NEC 300.4 Protection Against Physical Damage

Opening Statement:

This petition is focused on minimizing the penetration of wires during and after installation by screws, nails, and drills, as well as minimizing scraping of wires during installation.

It is the petitioner's conclusion that NEC 300.4 does not provide adequate damage protection of wires passing through a structural wood frame member. Extensive research of multiple sources will prove justification for the conclusion drawn. It is documented that Electrical wiring in homes can be damaged during and after installation through over-stapling, crushing, bending, scraping, or PENETRATION by SCREWS, NAILS or DRILLS. Over time, damaged cabling degrades due to exposure to elevated temperatures or humidity, eventually leading to arc faults and ignition of combustible materials in proximity. *(EXHIBIT D: 2011 Ul paper on Mitigating parallel arc faults, first two paragraphs of the background page 6).*

Source documents are referenced throughout the summary and are included with the petition as exhibits.

Background:

Per NFPA's own study, between 2012 – 2016, on average, 44,800 home fires per year involved electrical failure or malfunction. Of those fires the first items ignited were as follows *(Exhibit B NFPA Home Electrical Fires Full Report 2012 – 2016 Page 1):*

31%	Electrical Wire or Cable Insulation	14,120 fires per year.
13%	Structural Member or Framing	5,950 fires per year.
6%	Insulation Within Structural Area	2,510 fires per year.
7%	Unclassified / Unclassified Structural Component	3,510 fires per year.
		26,090 Total fires per year.

This equates to 22,580 verifiable instances of home fires that started behind the wall in homes each year, with an additional 3,510 unclassified instances. *(EXHIBIT C: NFPA Home Electrical Fires Supporting Tables 2012 – 2016 page 12).*

This has caused serious damage, many civilian injuries, and deaths each year.

190 Civilian Deaths each year.

530 Civilian Injuries each year.

$631,000,000 In direct property damage each year.

(EXHIBIT C: NFPA Home Electrical Fires Supporting Tables 2012 – 2016 page 12)

The condition of Arc faults may form over a wide range of time intervals, from milliseconds to decades, before an arcing fault develops. Both current levels and duration are factors that allow arcs to generate the amount of heat needed to cause a fire. Arcing faults can readily produce temperatures in-excess of 1,000 degrees Celsius (1,832 deg. F). *(EXHIBIT E Causes of Electrical Fires the Hidden Dangers of Arc Faults Siemens 2018 page 2).*

Arc faults can be classified into two types, series faults and parallel faults. In a series fault, the arc occurs within only one conductor and is in series with the normal flow of electrical current. Series faults occur, for example if ONE CONDUCTOR IS NICKED, CUT, OR PENETRATED, or an interconnect is loose or corroded. Current flow through a series fault is limited by the connected load to the circuit and therefore will NOT BE MITIGATED by a circuit breaker. (*EXHIBIT B: Effectiveness of Circuit Breakers in Mitigating Parallel Arcing Faults in the Home Run page 6)*.

Anywhere a cable is damaged or loose, there is the potential of a “series arc” between the two parts of the same cable. This happens as a localized hot spot develops which starts to carbonize, the adjacent insulation materials. This carbon is conductive, allowing current to flow through it by means of electric arcs. The arcs amplify the carbonization causing a chain reaction that eventually leads to sparking a spontaneous fire. (*EXHIBIT F: Arc Faults the Hidden Risk Revealed Schneider Electric Blog 2020 page 2)*.

Parallel faults can be caused by damaged wire insulation, contaminants, rodent damage to insulation or METALIC OBJECTS (nails, screws, drills, etc.) scraping or penetrating wires. In the parallel case the arc occurs between the supply and return wires i.e., between the “hot” and “neutral” or between the “hot” and “ground” and is only limited by the available current from the panel. In this scenario, there is a potential for a current of several hundred amperes. However, these arcing events may have short duration or contain long pauses between individual arcs. For this reason, parallel arcs MAY NOT cause a conventional circuit breaker to react. (*EXHIBIT B: Effectiveness of Circuit Breakers in Mitigating Parallel Arcing Faults in the Home Run page 6)*.

Justification for Amendment:

Current Code as Written:

NFPA 70 NEC National Electrical Code Article 300

Section 300.4 Protection Against Physical Damage

Where subject to physical damage, conductors, raceways, and cables shall be protected.

(A)Cables and Raceways Through Wood Members.

(1) Bored Holes.

In both exposed and concealed locations, where a cable- or raceway-type wiring method is installed through bored holes in joists, rafters, or wood members, holes shall be bored so that the edge of the hole is not less than 32 mm (1 ¼ in.) from the nearest edge of the wood member. Where the distance cannot be maintained the cable or raceway shall be protected from penetration by screws or nails by a steel plate (s) or Steel bushing(s) at least 1.6 mm (1/16 in) thick and of appropriate length and width installed to cover the area of the wiring.

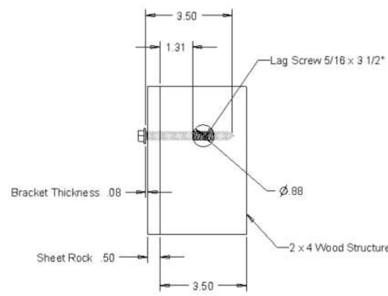
Analysis:

As the code is currently written the first line of defense from penetration from nails, screws or drills is the distance of the edge of the bored hole to the nearest edge of the wood member.

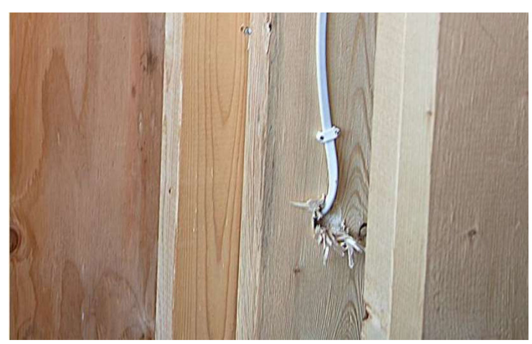
We have found that the 32mm (1 ¼ in.) distance is not adequate for the following reasons:

- The standard 2 x 4 measures 1 ½ x 3 ½ inches.
- Building contractors on new and renovation construction are frequently using longer wood screws than in the past. This happens when mounting kitchen cabinets, bathroom vanities, custom built-in-shelving units, etc. These operations happen after sheeting is installed on new construction and renovation jobs, so the finish carpenter / installer has no idea what or where the electrical wires are located.
- Home or building owners are using longer and random-length screws or nails to mount large screen televisions, artwork, and other objects. Typical mounting kits for televisions and monitors come with 2 ½ -3 ½ in. lag screws *(EXHIBIT G: Typical Monitor Mounting kits - Instructions)*. These longer fasteners can easily penetrate wires running through bored holes that meet the current code requirement of 32 mm (1 ¼ in.) from edge of wood member. It is also common to drill a pilot hole into a stud prior to installing a screw or fastener. This doubles the opportunity to compromise the wire. There is documented evidence that drills have penetrated conductors as they pass through a wooden structural member. *(EXHIBIT B: NFPA Home Electrical Fires Full Report 2012-2016 page 5).*
- The hole dimension is subject to either (a) installer verifies all bored holes and on his or her own merit installs steel plates or bushings where needed. OR. (b) During the electrical inspection process the bored holes are each visually checked and measured by the inspector. If any are in violation or do not meet the dimensional criteria per code, the inspector will contact the responsible installer to enforce the use of steel plates where necessary. This will usually happen after the wire is in place so a 360 deg steel

bushing will not be able to be installed. There are split bushings sold on the market today that could be used in this case but most likely a steel plate would be used which would only be required to be installed on the one surface of the wooden member that is in violation of the code dimension of 32 mm (1 ¼ in.). This solution is inadequate because the other surface of the wood member is still exposed to the threat of longer screws, nails, or drills. The standard 2 x 4 measures 1 ½ x 3 ½ inches. Clearly the longer screws commonly used can penetrate the wire from the opposite non-protected side of the stud.



- The current code does not address the workmanship of the bored hole. Protection from scraping of wires as they are routed through the bored holes is critical. I have been on many of job sites both residential, commercial, and multi-family unit sites where the bored holes are not clean. The majority of the holes have massive splinters on the exiting side of the bore. These splinters cause problems **scraping wires** as they are routed through the structures. Installing an insulated steel bushing in the holes prior to routing of wires will drastically reduce the amount of wire scraping during the routing process.



The second line of defense per the current code) from penetration from screws, nails or drills is the installation of steel plate (s) or bushing (s) at least 1.6 mm (1/16 in) thick and of appropriate length and width installed to cover the area of the wiring.

- This second line of defense falls short of adequate protection because it is a secondary option ***only required*** if (a) the installer realizes the hole is not code compliant or (b) The inspector notices that the hole is not code compliant.

- The Steel Plate does not protect both sides of the wooden structural member and we know that nails, screws, and drills can easily penetrate up to 3 inches into a structural member. *(Reference above illustrations)*

To be clear, this petition ***does not suggest*** the elimination of steel plates, nor does it eliminate steel split bushings. Rather, it clearly defines the appropriate use of steel plates and split bushings as exceptions to the requirement of secured 360-degree insulated steel bushings.

- **Per the petition Exception No. 1: will read as follows;** In areas in which a secured 360-degree insulated steel bushing cannot be installed, such as "Old work" or remodel jobs where wiring is already in place, a 1.6 mm (1/16 in.) secured split steel bushing with minimum of 270- degree protection against nails, screws or drill penetration shall be permitted.
- **Per the Petition Exception No. 2. Will read as follows;** In areas in which neither a secured 360-degree Insulated steel bushing, or a secured 270-degree split steel bushing cannot be installed, a steel plate no less than 1.6 mm (1⁄16 in.) thick that provides protection against drills, nails or screw penetration installed on both sides of the wooden structure that is potentially exposed to penetration to provide 180-degrees of protection shall be permitted.
- **Per the Petition Exception NO. 3. Will read as follows;** Where a secured 360-degree insulated steel bushing or a secured 270-degree split bushing cannot be installed, and the wood structures are set against a solid surface such as the inside of a concrete wall, a listed and marked steel plate no less than 1.6 mm (1⁄16 in.) thick that provides equal or better protection against drills, nails or screw penetration shall be required only on the exposed surface Where a 360-degree or a split bushing cannot be installed, and the wooden structures are set against a solid surface such as the inside of a concrete basement wall a listed and marked steel plate no less than 1.6 mm (1⁄16 in.) thick that provides equal or better protection against drills, nails or screw penetration shall be permitted on the exposed surface.
- **Per the Petition Exception NO. 4. Will read as follows;** Secured 360-degree insulated steel bushings, secured 270-degree split steel bushings or steel plates shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing.
- The Petition further describes the appropriate usage of steel plates in the section of notches in wood.

Conclusion:

It is the petitioner's conclusion that the code 300.4 as currently written, does not provide adequate protection in relation to the known risks of fires caused by Arc fault conditions. This petition provides undeniable evidence of the issue regarding the penetration of wire conductors as they pass through wood members. The supporting statistical information provided is from highly respected industry sources (NFPA and UL). The NFPA study is the most comprehensive, in-depth, and multi-year study available.

The NEC & NFPA as organizations have a dedicated mission off improving safety in the industry. This proposed code amendment addresses the documented safety hazards that currently exist under the current code.

The statistical information provided regarding electrical fires, deaths, injuries, and property damage caused by Arc fault conditions is **alarming**. We can reduce these numbers drastically with this proposed code amendment.

The cost of implementation should not be a consideration for fire safety. However, it is very minimal in comparison to other safety measures that have been implemented in the past. The average cost to a home to have 360 degree insulated bushings installed in all holes a wire passes through is less than ½ of 1% of an average home cost. (Approx. $1,500.00 for a 2,800 SF home).

The Petitioner understands that there is some hesitancy regarding this topic. However, there are too many electrical fires due to Arc faults annually to ignore.

The one time a homeowner or contractor drills into that stud and rather than penetrates a conductor, they hit the 360-degree steel bushing may save an entire family's life. **We as a fire protection organization need to address this issue by amending the code. I believe it is our responsibility.**

Appendix:

Cited Documents:

EXHIBIT A: Code Petition Summary (this document)

Code Petition Author - Glenn Liubakka 2021

EXHIBIT B: NFPA Home Electrical Fires Full Report 2012 - 2016

Richard Campbell - March 2019

EXHIBIT C: NFPA Home Electrical Fires Supporting Tables 2012 - 2016

Richard Campbell - March 2019

EXHIBIT D: Effectiveness of Circuit Breakers in Mitigating Parallel Arcing Faults UL 2011

UL-Paul W. Brazis Jr., PhD and Fan He, PhD

EXHIBIT G: Typical TV and Monitor Mount Kits Instructions 2021

Glenn Liubakka 2021

Other Reference Documents regarding Arc Faults:

EXHIBIT E: Causes of Electrical Fires the Hidden Dangers of Arc Faults Siemens 2018

Siemens Industry, Inc.

EXHIBIT F: Arc Faults: The Hidden Fire Risk Revealed Schneider Electric 2020

Schneider Electric.

NFPA RESEARCH

HOME ELECTRICAL FIRES

Richard Campbell
March 2019

Key Findings

Fires involving electrical failure or malfunction

- Local fire departments responded to an estimated average of 44,880 home fires involving electrical failure or malfunction each year in 2012-2016.
- Home fires involving electrical failure or malfunction caused an estimated average of 440 civilian deaths and 1,250 civilian injuries each year in 2012-2016, as well as an estimated $1.3 billion in direct property damage a year.
- Electrical distribution, lighting, and power transfer equipment accounted for half (50%) of home fires involving electrical failure or malfunction, followed by cooking equipment (15%), heating equipment (9%), fans (6%), air conditioners (3%), and clothes dryers (3%).
- Nearly two of five fires (39%) involving electrical failure or malfunction occurred in the cold weather months from November through February. These fires were less likely to occur in the overnight hours between midnight and 8 a.m. (22% of total), but fires during this time period accounted for 60% of the civilian deaths.

Fires involving electrical distribution and lighting equipment[1]

- Local fire departments responded to an estimated average of 35,150 home fires involving electrical distribution and lighting equipment each year in 2012-2016.
- Home fires involving electrical distribution and lighting equipment caused an estimated average of 490 civilian deaths and 1,200 civilian injuries each year in 2012-2016, as well as an estimated $1.3 billion in direct property damage a year.
- Home fires involving electrical distribution and lighting equipment most often originated in a bedroom (17% of total), attic or ceiling (12%), or a wall assembly or concealed space (9%).
- Approximately one-quarter (24%) of these fires occurred between midnight and 8 a.m., but these fires accounted for 60% of deaths.

[1] Estimates exclude the six structure fire incident types for confined cooking fires, chimney or flue fires, fuel burner or boiler fires, incinerator, compactor, or trash fires.

Home Electrical Fires

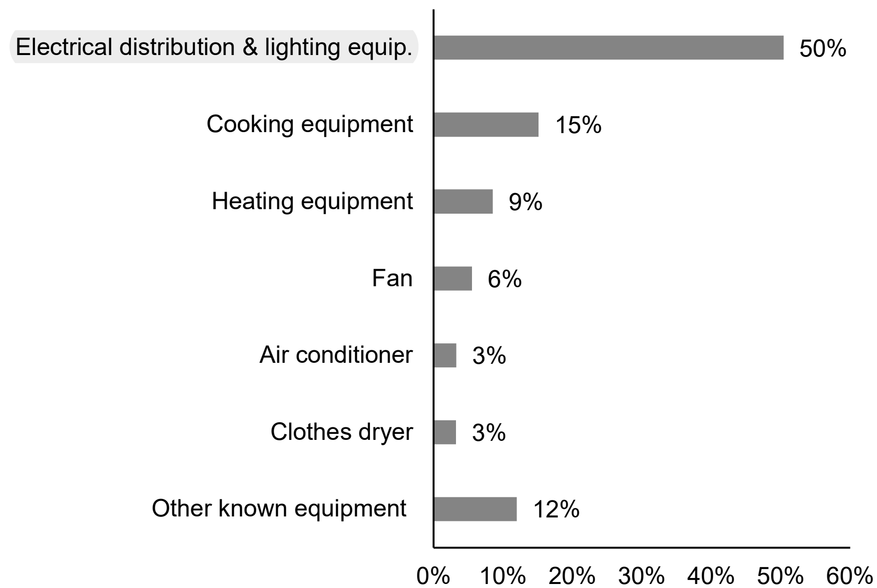
Home electrical fires can start in wiring, electrical distribution systems, and lighting equipment, as well as in any equipment powered by electricity such as cooking, heating, office and entertainment equipment, washers and dryers, as well as electrical distribution or lighting equipment. To better understand if these types of fires can be prevented through code changes, equipment changes, and/or public education, this report splits home electrical fires into two groups, based on data from two separate data elements in the National Fire Incident Reporting System (NFIRS):

1. Fires in which electrical failure or malfunction is a factor contributing to ignition.

2. Fires involving electrical distribution and lighting equipment. These are fires in which electrical distribution or lighting equipment are somehow involved in a fire's ignition. The form of involvement could include electrical failure or malfunction but may also involve other types of involvement, such as serving as a heat source by being in close proximity to combustible material or by overloaded equipment.

Figure 1 shows the types of equipment involved in home fires in which electrical failure or malfunction contributed to ignition. As indicated, electrical distribution and lighting equipment accounts for half of these fires.

Figure 1. Home Fires Involving Electrical Failure or Malfunction by Equipment Involved in Ignition 2012-2016



Home Fires Involving Electrical Failure or Malfunction

Electrical failures or malfunctions are a leading factor in the ignition of fires in U.S. homes. Electrical failures or malfunctions were responsible for 13% of home structure fires in 2012-2016, ranking as the second leading contributing factor behind fires caused by unattended equipment. Electrical failure or malfunction fires also accounted for nearly one-fifth (18%) of civilian deaths (the second leading contributing factor behind fires caused by heat sources too close to combustibles), 11% of civilian injuries, and accounted for the greatest share of direct property damage (20%).

Types of Electrical Failure or Malfunction Contributing to the Ignition of Home Fires

As shown in Figure 2, home fires due to electrical failure or malfunction primarily involve some form of arcing, which results from an unintentional discharge of electrical current between conductors. Given sufficient time and level of current, arc faults can produce enough heat to ignite a fire. Arc faults are produced by damaged conductors and connectors and may involve damaged wiring, frayed appliance cords, loose connections in wall outlets, or faulty switches and junction boxes. Arc faults may originate in different areas of the home or virtually any electrical fixture or equipment.

Electrical fault sparks fire that displaces residents

An electrical fault in a ceiling fan was blamed for an early morning fire in a multifamily residence.

Firefighters were dispatched to the fire following a 911 call from one of the occupants after a smoke alarm in his unit activated just after midnight. On arrival, crews reported fire on the second floor of a two-and-a-half-story wood-frame structure.

The fire escalated to four alarms before firefighters were able to knock it down. News reports indicated that 11 occupants were displaced by the fire, but none were injured. One firefighter was reported to have suffered a back injury at the scene.

Investigators determined that the fire was caused by an electrical short circuit in a ceiling fan in a second-floor bathroom.

The building was composed of five residential units. According to news reports, a city inspector indicated that he did not find the number of smoke alarms in the building that were required by municipal codes. The building did not have sprinkler protection.

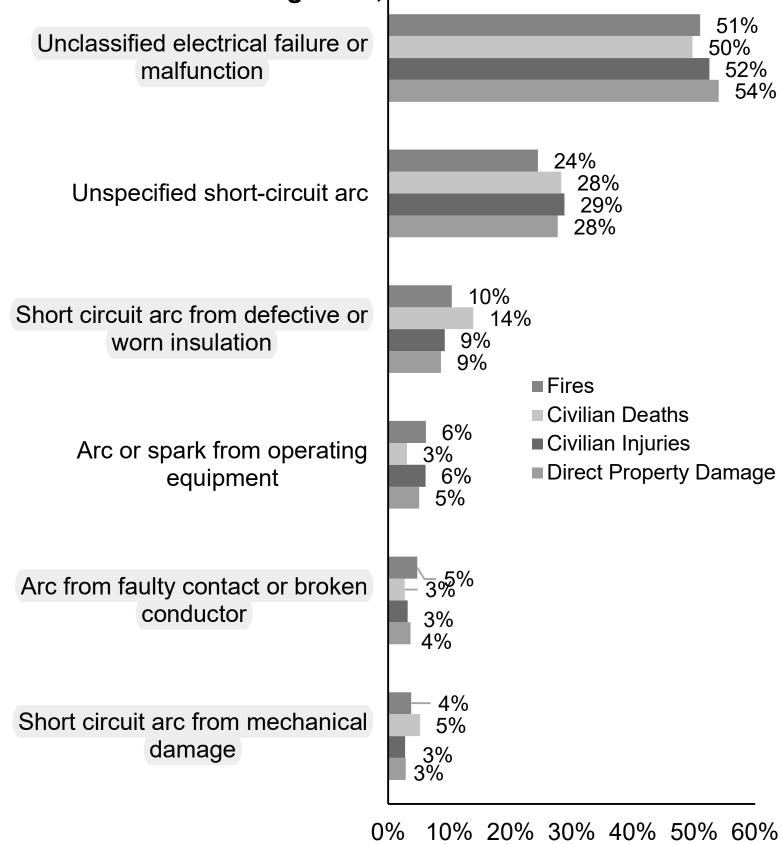
The fire caused an estimated $500,000 in damage to the structure and an additional $500,000 in damage to its contents.

Source: Richard Campbell, “Firewatch,” *NFPA Journal*, July/August, 2018.

- Short circuits from defective and worn insulation caused 14% of civilian home fire deaths as shown in Figure 2. This can be caused when cords are pinched by doors or furniture or through repetitive flexing of appliance cords. It can also be due to damaged wiring inside walls from nails, screws, or drill bits that puncture insulation during ordinary activities like hanging a picture. Even electrical cords running under carpets can generate enough heat to produce an arc fault.

- Aging electrical systems in older homes can be a source of arc faults, either through normal wear and tear or because the systems cannot accommodate the greater demands of modern appliances. Circuits can also be overloaded by providing electricity to too many appliances, often through power cords.

Figure 2. Home Fires Involving Electrical Failure or Malfunction by Factor Contributing to Ignition, 2012-2016*



TRENDS IN HOME FIRES INVOLVING ELECTRICAL FAILURE OR MALFUNCTION

The number of home fires involving electrical failure or malfunction has followed a distinct downward trend since 1980, despite year-to-year fluctuations. From a peak of 75,000 fires in 1980, the estimated number of fires involving electrical failure or malfunction has fallen to fewer than 60,000 annual fires since 1998 and fewer than 50,000 each year since 2008, with the 40,900 fires in 2012 representing a new low point (Figure 3).

A recent NFPA report on home structure fires by Marty Ahrens found that overall home structure fires have plateaued over the past two decades. The continued, if uneven, decline in home fires involving electrical failure or malfunction over this same period suggests that this is an area of relative progress. The data indicate that civilian deaths in these fires have not followed a similar downward trend to that seen in fires, showing distinct fluctuations from year to year (Figure 4).

Figure 3. Home Fires Involving Electrical Failure or Malfunction, 1980-2016

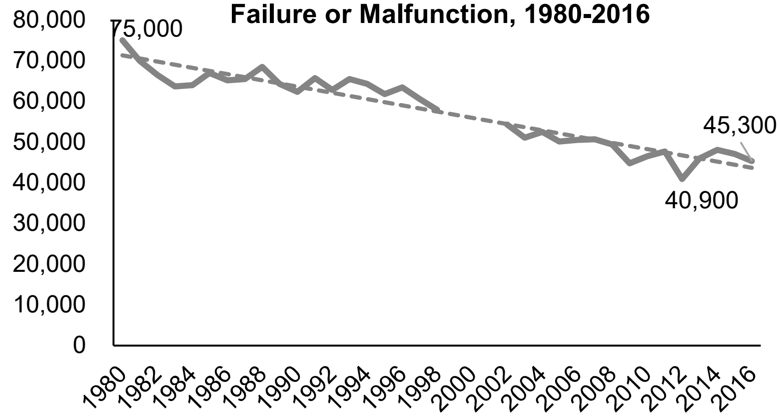
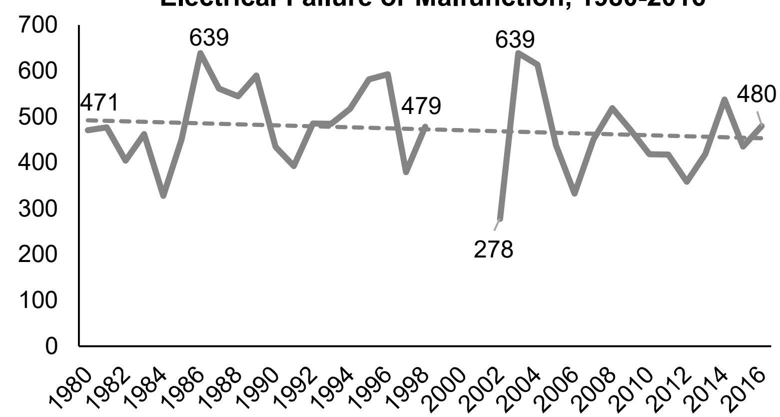


Figure 4. Civilian Deaths in Home Fires Involving Electrical Failure or Malfunction, 1980-2016

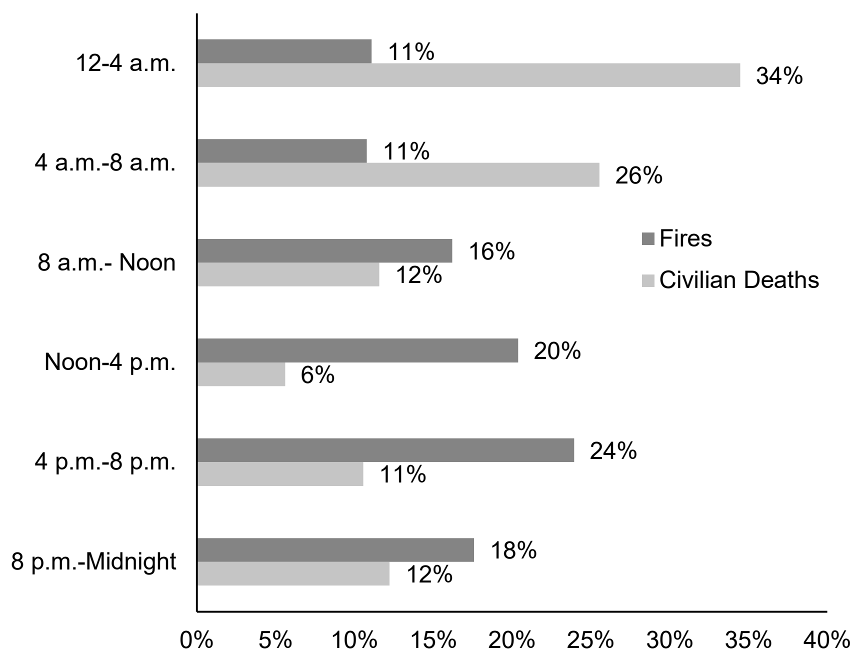


Note: Because of low participation in NFIRS Version 5.0 during 1999-2001, data from these years is not reported in these graphs.

When do home fires involving electrical failure or malfunction occur?

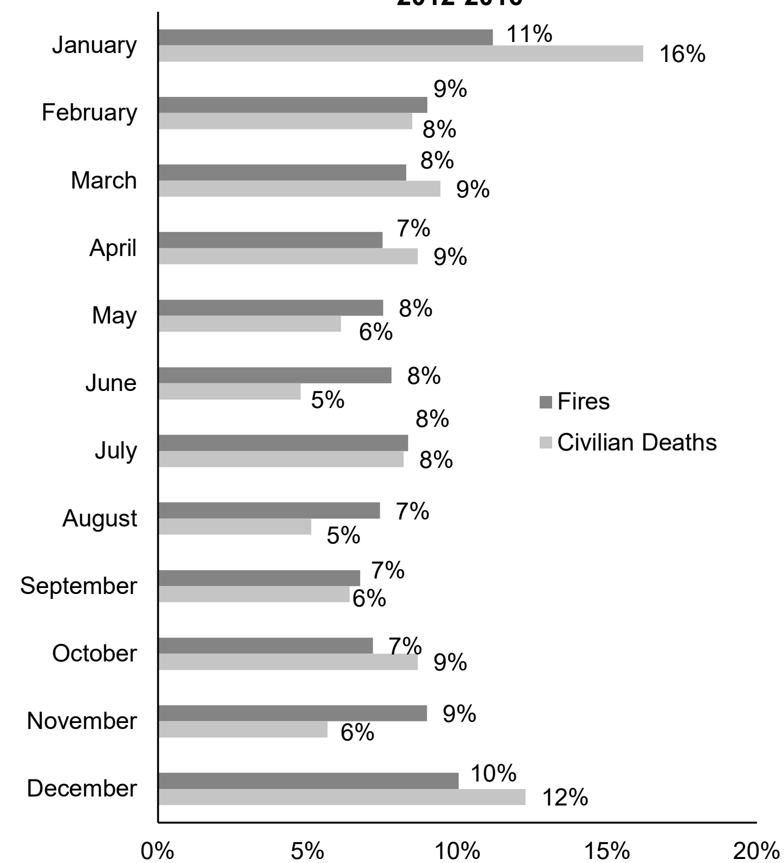
Home fires involving electrical failure or malfunction are less likely to occur in the overnight hours between midnight and 8 a.m. (22% of total), but these fires account for 60% of the civilian deaths. Fires that occur during the night when most people are asleep are more likely to be fatal. Working smoke alarms can provide an early warning of fire and allow additional time for evacuation.

Figure 5. Home Fires Involving Electrical Failure or Malfunction, by Time of Day 2012-2016



The peak months for home fires involving electrical failure or malfunction are November through March (47% of total), and these fires account for 52% of the civilian deaths. This is the time of year when more time is spent indoors, leading to an increased use of electrical equipment.

Figure 6. Home Fires Involving Electrical Failure or Malfunction by Month 2012-2016

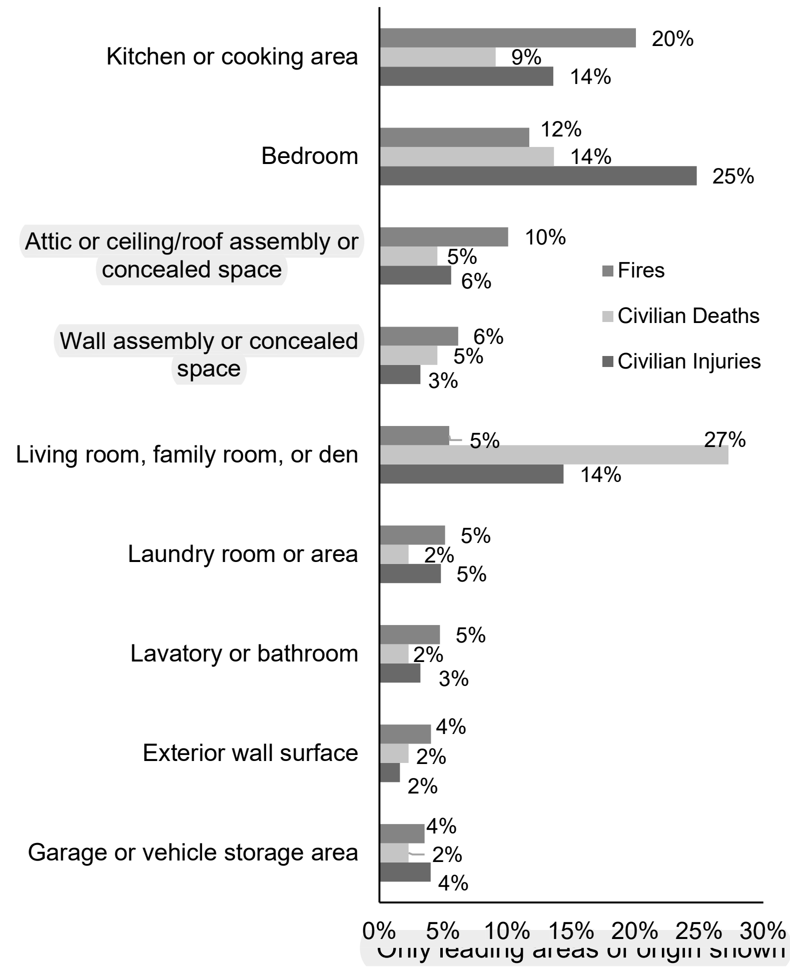


Area of Origin in Home Fires Involving Electrical Failure or Malfunction

One in five home fires (20%) involving electrical failure or malfunction originated in a kitchen or cooking area, with another 12% originating in a bedroom and 10% originating in an attic or ceiling/roof assembly or concealed space. Electrical failures or malfunctions within the wall assembly or concealed space is the fourth leading area of origin for these fires.

Fires originating in a living room, family room, or den accounted for a disproportionately large share of civilian deaths, while those originating in a bedroom accounted for a disproportionately large share of civilian injuries.

Figure 7. Area of Origin in Home Fires Involving Electrical Failure or Malfunction 2012-2016*



Home Fires Involving Electrical Distribution and Lighting Equipment

Electrical distribution and lighting equipment was the third leading type of equipment involved in fires in U.S. homes in 2012-2016, accounting for 10% of fires (behind cooking equipment and heating equipment). These fires accounted for a disproportionate share of home fire deaths (19%) and direct property damage (20%), as well as 10% of civilian injuries.

The previously mentioned change in data entry rules for incidents with an equipment-related heat source or factor contributing to ignition in 2012 is likely to have influenced estimates of electrical distribution and lighting equipment fires.

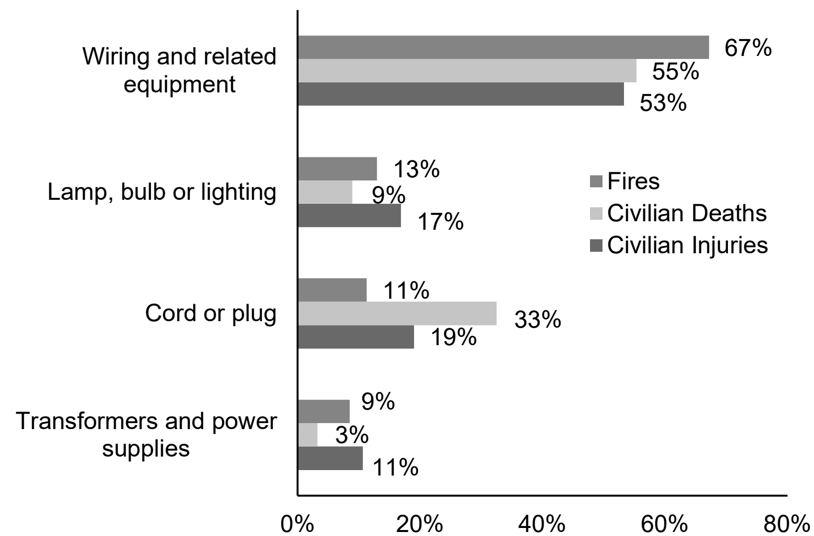
Types of Electrical Distribution and Lighting Equipment Involved in Home Fires

As shown in Figure 8, wiring and related equipment accounted for two-thirds of home fires caused by electrical distribution and lighting equipment and the same share of direct property damage, as well as over half of the civilian deaths and injuries.

Faulty wiring in concealed spaces, such as attics or behind walls, is particularly dangerous because it can start fires that burn for a prolonged period of time before detection.

Aluminum wire connections have been found to be prone to deterioration that results in increased resistance to electric current, with the cumulative damage capable of producing hazardous overheating, leading the Consumer Product Safety Commission (CPSC) to recommend that home aluminum wiring be replaced or repaired by a qualified electrician to reduce the potential for fire.

Figure 8. Types of Electrical Distribution or Lighting Equipment Involved in Home Fires, 2012-2016*

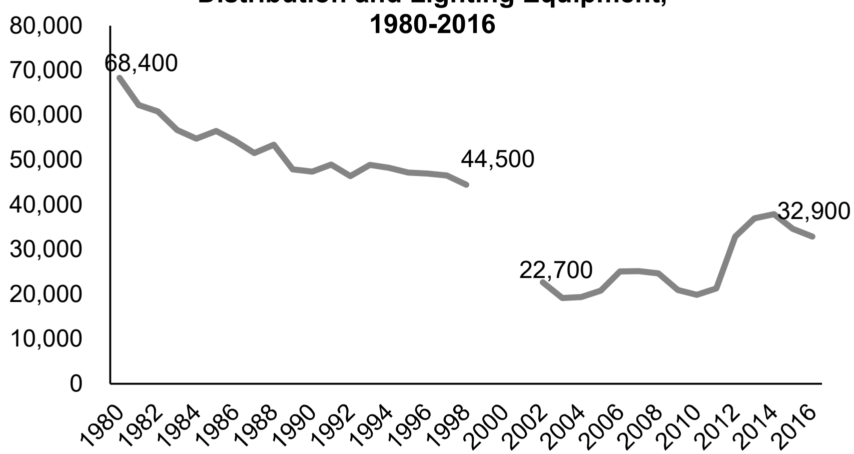


*All data in this section are non-confined fires only.

TRENDS IN HOME FIRES INVOLVING ELECTRICAL DISTRIBUTION AND LIGHTING EQUIPMENT

Home fires involving electrical distribution or lighting equipment showed a steady downward trend between 1980 and 1998, declining by about one-third during this period. See Figure 9. Following the introduction of a new version of NFIRS (NFIRS 5.0) and a transition period of 1999-2001, the downward trend was arrested and even reversed between 2011 and 2014 before falling again in 2015 and 2016, although fires are still well below those reported prior to 1999. A 2012 change in NFIRS data entry rules which required a valid entry in the "equipment involved in ignition" field for incidents having an equipment-related heat source or contributing factor had the largest impact on estimates of electrical distribution or lighting equipment fires.

Figure 9. Home Fires Involving Electrical Distribution and Lighting Equipment, 1980-2016



Note: Because of low participation in NFIRS Version 5.0 during 1999-2001, data from these years is not reported in this graph.

Electrical wiring causes house fire that kills elderly resident

An elderly resident died when degraded electrical wiring ignited combustible material in a wall cavity in the kitchen of his residence.

The fire department was summoned to the scene following a neighbor's call to 911 at 1:15 a.m., but investigators estimated that the fire had burned for an hour before it was detected.

According to news reports, firefighters found flames shooting from the rear of the house upon arrival, but they located the victim on a couch in a front room and quickly rushed him to the hospital. The victim, who had a mobility disability, succumbed to smoke inhalation injuries shortly afterwards.

Reports indicated that the resident had an unspecified physical disability.

The house was equipped with smoke alarms in the living room, bedroom, and on the second floor, and the engine company indicated that they were activated by the fire. It did not have sprinkler protection.

The house was a two story building with brick walls, a wooden roof frame, and an asphalt roof deck. It occupied a ground floor area of 700 square feet (65 square meters).

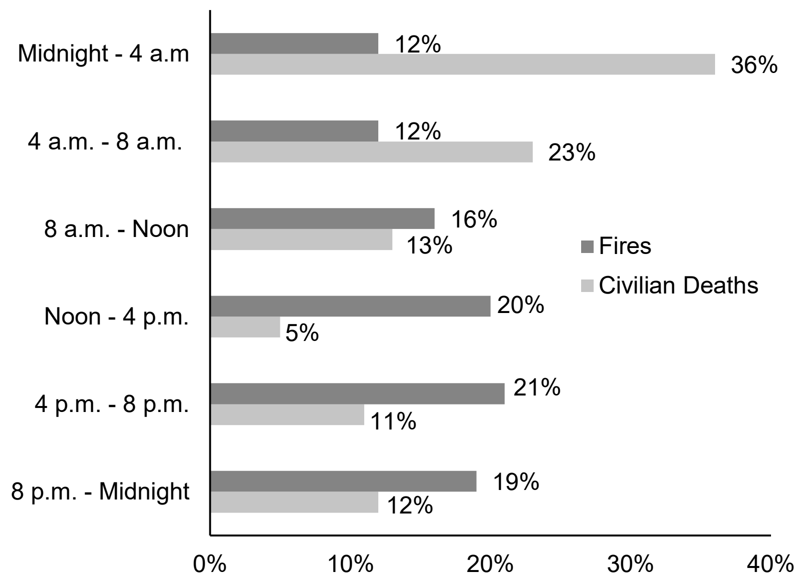
The house, valued at $80,000, and its contents, with an estimated value of $50,000, were a total loss.

Source: Richard Campbell, "Firewatch," *NFPA Journal*, January/February, 2017.

When do Home fires involving electrical distribution and lighting equipment occur?

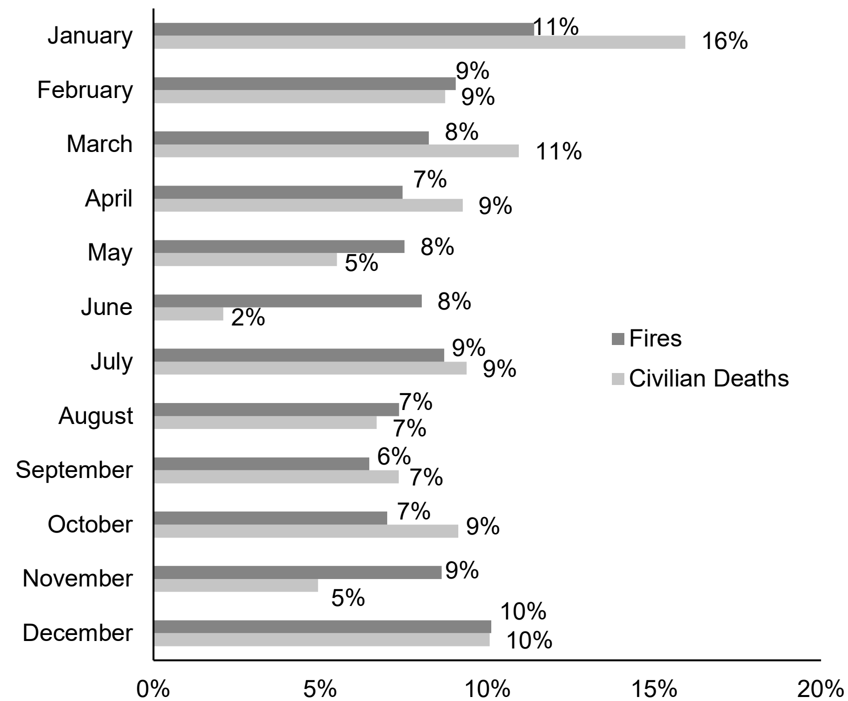
Home fires involving electrical distribution and lighting equipment are less likely to occur in the overnight hours between midnight and 8 a.m. (24% of total), but these fires account for three of five (59%) of the civilian deaths, reflecting the likelihood that people are more apt to be in the home and asleep than in the daytime hours. See Figure 10.

Figure 10. Home Fires Involving Electrical Distribution and Lighting Equipment by Time of Day, 2012-2016



As with fires caused by electrical failure or malfunction, the peak months for home fires involving electrical distribution or lighting equipment are November through March (47% of total). These fires also account for 51% of civilian deaths. This again is likely to reflect the greater tendency for people to be in the home and using electrical equipment during the cold weather months. Another one-quarter (24%) of fires occur from May through July. See Figure 11.

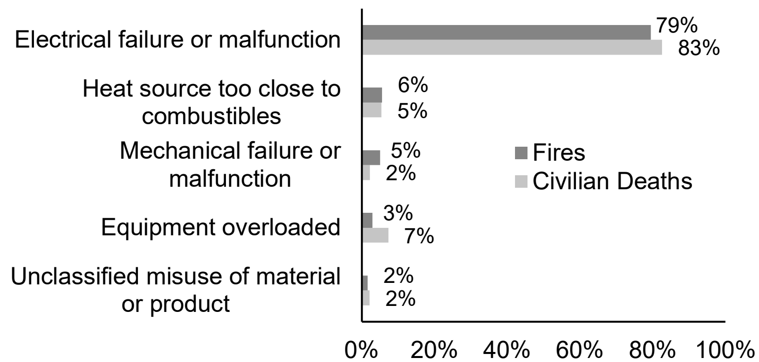
Figure 11. Home Fires Involving Electrical Distribution and Lighting Equipment by Month 2012-2016



Factors Contributing to the Ignition of Home Fires Involving Electrical Distribution or Lighting Equipment

Electrical failures or malfunctions were a factor contributing to the ignition of nearly four of five home fires (79%) involving electrical distribution or lighting equipment, and these fires accounted for 83% of civilian deaths. Other factors contributing to home fires involving electrical distribution and lighting equipment included heat sources being too close to combustibles, mechanical failures or malfunctions, overloaded equipment, and unclassified misuse of productions or materials.

Figure 12. Factors Contributing to the Ignition of Home Fires Involving Electrical Distribution and Lighting Equipment, 2012-2016*



*All data in this section is for non-confined fires only.

Some differences can be observed between specific types of electrical distribution and lighting equipment in relation to factors contributing to the ignition of fires. For instance, electrical failure or malfunction is a factor in nearly nine of ten home fires involving wiring and related equipment (Figure 13), but just less than half of those involving lamps, bulbs, or lighting (Figure 14). Approximately three in ten of the latter fires are caused by lamps, bulbs, or lighting being too close to combustible material.

In home fires involving cords and plugs, in addition to the fires involving electrical failure or malfunction (three-quarters of the total), overloaded equipment contributed to just over one in ten fires, as shown in Figure 15.

Electrical failure or malfunction also accounted for a smaller share of home fires involving transformers and power supplies (65%) than those involving wiring and related equipment or cords and plugs, but higher shares of these fires involved mechanical failures or malfunctions (9%), heat sources too close to combustibles (8%), and equipment overloaded (6%), as shown in Figure 16.

Figure 13. Factors Contributing to the Ignition of Home Fires Involving Wiring and Related Equipment, 2012-2016

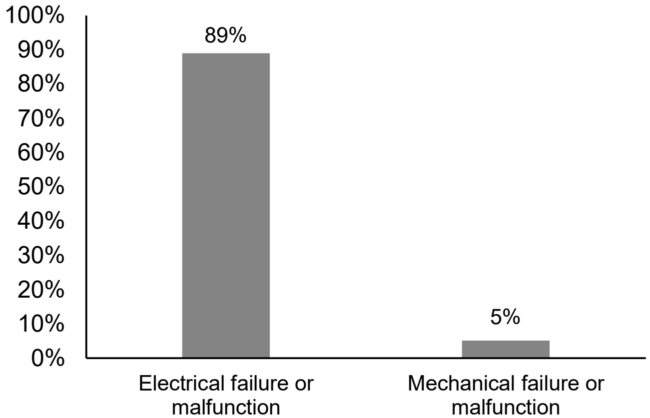


Figure 14. Factors Contributing to the Ignition of Home Fires Involving Lamps, Bulbs, or Lighting, 2012-2016

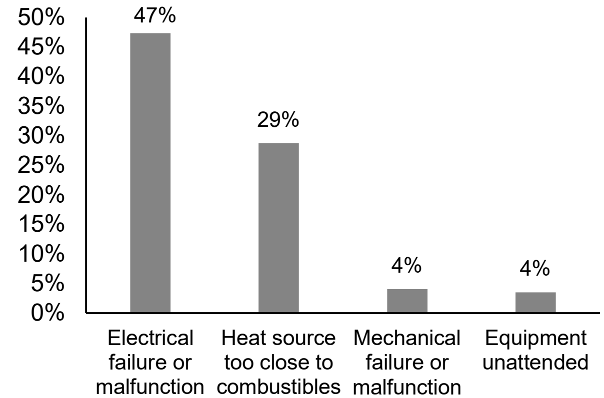


Figure 15. Factors Contributing to the Ignition of Home Fires Involving Cords or Plugs, 2012-2016

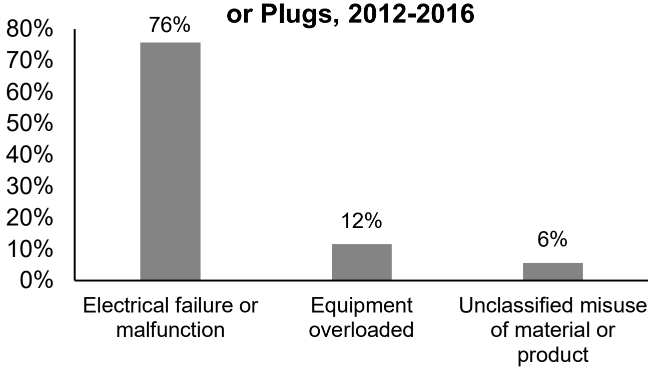
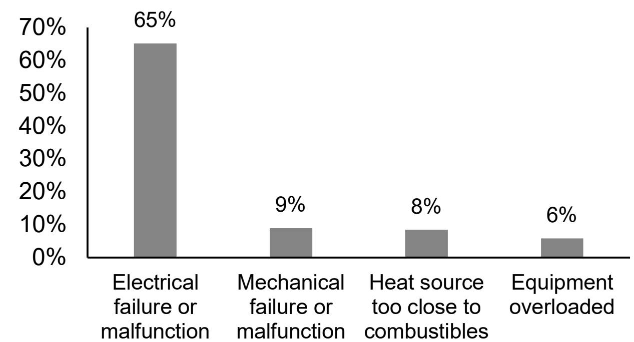


Figure 16. Factors Contributing to the Ignition of Home Fires Involving Transformers and Power Supplies 2012-2016

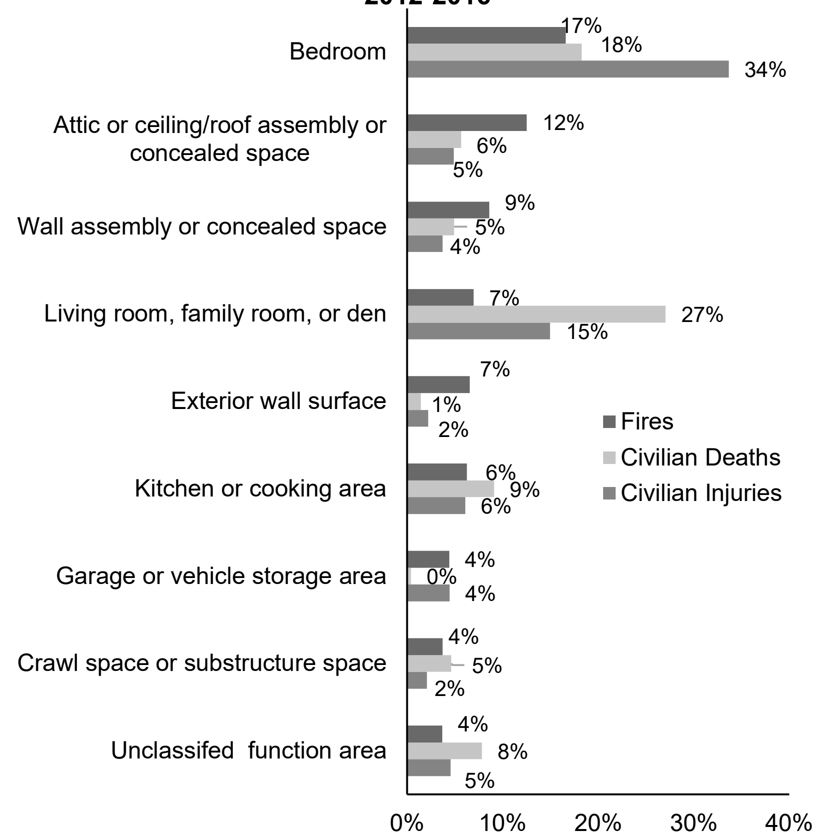


Area of Origin in Home Fires Involving Electrical Distribution or Lighting Equipment

Almost one in five home fires (17%) involving electrical distribution or lighting equipment originated in a bedroom, with another 12% originating in an attic or ceiling/roof assembly or concealed space. Fires originating in a living room, family room, or den accounted for a disproportionately large share of civilian deaths, while those originating in a bedroom accounted for a disproportionately large share of civilian injuries. Fires originating in concealed spaces, such as attics or ceiling roof assemblies, wall assemblies, and crawl spaces, were also common.

Although the bedroom is the leading area of origin for overall electrical distribution and lighting equipment home fires, there are some differences by type of equipment. Figure 18 shows that fires involving wiring and related equipment, which accounts for the great majority of these fires (67%), are most likely to originate in the attic or ceiling/roof assembly or concealed space (16% of total), followed by bedrooms (13%), and wall assemblies or concealed spaces (12%). Hence, over two of five (42%) of the wiring and related equipment fires originate in areas where they are unlikely to be immediately detected.

Figure 17. Area of Origin in Home Fires Involving Electrical Distribution or Lighting Equipment 2012-2016



The bedroom is the leading area of origin in home fires involving lamps, bulbs, or lighting, cords or plugs, and transformers and power supplies. As Figure 19 shows, lamp, bulb, and lighting fires can also originate in areas that may not be readily detected, including attics or ceiling/roof assemblies or concealed spaces, exterior wall surfaces, ceilings/floor assemblies or concealed spaces, and exterior balconies.

Figure 18. Area of Origin in Home Fires Involving Wiring and Related Equipment, 2012-2016

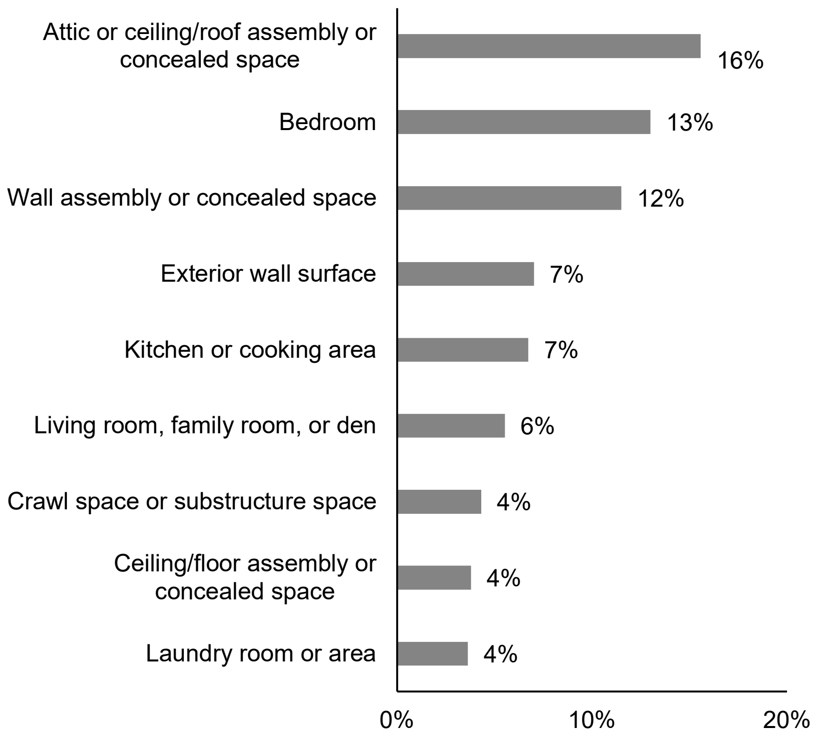


Figure 20 indicates that fires involving cords and plugs are less likely to originate in concealed areas, with nearly half of the fires originating in either the bedroom, living room, family room, or den.

Of home fires involving electrical distribution or lighting equipment that originated in a garage or vehicle storage area, the largest share were those involving transformers and power cords, as shown in Figure 21.

Figure 19. Area of Origin in Home Fires Involving Lamps, Bulbs, or Lighting 2012-2016

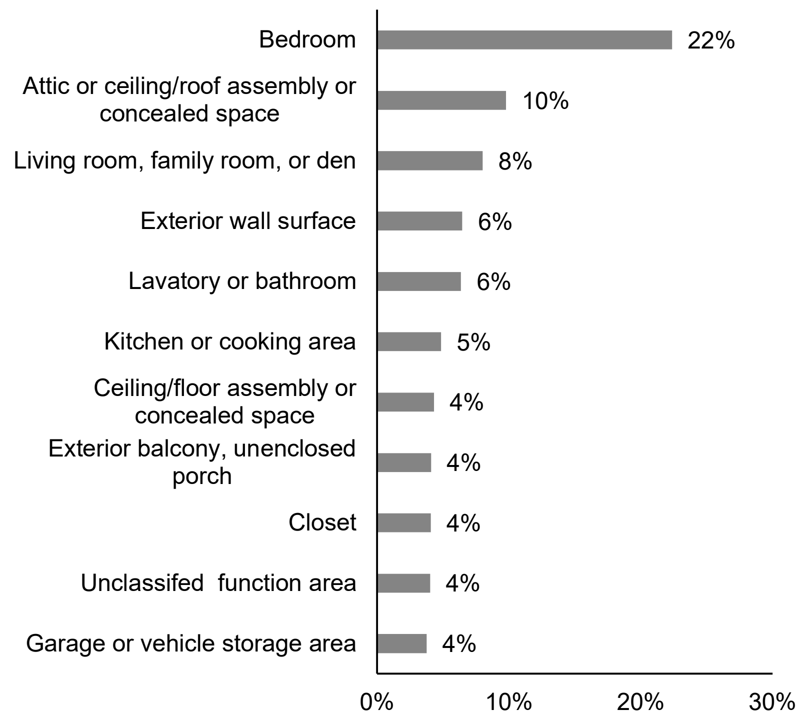


Figure 20. Area of Origin in Home Fires Involving Cords or Plugs, 2012-2016

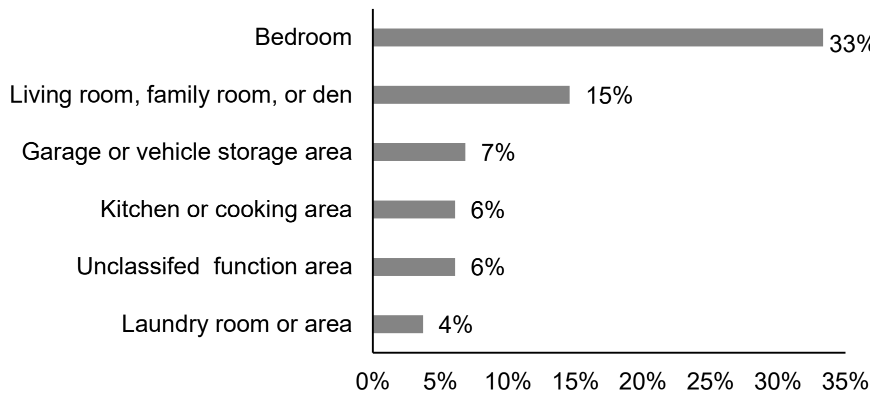
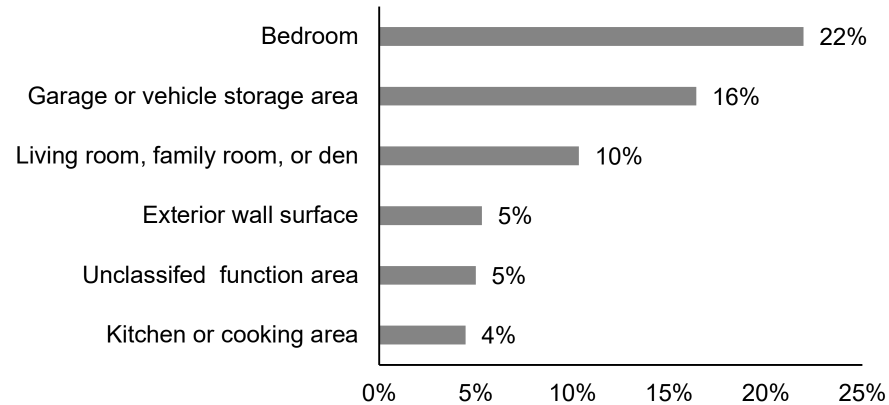


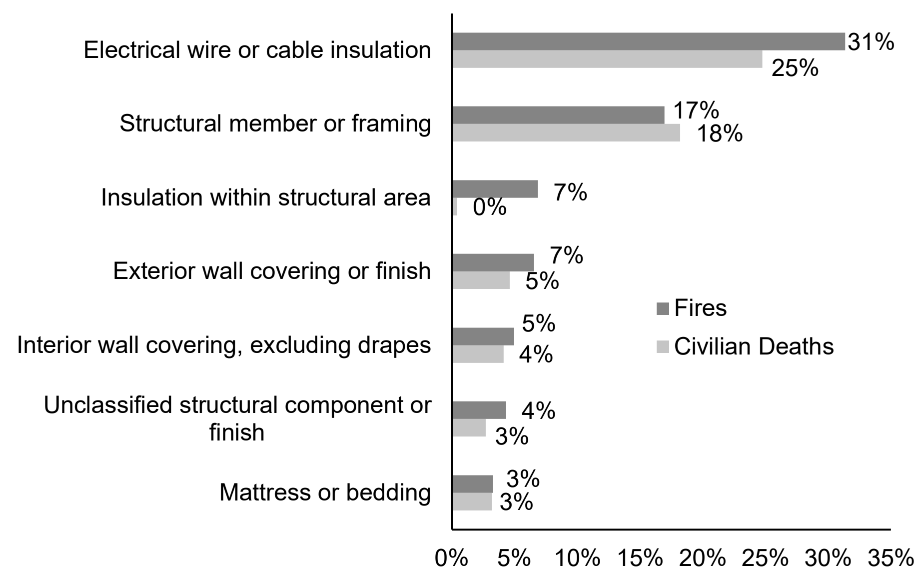
Figure 21. Area of Origin in Home Fires Involving Transformers and Power Supplies, 2012-2016



Home Fires Involving Electrical Distribution and Lighting Equipment by Item First Ignited

The item that first ignited in home fires involving electrical distribution and lighting equipment was electrical wire or cable insulation (31% of fires). Two of five fires (40%) involving electrical distribution and lighting equipment first ignited an item that was part of the building (i.e., structural member or framing, insulation within building area, exterior or interior wall cover or finish, unclassified structural component or finish). See Figure 22. This indicates the need to be attentive to hidden electrical hazards, including electrical distribution and lighting equipment that is installed close to combustible structural elements.

Figure 22. Item First Ignited in Home Fires Involving Electrical Distribution or Lighting Equipment 2012-2016



Methodology

The statistics in this analysis are estimates derived from the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association's (NFPA's) annual survey of U.S. fire departments. Fires reported to federal or state fire departments or industrial fire brigades are not included in these estimates. Only civilian (non-firefighter) casualties are discussed in this analysis.

NFPA's fire department experience survey provides estimates of the big picture. NFIRS is a voluntary system through which participating fire departments report detailed factors about the fires to which they respond. To compensate for fires reported to local fire departments but not captured in NFIRS, scaling ratios are calculated and then applied to the NFIRS database using the formula below.

$$\frac{\text{NFPA's fire experience survey projections}}{\text{NFIRS totals}}$$

The NFIRS data element of Factors Contributing to Ignition was used to identify and estimate electrical failures or malfunctions. In this field, the code "none" is treated as an unknown and allocated proportionally. Multiple entries are allowed in this field. Percentages are calculated on the total number of fires, not entries, resulting in sums greater than 100%. Any fire in which no factor contributing to ignition was entered was treated as unknown.

Entries in the "electrical failure, malfunction" category (factor contributing to ignition 30-39) were grouped together in this analysis.

This category includes:

31. Water-caused short circuit arc
32. Short-circuit arc from mechanical damage
33. Short-circuit arc from defective or worn insulation
34. Unspecified short circuit arc
35. Arc from faulty contact or broken connector, including broken power lines and loose connections
36. Arc or spark from operating equipment, switch, or electric fence
37. Fluorescent light ballast
30. Electrical failure or malfunction, other

NFIRS data element Equipment Involved in Ignition (EII) codes 200-263 were used to identify and estimate electrical distribution and lighting equipment as identified by NFIRS.

NFPA noticed that many fires in which EII was coded as None (NNN) have had other causal factors that indicated equipment was a factor or were completely unknown. To compensate, NFPA treats fires in which EII = NNN and heat source is not in the range of 40-99 as an additional unknown.

To allocate unknown data for EII, known data is multiplied by

$$\frac{\text{All fires}}{\text{(All fires – blank – undetermined – [fires in which EII =NNN and heat source <>40-99])}}$$

In addition, fires and losses associated with code EII 200, "electrical distribution, lighting, and power transfer, other," were allocated proportionally across specific kitchen and equipment codes EII codes, 211-263. Equipment that is totally unclassified (EII code 000) was not allocated further. Unfortunately, equipment that is truly different is erroneously assigned to other categories.

Because of the large number of specific EII codes, most have been grouped into more general categories.

Code Grouping	EII Code	NFIRS definition
Fixed wiring and related equipment	210	Unclassified electrical wiring
	211	Electrical power or utility line
	212	Electrical service supply wires from utility
	213	Electric meter or meter box
	214	Wiring from meter box to circuit breaker
	215	Panel board, switch board or circuit breaker board
	216	Electrical branch circuit
	217	Outlet or receptacle
	218	Wall switch
	219	Ground fault interrupter
Transformers and power supplies	221	Distribution-type transformer
	222	Overcurrent, disconnect equipment
	223	Low-voltage transformer
	224	Generator
	225	Inverter
	226	Uninterrupted power supply (UPS)
	227	Surge protector
	228	Battery charger or rectifier
	229	Battery (all types)
Lamp, bulb or lighting	230	Unclassified lamp or lighting
	231	Lamp-tabletop, floor or desk
	232	Lantern or flashlight
	233	Incandescent lighting fixture
	234	Fluorescent light fixture or ballast
	235	Halogen light fixture or lamp
	236	Sodium or mercury vapor light fixture or lamp
	237	Work or trouble light
	238	Light bulb
	241	Nightlight
	242	Decorative lights – line voltage
	243	Decorative or landscape lighting – low voltage
	244	Sign
Cord or plug	260	Unclassified cord or plug
	261	Power cord or plug, detachable from appliance
	262	Power cord or plug- permanently attached
	263	Extension cord

For more information on the methodology used for this report see, *How NFPA's National Estimates Are Calculated for Home Structure Fires.*

Acknowledgements

The National Fire Protection Association thanks all the fire departments and state fire authorities that participate in the National Fire Incident Reporting System (NFIRS) and the annual NFPA fire experience survey. These firefighters are the original sources of the detailed data that make this analysis possible. Their contributions allow us to estimate the size of the fire problem.

We are also grateful to the U.S. Fire Administration for its work in developing, coordinating, and maintaining NFIRS.

To learn more about research at NFPA visit www.nfpa.org/research.
E-mail: research@nfpa.org.
NFPA No. USS37

RESEARCH

Home Electrical Fires
Supporting Tables

March 2019
Richard Campbell

Home Electrical Fires: Supporting Tables

The tables in this document are a companion to the report of the same name. Firefighter deaths and injuries are excluded from this analysis.

Most tables, with the exception of fires by year, show estimates of 2012-2016 annual averages. Estimates were derived from the U.S. Fire Administration's National Fire Incident Reporting System (NFIRS) and NFPA's annual fire department experience survey and include proportional shares of unknown or missing data. Fires are rounded to the nearest 100, deaths and injuries are rounded to the nearest ten, and property loss is rounded to the nearest million dollars. Inflation adjustments were made only for the trend table. Percentages were calculated on unrounded estimates.

NFIRS 5.0 includes a category of structure fires collectively referred to as "confined fires," identified by NFIRS incident type codes 113-118. These include confined cooking fires, confined chimney or flue fires, confined trash fires, and confined fuel burner or boiler fires. Losses are generally minimal in these fires, which by definition, are assumed to have been limited to the object of origin. Although causal data is not required for these fires, it is sometimes present. To obtain estimates of fires, unknown data for confined and non-confined fires were analyzed separately and the results summed.

For more information on how these estimates were calculated, please see full report and *How NFPA's National Estimates Are Calculated for Home Structure Fires*

List of Tables

Table 1.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition, by Year
Structure Fires Reported to U.S. Fire Departments

Year	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions) As Reported		In 2016 Dollars	
1980	75,000		471		1,500		$426		$1,227	
1981	70,000		477		1,670		$409		$1,064	
1982	66,500		405		1,760		$450		$1,104	
1983	63,700		463		1,750		$530		$1,260	
1984	63,960		328		1,440		$551		$1,255	
1985	67,000		451		1,600		$603		$1,326	
1986	65,200		639		1,640		$600		$1,298	
1987	65,500		562		1,880		$616		$1,285	
1988	68,500		545		2,190		$745		$1,494	
1989	64,300		590		2,000		$693		$1,325	
1990	62,300		435		2,000		$737		$1,338	
1991	65,700		393		2,370		$981		$1,706	
1992	62,800		486		2,270		$727		$1,228	
1993	65,500		485		2,540		$936		$1,535	
1994	64,300		518		2,160		$835		$1,336	
1995	61,800		582		2,110		$867		$1,348	
1996	63,400		593		2,070		$1,031		$1,559	
1997	60,600		380		1,790		$980		$1,447	
1998	57,900		479		1,820		$943		$1,372	
1999	46,000	(44,300)	387	(387)	1,620	(1,620)	$917	($917)	$1,319	($1,319)
2000	49,200	(46,400)	348	(348)	1,670	(1,670)	$1,085	($1,082)	$1,512	($1,508)
2001	53,600	(49,200)	548	(548)	1,680	(1,630)	$1,237	($1,235)	$1,676	($1,673)
2002	54,300	(49,300)	278	(278)	1,290	(1,290)	$1,183	($1,181)	$1,577	($1,575)
2003	51,100	(45,200)	639	(639)	1,350	(1,350)	$1,283	($1,281)	$1,674	($1,671)
2004	52,500	(46,400)	614	(614)	1,500	(1,490)	$1,360	($1,357)	$1,729	($1,725)
2005	50,100	(44,500)	438	(438)	1,360	(1,340)	$1,530	($1,522)	$1,879	($1,869)
2006	50,500	(45,100)	333	(333)	1,370	(1,360)	$1,390	($1,389)	$1,653	($1,652)
2007	50,700	(45,500)	451	(451)	1,640	(1,630)	$1,228	($1,227)	$1,419	($1,418)
2008	49,400	(44,800)	519	(519)	1,350	(1,320)	$1,633	($1,632)	$1,821	($1,820)
2009	44,800	(39,500)	472	(472)	1,500	(1,470)	$1,644	($1,643)	$1,837	($1,836)
2010	46,500	(42,000)	419	(419)	1,520	(1,510)	$1,507	($1,506)	$1,659	($1,658)
2011	47,700	(42,600)	418	(418)	1,570	(1,570)	$1,434	($1,432)	$1,530	($1,528)
2012	40,900	(35,300)	359	(359)	1,410	(1,390)	$1,310	($1,309)	$1,370	($1,368)
2013	46,000	(39,900)	419	(419)	1,220	(1,200)	$1,370	($1,368)	$1,410	($1,408)
2014	48,100	(41,200)	538	(538)	1,280	(1,270)	$1,387	($1,385)	$1,404	($1,402)
2015	47,100	(40,700)	435	(435)	1,240	(1,240)	$1,463	($1,460)	$1,480	($1,478)
2016	45,300	(38,700)	480	(480)	1,260	(1,230)	$1,005	($1,003)	$1,005	($1,003)

Table 1.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition, by Year
Structure Fires Reported to U.S. Fire Departments (Continued)

Note: Figures in parentheses exclude confined fires, which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported to only federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of a small number of unusually serious fires. Fires are rounded to the nearest hundred, civilian deaths to the nearest one, civilian injuries to the nearest ten, and direct property damage to the nearest million dollars. Figures for 1980-1998 are based on ignition factor 54-55 and reflect a proportional share of home fires with ignition factor unknown, unreported, none, or blank. Figures for 1999 and later years reflect a proportional share of home fires with factor contributing to ignition as unknown, reported, none, or blank. Because of low participation in NFIRS Version 5.0 during 1999-2001, estimates for these years are highly uncertain and must be used with caution. Inflation adjustment to 2014 dollars is calculated using the Consumer Price Index. Home fire property damage figures for 1991 are inflated by estimation problems related to the Oakland fire storm.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 2.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition, by Month
2012-2016 Annual Averages

Month	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
January	5,020	(11%)	70	(16%)	140	(11%)	$160	(13%)
February	4,040	(9%)	40	(8%)	110	(9%)	$125	(10%)
March	3,720	(8%)	40	(9%)	130	(10%)	$110	(9%)
April	3,360	(7%)	40	(9%)	100	(8%)	$102	(8%)
May	3,380	(8%)	30	(6%)	100	(8%)	$90	(7%)
June	3,500	(8%)	20	(5%)	100	(8%)	$96	(7%)
July	3,750	(8%)	40	(8%)	90	(7%)	$111	(9%)
August	3,330	(7%)	20	(5%)	110	(9%)	$89	(7%)
September	3,030	(7%)	30	(6%)	70	(6%)	$77	(6%)
October	3,220	(7%)	40	(9%)	80	(7%)	$85	(7%)
November	4,030	(9%)	20	(6%)	90	(7%)	$110	(9%)
December	4,510	(10%)	50	(12%)	120	(9%)	$124	(10%)
Total	44,880	(100%)	440	(100%)	1,250	(100%)	$1,278	(100%)

Note: Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 3.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition, by Day of Week
2012-2016 Annual Averages

Day of Week	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Sunday	6,480	(14%)	50	(11%)	200	(16%)	$177	(14%)
Monday	6,400	(14%)	80	(19%)	150	(12%)	$189	(15%)
Tuesday	6,370	(14%)	40	(10%)	210	(16%)	$177	(14%)
Wednesday	6,300	(14%)	70	(16%)	160	(12%)	$180	(14%)
Thursday	6,400	(14%)	60	(13%)	160	(13%)	$189	(15%)
Friday	6,310	(14%)	70	(15%)	200	(16%)	$182	(14%)
Saturday	6,620	(15%)	70	(17%)	180	(14%)	$184	(14%)
Totals	44,880	(100%)	440	(100%)	1,250	(100%)	$1,278	(100%)

Note: Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 4.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition, by Time of Day
2012-2016 Annual Averages

Time of Day	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Midnight-12:59 a.m.	1,390	(3%)	20	(6%)	50	(4%)	$49	(4%)
1:00-1:59 a.m.	1,220	(3%)	50	(11%)	70	(5%)	$46	(4%)
2:00-2:59 a.m.	1,210	(3%)	40	(8%)	60	(5%)	$49	(4%)
3:00-3:59 a.m.	1,170	(3%)	40	(9%)	70	(6%)	$58	(5%)
4:00-4:59 a.m.	1,100	(2%)	30	(7%)	50	(4%)	$43	(3%)
5:00-5:59 a.m.	1,060	(2%)	30	(6%)	60	(5%)	$40	(3%)
6:00-6:59 a.m.	1,240	(3%)	30	(6%)	50	(4%)	$39	(3%)
7:00-7:59 a.m.	1,440	(3%)	30	(6%)	50	(4%)	$46	(4%)
8:00-8:59 a.m.	1,570	(4%)	10	(3%)	50	(4%)	$44	(3%)
9:00-9:59 a.m.	1,790	(4%)	10	(2%)	40	(3%)	$50	(4%)
10:00-10:59 a.m.	1,860	(4%)	20	(4%)	50	(4%)	$47	(4%)
11:00-11:59 a.m.	2,060	(5%)	10	(2%)	40	(3%)	$61	(5%)
12:00-12:59 p.m.	2,200	(5%)	10	(2%)	50	(4%)	$61	(5%)
1:00-1:59 p.m.	2,220	(5%)	0	(1%)	40	(3%)	$63	(5%)
2:00-2:59 p.m.	2,270	(5%)	10	(1%)	40	(3%)	$59	(5%)
3:00-3:59 p.m.	2,450	(5%)	10	(1%)	50	(4%)	$66	(5%)
4:00-4:59 p.m.	2,570	(6%)	10	(2%)	60	(5%)	$68	(5%)
5:00-5:59 p.m.	2,730	(6%)	10	(3%)	50	(4%)	$58	(5%)
6:00-6:59 p.m.	2,840	(6%)	10	(3%)	70	(5%)	$62	(5%)
7:00-7:59 p.m.	2,600	(6%)	10	(2%)	50	(4%)	$56	(4%)
8:00-8:59 p.m.	2,320	(5%)	10	(2%)	70	(6%)	$56	(4%)
9:00-9:59 p.m.	2,130	(5%)	10	(3%)	40	(3%)	$51	(4%)
10:00-10:59 p.m.	1,840	(4%)	20	(5%)	50	(4%)	$55	(4%)
11:00-11:59 p.m.	1,600	(4%)	10	(2%)	50	(4%)	$51	(4%)
Total	44,880	(100%)	440	(100%)	1,250	(100%)	$1,278	(100%)

Note: Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 5.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition by Equipment Involved in Ignition, 2012-2016 Annual Averages

Equipment Involved	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Electrical distribution and lighting equipment	**22,620**	**(50%)**	**310**	**(71%)**	**700**	**(56%)**	**$786**	**(62%)**
Wiring and related equipment	17,600	(39%)	190	(43%)	440	(35%)	$588	(46%)
Cord or plug	2,080	(5%)	100	(23%)	130	(11%)	$85	(7%)
Lamp, bulb or lighting	1,850	(4%)	10	(3%)	70	(5%)	$64	(5%)
Transformers and power supplies	1,080	(2%)	10	(2%)	60	(5%)	$49	(4%)
Cooking equipment	**6,780**	**(15%)**	**10**	**(1%)**	**110**	**(9%)**	**$43**	**(3%)**
Confined cooking fire	4,820	(11%)	0	(0%)	10	(1%)	$1	(0%)
Range with or without oven, cooking surface	960	(2%)	0	(1%)	50	(4%)	$18	(1%)
Microwave oven	430	(1%)	0	(0%)	20	(1%)	$10	(1%)
Portable cooking or warming equipment	230	(1%)	0	(0%)	20	(2%)	$8	(1%)
Other known cooking equipment	340	(1%)	0	(0%)	10	(1%)	$6	(1%)
Heating equipment	**3,830**	**(9%)**	**30**	**(8%)**	**60**	**(5%)**	**$80**	**(6%)**
Fixed or portable space heater	1,300	(3%)	30	(6%)	40	(3%)	$46	(4%)
Water heater	1,020	(2%)	0	(0%)	10	(1%)	$16	(1%)
Confined fuel burner or boiler fire	730	(2%)	0	(0%)	0	(0%)	$0	(0%)
Central heat	350	(1%)	0	(0%)	0	(0%)	$9	(1%)
Other known heating equipment	430	(1%)	7	(2%)	5	(0%)	$9	(1%)
Fan	**2,480**	**(6%)**	**10**	**(3%)**	**70**	**(6%)**	**$62**	**(5%)**
Air conditioner	**1,460**	**(3%)**	**20**	**(5%)**	**60**	**(5%)**	**$41**	**(3%)**
Clothes dryer	**1,450**	**(3%)**	**0**	**(0%)**	**30**	**(3%)**	**$32**	**(2%)**
No equipment involved in ignition	**890**	**(2%)**	**10**	**(3%)**	**10**	**(1%)**	**$56**	**(4%)**
Unclassified equipment involved in ignition	**800**	**(2%)**	**0**	**(1%)**	**30**	**(2%)**	**$36**	**(3%)**
Refrigerator or refrigerator/freezer	**560**	**(1%)**	**10**	**(1%)**	**40**	**(3%)**	**$21**	**(2%)**
Dishwasher	**400**	**(1%)**	**0**	**(0%)**	**10**	**(1%)**	**$9**	**(1%)**
Television	**390**	**(1%)**	**0**	**(0%)**	**20**	**(2%)**	**$15**	**(1%)**
Confined incinerator overload or malfunction fire	**290**	**(1%)**	**0**	**(0%)**	**0**	**(0%)**	**$0**	**(0%)**
Contained trash or rubbish fire	**280**	**(1%)**	**0**	**(0%)**	**0**	**(0%)**	**$0**	**(0%)**
Other known equipment involved in ignition	**2,650**	**(6%)**	**30**	**(7%)**	**100**	**(8%)**	**$96**	**(8%)**
Total	**44,880**	**(100%)**	**440**	**(100%)**	**1,250**	**(100%)**	**$1,278**	**(100%)**

Note: Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 6.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition
by Cause of Ignition, 2012-2016 Annual Averages

Cause of Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Failure of equipment or heat source	23,500	(52%)	190	(43%)	590	(47%)	$536	(42%)
Non-confined	19,370	(43%)	190	(43%)	590	(47%)	$535	(42%)
Confined	4,130	(9%)	0	(0%)	0	(0%)	$1	(0%)
Unintentional	20,680	(46%)	250	(57%)	650	(52%)	$724	(57%)
Non-confined	18,640	(42%)	250	(57%)	640	(51%)	$723	(57%)
Confined	2,050	(5%)	0	(0%)	10	(1%)	$1	(0%)
Act of nature	369	(1%)	0	(0%)	0	(0%)	$9	(1%)
Non-confined	341	(2%)	0	(0%)	0	(1%)	$9	(2%)
Confined	28	(4%)	0	(0%)	0	(0%)	$0	(3%)
Other causes	323	(1%)	0	(0%)	10	(1%)	$9	(1%)
Non-confined	250	(1%)	0	(1%)	10	(1%)	$9	(2%)
Confined	72	(11%)	0	(0%)	0	(0%)	$0	(3%)
Total	44,880	(100%)	440	(100%)	1,250	(100%)	$1,278	(100%)
Non-confined	38,600	(86%)	440	(100%)	1,230	(98%)	$1,276	(100%)
Confined	6,270	(14%)	0	(0%)	10	(1%)	$2	(0%)

Note: Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 7.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition, by Heat Source
2012-2016 Annual Averages

Heat Source	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Arcing	27,290	(61%)	300	(69%)	770	(62%)	$785	(61%)
Non-confined	24,530	(55%)	300	(69%)	770	(61%)	$784	(61%)
Confined	2,760	(6%)	0	(0%)	0	(0%)	$1	(0%)
Unclassified heat from powered equipment	6,750	(15%)	50	(12%)	210	(17%)	$170	(13%)
Non-confined	5,300	(12%)	50	(12%)	210	(17%)	$170	(13%)
Confined	1,450	(3%)	0	(0%)	10	(1%)	$0	(0%)
Radiated or conducted heat from operating equipment	2,460	(5%)	20	(5%)	70	(6%)	$54	(4%)
Non-confined	1,770	(4%)	20	(5%)	70	(5%)	$54	(4%)
Confined	690	(2%)	0	(0%)	0	(0%)	$0	(0%)
Spark, ember or flame from operating equipment	2,460	(5%)	10	(3%)	80	(6%)	$61	(5%)
Non-confined	1,810	(4%)	10	(3%)	80	(6%)	$61	(5%)
Confined	650	(1%)	0	(0%)	0	(0%)	$0	(0%)
Unclassified heat source	2,280	(5%)	30	(6%)	60	(5%)	$88	(7%)
Non-confined	1,980	(4%)	30	(6%)	60	(5%)	$88	(7%)
Confined	300	(1%)	0	(0%)	0	(0%)	$0	(0%)
Unclassified hot or smoldering object	1,970	(4%)	20	(4%)	30	(2%)	$68	(5%)
Non-confined	1,780	(4%)	20	(4%)	20	(2%)	$68	(5%)
Confined	180	(0%)	0	(0%)	0	(0%)	$0	(0%)
Other known heat source	1,680	(4%)	10	(1%)	30	(2%)	$51	(4%)
Non-confined	1,430	(3%)	10	(1%)	30	(2%)	$51	(4%)
Confined	240	(1%)	0	(0%)	0	(0%)	$0	(0%)
Total	44,880	(100%)	440	(100%)	1,250	(100%)	$1,278	(100%)
Non-confined	38,600	(86%)	440	(100%)	1,230	(99%)	$1,276	(100%)
Confined	6,270	(14%)	0	(0%)	10	(1%)	$2	(0%)

Note: Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 8.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition by Area of Origin, 2012-2016 Annual Averages

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Kitchen or cooking area	9,000	(20%)	40	(9%)	170	(14%)	$114	(9%)
Non-confined	4,360	(10%)	40	(9%)	160	(13%)	$113	(9%)
Confined	4,630	(10%)	0	(0%)	10	(1%)	$1	(0%)
Bedroom	5,260	(12%)	60	(14%)	310	(25%)	$190	(15%)
Non-confined	5,210	(12%)	60	(14%)	310	(25%)	$190	(15%)
Confined	50	(0%)	0	(0%)	0	(0%)	$0	(0%)
Attic or ceiling/roof assembly or concealed space	4,520	(10%)	20	(5%)	70	(6%)	$159	(12%)
Non-confined	4,490	(10%)	20	(5%)	70	(6%)	$159	(12%)
Confined	30	(0%)	0	(0%)	0	(0%)	$0	(0%)
Wall assembly or concealed space	2,760	(6%)	20	(5%)	40	(3%)	$76	(6%)
Non-confined	2,740	(6%)	20	(5%)	40	(3%)	$76	(6%)
Confined	20	(0%)	0	(0%)	0	(0%)	$0	(0%)
Common room, living room, family room, lounge or den	2,450	(5%)	120	(27%)	180	(14%)	$120	(9%)
Non-confined	2,390	(5%)	120	(27%)	180	(14%)	$120	(9%)
Confined	50	(0%)	0	(0%)	0	(0%)	$0	(0%)
Laundry room or area	2,300	(5%)	10	(2%)	60	(5%)	$46	(4%)
Non-confined	2,170	(5%)	10	(2%)	50	(4%)	$46	(4%)
Confined	130	(0%)	0	(0%)	0	(0%)	$0	(0%)
Lavatory, bathroom, locker room or check room	2,120	(5%)	10	(2%)	40	(3%)	$39	(3%)
Non-confined	2,080	(5%)	10	(2%)	40	(3%)	$39	(3%)
Confined	40	(0%)	0	(0%)	0	(0%)	$0	(0%)
Exterior wall surface	1,810	(4%)	10	(2%)	20	(2%)	$39	(3%)
Non-confined	1,790	(4%)	10	(2%)	20	(2%)	$39	(3%)
Confined	20	(0%)	0	(0%)	0	(0%)	$0	(0%)
Garage or vehicle storage area	1,590	(4%)	10	(2%)	50	(4%)	$99	(8%)
Non-confined	1,520	(3%)	10	(2%)	50	(4%)	$99	(8%)
Confined	70	(0%)	0	(0%)	0	(0%)	$0	(0%)
Unclassified function area	1,370	(3%)	30	(7%)	70	(6%)	$56	(4%)
Non-confined	1,340	(3%)	30	(7%)	70	(6%)	$56	(4%)
Confined	30	(0%)	0	(0%)	0	(0%)	$0	(0%)

Table 8.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition by Area of Origin, 2012-2016 Annual Averages (Continued)

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Crawl space or substructure space	1,360	(3%)	10	(2%)	20	(2%)	$42	(3%)
Non-confined	1,310	(3%)	10	(2%)	20	(2%)	$42	(3%)
Confined	50	(0%)	0	(0%)	0	(0%)	$0	(0%)
Ceiling/floor assembly or concealed space	1,200	(3%)	20	(5%)	20	(2%)	$47	(4%)
Non-confined	1,190	(3%)	20	(5%)	20	(2%)	$47	(4%)
Confined	10	(0%)	0	(0%)	0	(0%)	$0	(0%)
Heating equipment room	1,060	(2%)	0	(0%)	10	(1%)	$16	(1%)
Non-confined	740	(2%)	0	(0%)	10	(1%)	$16	(1%)
Confined	330	(1%)	0	(0%)	0	(0%)	$0	(0%)
Closet	740	(2%)	0	(0%)	20	(2%)	$20	(2%)
Non-confined	680	(2%)	0	(0%)	20	(2%)	$20	(2%)
Confined	60	(0%)	0	(0%)	0	(0%)	$0	(0%)
Unclassified structural area	720	(2%)	10	(2%)	20	(2%)	$31	(2%)
Non-confined	680	(2%)	10	(2%)	20	(2%)	$31	(2%)
Confined	40	(0%)	0	(0%)	0	(0%)	$0	(0%)
Confined chimney or flue fire	140	(0%)	0	(0%)	0	(0%)	$0	(0%)
Other known area of origin	6,500	(14%)	50	(11%)	160	(13%)	$184	(14%)
Non-confined	5,900	(13%)	50	(11%)	160	(13%)	$183	(14%)
Confined	600	(1%)	0	(0%)	0	(0%)	$0	(0%)
Total	44,880	(100%)	440	(100%)	1,250	(100%)	$1,278	(100%)
Non-confined	38,600	(86%)	440	(100%)	1,230	(98%)	$1,276	(100%)
Confined	6,270	(14%)	0	(0%)	10	(1%)	$2	(0%)

Note: Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 9.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition, by Item First Ignited, 2012-2016 Annual Averages

Item First Ignited	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Electrical wire or cable insulation	14,120	(31%)	110	(26%)	360	(28%)	$307	(24%)
Non-confined	12,410	(28%)	110	(26%)	350	(28%)	$306	(24%)
Confined	1,710	(4%)	0	(0%)	0	(0%)	$1	(0%)
Structural member or framing	5,950	(13%)	80	(18%)	140	(11%)	$266	(21%)
Non-confined	5,950	(13%)	80	(18%)	140	(11%)	$266	(21%)
Confined	10	(0%)	0	(0%)	0	(0%)	$0	(0%)
Appliance housing or casing	4,050	(9%)	10	(2%)	80	(6%)	$48	(4%)
Non-confined	2,120	(5%)	10	(2%)	80	(6%)	$47	(4%)
Confined	1,930	(4%)	0	(0%)	0	(0%)	$1	(0%)
Insulation within structural area	2,510	(6%)	0	(1%)	30	(2%)	$58	(5%)
Non-confined	2,490	(6%)	0	(1%)	30	(2%)	$58	(5%)
Confined	20	(0%)	0	(0%)	0	(0%)	$0	(0%)
Interior wall covering, excluding drapes	2,180	(5%)	20	(5%)	60	(5%)	$88	(7%)
Non-confined	2,150	(5%)	20	(5%)	60	(5%)	$88	(7%)
Confined	30	(0%)	0	(0%)	0	(0%)	$0	(0%)
Unclassified item first ignited	2,010	(4%)	0	(0%)	40	(4%)	$35	(3%)
Non-confined	1,390	(3%)	0	(0%)	40	(4%)	$35	(3%)
Confined	620	(1%)	0	(0%)	0	(0%)	$0	(0%)
Exterior wall covering or finish	2,000	(4%)	20	(4%)	30	(2%)	$60	(5%)
Non-confined	1,980	(4%)	20	(4%)	30	(2%)	$60	(5%)
Confined	20	(0%)	0	(0%)	0	(0%)	$0	(0%)
Unclassified structural component or finish	1,500	(3%)	20	(4%)	50	(4%)	$62	(5%)
Non-confined	1,490	(3%)	20	(4%)	50	(4%)	$62	(5%)
Confined	10	(0%)	0	(0%)	0	(0%)	$0	(0%)
Cooking materials, including food	1,300	(3%)	0	(0%)	10	(1%)	$3	(0%)
Non-confined	180	(0%)	0	(0%)	10	(1%)	$3	(0%)
Confined	1,120	(2%)	0	(0%)	10	(0%)	$0	(0%)
Interior ceiling cover or finish	970	(2%)	10	(1%)	20	(1%)	$41	(3%)
Non-confined	970	(2%)	10	(1%)	20	(1%)	$41	(3%)
Confined	0	(0%)	0	(0%)	0	(0%)	$0	(0%)
Mattress or bedding	940	(2%)	20	(3%)	80	(6%)	$32	(3%)
Non-confined	930	(2%)	20	(3%)	80	(6%)	$32	(3%)
Confined	10	(0%)	0	(0%)	0	(0%)	$0	(0%)

Table 9.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition, by Item First Ignited, 2012-2016 Annual Averages (Continued)

Item First Ignited	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Floor covering rug, carpet, or mat	730	(2%)	30	(6%)	40	(3%)	$26	(2%)
Non-confined	730	(2%)	30	(6%)	40	(3%)	$26	(2%)
Confined	0	(0%)	0	(0%)	0	(0%)	$0	(0%)
Other known item first ignited	6,620	(15%)	130	(30%)	310	(25%)	$250	(20%)
Non-confined	5,820	(13%)	130	(30%)	310	(25%)	$250	(20%)
Confined	800	(2%)	0	(0%)	10	(0%)	$0	(0%)
Total	44,880	(100%)	440	(100%)	1,250	(100%)	$1,278	(100%)
Non-confined	38,600	(86%)	440	(100%)	1,230	(99%)	$1,276	(100%)
Confined	6,270	(14%)	0	(0%)	10	(1%)	$2	(0%)

Note: Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 10.
Home Fires Involving Electrical Distribution and Lighting Equipment by Year
Structure Fires Reported to U.S. Fire Departments

				Direct Property Damage (in Millions)	
Year	**Fires**	**Civilian Deaths**	**Civilian Injuries**	**As Reported**	**In 2016 Dollars**
1980	68,400	523	1,650	$493	$1,436
1981	62,300	553	1,500	$459	$1,209
1982	60,900	408	1,820	$519	$1,288
1983	56,700	500	1,570	$548	$1,318
1984	54,800	445	1,520	$549	$1,265
1985	56,500	470	1,400	$720	$1,602
1986	54,300	717	1,420	$597	$1,307
1987	51,600	522	1,580	$512	$1,080
1988	53,400	439	1,720	$715	$1,451
1989	47,900	610	1,500	$642	$1,242
1990	47,400	438	1,540	$683	$1,255
1991	49,000	354	1,890	$958	$1,686
1992	46,400	403	1,770	$617	$1,055
1993	48,900	418	1,900	$818	$1,357
1994	48,300	464	1,640	$714	$1,156
1995	47,200	489	1,650	$775	$1,219
1996	47,000	470	1,560	$839	$1,284
1997	46,600	352	1,580	$865	$1,292
1998	44,500	363	1,370	$843	$1,241
1999	34,800	183	530	$806	$1,160
2000	26,600	122	1,130	$631	$879
2001	26,200	436	1,030	$717	$971
2002	22,700	166	700	$593	$791
2003	19,200	320	600	$698	$911
2004	19,400	292	840	$623	$792
2005	20,800	498	1,060	$858	$1,053
2006	25,100	366	840	$776	$923
2007	25,200	274	1,050	$663	$766
2008	24,700	515	880	$964	$1,075
2009	21,000	318	1,000	$935	$1,045
2010	19,900	242	980	$774	$852
2011	21,300	295	840	$822	$877
2012	32,900	292	1,250	$1,326	$1,386
2013	37,000	601	1,290	$1,418	$1,458
2014	37,900	535	1,290	$1,433	$1,450
2015	34,600	461	1,020	$1,136	$1,149
2016	32,900	562	1,120	$1,020	$1,020

Table 10.
Home Fires Involving Electrical Distribution and Lighting Equipment by Year
Structure Fires Reported to U.S. Fire Departments (Continued)

* All 1991 home fire property damage figures are inflated by estimation problems related to the handling of the Oakland fire storm.

Note: Figures exclude confined fires. Fires are rounded to the nearest hundred, deaths to the nearest one, injuries to the nearest ten, and property damage is rounded to the nearest million dollars. Figures reflect a proportional share of home fires with equipment involved in ignition unknown or reported as electrical distribution or lighting equipment of undetermined type. Because of low participation in NFIRS Version 5.0 during 1999-2001, estimates for those years are highly uncertain and must be used with caution. Inflation adjustment to 2016 dollars is calculated using the Consumer Price Index.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 11.
Home Fires Involving Electrical Distribution and Lighting Equipment, by Month
2012-2016 Annual Averages

Month	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
January	4,010	(11%)	80	(16%)	140	(12%)	$149	(12%)
February	3,180	(9%)	40	(9%)	100	(8%)	$116	(9%)
March	2,900	(8%)	50	(11%)	140	(11%)	$117	(9%)
April	2,620	(7%)	50	(9%)	80	(7%)	$100	(8%)
May	2,640	(8%)	30	(5%)	100	(8%)	$103	(8%)
June	2,820	(8%)	10	(2%)	80	(6%)	$95	(7%)
July	3,060	(9%)	50	(9%)	100	(8%)	$106	(8%)
August	2,580	(7%)	30	(7%)	110	(9%)	$84	(7%)
September	2,270	(6%)	40	(7%)	60	(5%)	$81	(6%)
October	2,460	(7%)	40	(9%)	60	(5%)	$88	(7%)
November	3,030	(9%)	20	(5%)	110	(9%)	$104	(8%)
December	3,560	(10%)	50	(10%)	120	(10%)	$126	(10%)
Total	35,150	(100%)	490	(100%)	1,200	(100%)	$1,270	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest ten million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 12.
Home Fires Involving Electrical Distribution and Lighting Equipment, by Day of Week
2012-2016 Annual Averages

Day of Week	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Sunday	5,000	(14%)	50	(9%)	180	(15%)	$189	(15%)
Monday	5,090	(14%)	70	(15%)	130	(11%)	$182	(14%)
Tuesday	5,030	(14%)	80	(15%)	200	(17%)	$178	(14%)
Wednesday	5,060	(14%)	80	(17%)	150	(13%)	$177	(14%)
Thursday	4,860	(14%)	90	(19%)	180	(15%)	$182	(14%)
Friday	5,000	(14%)	50	(11%)	190	(16%)	$184	(14%)
Saturday	5,100	(15%)	70	(14%)	160	(14%)	$178	(14%)
Totals	35,150	(100%)	490	(100%)	1,200	(100%)	$1,270	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 13.
Home Fires Involving Electrical Distribution and Lighting Equipment, by Time of Day
2012-2016 Annual Averages

Time of Day	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Midnight-12:59 a.m.	1,250	(4%)	30	(7%)	50	(4%)	$59	(5%)
1:00-1:59 a.m.	1,040	(3%)	60	(13%)	70	(6%)	$50	(4%)
2:00-2:59 a.m.	1,000	(3%)	50	(9%)	60	(5%)	$51	(4%)
3:00-3:59 a.m.	990	(3%)	40	(7%)	40	(4%)	$45	(4%)
4:00-4:59 a.m.	930	(3%)	50	(10%)	60	(5%)	$44	(3%)
5:00-5:59 a.m.	890	(3%)	30	(6%)	40	(3%)	$42	(3%)
6:00-6:59 a.m.	1,090	(3%)	10	(3%)	50	(5%)	$41	(3%)
7:00-7:59 a.m.	1,140	(3%)	20	(5%)	40	(3%)	$44	(3%)
8:00-8:59 a.m.	1,260	(4%)	10	(2%)	50	(4%)	$42	(3%)
9:00-9:59 a.m.	1,370	(4%)	20	(5%)	50	(4%)	$44	(3%)
10:00-10:59 a.m.	1,480	(4%)	10	(2%)	40	(3%)	$45	(4%)
11:00-11:59 a.m.	1,590	(5%)	10	(3%)	40	(4%)	$58	(5%)
12:00-12:59 p.m.	1,580	(5%)	0	(1%)	40	(4%)	$60	(5%)
1:00-1:59 p.m.	1,730	(5%)	0	(1%)	50	(4%)	$58	(5%)
2:00-2:59 p.m.	1,750	(5%)	10	(2%)	40	(4%)	$55	(4%)
3:00-3:59 p.m.	1,870	(5%)	10	(1%)	40	(3%)	$67	(5%)
4:00-4:59 p.m.	1,850	(5%)	10	(2%)	50	(4%)	$72	(6%)
5:00-5:59 p.m.	1,890	(5%)	10	(3%)	50	(4%)	$56	(4%)
6:00-6:59 p.m.	1,860	(5%)	20	(3%)	60	(5%)	$58	(5%)
7:00-7:59 p.m.	1,950	(6%)	10	(3%)	50	(4%)	$66	(5%)
8:00-8:59 p.m.	1,880	(5%)	20	(3%)	50	(4%)	$60	(5%)
9:00-9:59 p.m.	1,790	(5%)	10	(2%)	50	(4%)	$49	(4%)
10:00-10:59 p.m.	1,610	(5%)	20	(4%)	50	(5%)	$48	(4%)
11:00-11:59 p.m.	1,380	(4%)	10	(3%)	70	(6%)	$55	(4%)
Total	35,150	(100%)	490	(100%)	1,200	(100%)	$1,270	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 14.
Home Fires Involving Electrical Distribution and Lighting Equipment, by Equipment Involved in Ignition
2012-2016 Annual Averages

Equipment Involved	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Wiring and related equipment	24,780	(67%)	270	(55%)	640	(53%)	$853	(67%)
Lamp, bulb or lighting	4,970	(13%)	40	(9%)	200	(17%)	$164	(13%)
Cord or plug	3,330	(11%)	160	(33%)	230	(19%)	$143	(11%)
Transformers and power supplies	2,060	(9%)	20	(3%)	130	(11%)	$108	(9%)
Other known equipment involved in ignition	20	(0%)	0	(0%)	0	(0%)	$0	(0%)
Total	35,150	(100%)	490	(100%)	1,200	(100%)	$1,270	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 15.
Home Fires Involving Electrical Distribution and Lighting Equipment, by Cause of Ignition
2012-2016 Annual Averages

Cause of Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Unintentional	18,870	(54%)	250	(52%)	690	(57%)	$758	(60%)
Failure of equipment or heat source	15,210	(43%)	230	(47%)	500	(41%)	$481	(38%)
Act of nature	700	(2%)	0	(1%)	10	(1%)	$19	(1%)
Other or unknown cause	370	(1%)	10	(2%)	0	(0%)	$12	(1%)
Total	35,150	(100%)	490	(100%)	1,200	(100%)	$1,270	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 16.
Home Fires Involving Electrical Distribution and Lighting Equipment, by Factor Contributing to Ignition
2012-2016 Annual Averages

Factor Contributing to Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Electrical failure or malfunction	27,940	(79%)	400	(83%)	870	(72%)	$1,037	(82%)
Heat source too close to combustibles	1,960	(6%)	30	(5%)	110	(9%)	$69	(5%)
Mechanical failure or malfunction	1,780	(5%)	10	(2%)	50	(4%)	$56	(4%)
Equipment overloaded	1,030	(3%)	40	(7%)	70	(6%)	$40	(3%)
Unclassified misuse of material or product	580	(2%)	10	(2%)	40	(4%)	$19	(2%)
Other known factor contributing to ignition	3,430	(10%)	50	(9%)	150	(12%)	$122	(10%)
Total fires	35,150	(100%)	490	(100%)	1,200	(100%)	$1,270	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Multiple entries are allowed, which can result in sums higher than totals. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 16A.
Home Fires Involving Wiring and Related Equipment, by Factor Contributing to Ignition
2012-2016 Annual Averages

Factor Contributing to Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Electrical failure or malfunction	22,030	(89%)	250	(91%)	580	(91%)	$789	(92%)
Mechanical failure or malfunction	1,290	(5%)	10	(4%)	20	(4%)	$33	(4%)
Equipment overloaded	480	(2%)	10	(3%)	20	(3%)	$14	(2%)
Other known factor contributing to ignition	2,300	(9%)	20	(10%)	70	(10%)	$77	(9%)
Total fires	24,780	(100%)	270	(100%)	640	(100%)	$853	(100%)
Total factors	26,100	(105%)	290	(108%)	690	(108%)	$913	(107%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Multiple entries are allowed, which can result in sums higher than totals. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 16B.
Home Fires Involving Lamps, Bulbs, or Lighting Equipment, by Factor Contributing to Ignition
2012-2016 Annual Averages

Factor Contributing to Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Electrical failure or malfunction	2,350	(47%)	20	(39%)	80	(38%)	$91	(55%)
Heat source too close to combustibles	1,430	(29%)	20	(50%)	70	(36%)	$45	(28%)
Mechanical failure or malfunction	200	(4%)	0	(0%)	10	(5%)	$6	(4%)
Equipment unattended	180	(4%)	0	(0%)	10	(4%)	$5	(3%)
Animal	150	(3%)	0	(6%)	0	(1%)	$2	(1%)
Misuse of material or product, other	120	(2%)	0	(0%)	10	(5%)	$3	(2%)
Accidentally turned on, not turned off	120	(2%)	0	(0%)	0	(1%)	$6	(4%)
Other factor contributed to ignition	100	(2%)	0	(0%)	10	(3%)	$4	(3%)
Collision, knock down, run over, turn over	100	(2%)	0	(11%)	20	(7%)	$2	(1%)
Other known factor contributing to ignition	530	(11%)	10	(21%)	20	(10%)	$15	(9%)
Total fires	4,970	(100%)	40	(100%)	200	(100%)	$164	(100%)
Total factors	5,290	(106%)	60	(127%)	220	(109%)	$180	(110%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Multiple entries are allowed, which can result in sums higher than totals. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 16C.
Home Fires Involving Cords or Plugs, by Factor Contributing to Ignition
2012-2016 Annual Averages

Factor Contributing to Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Electrical failure or malfunction	2,520	(76%)	130	(81%)	170	(74%)	$111	(77%)
Equipment overloaded	390	(12%)	30	(16%)	40	(17%)	$17	(12%)
Unclassified misuse of material or product	190	(6%)	10	(5%)	20	(7%)	$9	(7%)
Mechanical failure or malfunction	110	(3%)	0	(3%)	10	(3%)	$4	(3%)
Heat source too close to combustibles	110	(3%)	0	(3%)	10	(3%)	$5	(3%)
Equipment used for not intended purpose	60	(2%)	0	(3%)	10	(5%)	$2	(1%)
Other known factor contributing to ignition	180	(5%)	10	(4%)	10	(6%)	$8	(6%)
Total fires	3,330	(100%)	160	(100%)	230	(100%)	$143	(100%)
Total factors	3,560	(107%)	180	(115%)	260	(114%)	$156	(109%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Multiple entries are allowed, which can result in sums higher than totals. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 16D.
Home Fires Involving Transformers and Power Supplies, by Factor Contributing to Ignition
2012-2016 Annual Averages

Factor Contributing to Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Electrical failure or malfunction	1,340	(65%)	10	(81%)	70	(54%)	$64	(59%)
Mechanical failure or malfunction	180	(9%)	0	(0%)	10	(8%)	$13	(12%)
Heat source too close to combustibles	170	(8%)	0	(0%)	20	(12%)	$12	(11%)
Equipment overloaded	120	(6%)	0	(0%)	10	(7%)	$7	(7%)
Equipment unattended	80	(4%)	0	(0%)	0	(2%)	$5	(5%)
Unclassified misuse of material or product	60	(3%)	0	(19%)	10	(4%)	$3	(3%)
Equipment not being operated properly	40	(2%)	0	(0%)	0	(4%)	$2	(2%)
Other known factor contributing to ignition	230	(11%)	0	(19%)	20	(19%)	$13	(12%)
Total fires	2,060	(100%)	20	(100%)	130	(100%)	$108	(100%)
Total factors	2,220	(108%)	20	(118%)	140	(110%)	$120	(110%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Multiple entries are allowed, which can result in sums higher than totals. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 17. Home Fires Involving Electrical Distribution and Lighting Equipment, by Heat Source
2012-2016 Annual Averages

Heat Source	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Arcing	25,770	(73%)	340	(69%)	791	(66%)	$902	(71%)
Unclassified heat from powered equipment	4,230	(12%)	70	(14%)	194	(16%)	$177	(14%)
Radiated or conducted heat from operating equipment	2,800	(8%)	50	(9%)	137	(11%)	$96	(8%)
Spark, ember or flame from operating equipment	990	(3%)	10	(3%)	39	(3%)	$47	(4%)
Other known heat source	1,370	(4%)	20	(5%)	40	(3%)	$48	(4%)
Total	35,150	(100%)	490	(100%)	1,200	(100%)	$1,270	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 18.
Home Fires Involving Electrical Distribution and Lighting Equipment, by Area of Origin
2012-2016 Annual Averages

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Bedroom	5,830	(17%)	90	(18%)	400	(34%)	$201	(16%)
Attic or ceiling/roof assembly or concealed space	4,390	(12%)	30	(6%)	60	(5%)	$163	(13%)
Wall assembly or concealed space	3,020	(9%)	20	(5%)	40	(4%)	$92	(7%)
Common room, living room, family room, lounge or den	2,450	(7%)	130	(27%)	180	(15%)	$115	(9%)
Exterior wall surface	2,300	(7%)	10	(1%)	30	(2%)	$51	(4%)
Kitchen or cooking area	2,190	(6%)	40	(9%)	70	(6%)	$75	(6%)
Garage or vehicle storage area	1,550	(4%)	0	(0%)	50	(4%)	$104	(8%)
Crawl space or substructure space	1,300	(4%)	20	(5%)	20	(2%)	$43	(3%)
Unclassified function area	1,290	(4%)	40	(8%)	50	(5%)	$46	(4%)
Ceiling/floor assembly or concealed space	1,200	(3%)	30	(5%)	30	(2%)	$54	(4%)
Laundry room or area	1,110	(3%)	10	(1%)	40	(3%)	$29	(2%)
Lavatory, bathroom, locker room or check room	1,080	(3%)	0	(0%)	20	(1%)	$27	(2%)
Closet	690	(2%)	0	(1%)	30	(2%)	$28	(2%)
Exterior balcony or unenclosed porch	570	(2%)	10	(2%)	10	(1%)	$26	(2%)
Unclassified structural area	530	(2%)	10	(2%)	20	(1%)	$29	(2%)
Other known area of origin	5,660	(16%)	50	(10%)	150	(12%)	$186	(15%)
Total	35,150	(100%)	490	(100%)	1,200	(100%)	$1,270	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 18A.
Home Fires Involving Wiring and Related Equipment, by Area of Origin
2012-2016 Annual Averages

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Attic or ceiling/roof assembly or concealed space	3,860	(16%)	20	(7%)	50	(8%)	$142	(17%)
Bedroom	3,220	(13%)	40	(15%)	180	(28%)	$105	(12%)
Wall assembly or concealed space	2,850	(12%)	20	(7%)	40	(6%)	$87	(10%)
Exterior wall surface	1,740	(7%)	10	(4%)	20	(3%)	$37	(4%)
Kitchen or cooking area	1,670	(7%)	30	(11%)	40	(6%)	$57	(7%)
Living room, family room, or den	1,370	(6%)	40	(15%)	80	(13%)	$64	(7%)
Crawl space or substructure space	1,070	(4%)	20	(7%)	10	(2%)	$34	(4%)
Ceiling/floor assembly or concealed space	940	(4%)	30	(11%)	20	(3%)	$47	(5%)
Laundry room or area	900	(4%)	0	(0%)	30	(5%)	$25	(3%)
Garage or vehicle storage area	800	(3%)	0	(0%)	20	(3%)	$47	(6%)
Unclassified function area	780	(3%)	20	(7%)	20	(3%)	$29	(3%)
Lavatory, bathroom, locker room or check room	710	(3%)	0	(0%)	10	(2%)	$19	(2%)
Closet	430	(2%)	0	(0%)	20	(3%)	$17	(2%)
Unclassified structural area	390	(2%)	0	(0%)	10	(2%)	$21	(2%)
Conduit, pipe, utility, or ventilation shaft	380	(2%)	0	(0%)	0	(0%)	$8	(1%)
Other known area of origin	3,670	(15%)	30	(11%)	80	(13%)	$116	(14%)
Total	24,780	(100%)	270	(100%)	640	(100%)	$853	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 18B.
Home Fires Involving Lamp, Bulb, or Lighting, by Area of Origin
2012-2016 Annual Averages

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Bedroom	1,110	(22%)	20	(45%)	90	(46%)	$32	(19%)
Attic or ceiling/roof assembly or concealed space	490	(10%)	0	(4%)	10	(4%)	$19	(12%)
Living room, family room, or den	400	(8%)	10	(29%)	30	(16%)	$19	(11%)
Exterior wall surface	320	(6%)	0	(0%)	0	(2%)	$6	(4%)
Lavatory, bathroom, locker room or check room	320	(6%)	0	(0%)	0	(1%)	$6	(4%)
Kitchen or cooking area	240	(5%)	0	(4%)	10	(4%)	$8	(5%)
Ceiling/floor assembly or concealed space	210	(4%)	0	(0%)	0	(2%)	$7	(4%)
Exterior balcony, unenclosed porch	200	(4%)	0	(0%)	0	(1%)	$9	(5%)
Closet	200	(4%)	0	(0%)	10	(4%)	$9	(6%)
Unclassified function area	200	(4%)	0	(4%)	10	(4%)	$6	(4%)
Garage or vehicle storage area	190	(4%)	0	(4%)	10	(4%)	$8	(5%)
Wall assembly or concealed space	90	(2%)	0	(0%)	0	(0%)	$3	(2%)
Courtyard, terrace or patio	90	(2%)	0	(0%)	0	(1%)	$4	(3%)
Unclassified outside area	90	(2%)	0	(0%)	0	(0%)	$4	(2%)
Other known area of origin	830	(17%)	0	(9%)	20	(11%)	$23	(14%)
Total	4,970	(100%)	40	(100%)	200	(100%)	$164	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 18C.
Home Fires Involving Cords or Plugs, by Area of Origin
2012-2016 Annual Averages

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Bedroom	1,110	(33%)	30	(18%)	100	(42%)	$45	(32%)
Living room, family room, or den	485	(15%)	70	(44%)	50	(21%)	$25	(17%)
Garage or vehicle storage area	228	(7%)	0	(0%)	10	(4%)	$15	(10%)
Kitchen or cooking area	203	(6%)	10	(6%)	10	(5%)	$7	(5%)
Unclassified function area	202	(6%)	20	(10%)	10	(6%)	$8	(6%)
Laundry room or area	124	(4%)	0	(1%)	0	(2%)	$2	(2%)
Crawl space or substructure space	104	(3%)	0	(1%)	10	(3%)	$2	(2%)
Exterior wall surface	91	(3%)	0	(1%)	0	(1%)	$2	(2%)
Exterior balcony, unenclosed porch	67	(2%)	10	(6%)	0	(1%)	$3	(2%)
Wall assembly or concealed space	66	(2%)	0	(1%)	0	(0%)	$2	(1%)
Unclassified structural area	51	(2%)	10	(4%)	0	(2%)	$3	(2%)
Other known area of origin	600	(18%)	10	(8%)	30	(12%)	$28	(19%)
Total	3,330	(100%)	160	(100%)	230	(100%)	$143	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 18D.
Home Fires Involving Transformers and Power Supplies, by Area of Origin
2012-2016 Annual Averages

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Bedroom	450	(22%)	10	(45%)	40	(32%)	$21	(19%)
Garage or vehicle storage area	340	(16%)	0	(0%)	20	(14%)	$36	(33%)
Living room, family room, or den	210	(10%)	0	(21%)	20	(13%)	$9	(8%)
Exterior wall surface	110	(5%)	0	(0%)	0	(3%)	$4	(4%)
Unclassified function area	100	(5%)	0	(0%)	10	(8%)	$2	(2%)
Kitchen or cooking area	90	(4%)	0	(0%)	0	(3%)	$2	(2%)
Exterior balcony, unenclosed porch	50	(2%)	0	(12%)	10	(5%)	$4	(3%)
Unclassified outside area	50	(2%)	0	(0%)	0	(1%)	$2	(2%)
Crawl space or substructure space	50	(2%)	0	(0%)	0	(1%)	$3	(2%)
Office	40	(2%)	0	(0%)	0	(0%)	$2	(2%)
Storage of supplies or tools or dead storage	40	(2%)	0	(0%)	0	(1%)	$2	(2%)
Dining room, bar or beverage area, cafeteria	30	(2%)	0	(0%)	10	(6%)	$1	(1%)
Unclassified storage area	30	(2%)	0	(0%)	0	(2%)	$1	(1%)
Other known area of origin	460	(22%)	0	(22%)	10	(12%)	$19	(17%)
Total	2,060	(100%)	20	(100%)	130	(100%)	$108	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 19.
Home Fires Involving Electrical Distribution and Lighting Equipment, by Item First Ignited
2012-2016 Annual Averages

Item First Ignited	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Electrical wire or cable insulation	11,020	(31%)	120	(25%)	330	(27%)	$319	(25%)
Structural member or framing	5,960	(17%)	90	(18%)	150	(13%)	$283	(22%)
Insulation within structural area	2,400	(7%)	0	(0%)	20	(2%)	$60	(5%)
Exterior wall covering or finish	2,300	(7%)	20	(5%)	30	(3%)	$75	(6%)
Interior wall covering, excluding drapes	1,740	(5%)	20	(4%)	50	(5%)	$73	(6%)
Unclassified structural component or finish	1,520	(4%)	10	(3%)	40	(3%)	$60	(5%)
Mattress or bedding	1,150	(3%)	20	(3%)	110	(9%)	$38	(3%)
Unclassified item first ignited	950	(3%)	10	(1%)	20	(2%)	$24	(2%)
Interior ceiling cover or finish	760	(2%)	10	(1%)	10	(1%)	$35	(3%)
Clothing	720	(2%)	30	(7%)	50	(5%)	$24	(2%)
Floor covering rug, carpet, or mat	700	(2%)	10	(1%)	40	(3%)	$33	(3%)
Upholstered furniture or vehicle seat	610	(2%)	50	(10%)	70	(6%)	$35	(3%)
Unclassified furniture or utensils	540	(2%)	20	(5%)	20	(2%)	$22	(2%)
Other known item first ignited	4,760	(14%)	80	(16%)	240	(20%)	$188	(15%)
Total	35,150	(100%)	490	(100%)	1,200	(100%)	$1,270	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Acknowledgements

The National Fire Protection Association thanks all the fire departments and state fire authorities that participate in the National Fire Incident Reporting System (NFIRS) and the annual NFPA fire experience survey. These firefighters are the original sources of the detailed data that make this analysis possible. Their contributions allow us to estimate the size of the fire problem.

We are also grateful to the U.S. Fire Administration for its work in developing, coordinating, and maintaining NFIRS.

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*Black = original text **not** removed ~~RED = Original Text removed~~ Blue = New Text*

300.4 Protection Against Physical Damage.

Where subject to physical damage, conductors, raceways, and cables shall be protected.

(A) Cables and Raceways Through Wood Members.

(1) Bored Holes.

In both exposed and concealed locations, where a cable- or raceway-type wiring method is installed through bored holes in joists, rafters, or wood members, 29 mm (1 1/8 in.) diameter holes shall be bored. ~~so that the edge of the hole is not less than 32 mm (11⁄4 in.) from the nearest edge of the wood member~~. ~~Where this distance cannot be maintained, the~~ The cable or raceway shall be protected from penetration by drills, screws or nails by ~~a steel plate(s) or~~ a 29 mm (1 1/8 in) 360-degree insulated Steel bushing(s), at least 1.6 mm (1⁄16 in.) thick, and of appropriate length ~~and width installed~~ to ~~cover~~ fully protect the area of the wiring.

Exception No. 1:

~~Steel plates shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing~~.

In areas in which a secured 360-degree insulated steel bushing cannot be installed, such as “Old work” or remodel jobs where wiring is already in place, a 1.6 mm (1/16 in.) secured split steel bushing with minimum of 270- degree protection against nails, screws or drill penetration shall be permitted.

Exception No. 2:

In areas in which either a secured 360-degree insulated steel bushing, or a secured 270-degree split steel bushing cannot be installed, a listed and marked steel plate no less than 1.6 mm (1⁄16 in.) thick that provides ~~equal or better~~ protection against drills, nails or screw penetration shall be installed on both sides of the wooden structure that is potentially exposed to penetration to provide 180 degrees of protection shall be permitted.

Exception No. 3:

Where a secured 360-degree insulated steel bushing or a secured 270-degree split bushing cannot be installed, and the wood structures are set against a solid surface such as the inside of a concrete wall, a listed and marked steel plate no less than 1.6 mm (1⁄16 in.) thick that provides equal or better protection against drills, nails or screw penetration shall be required only on the exposed surface.

Exception No. 4:

Secured 360-degree insulated steel bushings, secured 270-degree split steel bushings or steel plates shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing.

(2) Notches in Wood.

Where there is no objection because of weakening the building structure, in both exposed and concealed locations, cables or raceways shall be permitted to be laid in notches in wood studs, joists, rafters, or other wood members where the cable or raceway at those points is protected against nails or screws by a steel plate at least 1.6 mm (1⁄16 in.) thick, and of appropriate length and width, installed to cover the area of the wiring. The minimum protection requirement is 180 degrees. If the wooden structure is positioned that that the side without the notch is potentially accessible by nails, drills, or screws a second steel plate shall be required to provide 180 degrees of protection. The steel plate shall be installed before the building finish is applied.

Exception No. 1:

Steel plates shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing.

Exception No. 2:

A listed and marked steel plate no less than 1.6 mm (1⁄16 in.) thick that provides equal or better protection against nail or screw penetration shall be permitted.

Exception No. 3:

If the wooden structure is positioned in a place that has a natural barrier against nails, drills, or screws. (EX: wood structure against an outer cement wall), a listed and marked steel plate no less than 1.6 mm (1⁄16 in.) thick that provides equal or better protection against drill, nail, or screw penetration shall only be required on the notched side of the wood structure.

(B) Nonmetallic-Sheathed Cables and Electrical Nonmetallic Tubing Through Metal Framing Members.

(1) Nonmetallic-Sheathed Cable.

In both exposed and concealed locations where nonmetallic-sheathed cables pass through either factory- or field-punched, cut, or drilled slots or holes in metal members, the cable shall be protected by listed bushings or listed grommets covering all metal edges that are securely fastened in the opening prior to installation of the cable.

(2) Nonmetallic-Sheathed Cable and Electrical Nonmetallic Tubing.

Where nails or screws are likely to penetrate nonmetallic-sheathed cable or electrical nonmetallic tubing, a steel sleeve, steel plate, or steel clip not less than 1.6 mm (1⁄16 in.) in thickness shall be used to protect the cable or tubing.

Exception:

A listed and marked steel plate less than 1.6 mm (1⁄16 in.) thick that provides equal or better protection against nail or screw penetration shall be permitted.

(C) Cables Through Spaces Behind Panels Designed to Allow Access.

Cables or raceway-type wiring methods, installed behind panels designed to allow access, shall be supported according to their applicable articles.

(D) Cables and Raceways Parallel to Framing Members and Furring Strips.

In both exposed and concealed locations, where a cable- or raceway-type wiring method is installed parallel to framing members, such as joists, rafters, or studs, or is installed parallel to furring strips, the cable or raceway shall be installed and supported so that the nearest outside surface of the cable or raceway is not less than 32 mm (11⁄4 in.) from the nearest edge of the framing member or furring strips where nails or screws are likely to penetrate. Where this distance cannot be maintained, the cable or raceway shall be protected from penetration by nails or screws by a steel plate, sleeve, or equivalent at least 1.6 mm (1⁄16 in.) thick.

Exception No. 1:

Steel plates, sleeves, or the equivalent shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing.

Exception No. 2:

For concealed work in finished buildings, or finished panels for prefabricated buildings where such supporting is impracticable, it shall be permissible to fish the cables between access points.

Exception No. 3:

A listed and marked steel plate less than 1.6 mm (1⁄16 in.) thick that provides equal or better protection against nail or screw penetration shall be permitted.

(E) Cables, Raceways, or Boxes Installed in or Under Roof Decking.

A cable, raceway, or box, installed in exposed or concealed locations under metal-corrugated sheet roof decking, shall be installed and supported so there is not less than 38 mm (11⁄2 in.) measured from the lowest surface of the roof decking to the top of the cable, raceway, or box. A cable, raceway, or box shall not be installed in concealed locations in metal-corrugated, sheet decking–type roof.

Informational Note:

Roof decking material is often repaired or replaced after the initial raceway or cabling and roofing installation and may be penetrated by the screws or other mechanical devices designed to provide “hold down” strength of the waterproof membrane or roof insulating material.

Exception:

Rigid metal conduit and intermediate metal conduit shall not be required to comply with 300.4(E).

(F) Cables and Raceways Installed in Shallow Grooves.

Cable- or raceway-type wiring methods installed in a groove, to be covered by wallboard, siding, paneling, carpeting, or similar finish, shall be protected by 1.6 mm (1⁄16 in.) thick steel plate, sleeve, or equivalent or by not less than 32-mm (11⁄4-in.) free space for the full length of the groove in which the cable or raceway is installed.

Exception No. 1:

Steel plates, sleeves, or the equivalent shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing.

Exception No. 2:

A listed and marked steel plate less than 1.6 mm (1⁄16 in.) thick that provides equal or better protection against nail or screw penetration shall be permitted.

(G) Fittings.

Where raceways contain 4 AWG or larger insulated circuit conductors, and these conductors enter a cabinet, a box, an enclosure, or a raceway, the conductors shall be protected in accordance with any of the following:

- (1)

  An identified fitting providing a smoothly rounded insulating surface

- (2)

  A listed metal fitting that has smoothly rounded edges

- (3)

  Separation from the fitting or raceway using an identified insulating material that is securely fastened in place

- (4)

  Threaded hubs or bosses that are an integral part of a cabinet, box, enclosure, or raceway providing a smoothly rounded or flared entry for conductors

Conduit bushings constructed wholly of insulating material shall not be used to secure a fitting or raceway. The insulating fitting or insulating material shall have a temperature rating not less than the insulation temperature rating of the installed conductors.

(H) Structural Joints.

A listed expansion/deflection fitting or other approved means shall be used where a raceway crosses a structural joint intended for expansion, contraction or deflection, used in buildings, bridges, parking garages, or other structures.

Public Comment No. 20-NFPA 70-2021 [Section No. 300.4(A)]

(A)_ Cables and Raceways Through Wood Members.

(1)~~–~~ Bored Holes.

300.4 Protection Against Physical Damage.

Where subject to physical damage, conductors, raceways, and cables shall be protected .

(A) Cables and Raceways Through Wood Members.

Original Text Not removed *Original text removed* ***New Text***

(1) Bored Holes.

In both exposed and concealed locations, where a cable- or raceway-type wiring method is installed through bored holes in joists, rafters, or wood members, ***29 mm (1 1/8 in.) diameter*** holes shall be bored. *so that the edge of the hole is not less than* ~~32 mm (1 1⁄4~~ *32 mm (1¼ in.) from the nearest edge of the wood member. Where this distance cannot be maintained, the* ***The*** cable or raceway shall be protected from penetration by ***drills,*** screws or nails by *a steel plate(s) or* ***a secured 29 mm (1 1/8 in) 360-degree insulated*** Steel bushing(s), at least 1.~~6 mm (1⁄16~~ 6 mm (1⁄16 in.) thick, and of appropriate length *and width installed* to *cover* ***fully protect*** the area of the wiring.

~~Exception No~~

Exception No .

~~1~~

1 :

Steel plates shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid

~~PVC~~

nonmetallic conduit,

RTRC , ~~Exception No. 2: A~~

or electrical metallic tubing.

~~*I n a* reas in which a secured 360-degree insulated steel bushing cannot be installed, such as "Old work" or remodel jobs where wiring is already in place, a 1.6 mm (1/16 in.) secured split steel bushing with minimum of 270- degree protection against nails, screws or drill penetration shall be permitted.~~

~~Exception No. 2:~~

~~***In areas in which either a secured 360-degree insulated steel bushing, or a secured 270- degree split steel bushing cannot be installed,*** a listed and marked steel plate no less than 1.~~

~~6 mm (1⁄16 in~~

~~6 mm (1⁄16 in .) thick that provides *equal or better* protection against~~

~~nail~~

~~drills, nails or screw penetration ***shall be installed on both sides of the wooden structure that is potentially exposed to penetration to provide 180 degrees of*** protection shall be permitted.~~

~~***Exception No. 3:***~~

~~***Where a secured 360-degree insulated steel bushing or a secured 270-degree split bushing cannot be installed, and the wood structures are set against a solid surface such as the inside of a concrete wall, a listed and marked steel plate no less than 1.6 mm (***~~

~~2)~~

1⁄16 in.) thick that provides equal or better protection against drills, nails or screw penetration shall be required only on the exposed surface.

Exception No. 4:

Secured 360-degree insulated steel bushings, secured 270-degree split steel bushings or steel plates shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing.

(2) Notches in Wood .

Where there is no objection because of weakening the building structure, in both exposed and concealed locations, cables or raceways shall be permitted to be laid in notches in wood studs, joists, rafters, or other wood members where the cable or raceway at those points is protected against nails or screws by a steel plate at least 1.~~6 mm (1⁄16 in~~ 6 mm (1⁄16 in .) thick, and of appropriate length and width, installed to cover the area of the wiring. ***The minimum protection requirement is 180 degrees. If the wooden structure is positioned that that the side without the notch is potentially accessible by nails, drills, or screws a second steel plate shall be required to provide 180 degrees of protection.*** The steel plate shall be installed before the building finish is applied.

~~Exception No~~

Exception No .

~~1~~

1 :

Steel plates shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing.

~~Exception No~~

Exception No .

~~2~~

2 :

A listed and marked steel plate no less than 1.

~~6 mm (1⁄16 in~~

6 mm (1⁄16 in .) thick that provides equal or better protection against nail or screw penetration shall be permitted.

Exception No. 3:

If the wooden structure is positioned in a place that has a natural barrier against nails, drills, or screws. (EX: wood structure against an outer cement wall), a listed and marked steel plate no less than 1.6 mm (1⁄16 in.) thick that provides equal or better protection against drill, nail, or screw penetration shall only be required on the notched side of the wood structure.

Additional Proposed Changes

File Name	Description	Approved
A.01_300.4_Mark-up_Final.pdf	A.01.300.4 Mark -up Final COLOR CODED	
EXHIBIT_A_CODE_PETITION_SUMMARY.pdf	EXHIBIT A CODE PETITION SUMMARY	

EXHIBIT_B_NFPA_Home_Electrical_Fires_Full_Report_2012-2016.pdf	EXHIBIT B NFPA Home Electrical Fires Full Report 2012-2016
EXHIBIT_C_NFPA_Home_Electrical_Fires_Supporting_Tables_2012_-_2016.pdf	EXHIBIT C NFPA Home Electrical Fires Supporting Tables 2012-2016
EXHIBIT_D_Effectiveness_of_Circuit_Breakers_in_Mitigation_of_Arc_Faults_UL_2011.pdf	EXHIBIT D Effectiveness of Circuit Breakers in Mitigation of Arc Faults UL 2011
EXHIBIT_E_Causes_of_Electrical_Fires_The_hidden_dangers_of_arc_fault_Siemens_2018.pdf	EXHIBIT E Causes of Electrical Fires The Hidden Dangers of Arc Fault Siemens 2018
EXHIBIT_F_Arc_Faults_The_Hidden_Fire_Risk_Revealed_Schneider_Electric_2020.pdf	EXHIBIT F Arc Faults The Hidden Fire Risk Revealed Schneider Electric 2020
EXHIBIT_G_Typical_TV_and_Monitor_Monitor_Mount_Kits_Instructions_2021.pdf	EXHIBIT G Typical TV and Monitor Mount Kits Instructions 2021

Statement of Problem and Substantiation for Public Comment

The problems this proposed change is addressing is to reduce the risk of arc faults caused by wires running though wood structures when either punctured or nicked by drills, Nails or screws. It further addresses wires being scraped during installation. The code as written does not provide adequate wire protection. The Code Petition Summary document (uploaded with this proposed change) provides substantiation of the problem. The summary document also refers to multiple sources (also uploaded and highlighted) including NFPA studies as well as UL studies that verify the problem and backs up the occurrences with published data which is sited in the summary document. The problem is very well acknowledge through out the industry. This change will provide the added safety protection we need to make homes safer and reduce the amount of electrical fires in homes. Most importantly this change will save lives.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 19-NFPA 70-2021 [New Section after 300.4]	

Related Item

- 20-NFPA-70-2021

Submitter Information Verification

Submitter Full Name: Glenn Liubakka
Organization: EZ Electrical System Solutions
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 29 14:20:30 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: While wiring in homes can be damaged as indicated in the "Code Petition Summary", workmanship as cited in the report can be an issue also; and is outside the scope of the NEC. As stated in the panel's statement to resolve the original PI's associated with this public comment, cables installed less than 1 ¼ inches from the nearest edge require protection. Section 110.2 requires conductors and equipment to be acceptable if approved. If the authority having jurisdiction feels that the cable or raceway type wiring method is subject to physical damage, they may require additional protection. Protection of circuitry has increased over time with the creation, and increased use of, AFCI protection. AFCI protection detects and protects against issues raised by this public comment.

Code Petition Summary

NFPA 70 NEC 300.4 Protection Against Physical Damage

Opening Statement:

This petition is focused on minimizing the penetration of wires during and after installation by screws, nails, and drills, as well as minimizing scraping of wires during installation.

It is the petitioner's conclusion that NEC 300.4 does not provide adequate damage protection of wires passing through a structural wood frame member. Extensive research of multiple sources will prove justification for the conclusion drawn. It is documented that Electrical wiring in homes can be damaged during and after installation through over-stapling, crushing, bending, scraping, or PENETRATION by SCREWS, NAILS or DRILLS. Over time, damaged cabling degrades due to exposure to elevated temperatures or humidity, eventually leading to arc faults and ignition of combustible materials in proximity. *(EXHIBIT D: 2011 Ul paper on Mitigating parallel arc faults, first two paragraphs of the background page 6).*

Source documents are referenced throughout the summary and are included with the petition as exhibits.

Background:

Per NFPA's own study, between 2012 – 2016, on average, 44,800 home fires per year involved electrical failure or malfunction. Of those fires the first items ignited were as follows *(Exhibit B NFPA Home Electrical Fires Full Report 2012 – 2016 Page 1):*

31%	Electrical Wire or Cable Insulation	14,120 fires per year.
13%	Structural Member or Framing	5,950 fires per year.
6%	Insulation Within Structural Area	2,510 fires per year.
7%	Unclassified / Unclassified Structural Component	3,510 fires per year.
		26,090 Total fires per year.

This equates to 22,580 verifiable instances of home fires that started behind the wall in homes each year, with an additional 3,510 unclassified instances. *(EXHIBIT C: NFPA Home Electrical Fires Supporting Tables 2012 – 2016 page 12).*

This has caused serious damage, many civilian injuries, and deaths each year.

190 Civilian Deaths each year.

530 Civilian Injuries each year.

$631,000,000 In direct property damage each year.

(EXHIBIT C: NFPA Home Electrical Fires Supporting Tables 2012 – 2016 page 12)

The condition of Arc faults may form over a wide range of time intervals, from milliseconds to decades, before an arcing fault develops. Both current levels and duration are factors that allow arcs to generate the amount of heat needed to cause a fire. Arcing faults can readily produce temperatures in-excess of 1,000 degrees Celsius (1,832 deg. F). *(EXHIBIT E Causes of Electrical Fires the Hidden Dangers of Arc Faults Siemens 2018 page 2).*

Arc faults can be classified into two types, series faults and parallel faults. In a series fault, the arc occurs within only one conductor and is in series with the normal flow of electrical current. Series faults occur, for example if ONE CONDUCTOR IS NICKED, CUT, OR PENETRATED, or an interconnect is loose or corroded. Current flow through a series fault is limited by the connected load to the circuit and therefore will NOT BE MITIGATED by a circuit breaker. (*EXHIBIT B: Effectiveness of Circuit Breakers in Mitigating Parallel Arcing Faults in the Home Run page 6)*.

Anywhere a cable is damaged or loose, there is the potential of a "series arc" between the two parts of the same cable. This happens as a localized hot spot develops which starts to carbonize, the adjacent insulation materials. This carbon is conductive, allowing current to flow through it by means of electric arcs. The arcs amplify the carbonization causing a chain reaction that eventually leads to sparking a spontaneous fire. (*EXHIBIT F: Arc Faults the Hidden Risk Revealed Schneider Electric Blog 2020 page 2)*.

Parallel faults can be caused by damaged wire insulation, contaminants, rodent damage to insulation or METALIC OBJECTS (nails, screws, drills, etc.) scraping or penetrating wires. In the parallel case the arc occurs between the supply and return wires i.e., between the "hot" and "neutral" or between the "hot" and "ground" and is only limited by the available current from the panel. In this scenario, there is a potential for a current of several hundred amperes. However, these arcing events may have short duration or contain long pauses between individual arcs. For this reason, parallel arcs MAY NOT cause a conventional circuit breaker to react. (*EXHIBIT B: Effectiveness of Circuit Breakers in Mitigating Parallel Arcing Faults in the Home Run page 6)*.

Justification for Amendment:

Current Code as Written:

NFPA 70 NEC National Electrical Code Article 300

Section 300.4 Protection Against Physical Damage

Where subject to physical damage, conductors, raceways, and cables shall be protected.

(A)Cables and Raceways Through Wood Members.

(1) Bored Holes.

In both exposed and concealed locations, where a cable- or raceway-type wiring method is installed through bored holes in joists, rafters, or wood members, holes shall be bored so that the edge of the hole is not less than 32 mm (1 ¼ in.) from the nearest edge of the wood member. Where the distance cannot be maintained the cable or raceway shall be protected from penetration by screws or nails by a steel plate (s) or Steel bushing(s) at least 1.6 mm (1/16 in) thick and of appropriate length and width installed to cover the area of the wiring.

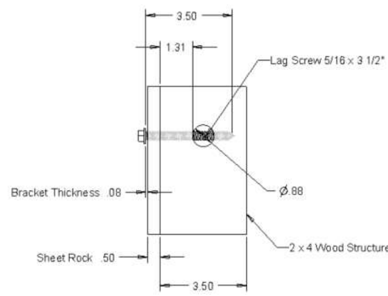
Analysis:

As the code is currently written the first line of defense from penetration from nails, screws or drills is the distance of the edge of the bored hole to the nearest edge of the wood member.

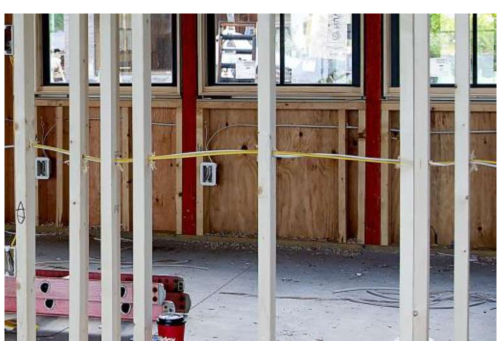
We have found that the 32mm (1 ¼ in.) distance is not adequate for the following reasons:

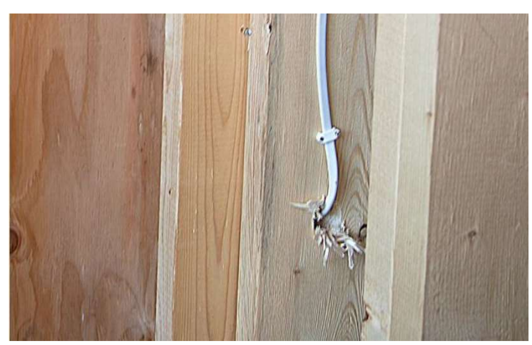
- The standard 2 x 4 measures 1 ½ x 3 ½ inches.
- Building contractors on new and renovation construction are frequently using longer wood screws than in the past. This happens when mounting kitchen cabinets, bathroom vanities, custom built-in-shelving units, etc. These operations happen after sheeting is installed on new construction and renovation jobs, so the finish carpenter / installer has no idea what or where the electrical wires are located.
- Home or building owners are using longer and random-length screws or nails to mount large screen televisions, artwork, and other objects. Typical mounting kits for televisions and monitors come with 2 ½ -3 ½ in. lag screws *(EXHIBIT G: Typical Monitor Mounting kits - Instructions)*. These longer fasteners can easily penetrate wires running through bored holes that meet the current code requirement of 32 mm (1 ¼ in.) from edge of wood member. It is also common to drill a pilot hole into a stud prior to installing a screw or fastener. This doubles the opportunity to compromise the wire. There is documented evidence that drills have penetrated conductors as they pass through a wooden structural member. *(EXHIBIT B: NFPA Home Electrical Fires Full Report 2012-2016 page 5).*
- The hole dimension is subject to either (a) installer verifies all bored holes and on his or her own merit installs steel plates or bushings where needed. OR. (b) During the electrical inspection process the bored holes are each visually checked and measured by the inspector. If any are in violation or do not meet the dimensional criteria per code, the inspector will contact the responsible installer to enforce the use of steel plates where necessary. This will usually happen after the wire is in place so a 360 deg steel

bushing will not be able to be installed. There are split bushings sold on the market today that could be used in this case but most likely a steel plate would be used which would only be required to be installed on the one surface of the wooden member that is in violation of the code dimension of 32 mm (1 ¼ in.). This solution is inadequate because the other surface of the wood member is still exposed to the threat of longer screws, nails, or drills. The standard 2 x 4 measures 1 ½ x 3 ½ inches. Clearly the longer screws commonly used can penetrate the wire from the opposite non-protected side of the stud.



- The current code does not address the workmanship of the bored hole. Protection from scraping of wires as they are routed through the bored holes is critical. I have been on many of job sites both residential, commercial, and multi-family unit sites where the bored holes are not clean. The majority of the holes have massive splinters on the exiting side of the bore. These splinters cause problems **scraping wires** as they are routed through the structures. Installing an insulated steel bushing in the holes prior to routing of wires will drastically reduce the amount of wire scraping during the routing process.





The second line of defense per the current code) from penetration from screws, nails or drills is the installation of steel plate (s) or bushing (s) at least 1.6 mm (1/16 in) thick and of appropriate length and width installed to cover the area of the wiring.

- This second line of defense falls short of adequate protection because it is a secondary option ***only required*** if (a) the installer realizes the hole is not code compliant or (b) The inspector notices that the hole is not code compliant.

- The Steel Plate does not protect both sides of the wooden structural member and we know that nails, screws, and drills can easily penetrate up to 3 inches into a structural member. *(Reference above illustrations)*

To be clear, this petition ***does not suggest*** the elimination of steel plates, nor does it eliminate steel split bushings. Rather, it clearly defines the appropriate use of steel plates and split bushings as exceptions to the requirement of secured 360-degree insulated steel bushings.

- **Per the petition Exception No. 1: will read as follows;** In areas in which a secured 360-degree insulated steel bushing cannot be installed, such as "Old work" or remodel jobs where wiring is already in place, a 1.6 mm (1/16 in.) secured split steel bushing with minimum of 270- degree protection against nails, screws or drill penetration shall be permitted.
- **Per the Petition Exception No. 2. Will read as follows;** In areas in which neither a secured 360-degree Insulated steel bushing, or a secured 270-degree split steel bushing cannot be installed, a steel plate no less than 1.6 mm (1⁄16 in.) thick that provides protection against drills, nails or screw penetration installed on both sides of the wooden structure that is potentially exposed to penetration to provide 180-degrees of protection shall be permitted.
- **Per the Petition Exception NO. 3. Will read as follows;** Where a secured 360-degree insulated steel bushing or a secured 270-degree split bushing cannot be installed, and the wood structures are set against a solid surface such as the inside of a concrete wall, a listed and marked steel plate no less than 1.6 mm (1⁄16 in.) thick that provides equal or better protection against drills, nails or screw penetration shall be required only on the exposed surface Where a 360-degree or a split bushing cannot be installed, and the wooden structures are set against a solid surface such as the inside of a concrete basement wall a listed and marked steel plate no less than 1.6 mm (1⁄16 in.) thick that provides equal or better protection against drills, nails or screw penetration shall be permitted on the exposed surface.
- **Per the Petition Exception NO. 4. Will read as follows;** Secured 360-degree insulated steel bushings, secured 270-degree split steel bushings or steel plates shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing.
- The Petition further describes the appropriate usage of steel plates in the section of notches in wood.

Conclusion:

It is the petitioner's conclusion that the code 300.4 as currently written, does not provide adequate protection in relation to the known risks of fires caused by Arc fault conditions. This petition provides undeniable evidence of the issue regarding the penetration of wire conductors as they pass through wood members. The supporting statistical information provided is from highly respected industry sources (NFPA and UL). The NFPA study is the most comprehensive, in-depth, and multi-year study available.

The NEC & NFPA as organizations have a dedicated mission off improving safety in the industry. This proposed code amendment addresses the documented safety hazards that currently exist under the current code.

The statistical information provided regarding electrical fires, deaths, injuries, and property damage caused by Arc fault conditions is **alarming**. We can reduce these numbers drastically with this proposed code amendment.

The cost of implementation should not be a consideration for fire safety. However, it is very minimal in comparison to other safety measures that have been implemented in the past. The average cost to a home to have 360 degree insulated bushings installed in all holes a wire passes through is less than ½ of 1% of an average home cost. (Approx. $1,500.00 for a 2,800 SF home).

The Petitioner understands that there is some hesitancy regarding this topic. However, there are too many electrical fires due to Arc faults annually to ignore.

The one time a homeowner or contractor drills into that stud and rather than penetrates a conductor, they hit the 360-degree steel bushing may save an entire family's life. **We as a fire protection organization need to address this issue by amending the code. I believe it is our responsibility.**

Appendix:

Cited Documents:

EXHIBIT A: Code Petition Summary (this document)

Code Petition Author - Glenn Liubakka 2021

EXHIBIT B: NFPA Home Electrical Fires Full Report 2012 - 2016

Richard Campbell - March 2019

EXHIBIT C: NFPA Home Electrical Fires Supporting Tables 2012 - 2016

Richard Campbell - March 2019

EXHIBIT D: Effectiveness of Circuit Breakers in Mitigating Parallel Arcing Faults UL 2011

UL-Paul W. Brazis Jr., PhD and Fan He, PhD

EXHIBIT G: Typical TV and Monitor Mount Kits Instructions 2021

Glenn Liubakka 2021

Other Reference Documents regarding Arc Faults:

EXHIBIT E: Causes of Electrical Fires the Hidden Dangers of Arc Faults Siemens 2018

Siemens Industry, Inc.

EXHIBIT F: Arc Faults: The Hidden Fire Risk Revealed Schneider Electric 2020

Schneider Electric.

HOME ELECTRICAL FIRES

Richard Campbell
March 2019

Key Findings

Fires involving electrical failure or malfunction

- Local fire departments responded to an estimated average of 44,880 home fires involving electrical failure or malfunction each year in 2012-2016.
- Home fires involving electrical failure or malfunction caused an estimated average of 440 civilian deaths and 1,250 civilian injuries each year in 2012-2016, as well as an estimated $1.3 billion in direct property damage a year.
- Electrical distribution, lighting, and power transfer equipment accounted for half (50%) of home fires involving electrical failure or malfunction, followed by cooking equipment (15%), heating equipment (9%), fans (6%), air conditioners (3%), and clothes dryers (3%).
- Nearly two of five fires (39%) involving electrical failure or malfunction occurred in the cold weather months from November through February. These fires were less likely to occur in the overnight hours between midnight and 8 a.m. (22% of total), but fires during this time period accounted for 60% of the civilian deaths.

Fires involving electrical distribution and lighting equipment[1]

- Local fire departments responded to an estimated average of 35,150 home fires involving electrical distribution and lighting equipment each year in 2012-2016.
- Home fires involving electrical distribution and lighting equipment caused an estimated average of 490 civilian deaths and 1,200 civilian injuries each year in 2012-2016, as well as an estimated $1.3 billion in direct property damage a year.
- Home fires involving electrical distribution and lighting equipment most often originated in a bedroom (17% of total), attic or ceiling (12%), or a wall assembly or concealed space (9%).
- Approximately one-quarter (24%) of these fires occurred between midnight and 8 a.m., but these fires accounted for 60% of deaths.

[1] Estimates exclude the six structure fire incident types for confined cooking fires, chimney or flue fires, fuel burner or boiler fires, incinerator, compactor, or trash fires.

Home Electrical Fires

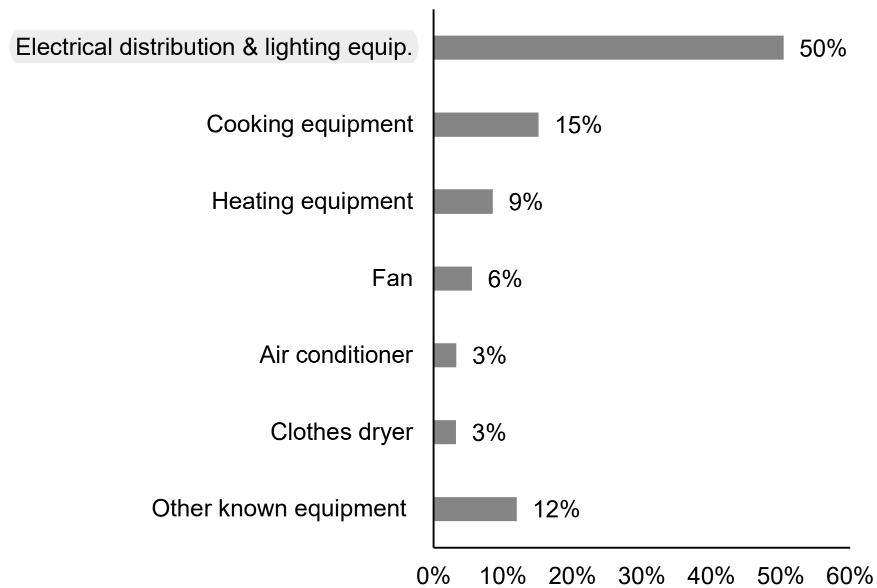
Home electrical fires can start in wiring, electrical distribution systems, and lighting equipment, as well as in any equipment powered by electricity such as cooking, heating, office and entertainment equipment, washers and dryers, as well as electrical distribution or lighting equipment. To better understand if these types of fires can be prevented through code changes, equipment changes, and/or public education, this report splits home electrical fires into two groups, based on data from two separate data elements in the National Fire Incident Reporting System (NFIRS):

1. Fires in which electrical failure or malfunction is a factor contributing to ignition.

2. Fires involving electrical distribution and lighting equipment. These are fires in which electrical distribution or lighting equipment are somehow involved in a fire's ignition. The form of involvement could include electrical failure or malfunction but may also involve other types of involvement, such as serving as a heat source by being in close proximity to combustible material or by overloaded equipment.

Figure 1 shows the types of equipment involved in home fires in which electrical failure or malfunction contributed to ignition. As indicated, electrical distribution and lighting equipment accounts for half of these fires.

Figure 1. Home Fires Involving Electrical Failure or Malfunction by Equipment Involved in Ignition 2012-2016



Home Fires Involving Electrical Failure or Malfunction

Electrical failures or malfunctions are a leading factor in the ignition of fires in U.S. homes. Electrical failures or malfunctions were responsible for 13% of home structure fires in 2012-2016, ranking as the second leading contributing factor behind fires caused by unattended equipment. Electrical failure or malfunction fires also accounted for nearly one-fifth (18%) of civilian deaths (the second leading contributing factor behind fires caused by heat sources too close to combustibles), 11% of civilian injuries, and accounted for the greatest share of direct property damage (20%).

Types of Electrical Failure or Malfunction Contributing to the Ignition of Home Fires

As shown in Figure 2, home fires due to electrical failure or malfunction primarily involve some form of arcing, which results from an unintentional discharge of electrical current between conductors. Given sufficient time and level of current, arc faults can produce enough heat to ignite a fire. Arc faults are produced by damaged conductors and connectors and may involve damaged wiring, frayed appliance cords, loose connections in wall outlets, or faulty switches and junction boxes. Arc faults may originate in different areas of the home or virtually any electrical fixture or equipment.

Electrical fault sparks fire that displaces residents

An electrical fault in a ceiling fan was blamed for an early morning fire in a multifamily residence.

Firefighters were dispatched to the fire following a 911 call from one of the occupants after a smoke alarm in his unit activated just after midnight. On arrival, crews reported fire on the second floor of a two-and-a-half-story wood-frame structure.

The fire escalated to four alarms before firefighters were able to knock it down. News reports indicated that 11 occupants were displaced by the fire, but none were injured. One firefighter was reported to have suffered a back injury at the scene.

Investigators determined that the fire was caused by an electrical short circuit in a ceiling fan in a second-floor bathroom.

The building was composed of five residential units. According to news reports, a city inspector indicated that he did not find the number of smoke alarms in the building that were required by municipal codes. The building did not have sprinkler protection.

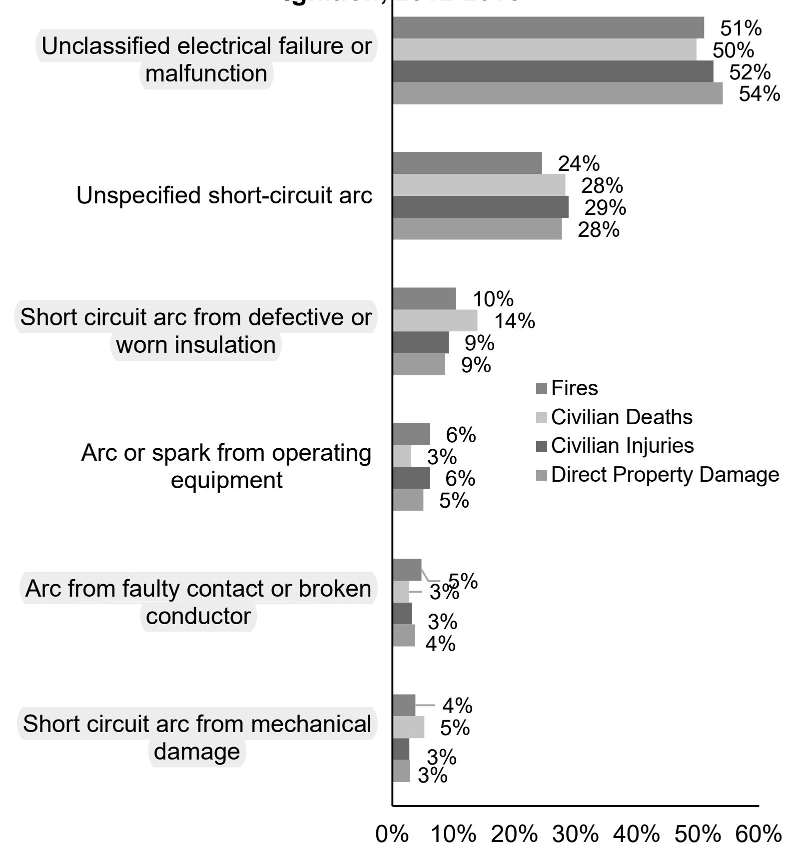
The fire caused an estimated $500,000 in damage to the structure and an additional $500,000 in damage to its contents.

Source: Richard Campbell, “Firewatch,” *NFPA Journal*, July/August, 2018.

- Short circuits from defective and worn insulation caused 14% of civilian home fire deaths as shown in Figure 2. This can be caused when cords are pinched by doors or furniture or through repetitive flexing of appliance cords. It can also be due to damaged wiring inside walls from nails, screws, or drill bits that puncture insulation during ordinary activities like hanging a picture. Even electrical cords running under carpets can generate enough heat to produce an arc fault.

- Aging electrical systems in older homes can be a source of arc faults, either through normal wear and tear or because the systems cannot accommodate the greater demands of modern appliances. Circuits can also be overloaded by providing electricity to too many appliances, often through power cords.

Figure 2. Home Fires Involving Electrical Failure or Malfunction by Factor Contributing to Ignition, 2012-2016*



Trends in Home Fires Involving Electrical Failure or Malfunction

The number of home fires involving electrical failure or malfunction has followed a distinct downward trend since 1980, despite year-to-year fluctuations. From a peak of 75,000 fires in 1980, the estimated number of fires involving electrical failure or malfunction has fallen to fewer than 60,000 annual fires since 1998 and fewer than 50,000 each year since 2008, with the 40,900 fires in 2012 representing a new low point (Figure 3).

A recent NFPA report on home structure fires by Marty Ahrens found that overall home structure fires have plateaued over the past two decades. The continued, if uneven, decline in home fires involving electrical failure or malfunction over this same period suggests that this is an area of relative progress. The data indicate that civilian deaths in these fires have not followed a similar downward trend to that seen in fires, showing distinct fluctuations from year to year (Figure 4).

Figure 3. Home Fires Involving Electrical Failure or Malfunction, 1980-2016

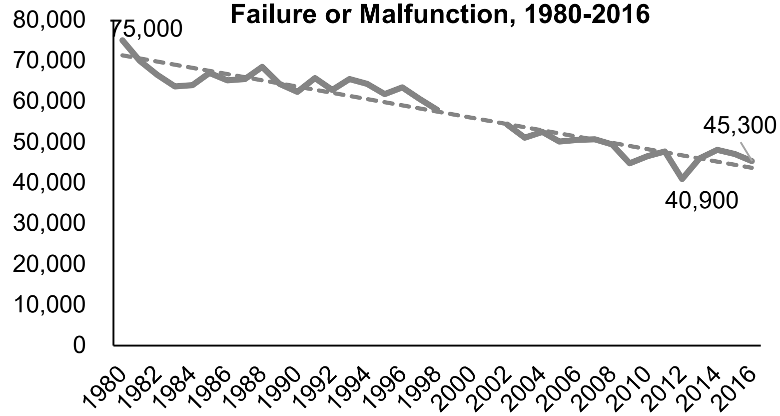
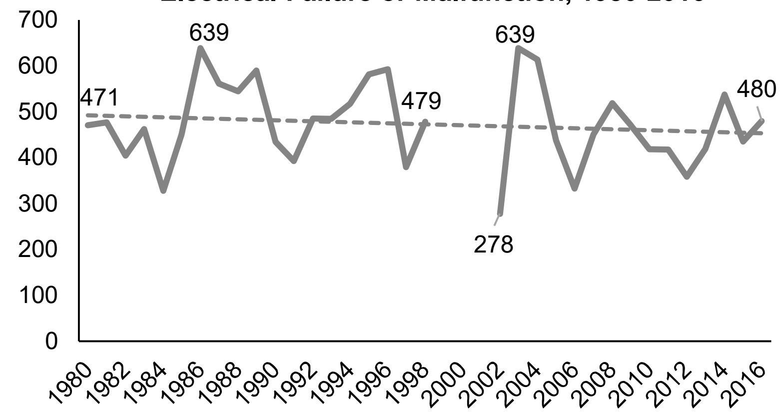


Figure 4. Civilian Deaths in Home Fires Involving Electrical Failure or Malfunction, 1980-2016

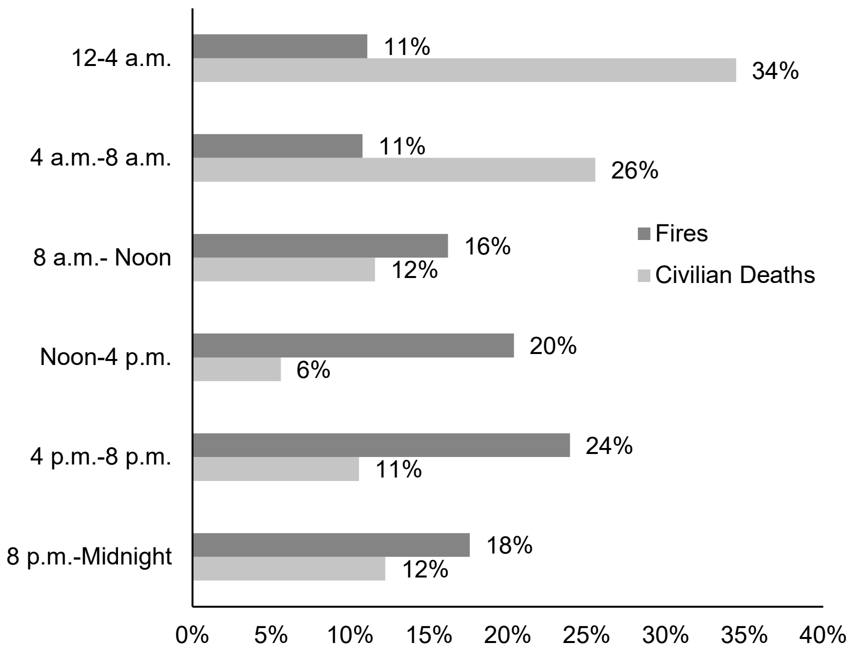


Note: Because of low participation in NFIRS Version 5.0 during 1999-2001, data from these years is not reported in these graphs.

WHEN DO HOME FIRES INVOLVING ELECTRICAL FAILURE OR MALFUNCTION OCCUR?

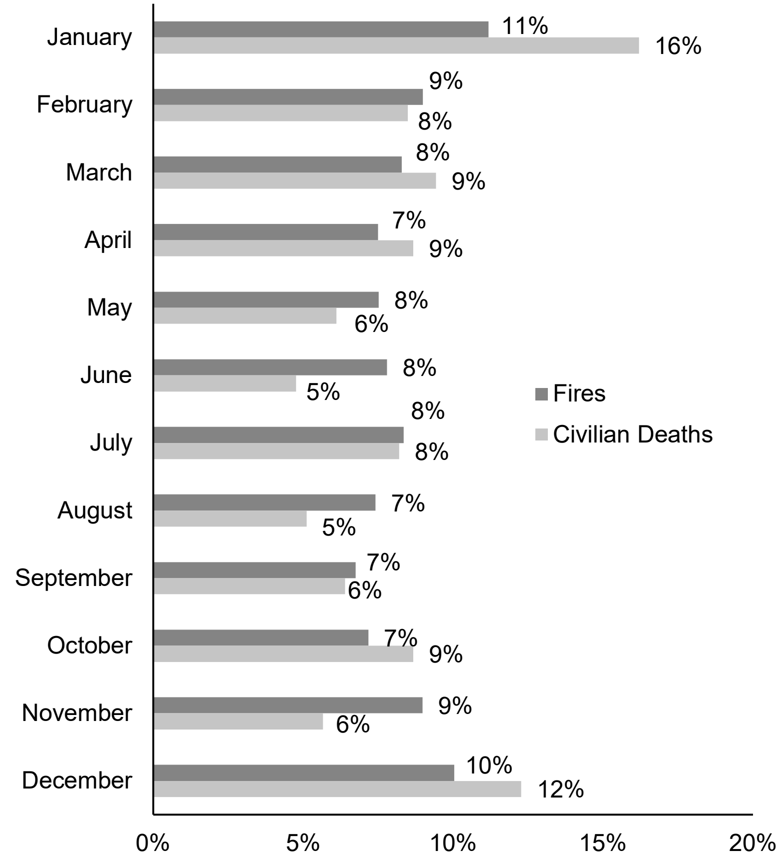
Home fires involving electrical failure or malfunction are less likely to occur in the overnight hours between midnight and 8 a.m. (22% of total), but these fires account for 60% of the civilian deaths. Fires that occur during the night when most people are asleep are more likely to be fatal. Working smoke alarms can provide an early warning of fire and allow additional time for evacuation.

Figure 5. Home Fires Involving Electrical Failure or Malfunction, by Time of Day 2012-2016



The peak months for home fires involving electrical failure or malfunction are November through March (47% of total), and these fires account for 52% of the civilian deaths. This is the time of year when more time is spent indoors, leading to an increased use of electrical equipment.

Figure 6. Home Fires Involving Electrical Failure or Malfunction by Month 2012-2016

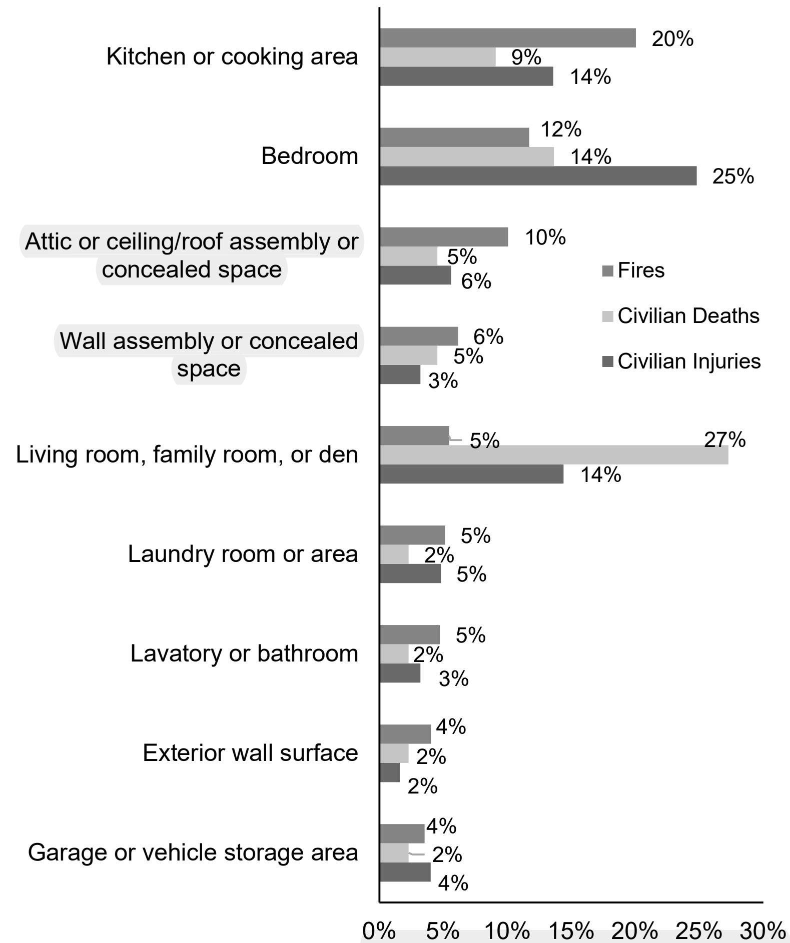


Area of Origin in Home Fires Involving Electrical Failure or Malfunction

One in five home fires (20%) involving electrical failure or malfunction originated in a kitchen or cooking area, with another 12% originating in a bedroom and 10% originating in an attic or ceiling/roof assembly or concealed space. Electrical failures or malfunctions within the wall assembly or concealed space is the fourth leading area of origin for these fires.

Fires originating in a living room, family room, or den accounted for a disproportionately large share of civilian deaths, while those originating in a bedroom accounted for a disproportionately large share of civilian injuries.

Figure 7. Area of Origin in Home Fires Involving Electrical Failure or Malfunction 2012-2016*



Only leading areas of origin shown

Home Fires Involving Electrical Distribution and Lighting Equipment

Electrical distribution and lighting equipment was the third leading type of equipment involved in fires in U.S. homes in 2012-2016, accounting for 10% of fires (behind cooking equipment and heating equipment). These fires accounted for a disproportionate share of home fire deaths (19%) and direct property damage (20%), as well as 10% of civilian injuries.

The previously mentioned change in data entry rules for incidents with an equipment-related heat source or factor contributing to ignition in 2012 is likely to have influenced estimates of electrical distribution and lighting equipment fires.

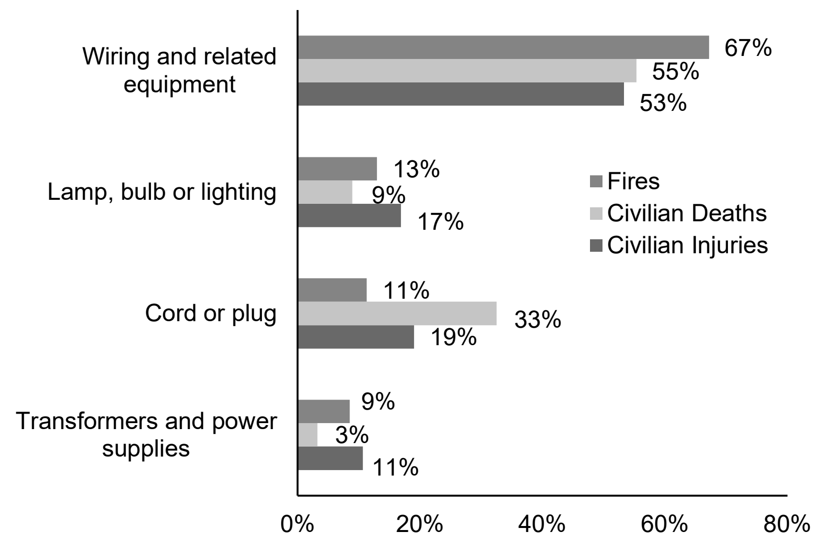
Types of Electrical Distribution and Lighting Equipment Involved in Home Fires

As shown in Figure 8, wiring and related equipment accounted for two-thirds of home fires caused by electrical distribution and lighting equipment and the same share of direct property damage, as well as over half of the civilian deaths and injuries.

Faulty wiring in concealed spaces, such as attics or behind walls, is particularly dangerous because it can start fires that burn for a prolonged period of time before detection.

Aluminum wire connections have been found to be prone to deterioration that results in increased resistance to electric current, with the cumulative damage capable of producing hazardous overheating, leading the Consumer Product Safety Commission (CPSC) to recommend that home aluminum wiring be replaced or repaired by a qualified electrician to reduce the potential for fire.

Figure 8. Types of Electrical Distribution or Lighting Equipment Involved in Home Fires, 2012-2016*

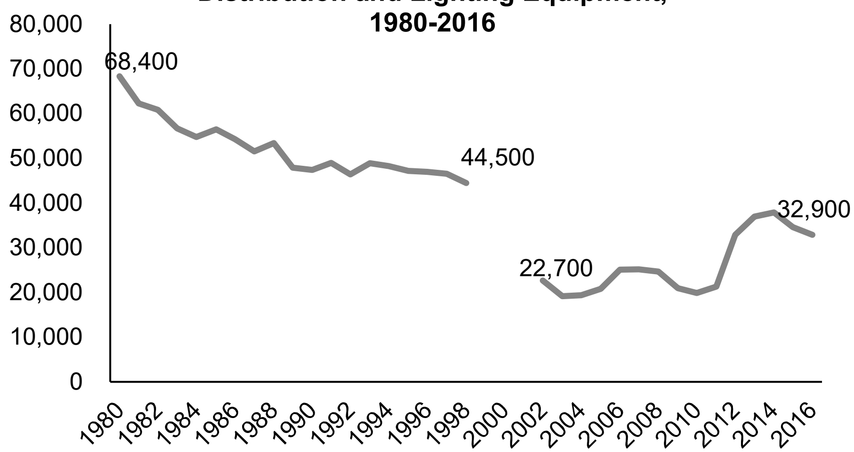


*All data in this section are non-confined fires only.

Trends in Home Fires Involving Electrical Distribution and Lighting Equipment

Home fires involving electrical distribution or lighting equipment showed a steady downward trend between 1980 and 1998, declining by about one-third during this period. See Figure 9. Following the introduction of a new version of NFIRS (NFIRS 5.0) and a transition period of 1999-2001, the downward trend was arrested and even reversed between 2011 and 2014 before falling again in 2015 and 2016, although fires are still well below those reported prior to 1999. A 2012 change in NFIRS data entry rules which required a valid entry in the "equipment involved in ignition" field for incidents having an equipment-related heat source or contributing factor had the largest impact on estimates of electrical distribution or lighting equipment fires.

Figure 9. Home Fires Involving Electrical Distribution and Lighting Equipment, 1980-2016



Note: Because of low participation in NFIRS Version 5.0 during 1999-2001, data from these years is not reported in this graph.

Electrical wiring causes house fire that kills elderly resident

An elderly resident died when degraded electrical wiring ignited combustible material in a wall cavity in the kitchen of his residence.

The fire department was summoned to the scene following a neighbor's call to 911 at 1:15 a.m., but investigators estimated that the fire had burned for an hour before it was detected.

According to news reports, firefighters found flames shooting from the rear of the house upon arrival, but they located the victim on a couch in a front room and quickly rushed him to the hospital. The victim, who had a mobility disability, succumbed to smoke inhalation injuries shortly afterwards.

Reports indicated that the resident had an unspecified physical disability.

The house was equipped with smoke alarms in the living room, bedroom, and on the second floor, and the engine company indicated that they were activated by the fire. It did not have sprinkler protection.

The house was a two story building with brick walls, a wooden roof frame, and an asphalt roof deck. It occupied a ground floor area of 700 square feet (65 square meters).

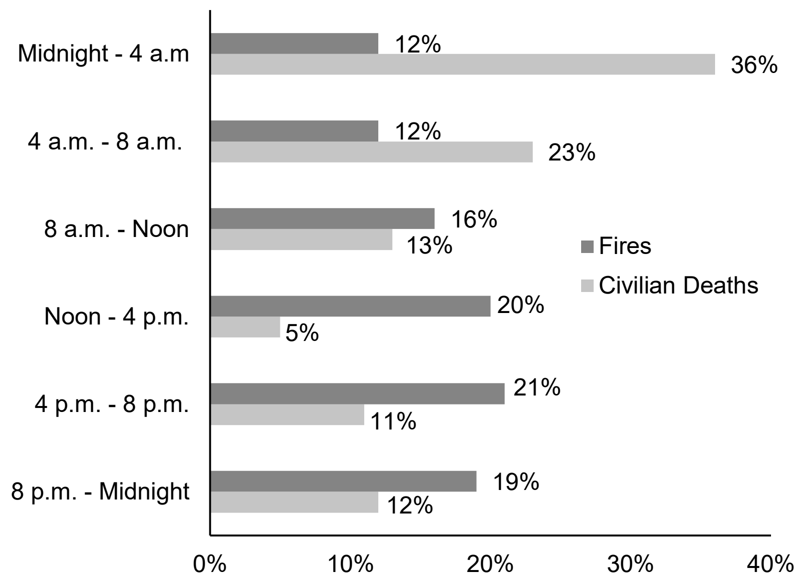
The house, valued at $80,000, and its contents, with an estimated value of $50,000, were a total loss.

Source: Richard Campbell, "Firewatch," *NFPA Journal*, January/February, 2017.

WHEN DO HOME FIRES INVOLVING ELECTRICAL DISTRIBUTION AND LIGHTING EQUIPMENT OCCUR?

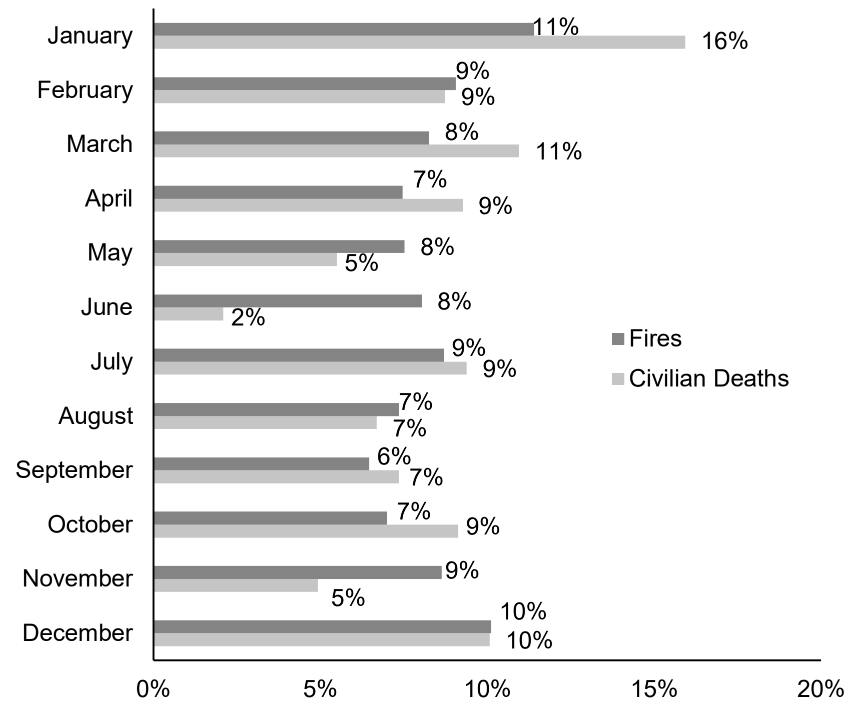
Home fires involving electrical distribution and lighting equipment are less likely to occur in the overnight hours between midnight and 8 a.m. (24% of total), but these fires account for three of five (59%) of the civilian deaths, reflecting the likelihood that people are more apt to be in the home and asleep than in the daytime hours. See Figure 10.

Figure 10. Home Fires Involving Electrical Distribution and Lighting Equipment by Time of Day, 2012-2016



As with fires caused by electrical failure or malfunction, the peak months for home fires involving electrical distribution or lighting equipment are November through March (47% of total). These fires also account for 51% of civilian deaths. This again is likely to reflect the greater tendency for people to be in the home and using electrical equipment during the cold weather months. Another one-quarter (24%) of fires occur from May through July. See Figure 11.

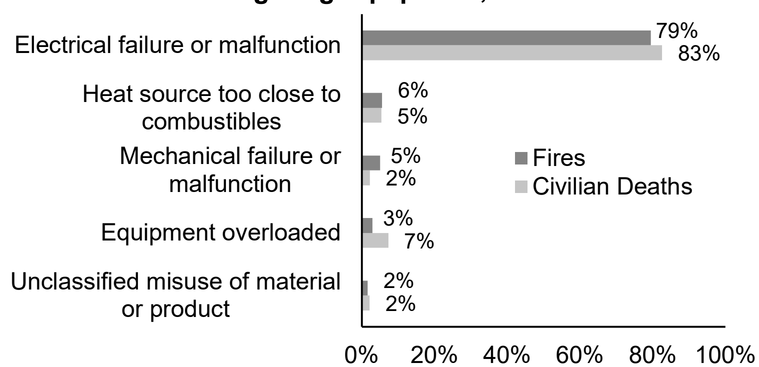
Figure 11. Home Fires Involving Electrical Distribution and Lighting Equipment by Month 2012-2016



Factors Contributing to the Ignition of Home Fires Involving Electrical Distribution or Lighting Equipment

Electrical failures or malfunctions were a factor contributing to the ignition of nearly four of five home fires (79%) involving electrical distribution or lighting equipment, and these fires accounted for 83% of civilian deaths. Other factors contributing to home fires involving electrical distribution and lighting equipment included heat sources being too close to combustibles, mechanical failures or malfunctions, overloaded equipment, and unclassified misuse of productions or materials.

Figure 12. Factors Contributing to the Ignition of Home Fires Involving Electrical Distribution and Lighting Equipment, 2012-2016*



*All data in this section is for non-confined fires only.

Some differences can be observed between specific types of electrical distribution and lighting equipment in relation to factors contributing to the ignition of fires. For instance, electrical failure or malfunction is a factor in nearly nine of ten home fires involving wiring and related equipment (Figure 13), but just less than half of those involving lamps, bulbs, or lighting (Figure 14). Approximately three in ten of the latter fires are caused by lamps, bulbs, or lighting being too close to combustible material.

In home fires involving cords and plugs, in addition to the fires involving electrical failure or malfunction (three-quarters of the total), overloaded equipment contributed to just over one in ten fires, as shown in Figure 15.

Electrical failure or malfunction also accounted for a smaller share of home fires involving transformers and power supplies (65%) than those involving wiring and related equipment or cords and plugs, but higher shares of these fires involved mechanical failures or malfunctions (9%), heat sources too close to combustibles (8%), and equipment overloaded (6%), as shown in Figure 16.

Figure 13. Factors Contributing to the Ignition of Home Fires Involving Wiring and Related Equipment, 2012-2016

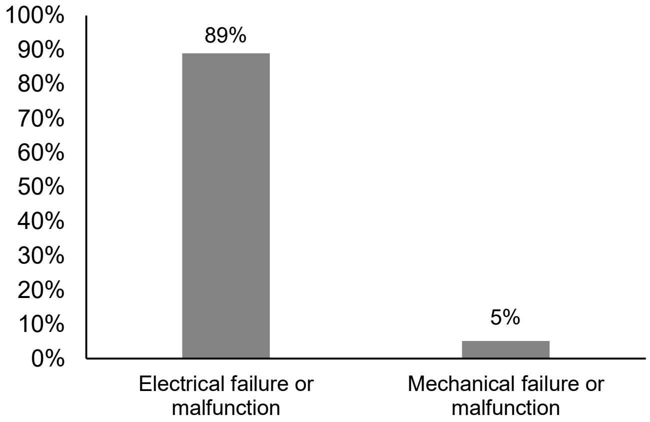


Figure 14. Factors Contributing to the Ignition of Home Fires Involving Lamps, Bulbs, or Lighting, 2012-2016

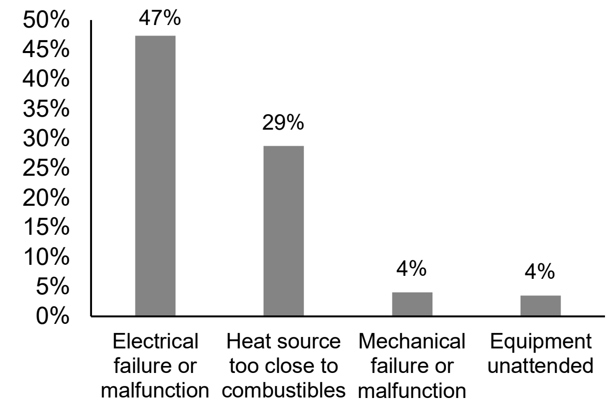


Figure 15. Factors Contributing to the Ignition of Home Fires Involving Cords or Plugs, 2012-2016

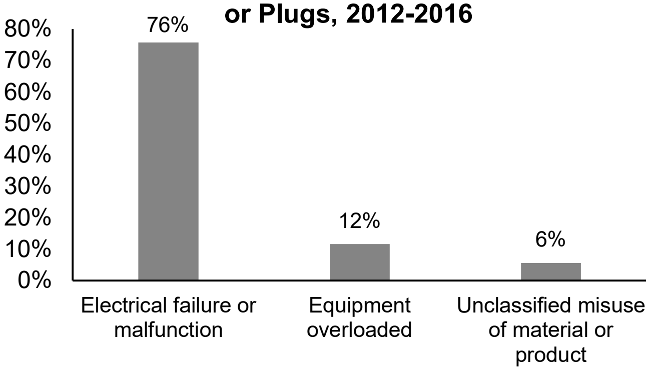
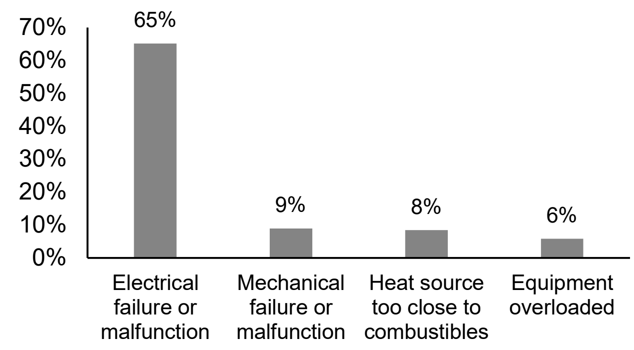


Figure 16. Factors Contributing to the Ignition of Home Fires Involving Transformers and Power Supplies 2012-2016

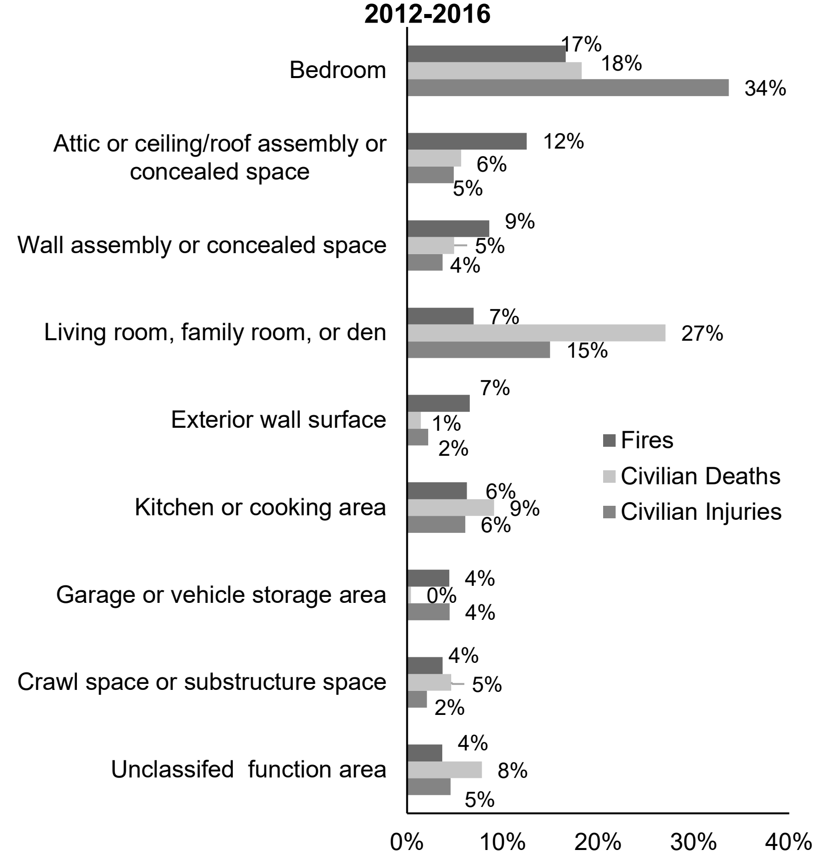


Area of Origin in Home Fires Involving Electrical Distribution or Lighting Equipment

Almost one in five home fires (17%) involving electrical distribution or lighting equipment originated in a bedroom, with another 12% originating in an attic or ceiling/roof assembly or concealed space. Fires originating in a living room, family room, or den accounted for a disproportionately large share of civilian deaths, while those originating in a bedroom accounted for a disproportionately large share of civilian injuries. Fires originating in concealed spaces, such as attics or ceiling roof assemblies, wall assemblies, and crawl spaces, were also common.

Although the bedroom is the leading area of origin for overall electrical distribution and lighting equipment home fires, there are some differences by type of equipment. Figure 18 shows that fires involving wiring and related equipment, which accounts for the great majority of these fires (67%), are most likely to originate in the attic or ceiling/roof assembly or concealed space (16% of total), followed by bedrooms (13%), and wall assemblies or concealed spaces (12%). Hence, over two of five (42%) of the wiring and related equipment fires originate in areas where they are unlikely to be immediately detected.

Figure 17. Area of Origin in Home Fires Involving Electrical Distribution or Lighting Equipment 2012-2016



The bedroom is the leading area of origin in home fires involving lamps, bulbs, or lighting, cords or plugs, and transformers and power supplies. As Figure 19 shows, lamp, bulb, and lighting fires can also originate in areas that may not be readily detected, including attics or ceiling/roof assemblies or concealed spaces, exterior wall surfaces, ceilings/floor assemblies or concealed spaces, and exterior balconies.

Figure 18. Area of Origin in Home Fires Involving Wiring and Related Equipment, 2012-2016

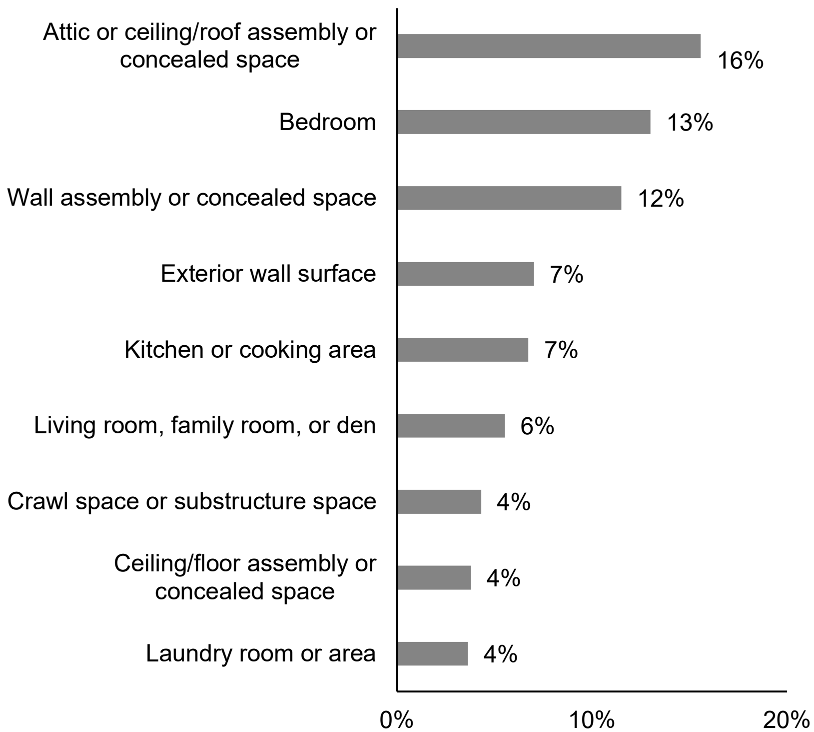


Figure 20 indicates that fires involving cords and plugs are less likely to originate in concealed areas, with nearly half of the fires originating in either the bedroom, living room, family room, or den.

Of home fires involving electrical distribution or lighting equipment that originated in a garage or vehicle storage area, the largest share were those involving transformers and power cords, as shown in Figure 21.

Figure 19. Area of Origin in Home Fires Involving Lamps, Bulbs, or Lighting 2012-2016

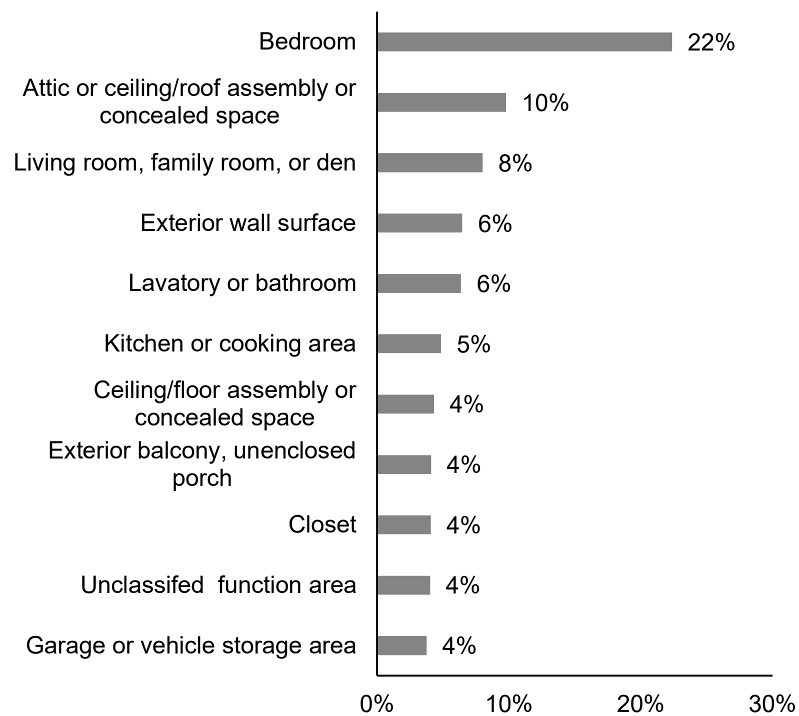


Figure 20. Area of Origin in Home Fires Involving Cords or Plugs, 2012-2016

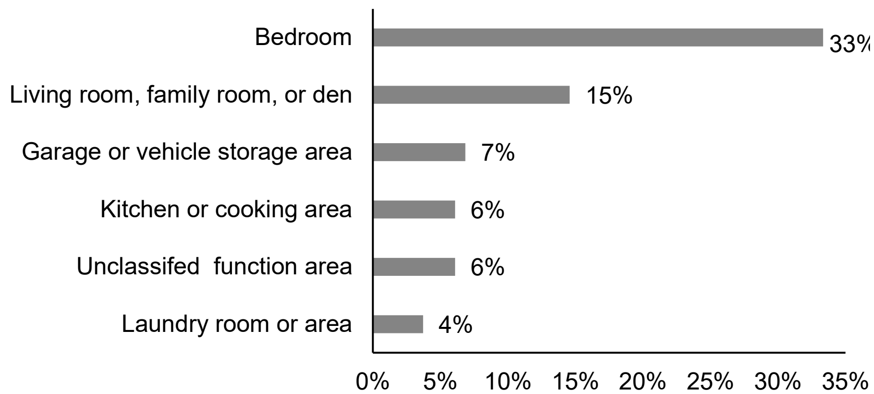
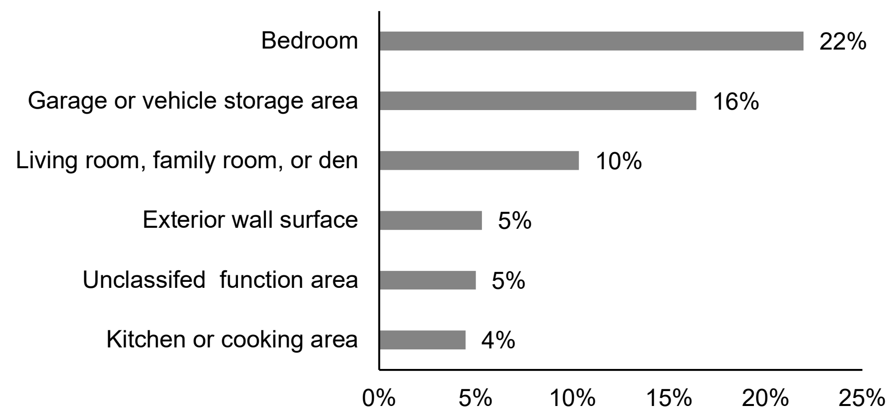


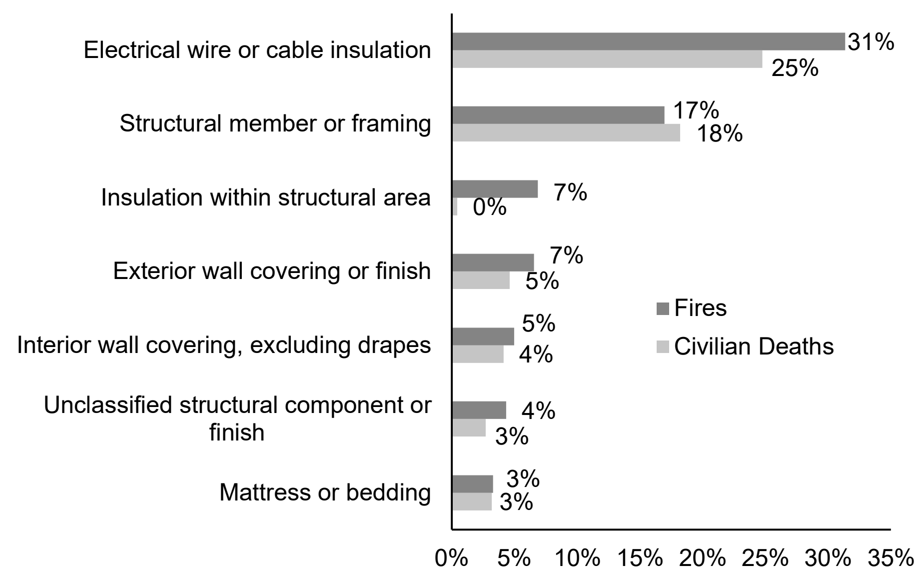
Figure 21. Area of Origin in Home Fires Involving Transformers and Power Supplies, 2012-2016



Home Fires Involving Electrical Distribution and Lighting Equipment by Item First Ignited

The item that first ignited in home fires involving electrical distribution and lighting equipment was electrical wire or cable insulation (31% of fires). Two of five fires (40%) involving electrical distribution and lighting equipment first ignited an item that was part of the building (i.e., structural member or framing, insulation within building area, exterior or interior wall cover or finish, unclassified structural component or finish). See Figure 22. This indicates the need to be attentive to hidden electrical hazards, including electrical distribution and lighting equipment that is installed close to combustible structural elements.

Figure 22. Item First Ignited in Home Fires Involving Electrical Distribution or Lighting Equipment 2012-2016



Methodology

The statistics in this analysis are estimates derived from the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association's (NFPA's) annual survey of U.S. fire departments. Fires reported to federal or state fire departments or industrial fire brigades are not included in these estimates. Only civilian (non-firefighter) casualties are discussed in this analysis.

NFPA's fire department experience survey provides estimates of the big picture. NFIRS is a voluntary system through which participating fire departments report detailed factors about the fires to which they respond. To compensate for fires reported to local fire departments but not captured in NFIRS, scaling ratios are calculated and then applied to the NFIRS database using the formula below.

$$\frac{\text{NFPA's fire experience survey projections}}{\text{NFIRS totals}}$$

The NFIRS data element of Factors Contributing to Ignition was used to identify and estimate electrical failures or malfunctions. In this field, the code "none" is treated as an unknown and allocated proportionally. Multiple entries are allowed in this field. Percentages are calculated on the total number of fires, not entries, resulting in sums greater than 100%. Any fire in which no factor contributing to ignition was entered was treated as unknown.

Entries in the "electrical failure, malfunction" category (factor contributing to ignition 30-39) were grouped together in this analysis.

This category includes:

31. Water-caused short circuit arc
32. Short-circuit arc from mechanical damage
33. Short-circuit arc from defective or worn insulation
34. Unspecified short circuit arc
35. Arc from faulty contact or broken connector, including broken power lines and loose connections
36. Arc or spark from operating equipment, switch, or electric fence
37. Fluorescent light ballast
30. Electrical failure or malfunction, other

NFIRS data element Equipment Involved in Ignition (EII) codes 200-263 were used to identify and estimate electrical distribution and lighting equipment as identified by NFIRS.

NFPA noticed that many fires in which EII was coded as None (NNN) have had other causal factors that indicated equipment was a factor or were completely unknown. To compensate, NFPA treats fires in which EII = NNN and heat source is not in the range of 40-99 as an additional unknown.

To allocate unknown data for EII, known data is multiplied by

$$\frac{\text{All fires}}{\text{(All fires – blank – undetermined – [fires in which EII =NNN and heat source <>40-99])}}$$

In addition, fires and losses associated with code EII 200, "electrical distribution, lighting, and power transfer, other," were allocated proportionally across specific kitchen and equipment codes EII codes, 211-263. Equipment that is totally unclassified (EII code 000) was not allocated further. Unfortunately, equipment that is truly different is erroneously assigned to other categories.

Because of the large number of specific EII codes, most have been grouped into more general categories.

Code Grouping	EII Code	NFIRS definition
Fixed wiring and related equipment	210	Unclassified electrical wiring
	211	Electrical power or utility line
	212	Electrical service supply wires from utility
	213	Electric meter or meter box
	214	Wiring from meter box to circuit breaker
	215	Panel board, switch board or circuit breaker board
	216	Electrical branch circuit
	217	Outlet or receptacle
	218	Wall switch
	219	Ground fault interrupter
Transformers and power supplies	221	Distribution-type transformer
	222	Overcurrent, disconnect equipment
	223	Low-voltage transformer
	224	Generator
	225	Inverter
	226	Uninterrupted power supply (UPS)
	227	Surge protector
	228	Battery charger or rectifier
	229	Battery (all types)
Lamp, bulb or lighting	230	Unclassified lamp or lighting
	231	Lamp-tabletop, floor or desk
	232	Lantern or flashlight
	233	Incandescent lighting fixture
	234	Fluorescent light fixture or ballast
	235	Halogen light fixture or lamp
	236	Sodium or mercury vapor light fixture or lamp
	237	Work or trouble light
	238	Light bulb
	241	Nightlight
	242	Decorative lights – line voltage
	243	Decorative or landscape lighting – low voltage
	244	Sign
Cord or plug	260	Unclassified cord or plug
	261	Power cord or plug, detachable from appliance
	262	Power cord or plug-permanently attached
	263	Extension cord

For more information on the methodology used for this report see, *How NFPA's National Estimates Are Calculated for Home Structure Fires.*

Acknowledgements

The National Fire Protection Association thanks all the fire departments and state fire authorities that participate in the National Fire Incident Reporting System (NFIRS) and the annual NFPA fire experience survey. These firefighters are the original sources of the detailed data that make this analysis possible. Their contributions allow us to estimate the size of the fire problem.

We are also grateful to the U.S. Fire Administration for its work in developing, coordinating, and maintaining NFIRS.

To learn more about research at NFPA visit www.nfpa.org/research.
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NFPA No. USS37

RESEARCH

Home Electrical Fires
Supporting Tables

March 2019

Richard Campbell

Home Electrical Fires: Supporting Tables

The tables in this document are a companion to the report of the same name. Firefighter deaths and injuries are excluded from this analysis.

Most tables, with the exception of fires by year, show estimates of 2012-2016 annual averages. Estimates were derived from the U.S. Fire Administration's National Fire Incident Reporting System (NFIRS) and NFPA's annual fire department experience survey and include proportional shares of unknown or missing data. Fires are rounded to the nearest 100, deaths and injuries are rounded to the nearest ten, and property loss is rounded to the nearest million dollars. Inflation adjustments were made only for the trend table. Percentages were calculated on unrounded estimates.

NFIRS 5.0 includes a category of structure fires collectively referred to as "confined fires," identified by NFIRS incident type codes 113-118. These include confined cooking fires, confined chimney or flue fires, confined trash fires, and confined fuel burner or boiler fires. Losses are generally minimal in these fires, which by definition, are assumed to have been limited to the object of origin. Although causal data is not required for these fires, it is sometimes present. To obtain estimates of fires, unknown data for confined and non-confined fires were analyzed separately and the results summed.

For more information on how these estimates were calculated, please see full report and *How NFPA's National Estimates Are Calculated for Home Structure Fires*

List of Tables

Table 1.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition, by Year
Structure Fires Reported to U.S. Fire Departments

Year	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions) As Reported		In 2016 Dollars	
1980	75,000		471		1,500		$426		$1,227	
1981	70,000		477		1,670		$409		$1,064	
1982	66,500		405		1,760		$450		$1,104	
1983	63,700		463		1,750		$530		$1,260	
1984	63,960		328		1,440		$551		$1,255	
1985	67,000		451		1,600		$603		$1,326	
1986	65,200		639		1,640		$600		$1,298	
1987	65,500		562		1,880		$616		$1,285	
1988	68,500		545		2,190		$745		$1,494	
1989	64,300		590		2,000		$693		$1,325	
1990	62,300		435		2,000		$737		$1,338	
1991	65,700		393		2,370		$981		$1,706	
1992	62,800		486		2,270		$727		$1,228	
1993	65,500		485		2,540		$936		$1,535	
1994	64,300		518		2,160		$835		$1,336	
1995	61,800		582		2,110		$867		$1,348	
1996	63,400		593		2,070		$1,031		$1,559	
1997	60,600		380		1,790		$980		$1,447	
1998	57,900		479		1,820		$943		$1,372	
1999	46,000	(44,300)	387	(387)	1,620	(1,620)	$917	($917)	$1,319	($1,319)
2000	49,200	(46,400)	348	(348)	1,670	(1,670)	$1,085	($1,082)	$1,512	($1,508)
2001	53,600	(49,200)	548	(548)	1,680	(1,630)	$1,237	($1,235)	$1,676	($1,673)
2002	54,300	(49,300)	278	(278)	1,290	(1,290)	$1,183	($1,181)	$1,577	($1,575)
2003	51,100	(45,200)	639	(639)	1,350	(1,350)	$1,283	($1,281)	$1,674	($1,671)
2004	52,500	(46,400)	614	(614)	1,500	(1,490)	$1,360	($1,357)	$1,729	($1,725)
2005	50,100	(44,500)	438	(438)	1,360	(1,340)	$1,530	($1,522)	$1,879	($1,869)
2006	50,500	(45,100)	333	(333)	1,370	(1,360)	$1,390	($1,389)	$1,653	($1,652)
2007	50,700	(45,500)	451	(451)	1,640	(1,630)	$1,228	($1,227)	$1,419	($1,418)
2008	49,400	(44,800)	519	(519)	1,350	(1,320)	$1,633	($1,632)	$1,821	($1,820)
2009	44,800	(39,500)	472	(472)	1,500	(1,470)	$1,644	($1,643)	$1,837	($1,836)
2010	46,500	(42,000)	419	(419)	1,520	(1,510)	$1,507	($1,506)	$1,659	($1,658)
2011	47,700	(42,600)	418	(418)	1,570	(1,570)	$1,434	($1,432)	$1,530	($1,528)
2012	40,900	(35,300)	359	(359)	1,410	(1,390)	$1,310	($1,309)	$1,370	($1,368)
2013	46,000	(39,900)	419	(419)	1,220	(1,200)	$1,370	($1,368)	$1,410	($1,408)
2014	48,100	(41,200)	538	(538)	1,280	(1,270)	$1,387	($1,385)	$1,404	($1,402)
2015	47,100	(40,700)	435	(435)	1,240	(1,240)	$1,463	($1,460)	$1,480	($1,478)
2016	45,300	(38,700)	480	(480)	1,260	(1,230)	$1,005	($1,003)	$1,005	($1,003)

Table 1.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition, by Year
Structure Fires Reported to U.S. Fire Departments (Continued)

Note: Figures in parentheses exclude confined fires, which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported to only federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of a small number of unusually serious fires. Fires are rounded to the nearest hundred, civilian deaths to the nearest one, civilian injuries to the nearest ten, and direct property damage to the nearest million dollars. Figures for 1980-1998 are based on ignition factor 54-55 and reflect a proportional share of home fires with ignition factor unknown, unreported, none, or blank. Figures for 1999 and later years reflect a proportional share of home fires with factor contributing to ignition as unknown, reported, none, or blank. Because of low participation in NFIRS Version 5.0 during 1999-2001, estimates for these years are highly uncertain and must be used with caution. Inflation adjustment to 2014 dollars is calculated using the Consumer Price Index. Home fire property damage figures for 1991 are inflated by estimation problems related to the Oakland fire storm.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 2.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition, by Month
2012-2016 Annual Averages

Month	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
January	5,020	(11%)	70	(16%)	140	(11%)	$160	(13%)
February	4,040	(9%)	40	(8%)	110	(9%)	$125	(10%)
March	3,720	(8%)	40	(9%)	130	(10%)	$110	(9%)
April	3,360	(7%)	40	(9%)	100	(8%)	$102	(8%)
May	3,380	(8%)	30	(6%)	100	(8%)	$90	(7%)
June	3,500	(8%)	20	(5%)	100	(8%)	$96	(7%)
July	3,750	(8%)	40	(8%)	90	(7%)	$111	(9%)
August	3,330	(7%)	20	(5%)	110	(9%)	$89	(7%)
September	3,030	(7%)	30	(6%)	70	(6%)	$77	(6%)
October	3,220	(7%)	40	(9%)	80	(7%)	$85	(7%)
November	4,030	(9%)	20	(6%)	90	(7%)	$110	(9%)
December	4,510	(10%)	50	(12%)	120	(9%)	$124	(10%)
Total	44,880	(100%)	440	(100%)	1,250	(100%)	$1,278	(100%)

Note: Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 3.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition, by Day of Week
2012-2016 Annual Averages

Day of Week	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Sunday	6,480	(14%)	50	(11%)	200	(16%)	$177	(14%)
Monday	6,400	(14%)	80	(19%)	150	(12%)	$189	(15%)
Tuesday	6,370	(14%)	40	(10%)	210	(16%)	$177	(14%)
Wednesday	6,300	(14%)	70	(16%)	160	(12%)	$180	(14%)
Thursday	6,400	(14%)	60	(13%)	160	(13%)	$189	(15%)
Friday	6,310	(14%)	70	(15%)	200	(16%)	$182	(14%)
Saturday	6,620	(15%)	70	(17%)	180	(14%)	$184	(14%)
Totals	44,880	(100%)	440	(100%)	1,250	(100%)	$1,278	(100%)

Note: Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 4.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition, by Time of Day
2012-2016 Annual Averages

Time of Day	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Midnight-12:59 a.m.	1,390	(3%)	20	(6%)	50	(4%)	$49	(4%)
1:00-1:59 a.m.	1,220	(3%)	50	(11%)	70	(5%)	$46	(4%)
2:00-2:59 a.m.	1,210	(3%)	40	(8%)	60	(5%)	$49	(4%)
3:00-3:59 a.m.	1,170	(3%)	40	(9%)	70	(6%)	$58	(5%)
4:00-4:59 a.m.	1,100	(2%)	30	(7%)	50	(4%)	$43	(3%)
5:00-5:59 a.m.	1,060	(2%)	30	(6%)	60	(5%)	$40	(3%)
6:00-6:59 a.m.	1,240	(3%)	30	(6%)	50	(4%)	$39	(3%)
7:00-7:59 a.m.	1,440	(3%)	30	(6%)	50	(4%)	$46	(4%)
8:00-8:59 a.m.	1,570	(4%)	10	(3%)	50	(4%)	$44	(3%)
9:00-9:59 a.m.	1,790	(4%)	10	(2%)	40	(3%)	$50	(4%)
10:00-10:59 a.m.	1,860	(4%)	20	(4%)	50	(4%)	$47	(4%)
11:00-11:59 a.m.	2,060	(5%)	10	(2%)	40	(3%)	$61	(5%)
12:00-12:59 p.m.	2,200	(5%)	10	(2%)	50	(4%)	$61	(5%)
1:00-1:59 p.m.	2,220	(5%)	0	(1%)	40	(3%)	$63	(5%)
2:00-2:59 p.m.	2,270	(5%)	10	(1%)	40	(3%)	$59	(5%)
3:00-3:59 p.m.	2,450	(5%)	10	(1%)	50	(4%)	$66	(5%)
4:00-4:59 p.m.	2,570	(6%)	10	(2%)	60	(5%)	$68	(5%)
5:00-5:59 p.m.	2,730	(6%)	10	(3%)	50	(4%)	$58	(5%)
6:00-6:59 p.m.	2,840	(6%)	10	(3%)	70	(5%)	$62	(5%)
7:00-7:59 p.m.	2,600	(6%)	10	(2%)	50	(4%)	$56	(4%)
8:00-8:59 p.m.	2,320	(5%)	10	(2%)	70	(6%)	$56	(4%)
9:00-9:59 p.m.	2,130	(5%)	10	(3%)	40	(3%)	$51	(4%)
10:00-10:59 p.m.	1,840	(4%)	20	(5%)	50	(4%)	$55	(4%)
11:00-11:59 p.m.	1,600	(4%)	10	(2%)	50	(4%)	$51	(4%)
Total	44,880	(100%)	440	(100%)	1,250	(100%)	$1,278	(100%)

Note: Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 5.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition by Equipment Involved in Ignition, 2012-2016 Annual Averages

Equipment Involved	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Electrical distribution and lighting equipment	**22,620**	**(50%)**	**310**	**(71%)**	**700**	**(56%)**	**$786**	**(62%)**
Wiring and related equipment	17,600	(39%)	190	(43%)	440	(35%)	$588	(46%)
Cord or plug	2,080	(5%)	100	(23%)	130	(11%)	$85	(7%)
Lamp, bulb or lighting	1,850	(4%)	10	(3%)	70	(5%)	$64	(5%)
Transformers and power supplies	1,080	(2%)	10	(2%)	60	(5%)	$49	(4%)
Cooking equipment	**6,780**	**(15%)**	**10**	**(1%)**	**110**	**(9%)**	**$43**	**(3%)**
Confined cooking fire	4,820	(11%)	0	(0%)	10	(1%)	$1	(0%)
Range with or without oven, cooking surface	960	(2%)	0	(1%)	50	(4%)	$18	(1%)
Microwave oven	430	(1%)	0	(0%)	20	(1%)	$10	(1%)
Portable cooking or warming equipment	230	(1%)	0	(0%)	20	(2%)	$8	(1%)
Other known cooking equipment	340	(1%)	0	(0%)	10	(1%)	$6	(1%)
Heating equipment	**3,830**	**(9%)**	**30**	**(8%)**	**60**	**(5%)**	**$80**	**(6%)**
Fixed or portable space heater	1,300	(3%)	30	(6%)	40	(3%)	$46	(4%)
Water heater	1,020	(2%)	0	(0%)	10	(1%)	$16	(1%)
Confined fuel burner or boiler fire	730	(2%)	0	(0%)	0	(0%)	$0	(0%)
Central heat	350	(1%)	0	(0%)	0	(0%)	$9	(1%)
Other known heating equipment	430	(1%)	7	(2%)	5	(0%)	$9	(1%)
Fan	**2,480**	**(6%)**	**10**	**(3%)**	**70**	**(6%)**	**$62**	**(5%)**
Air conditioner	**1,460**	**(3%)**	**20**	**(5%)**	**60**	**(5%)**	**$41**	**(3%)**
Clothes dryer	**1,450**	**(3%)**	**0**	**(0%)**	**30**	**(3%)**	**$32**	**(2%)**
No equipment involved in ignition	**890**	**(2%)**	**10**	**(3%)**	**10**	**(1%)**	**$56**	**(4%)**
Unclassified equipment involved in ignition	**800**	**(2%)**	**0**	**(1%)**	**30**	**(2%)**	**$36**	**(3%)**
Refrigerator or refrigerator/freezer	**560**	**(1%)**	**10**	**(1%)**	**40**	**(3%)**	**$21**	**(2%)**
Dishwasher	**400**	**(1%)**	**0**	**(0%)**	**10**	**(1%)**	**$9**	**(1%)**
Television	**390**	**(1%)**	**0**	**(0%)**	**20**	**(2%)**	**$15**	**(1%)**
Confined incinerator overload or malfunction fire	**290**	**(1%)**	**0**	**(0%)**	**0**	**(0%)**	**$0**	**(0%)**
Contained trash or rubbish fire	**280**	**(1%)**	**0**	**(0%)**	**0**	**(0%)**	**$0**	**(0%)**
Other known equipment involved in ignition	**2,650**	**(6%)**	**30**	**(7%)**	**100**	**(8%)**	**$96**	**(8%)**
Total	**44,880**	**(100%)**	**440**	**(100%)**	**1,250**	**(100%)**	**$1,278**	**(100%)**

Note: Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 6.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition by Cause of Ignition, 2012-2016 Annual Averages

Cause of Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Failure of equipment or heat source	23,500	(52%)	190	(43%)	590	(47%)	$536	(42%)
Non-confined	19,370	(43%)	190	(43%)	590	(47%)	$535	(42%)
Confined	4,130	(9%)	0	(0%)	0	(0%)	$1	(0%)
Unintentional	20,680	(46%)	250	(57%)	650	(52%)	$724	(57%)
Non-confined	18,640	(42%)	250	(57%)	640	(51%)	$723	(57%)
Confined	2,050	(5%)	0	(0%)	10	(1%)	$1	(0%)
Act of nature	369	(1%)	0	(0%)	0	(0%)	$9	(1%)
Non-confined	341	(2%)	0	(0%)	0	(1%)	$9	(2%)
Confined	28	(4%)	0	(0%)	0	(0%)	$0	(3%)
Other causes	323	(1%)	0	(0%)	10	(1%)	$9	(1%)
Non-confined	250	(1%)	0	(1%)	10	(1%)	$9	(2%)
Confined	72	(11%)	0	(0%)	0	(0%)	$0	(3%)
Total	44,880	(100%)	440	(100%)	1,250	(100%)	$1,278	(100%)
Non-confined	38,600	(86%)	440	(100%)	1,230	(98%)	$1,276	(100%)
Confined	6,270	(14%)	0	(0%)	10	(1%)	$2	(0%)

Note: Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 7.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition, by Heat Source
2012-2016 Annual Averages

Heat Source	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Arcing	27,290	(61%)	300	(69%)	770	(62%)	$785	(61%)
Non-confined	24,530	(55%)	300	(69%)	770	(61%)	$784	(61%)
Confined	2,760	(6%)	0	(0%)	0	(0%)	$1	(0%)
Unclassified heat from powered equipment	6,750	(15%)	50	(12%)	210	(17%)	$170	(13%)
Non-confined	5,300	(12%)	50	(12%)	210	(17%)	$170	(13%)
Confined	1,450	(3%)	0	(0%)	10	(1%)	$0	(0%)
Radiated or conducted heat from operating equipment	2,460	(5%)	20	(5%)	70	(6%)	$54	(4%)
Non-confined	1,770	(4%)	20	(5%)	70	(5%)	$54	(4%)
Confined	690	(2%)	0	(0%)	0	(0%)	$0	(0%)
Spark, ember or flame from operating equipment	2,460	(5%)	10	(3%)	80	(6%)	$61	(5%)
Non-confined	1,810	(4%)	10	(3%)	80	(6%)	$61	(5%)
Confined	650	(1%)	0	(0%)	0	(0%)	$0	(0%)
Unclassified heat source	2,280	(5%)	30	(6%)	60	(5%)	$88	(7%)
Non-confined	1,980	(4%)	30	(6%)	60	(5%)	$88	(7%)
Confined	300	(1%)	0	(0%)	0	(0%)	$0	(0%)
Unclassified hot or smoldering object	1,970	(4%)	20	(4%)	30	(2%)	$68	(5%)
Non-confined	1,780	(4%)	20	(4%)	20	(2%)	$68	(5%)
Confined	180	(0%)	0	(0%)	0	(0%)	$0	(0%)
Other known heat source	1,680	(4%)	10	(1%)	30	(2%)	$51	(4%)
Non-confined	1,430	(3%)	10	(1%)	30	(2%)	$51	(4%)
Confined	240	(1%)	0	(0%)	0	(0%)	$0	(0%)
Total	44,880	(100%)	440	(100%)	1,250	(100%)	$1,278	(100%)
Non-confined	38,600	(86%)	440	(100%)	1,230	(99%)	$1,276	(100%)
Confined	6,270	(14%)	0	(0%)	10	(1%)	$2	(0%)

Note: Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 8.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition by Area of Origin, 2012-2016 Annual Averages

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Kitchen or cooking area	9,000	(20%)	40	(9%)	170	(14%)	$114	(9%)
Non-confined	4,360	(10%)	40	(9%)	160	(13%)	$113	(9%)
Confined	4,630	(10%)	0	(0%)	10	(1%)	$1	(0%)
Bedroom	5,260	(12%)	60	(14%)	310	(25%)	$190	(15%)
Non-confined	5,210	(12%)	60	(14%)	310	(25%)	$190	(15%)
Confined	50	(0%)	0	(0%)	0	(0%)	$0	(0%)
Attic or ceiling/roof assembly or concealed space	4,520	(10%)	20	(5%)	70	(6%)	$159	(12%)
Non-confined	4,490	(10%)	20	(5%)	70	(6%)	$159	(12%)
Confined	30	(0%)	0	(0%)	0	(0%)	$0	(0%)
Wall assembly or concealed space	2,760	(6%)	20	(5%)	40	(3%)	$76	(6%)
Non-confined	2,740	(6%)	20	(5%)	40	(3%)	$76	(6%)
Confined	20	(0%)	0	(0%)	0	(0%)	$0	(0%)
Common room, living room, family room, lounge or den	2,450	(5%)	120	(27%)	180	(14%)	$120	(9%)
Non-confined	2,390	(5%)	120	(27%)	180	(14%)	$120	(9%)
Confined	50	(0%)	0	(0%)	0	(0%)	$0	(0%)
Laundry room or area	2,300	(5%)	10	(2%)	60	(5%)	$46	(4%)
Non-confined	2,170	(5%)	10	(2%)	50	(4%)	$46	(4%)
Confined	130	(0%)	0	(0%)	0	(0%)	$0	(0%)
Lavatory, bathroom, locker room or check room	2,120	(5%)	10	(2%)	40	(3%)	$39	(3%)
Non-confined	2,080	(5%)	10	(2%)	40	(3%)	$39	(3%)
Confined	40	(0%)	0	(0%)	0	(0%)	$0	(0%)
Exterior wall surface	1,810	(4%)	10	(2%)	20	(2%)	$39	(3%)
Non-confined	1,790	(4%)	10	(2%)	20	(2%)	$39	(3%)
Confined	20	(0%)	0	(0%)	0	(0%)	$0	(0%)
Garage or vehicle storage area	1,590	(4%)	10	(2%)	50	(4%)	$99	(8%)
Non-confined	1,520	(3%)	10	(2%)	50	(4%)	$99	(8%)
Confined	70	(0%)	0	(0%)	0	(0%)	$0	(0%)
Unclassified function area	1,370	(3%)	30	(7%)	70	(6%)	$56	(4%)
Non-confined	1,340	(3%)	30	(7%)	70	(6%)	$56	(4%)
Confined	30	(0%)	0	(0%)	0	(0%)	$0	(0%)

Table 8.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition by Area of Origin, 2012-2016 Annual Averages (Continued)

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Crawl space or substructure space	1,360	(3%)	10	(2%)	20	(2%)	$42	(3%)
Non-confined	1,310	(3%)	10	(2%)	20	(2%)	$42	(3%)
Confined	50	(0%)	0	(0%)	0	(0%)	$0	(0%)
Ceiling/floor assembly or concealed space	1,200	(3%)	20	(5%)	20	(2%)	$47	(4%)
Non-confined	1,190	(3%)	20	(5%)	20	(2%)	$47	(4%)
Confined	10	(0%)	0	(0%)	0	(0%)	$0	(0%)
Heating equipment room	1,060	(2%)	0	(0%)	10	(1%)	$16	(1%)
Non-confined	740	(2%)	0	(0%)	10	(1%)	$16	(1%)
Confined	330	(1%)	0	(0%)	0	(0%)	$0	(0%)
Closet	740	(2%)	0	(0%)	20	(2%)	$20	(2%)
Non-confined	680	(2%)	0	(0%)	20	(2%)	$20	(2%)
Confined	60	(0%)	0	(0%)	0	(0%)	$0	(0%)
Unclassified structural area	720	(2%)	10	(2%)	20	(2%)	$31	(2%)
Non-confined	680	(2%)	10	(2%)	20	(2%)	$31	(2%)
Confined	40	(0%)	0	(0%)	0	(0%)	$0	(0%)
Confined chimney or flue fire	140	(0%)	0	(0%)	0	(0%)	$0	(0%)
Other known area of origin	6,500	(14%)	50	(11%)	160	(13%)	$184	(14%)
Non-confined	5,900	(13%)	50	(11%)	160	(13%)	$183	(14%)
Confined	600	(1%)	0	(0%)	0	(0%)	$0	(0%)
Total	44,880	(100%)	440	(100%)	1,250	(100%)	$1,278	(100%)
Non-confined	38,600	(86%)	440	(100%)	1,230	(98%)	$1,276	(100%)
Confined	6,270	(14%)	0	(0%)	10	(1%)	$2	(0%)

Note: Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 9.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition, by Item First Ignited, 2012-2016 Annual Averages

Item First Ignited	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Electrical wire or cable insulation	14,120	(31%)	110	(26%)	360	(28%)	$307	(24%)
Non-confined	12,410	(28%)	110	(26%)	350	(28%)	$306	(24%)
Confined	1,710	(4%)	0	(0%)	0	(0%)	$1	(0%)
Structural member or framing	5,950	(13%)	80	(18%)	140	(11%)	$266	(21%)
Non-confined	5,950	(13%)	80	(18%)	140	(11%)	$266	(21%)
Confined	10	(0%)	0	(0%)	0	(0%)	$0	(0%)
Appliance housing or casing	4,050	(9%)	10	(2%)	80	(6%)	$48	(4%)
Non-confined	2,120	(5%)	10	(2%)	80	(6%)	$47	(4%)
Confined	1,930	(4%)	0	(0%)	0	(0%)	$1	(0%)
Insulation within structural area	2,510	(6%)	0	(1%)	30	(2%)	$58	(5%)
Non-confined	2,490	(6%)	0	(1%)	30	(2%)	$58	(5%)
Confined	20	(0%)	0	(0%)	0	(0%)	$0	(0%)
Interior wall covering, excluding drapes	2,180	(5%)	20	(5%)	60	(5%)	$88	(7%)
Non-confined	2,150	(5%)	20	(5%)	60	(5%)	$88	(7%)
Confined	30	(0%)	0	(0%)	0	(0%)	$0	(0%)
Unclassified item first ignited	2,010	(4%)	0	(0%)	40	(4%)	$35	(3%)
Non-confined	1,390	(3%)	0	(0%)	40	(4%)	$35	(3%)
Confined	620	(1%)	0	(0%)	0	(0%)	$0	(0%)
Exterior wall covering or finish	2,000	(4%)	20	(4%)	30	(2%)	$60	(5%)
Non-confined	1,980	(4%)	20	(4%)	30	(2%)	$60	(5%)
Confined	20	(0%)	0	(0%)	0	(0%)	$0	(0%)
Unclassified structural component or finish	1,500	(3%)	20	(4%)	50	(4%)	$62	(5%)
Non-confined	1,490	(3%)	20	(4%)	50	(4%)	$62	(5%)
Confined	10	(0%)	0	(0%)	0	(0%)	$0	(0%)
Cooking materials, including food	1,300	(3%)	0	(0%)	10	(1%)	$3	(0%)
Non-confined	180	(0%)	0	(0%)	10	(1%)	$3	(0%)
Confined	1,120	(2%)	0	(0%)	10	(0%)	$0	(0%)
Interior ceiling cover or finish	970	(2%)	10	(1%)	20	(1%)	$41	(3%)
Non-confined	970	(2%)	10	(1%)	20	(1%)	$41	(3%)
Confined	0	(0%)	0	(0%)	0	(0%)	$0	(0%)
Mattress or bedding	940	(2%)	20	(3%)	80	(6%)	$32	(3%)
Non-confined	930	(2%)	20	(3%)	80	(6%)	$32	(3%)
Confined	10	(0%)	0	(0%)	0	(0%)	$0	(0%)

Table 9.
Home Fires Involving Electrical Failure or Malfunction as Factor Contributing to Ignition, by Item First Ignited, 2012-2016 Annual Averages (Continued)

Item First Ignited	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Floor covering rug, carpet, or mat	730	(2%)	30	(6%)	40	(3%)	$26	(2%)
Non-confined	730	(2%)	30	(6%)	40	(3%)	$26	(2%)
Confined	0	(0%)	0	(0%)	0	(0%)	$0	(0%)
Other known item first ignited	6,620	(15%)	130	(30%)	310	(25%)	$250	(20%)
Non-confined	5,820	(13%)	130	(30%)	310	(25%)	$250	(20%)
Confined	800	(2%)	0	(0%)	10	(0%)	$0	(0%)
Total	44,880	(100%)	440	(100%)	1,250	(100%)	$1,278	(100%)
Non-confined	38,600	(86%)	440	(100%)	1,230	(99%)	$1,276	(100%)
Confined	6,270	(14%)	0	(0%)	10	(1%)	$2	(0%)

Note: Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 10.
Home Fires Involving Electrical Distribution and Lighting Equipment by Year
Structure Fires Reported to U.S. Fire Departments

				Direct Property Damage (in Millions)	
Year	**Fires**	**Civilian Deaths**	**Civilian Injuries**	**As Reported**	**In 2016 Dollars**
1980	68,400	523	1,650	$493	$1,436
1981	62,300	553	1,500	$459	$1,209
1982	60,900	408	1,820	$519	$1,288
1983	56,700	500	1,570	$548	$1,318
1984	54,800	445	1,520	$549	$1,265
1985	56,500	470	1,400	$720	$1,602
1986	54,300	717	1,420	$597	$1,307
1987	51,600	522	1,580	$512	$1,080
1988	53,400	439	1,720	$715	$1,451
1989	47,900	610	1,500	$642	$1,242
1990	47,400	438	1,540	$683	$1,255
1991	49,000	354	1,890	$958	$1,686
1992	46,400	403	1,770	$617	$1,055
1993	48,900	418	1,900	$818	$1,357
1994	48,300	464	1,640	$714	$1,156
1995	47,200	489	1,650	$775	$1,219
1996	47,000	470	1,560	$839	$1,284
1997	46,600	352	1,580	$865	$1,292
1998	44,500	363	1,370	$843	$1,241
1999	34,800	183	530	$806	$1,160
2000	26,600	122	1,130	$631	$879
2001	26,200	436	1,030	$717	$971
2002	22,700	166	700	$593	$791
2003	19,200	320	600	$698	$911
2004	19,400	292	840	$623	$792
2005	20,800	498	1,060	$858	$1,053
2006	25,100	366	840	$776	$923
2007	25,200	274	1,050	$663	$766
2008	24,700	515	880	$964	$1,075
2009	21,000	318	1,000	$935	$1,045
2010	19,900	242	980	$774	$852
2011	21,300	295	840	$822	$877
2012	32,900	292	1,250	$1,326	$1,386
2013	37,000	601	1,290	$1,418	$1,458
2014	37,900	535	1,290	$1,433	$1,450
2015	34,600	461	1,020	$1,136	$1,149
2016	32,900	562	1,120	$1,020	$1,020

Table 10.
Home Fires Involving Electrical Distribution and Lighting Equipment by Year
Structure Fires Reported to U.S. Fire Departments (Continued)

* All 1991 home fire property damage figures are inflated by estimation problems related to the handling of the Oakland fire storm.

Note: Figures exclude confined fires. Fires are rounded to the nearest hundred, deaths to the nearest one, injuries to the nearest ten, and property damage is rounded to the nearest million dollars. Figures reflect a proportional share of home fires with equipment involved in ignition unknown or reported as electrical distribution or lighting equipment of undetermined type. Because of low participation in NFIRS Version 5.0 during 1999-2001, estimates for those years are highly uncertain and must be used with caution. Inflation adjustment to 2016 dollars is calculated using the Consumer Price Index.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 11.
Home Fires Involving Electrical Distribution and Lighting Equipment, by Month
2012-2016 Annual Averages

Month	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
January	4,010	(11%)	80	(16%)	140	(12%)	$149	(12%)
February	3,180	(9%)	40	(9%)	100	(8%)	$116	(9%)
March	2,900	(8%)	50	(11%)	140	(11%)	$117	(9%)
April	2,620	(7%)	50	(9%)	80	(7%)	$100	(8%)
May	2,640	(8%)	30	(5%)	100	(8%)	$103	(8%)
June	2,820	(8%)	10	(2%)	80	(6%)	$95	(7%)
July	3,060	(9%)	50	(9%)	100	(8%)	$106	(8%)
August	2,580	(7%)	30	(7%)	110	(9%)	$84	(7%)
September	2,270	(6%)	40	(7%)	60	(5%)	$81	(6%)
October	2,460	(7%)	40	(9%)	60	(5%)	$88	(7%)
November	3,030	(9%)	20	(5%)	110	(9%)	$104	(8%)
December	3,560	(10%)	50	(10%)	120	(10%)	$126	(10%)
Total	35,150	(100%)	490	(100%)	1,200	(100%)	$1,270	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest ten million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 12.
Home Fires Involving Electrical Distribution and Lighting Equipment, by Day of Week
2012-2016 Annual Averages

Day of Week	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Sunday	5,000	(14%)	50	(9%)	180	(15%)	$189	(15%)
Monday	5,090	(14%)	70	(15%)	130	(11%)	$182	(14%)
Tuesday	5,030	(14%)	80	(15%)	200	(17%)	$178	(14%)
Wednesday	5,060	(14%)	80	(17%)	150	(13%)	$177	(14%)
Thursday	4,860	(14%)	90	(19%)	180	(15%)	$182	(14%)
Friday	5,000	(14%)	50	(11%)	190	(16%)	$184	(14%)
Saturday	5,100	(15%)	70	(14%)	160	(14%)	$178	(14%)
Totals	35,150	(100%)	490	(100%)	1,200	(100%)	$1,270	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 13.
Home Fires Involving Electrical Distribution and Lighting Equipment, by Time of Day
2012-2016 Annual Averages

Time of Day	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Midnight-12:59 a.m.	1,250	(4%)	30	(7%)	50	(4%)	$59	(5%)
1:00-1:59 a.m.	1,040	(3%)	60	(13%)	70	(6%)	$50	(4%)
2:00-2:59 a.m.	1,000	(3%)	50	(9%)	60	(5%)	$51	(4%)
3:00-3:59 a.m.	990	(3%)	40	(7%)	40	(4%)	$45	(4%)
4:00-4:59 a.m.	930	(3%)	50	(10%)	60	(5%)	$44	(3%)
5:00-5:59 a.m.	890	(3%)	30	(6%)	40	(3%)	$42	(3%)
6:00-6:59 a.m.	1,090	(3%)	10	(3%)	50	(5%)	$41	(3%)
7:00-7:59 a.m.	1,140	(3%)	20	(5%)	40	(3%)	$44	(3%)
8:00-8:59 a.m.	1,260	(4%)	10	(2%)	50	(4%)	$42	(3%)
9:00-9:59 a.m.	1,370	(4%)	20	(5%)	50	(4%)	$44	(3%)
10:00-10:59 a.m.	1,480	(4%)	10	(2%)	40	(3%)	$45	(4%)
11:00-11:59 a.m.	1,590	(5%)	10	(3%)	40	(4%)	$58	(5%)
12:00-12:59 p.m.	1,580	(5%)	0	(1%)	40	(4%)	$60	(5%)
1:00-1:59 p.m.	1,730	(5%)	0	(1%)	50	(4%)	$58	(5%)
2:00-2:59 p.m.	1,750	(5%)	10	(2%)	40	(4%)	$55	(4%)
3:00-3:59 p.m.	1,870	(5%)	10	(1%)	40	(3%)	$67	(5%)
4:00-4:59 p.m.	1,850	(5%)	10	(2%)	50	(4%)	$72	(6%)
5:00-5:59 p.m.	1,890	(5%)	10	(3%)	50	(4%)	$56	(4%)
6:00-6:59 p.m.	1,860	(5%)	20	(3%)	60	(5%)	$58	(5%)
7:00-7:59 p.m.	1,950	(6%)	10	(3%)	50	(4%)	$66	(5%)
8:00-8:59 p.m.	1,880	(5%)	20	(3%)	50	(4%)	$60	(5%)
9:00-9:59 p.m.	1,790	(5%)	10	(2%)	50	(4%)	$49	(4%)
10:00-10:59 p.m.	1,610	(5%)	20	(4%)	50	(5%)	$48	(4%)
11:00-11:59 p.m.	1,380	(4%)	10	(3%)	70	(6%)	$55	(4%)
Total	35,150	(100%)	490	(100%)	1,200	(100%)	$1,270	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 14.
Home Fires Involving Electrical Distribution and Lighting Equipment, by Equipment Involved in Ignition
2012-2016 Annual Averages

Equipment Involved	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Wiring and related equipment	24,780	(67%)	270	(55%)	640	(53%)	$853	(67%)
Lamp, bulb or lighting	4,970	(13%)	40	(9%)	200	(17%)	$164	(13%)
Cord or plug	3,330	(11%)	160	(33%)	230	(19%)	$143	(11%)
Transformers and power supplies	2,060	(9%)	20	(3%)	130	(11%)	$108	(9%)
Other known equipment involved in ignition	20	(0%)	0	(0%)	0	(0%)	$0	(0%)
Total	35,150	(100%)	490	(100%)	1,200	(100%)	$1,270	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 15.
Home Fires Involving Electrical Distribution and Lighting Equipment, by Cause of Ignition
2012-2016 Annual Averages

Cause of Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Unintentional	18,870	(54%)	250	(52%)	690	(57%)	$758	(60%)
Failure of equipment or heat source	15,210	(43%)	230	(47%)	500	(41%)	$481	(38%)
Act of nature	700	(2%)	0	(1%)	10	(1%)	$19	(1%)
Other or unknown cause	370	(1%)	10	(2%)	0	(0%)	$12	(1%)
Total	35,150	(100%)	490	(100%)	1,200	(100%)	$1,270	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 16.
Home Fires Involving Electrical Distribution and Lighting Equipment, by Factor Contributing to Ignition
2012-2016 Annual Averages

Factor Contributing to Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Electrical failure or malfunction	27,940	(79%)	400	(83%)	870	(72%)	$1,037	(82%)
Heat source too close to combustibles	1,960	(6%)	30	(5%)	110	(9%)	$69	(5%)
Mechanical failure or malfunction	1,780	(5%)	10	(2%)	50	(4%)	$56	(4%)
Equipment overloaded	1,030	(3%)	40	(7%)	70	(6%)	$40	(3%)
Unclassified misuse of material or product	580	(2%)	10	(2%)	40	(4%)	$19	(2%)
Other known factor contributing to ignition	3,430	(10%)	50	(9%)	150	(12%)	$122	(10%)
Total fires	35,150	(100%)	490	(100%)	1,200	(100%)	$1,270	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Multiple entries are allowed, which can result in sums higher than totals. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 16A.
Home Fires Involving Wiring and Related Equipment, by Factor Contributing to Ignition
2012-2016 Annual Averages

Factor Contributing to Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Electrical failure or malfunction	22,030	(89%)	250	(91%)	580	(91%)	$789	(92%)
Mechanical failure or malfunction	1,290	(5%)	10	(4%)	20	(4%)	$33	(4%)
Equipment overloaded	480	(2%)	10	(3%)	20	(3%)	$14	(2%)
Other known factor contributing to ignition	2,300	(9%)	20	(10%)	70	(10%)	$77	(9%)
Total fires	24,780	(100%)	270	(100%)	640	(100%)	$853	(100%)
Total factors	26,100	(105%)	290	(108%)	690	(108%)	$913	(107%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Multiple entries are allowed, which can result in sums higher than totals. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 16B.
Home Fires Involving Lamps, Bulbs, or Lighting Equipment, by Factor Contributing to Ignition
2012-2016 Annual Averages

Factor Contributing to Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Electrical failure or malfunction	2,350	(47%)	20	(39%)	80	(38%)	$91	(55%)
Heat source too close to combustibles	1,430	(29%)	20	(50%)	70	(36%)	$45	(28%)
Mechanical failure or malfunction	200	(4%)	0	(0%)	10	(5%)	$6	(4%)
Equipment unattended	180	(4%)	0	(0%)	10	(4%)	$5	(3%)
Animal	150	(3%)	0	(6%)	0	(1%)	$2	(1%)
Misuse of material or product, other	120	(2%)	0	(0%)	10	(5%)	$3	(2%)
Accidentally turned on, not turned off	120	(2%)	0	(0%)	0	(1%)	$6	(4%)
Other factor contributed to ignition	100	(2%)	0	(0%)	10	(3%)	$4	(3%)
Collision, knock down, run over, turn over	100	(2%)	0	(11%)	20	(7%)	$2	(1%)
Other known factor contributing to ignition	530	(11%)	10	(21%)	20	(10%)	$15	(9%)
Total fires	4,970	(100%)	40	(100%)	200	(100%)	$164	(100%)
Total factors	5,290	(106%)	60	(127%)	220	(109%)	$180	(110%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Multiple entries are allowed, which can result in sums higher than totals. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 16C.
Home Fires Involving Cords or Plugs, by Factor Contributing to Ignition
2012-2016 Annual Averages

Factor Contributing to Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Electrical failure or malfunction	2,520	(76%)	130	(81%)	170	(74%)	$111	(77%)
Equipment overloaded	390	(12%)	30	(16%)	40	(17%)	$17	(12%)
Unclassified misuse of material or product	190	(6%)	10	(5%)	20	(7%)	$9	(7%)
Mechanical failure or malfunction	110	(3%)	0	(3%)	10	(3%)	$4	(3%)
Heat source too close to combustibles	110	(3%)	0	(3%)	10	(3%)	$5	(3%)
Equipment used for not intended purpose	60	(2%)	0	(3%)	10	(5%)	$2	(1%)
Other known factor contributing to ignition	180	(5%)	10	(4%)	10	(6%)	$8	(6%)
Total fires	3,330	(100%)	160	(100%)	230	(100%)	$143	(100%)
Total factors	3,560	(107%)	180	(115%)	260	(114%)	$156	(109%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Multiple entries are allowed, which can result in sums higher than totals. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 16D.
Home Fires Involving Transformers and Power Supplies, by Factor Contributing to Ignition
2012-2016 Annual Averages

Factor Contributing to Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Electrical failure or malfunction	1,340	(65%)	10	(81%)	70	(54%)	$64	(59%)
Mechanical failure or malfunction	180	(9%)	0	(0%)	10	(8%)	$13	(12%)
Heat source too close to combustibles	170	(8%)	0	(0%)	20	(12%)	$12	(11%)
Equipment overloaded	120	(6%)	0	(0%)	10	(7%)	$7	(7%)
Equipment unattended	80	(4%)	0	(0%)	0	(2%)	$5	(5%)
Unclassified misuse of material or product	60	(3%)	0	(19%)	10	(4%)	$3	(3%)
Equipment not being operated properly	40	(2%)	0	(0%)	0	(4%)	$2	(2%)
Other known factor contributing to ignition	230	(11%)	0	(19%)	20	(19%)	$13	(12%)
Total fires	2,060	(100%)	20	(100%)	130	(100%)	$108	(100%)
Total factors	2,220	(108%)	20	(118%)	140	(110%)	$120	(110%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Multiple entries are allowed, which can result in sums higher than totals. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 17. Home Fires Involving Electrical Distribution and Lighting Equipment, by Heat Source
2012-2016 Annual Averages

Heat Source	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Arcing	25,770	(73%)	340	(69%)	791	(66%)	$902	(71%)
Unclassified heat from powered equipment	4,230	(12%)	70	(14%)	194	(16%)	$177	(14%)
Radiated or conducted heat from operating equipment	2,800	(8%)	50	(9%)	137	(11%)	$96	(8%)
Spark, ember or flame from operating equipment	990	(3%)	10	(3%)	39	(3%)	$47	(4%)
Other known heat source	1,370	(4%)	20	(5%)	40	(3%)	$48	(4%)
Total	35,150	(100%)	490	(100%)	1,200	(100%)	$1,270	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 18.
Home Fires Involving Electrical Distribution and Lighting Equipment, by Area of Origin
2012-2016 Annual Averages

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Bedroom	5,830	(17%)	90	(18%)	400	(34%)	$201	(16%)
Attic or ceiling/roof assembly or concealed space	4,390	(12%)	30	(6%)	60	(5%)	$163	(13%)
Wall assembly or concealed space	3,020	(9%)	20	(5%)	40	(4%)	$92	(7%)
Common room, living room, family room, lounge or den	2,450	(7%)	130	(27%)	180	(15%)	$115	(9%)
Exterior wall surface	2,300	(7%)	10	(1%)	30	(2%)	$51	(4%)
Kitchen or cooking area	2,190	(6%)	40	(9%)	70	(6%)	$75	(6%)
Garage or vehicle storage area	1,550	(4%)	0	(0%)	50	(4%)	$104	(8%)
Crawl space or substructure space	1,300	(4%)	20	(5%)	20	(2%)	$43	(3%)
Unclassified function area	1,290	(4%)	40	(8%)	50	(5%)	$46	(4%)
Ceiling/floor assembly or concealed space	1,200	(3%)	30	(5%)	30	(2%)	$54	(4%)
Laundry room or area	1,110	(3%)	10	(1%)	40	(3%)	$29	(2%)
Lavatory, bathroom, locker room or check room	1,080	(3%)	0	(0%)	20	(1%)	$27	(2%)
Closet	690	(2%)	0	(1%)	30	(2%)	$28	(2%)
Exterior balcony or unenclosed porch	570	(2%)	10	(2%)	10	(1%)	$26	(2%)
Unclassified structural area	530	(2%)	10	(2%)	20	(1%)	$29	(2%)
Other known area of origin	5,660	(16%)	50	(10%)	150	(12%)	$186	(15%)
Total	35,150	(100%)	490	(100%)	1,200	(100%)	$1,270	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 18A.
Home Fires Involving Wiring and Related Equipment, by Area of Origin
2012-2016 Annual Averages

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Attic or ceiling/roof assembly or concealed space	3,860	(16%)	20	(7%)	50	(8%)	$142	(17%)
Bedroom	3,220	(13%)	40	(15%)	180	(28%)	$105	(12%)
Wall assembly or concealed space	2,850	(12%)	20	(7%)	40	(6%)	$87	(10%)
Exterior wall surface	1,740	(7%)	10	(4%)	20	(3%)	$37	(4%)
Kitchen or cooking area	1,670	(7%)	30	(11%)	40	(6%)	$57	(7%)
Living room, family room, or den	1,370	(6%)	40	(15%)	80	(13%)	$64	(7%)
Crawl space or substructure space	1,070	(4%)	20	(7%)	10	(2%)	$34	(4%)
Ceiling/floor assembly or concealed space	940	(4%)	30	(11%)	20	(3%)	$47	(5%)
Laundry room or area	900	(4%)	0	(0%)	30	(5%)	$25	(3%)
Garage or vehicle storage area	800	(3%)	0	(0%)	20	(3%)	$47	(6%)
Unclassified function area	780	(3%)	20	(7%)	20	(3%)	$29	(3%)
Lavatory, bathroom, locker room or check room	710	(3%)	0	(0%)	10	(2%)	$19	(2%)
Closet	430	(2%)	0	(0%)	20	(3%)	$17	(2%)
Unclassified structural area	390	(2%)	0	(0%)	10	(2%)	$21	(2%)
Conduit, pipe, utility, or ventilation shaft	380	(2%)	0	(0%)	0	(0%)	$8	(1%)
Other known area of origin	3,670	(15%)	30	(11%)	80	(13%)	$116	(14%)
Total	24,780	(100%)	270	(100%)	640	(100%)	$853	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 18B.
Home Fires Involving Lamp, Bulb, or Lighting, by Area of Origin
2012-2016 Annual Averages

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Bedroom	1,110	(22%)	20	(45%)	90	(46%)	$32	(19%)
Attic or ceiling/roof assembly or concealed space	490	(10%)	0	(4%)	10	(4%)	$19	(12%)
Living room, family room, or den	400	(8%)	10	(29%)	30	(16%)	$19	(11%)
Exterior wall surface	320	(6%)	0	(0%)	0	(2%)	$6	(4%)
Lavatory, bathroom, locker room or check room	320	(6%)	0	(0%)	0	(1%)	$6	(4%)
Kitchen or cooking area	240	(5%)	0	(4%)	10	(4%)	$8	(5%)
Ceiling/floor assembly or concealed space	210	(4%)	0	(0%)	0	(2%)	$7	(4%)
Exterior balcony, unenclosed porch	200	(4%)	0	(0%)	0	(1%)	$9	(5%)
Closet	200	(4%)	0	(0%)	10	(4%)	$9	(6%)
Unclassified function area	200	(4%)	0	(4%)	10	(4%)	$6	(4%)
Garage or vehicle storage area	190	(4%)	0	(4%)	10	(4%)	$8	(5%)
Wall assembly or concealed space	90	(2%)	0	(0%)	0	(0%)	$3	(2%)
Courtyard, terrace or patio	90	(2%)	0	(0%)	0	(1%)	$4	(3%)
Unclassified outside area	90	(2%)	0	(0%)	0	(0%)	$4	(2%)
Other known area of origin	830	(17%)	0	(9%)	20	(11%)	$23	(14%)
Total	4,970	(100%)	40	(100%)	200	(100%)	$164	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 18C.
Home Fires Involving Cords or Plugs, by Area of Origin
2012-2016 Annual Averages

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Bedroom	1,110	(33%)	30	(18%)	100	(42%)	$45	(32%)
Living room, family room, or den	485	(15%)	70	(44%)	50	(21%)	$25	(17%)
Garage or vehicle storage area	228	(7%)	0	(0%)	10	(4%)	$15	(10%)
Kitchen or cooking area	203	(6%)	10	(6%)	10	(5%)	$7	(5%)
Unclassified function area	202	(6%)	20	(10%)	10	(6%)	$8	(6%)
Laundry room or area	124	(4%)	0	(1%)	0	(2%)	$2	(2%)
Crawl space or substructure space	104	(3%)	0	(1%)	10	(3%)	$2	(2%)
Exterior wall surface	91	(3%)	0	(1%)	0	(1%)	$2	(2%)
Exterior balcony, unenclosed porch	67	(2%)	10	(6%)	0	(1%)	$3	(2%)
Wall assembly or concealed space	66	(2%)	0	(1%)	0	(0%)	$2	(1%)
Unclassified structural area	51	(2%)	10	(4%)	0	(2%)	$3	(2%)
Other known area of origin	600	(18%)	10	(8%)	30	(12%)	$28	(19%)
Total	3,330	(100%)	160	(100%)	230	(100%)	$143	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 18D.
Home Fires Involving Transformers and Power Supplies, by Area of Origin
2012-2016 Annual Averages

Area of Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Bedroom	450	(22%)	10	(45%)	40	(32%)	$21	(19%)
Garage or vehicle storage area	340	(16%)	0	(0%)	20	(14%)	$36	(33%)
Living room, family room, or den	210	(10%)	0	(21%)	20	(13%)	$9	(8%)
Exterior wall surface	110	(5%)	0	(0%)	0	(3%)	$4	(4%)
Unclassified function area	100	(5%)	0	(0%)	10	(8%)	$2	(2%)
Kitchen or cooking area	90	(4%)	0	(0%)	0	(3%)	$2	(2%)
Exterior balcony, unenclosed porch	50	(2%)	0	(12%)	10	(5%)	$4	(3%)
Unclassified outside area	50	(2%)	0	(0%)	0	(1%)	$2	(2%)
Crawl space or substructure space	50	(2%)	0	(0%)	0	(1%)	$3	(2%)
Office	40	(2%)	0	(0%)	0	(0%)	$2	(2%)
Storage of supplies or tools or dead storage	40	(2%)	0	(0%)	0	(1%)	$2	(2%)
Dining room, bar or beverage area, cafeteria	30	(2%)	0	(0%)	10	(6%)	$1	(1%)
Unclassified storage area	30	(2%)	0	(0%)	0	(2%)	$1	(1%)
Other known area of origin	460	(22%)	0	(22%)	10	(12%)	$19	(17%)
Total	2,060	(100%)	20	(100%)	130	(100%)	$108	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Table 19.
Home Fires Involving Electrical Distribution and Lighting Equipment, by Item First Ignited
2012-2016 Annual Averages

Item First Ignited	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Electrical wire or cable insulation	11,020	(31%)	120	(25%)	330	(27%)	$319	(25%)
Structural member or framing	5,960	(17%)	90	(18%)	150	(13%)	$283	(22%)
Insulation within structural area	2,400	(7%)	0	(0%)	20	(2%)	$60	(5%)
Exterior wall covering or finish	2,300	(7%)	20	(5%)	30	(3%)	$75	(6%)
Interior wall covering, excluding drapes	1,740	(5%)	20	(4%)	50	(5%)	$73	(6%)
Unclassified structural component or finish	1,520	(4%)	10	(3%)	40	(3%)	$60	(5%)
Mattress or bedding	1,150	(3%)	20	(3%)	110	(9%)	$38	(3%)
Unclassified item first ignited	950	(3%)	10	(1%)	20	(2%)	$24	(2%)
Interior ceiling cover or finish	760	(2%)	10	(1%)	10	(1%)	$35	(3%)
Clothing	720	(2%)	30	(7%)	50	(5%)	$24	(2%)
Floor covering rug, carpet, or mat	700	(2%)	10	(1%)	40	(3%)	$33	(3%)
Upholstered furniture or vehicle seat	610	(2%)	50	(10%)	70	(6%)	$35	(3%)
Unclassified furniture or utensils	540	(2%)	20	(5%)	20	(2%)	$22	(2%)
Other known item first ignited	4,760	(14%)	80	(16%)	240	(20%)	$188	(15%)
Total	35,150	(100%)	490	(100%)	1,200	(100%)	$1,270	(100%)

Note: Figures exclude confined fires which are fires reported as confined to fuel burner or boiler, chimney or flue, cooking vessel, trash, incinerator, or commercial compactor. Fires, deaths, and injuries are rounded to the nearest ten, and direct property damage to the nearest million dollars. Figures reflect a proportional share of home fires with factor contributing to ignition listed as unknown, unreported, none, or blank. Totals may not equal sums because of rounding error.

Source: Data from NFIRS Version 5.0 and NFPA Fire Experience Survey.

Acknowledgements

The National Fire Protection Association thanks all the fire departments and state fire authorities that participate in the National Fire Incident Reporting System (NFIRS) and the annual NFPA fire experience survey. These firefighters are the original sources of the detailed data that make this analysis possible. Their contributions allow us to estimate the size of the fire problem.

We are also grateful to the U.S. Fire Administration for its work in developing, coordinating, and maintaining NFIRS.

To learn more about research at NFPA visit www.nfpa.org/research.
E-mail: research@nfpa.org.

NFPA No.USS37ST

*Black = original text **not** removed ~~RED = Original Text removed~~ Blue = New Text*

300.4 Protection Against Physical Damage.

Where subject to physical damage, conductors, raceways, and cables shall be protected.

(A) Cables and Raceways Through Wood Members.

(1) Bored Holes.

In both exposed and concealed locations, where a cable- or raceway-type wiring method is installed through bored holes in joists, rafters, or wood members, 29 mm (1 1/8 in.) diameter holes shall be bored. ~~so that the edge of the hole is not less than 32 mm (11⁄4 in.) from the nearest edge of the wood member~~. ~~Where this distance cannot be maintained, the~~ The cable or raceway shall be protected from penetration by drills, screws or nails by ~~a steel plate(s) or~~ a 29 mm (1 1/8 in) 360-degree insulated Steel bushing(s), at least 1.6 mm (1⁄16 in.) thick, and of appropriate length ~~and width installed~~ to ~~cover~~ fully protect the area of the wiring.

Exception No. 1:

~~Steel plates shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing~~.

In areas in which a secured 360-degree insulated steel bushing cannot be installed, such as “Old work” or remodel jobs where wiring is already in place, a 1.6 mm (1/16 in.) secured split steel bushing with minimum of 270- degree protection against nails, screws or drill penetration shall be permitted.

Exception No. 2:

In areas in which either a secured 360-degree insulated steel bushing, or a secured 270-degree split steel bushing cannot be installed, a listed and marked steel plate no less than 1.6 mm (1⁄16 in.) thick that provides ~~equal or better~~ protection against drills, nails or screw penetration shall be installed on both sides of the wooden structure that is potentially exposed to penetration to provide 180 degrees of protection shall be permitted.

Exception No. 3:

Where a secured 360-degree insulated steel bushing or a secured 270-degree split bushing cannot be installed, and the wood structures are set against a solid surface such as the inside of a concrete wall, a listed and marked steel plate no less than 1.6 mm (1⁄16 in.) thick that provides equal or better protection against drills, nails or screw penetration shall be required only on the exposed surface.

Exception No. 4:

Secured 360-degree insulated steel bushings, secured 270-degree split steel bushings or steel plates shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing.

(2) Notches in Wood.

Where there is no objection because of weakening the building structure, in both exposed and concealed locations, cables or raceways shall be permitted to be laid in notches in wood studs, joists, rafters, or other wood members where the cable or raceway at those points is protected against nails or screws by a steel plate at least 1.6 mm (1⁄16 in.) thick, and of appropriate length and width, installed to cover the area of the wiring. The minimum protection requirement is 180 degrees. If the wooden structure is positioned that that the side without the notch is potentially accessible by nails, drills, or screws a second steel plate shall be required to provide 180 degrees of protection. The steel plate shall be installed before the building finish is applied.

Exception No. 1:

Steel plates shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing.

Exception No. 2:

A listed and marked steel plate no less than 1.6 mm (1⁄16 in.) thick that provides equal or better protection against nail or screw penetration shall be permitted.

Exception No. 3:

If the wooden structure is positioned in a place that has a natural barrier against nails, drills, or screws. (EX: wood structure against an outer cement wall), a listed and marked steel plate no less than 1.6 mm (1⁄16 in.) thick that provides equal or better protection against drill, nail, or screw penetration shall only be required on the notched side of the wood structure.

(B) Nonmetallic-Sheathed Cables and Electrical Nonmetallic Tubing Through Metal Framing Members.

(1) Nonmetallic-Sheathed Cable.

In both exposed and concealed locations where nonmetallic-sheathed cables pass through either factory- or field-punched, cut, or drilled slots or holes in metal members, the cable shall be protected by listed bushings or listed grommets covering all metal edges that are securely fastened in the opening prior to installation of the cable.

(2) Nonmetallic-Sheathed Cable and Electrical Nonmetallic Tubing.

Where nails or screws are likely to penetrate nonmetallic-sheathed cable or electrical nonmetallic tubing, a steel sleeve, steel plate, or steel clip not less than 1.6 mm (1⁄16 in.) in thickness shall be used to protect the cable or tubing.

Exception:

A listed and marked steel plate less than 1.6 mm (1⁄16 in.) thick that provides equal or better protection against nail or screw penetration shall be permitted.

(C) Cables Through Spaces Behind Panels Designed to Allow Access.

Cables or raceway-type wiring methods, installed behind panels designed to allow access, shall be supported according to their applicable articles.

(D) Cables and Raceways Parallel to Framing Members and Furring Strips.

In both exposed and concealed locations, where a cable- or raceway-type wiring method is installed parallel to framing members, such as joists, rafters, or studs, or is installed parallel to furring strips, the cable or raceway shall be installed and supported so that the nearest outside surface of the cable or raceway is not less than 32 mm (11⁄4 in.) from the nearest edge of the framing member or furring strips where nails or screws are likely to penetrate. Where this distance cannot be maintained, the cable or raceway shall be protected from penetration by nails or screws by a steel plate, sleeve, or equivalent at least 1.6 mm (1⁄16 in.) thick.

Exception No. 1:

Steel plates, sleeves, or the equivalent shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing.

Exception No. 2:

For concealed work in finished buildings, or finished panels for prefabricated buildings where such supporting is impracticable, it shall be permissible to fish the cables between access points.

Exception No. 3:

A listed and marked steel plate less than 1.6 mm (1⁄16 in.) thick that provides equal or better protection against nail or screw penetration shall be permitted.

(E) Cables, Raceways, or Boxes Installed in or Under Roof Decking.

A cable, raceway, or box, installed in exposed or concealed locations under metal-corrugated sheet roof decking, shall be installed and supported so there is not less than 38 mm (11⁄2 in.) measured from the lowest surface of the roof decking to the top of the cable, raceway, or box. A cable, raceway, or box shall not be installed in concealed locations in metal-corrugated, sheet decking–type roof.

Informational Note:

Roof decking material is often repaired or replaced after the initial raceway or cabling and roofing installation and may be penetrated by the screws or other mechanical devices designed to provide “hold down” strength of the waterproof membrane or roof insulating material.

Exception:

Rigid metal conduit and intermediate metal conduit shall not be required to comply with 300.4(E).

(F) Cables and Raceways Installed in Shallow Grooves.

Cable- or raceway-type wiring methods installed in a groove, to be covered by wallboard, siding, paneling, carpeting, or similar finish, shall be protected by 1.6 mm (1⁄16 in.) thick steel plate, sleeve, or equivalent or by not less than 32-mm (11⁄4-in.) free space for the full length of the groove in which the cable or raceway is installed.

Exception No. 1:

Steel plates, sleeves, or the equivalent shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing.

Exception No. 2:

A listed and marked steel plate less than 1.6 mm (1⁄16 in.) thick that provides equal or better protection against nail or screw penetration shall be permitted.

(G) Fittings.

Where raceways contain 4 AWG or larger insulated circuit conductors, and these conductors enter a cabinet, a box, an enclosure, or a raceway, the conductors shall be protected in accordance with any of the following:

- (1)

  An identified fitting providing a smoothly rounded insulating surface

- (2)

  A listed metal fitting that has smoothly rounded edges

- (3)

  Separation from the fitting or raceway using an identified insulating material that is securely fastened in place

- (4)

  Threaded hubs or bosses that are an integral part of a cabinet, box, enclosure, or raceway providing a smoothly rounded or flared entry for conductors

Conduit bushings constructed wholly of insulating material shall not be used to secure a fitting or raceway. The insulating fitting or insulating material shall have a temperature rating not less than the insulation temperature rating of the installed conductors.

(H) Structural Joints.

A listed expansion/deflection fitting or other approved means shall be used where a raceway crosses a structural joint intended for expansion, contraction or deflection, used in buildings, bridges, parking garages, or other structures.

Public Comment No. 754-NFPA 70-2021 [Section No. 300.4(D)]

(D) Cables and Raceways Parallel to Framing Members and Furring Strips.

In both exposed and concealed locations, where a cable- or raceway-type wiring method is installed parallel to framing members, such as joists, rafters, or studs, or is installed parallel to furring strips, the cable or raceway shall be installed and supported so that the nearest outside surface of the cable or raceway is not less than 32 mm (1¼ in.) from the nearest edge of the framing member or furring strips where nails or screws are likely to penetrate. Where this distance cannot be maintained, the cable or raceway shall be protected from penetration by nails or screws by a steel plate, sleeve, or equivalent at least 1.6 mm (1⁄16 in.) thick.

Exception No. 1: Steel plates, sleeves, or the equivalent shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing.

Exception No. 2: For concealed work in finished buildings, or finished panels for prefabricated buildings where such supporting is impracticable, it shall be permissible to fish the cables between access points.

Exception No. 3: A listed and marked steel plate less than 1.6 mm (1⁄16 in.) thick that provides equal or better protection against nail or screw penetration shall be permitted.

<u>Exception No. 4: Where cables enter enclosure entries set back less than 3 cm (1 1/4 in.) from a face of a framing member, if the cable enters an opening that separated at least 2 cm (3/4 in.) from the member, that portion of the cable between the</u>

<u>enclosure and the closest cable securement that is recessed at least 3 cm (1 1/4 in.) from the face shall be not require protection by nail plates or equivalent barriers.</u>

Statement of Problem and Substantiation for Public Comment

Switch box entries often do mean cable running within 1.25 in of the edges of structural members. Contrary to Inspector Feck's understanding and his proposal, CMP 3 believes cables do require protection in these locations.

This doctrine is rarely enforced, and this is an issue. Rules that are rarely enforced by experienced and knowledgable inspectors have several problems. One, they result in the perception that inspection is a matter of people, not rules; a crude variant of "It's who you know, not what you know or do." Ideally, a jurisdiction's inspectors enforce the code uniformly. Two, when Third Party Inspectors have to enforce rules that are frequently ignored by their colleagues, there is a financial advantage to those Third Party agencies that don't enforce them, over those that do. This is harmful to the entire system. Third, even aside from any dishonest behavior, rules that may often be ignored serve as bludgeons for inspectors to use against inconvenient installers, such as those who expect AHJs to "cite when you write."

Now I want to examine the logic of the rule.

The largest concern with 300.4(D) is that someone later trying to attach something–building finish, or equipment supports–to the structural member will miss or go too deep. Passing cable through the structural member puts it at risk of the "too deep" scenario. Running it alongside the member makes it vulnerable to misses. The question is how large a miss is likely. Where the cable is stapled or strapped, the slightest miss–not slight in the sense of not hitting the center of a stud, as professionals tend to do, but in the sense of missing it altogether–will put too shallow a cable at risk. These misses occur, and angled near misses can pass out of a stud, putting cable at risk similarly. However, a carpenter who misses a stud or joist by anything approaching 1.25 in. could have set the fastener any old place. I propose that 1.25 in. is not a reasonable lateral or angled clearance, only a reasonable depth. I rather suspect that it has come to be used as a lateral clearance without substantiation for its necessity.

Nonetheless, it is judicious from a safety perspective to disallow bringing nonmetallic cable into an opening that requires it to all but hug a structural member as it comes forward–because of that Friday afternoon drywall hanger's miss.. I propose a compromise solution. Examining a number of boxes, I note that some have cable entries that, after mounting, are within considerably less than 1/4 in. of the edge of the structural member to which they are attached. Others have their closest cable entries further, more like 3/4 or 1 in. from the edge. However, even these with cable entries all but at the edge have other cable entries that could be used. I believe an allowance of 3/4 in will accommodate the vast majority of boxes, so long as the very closest cable entries typically provided are not used without an additional barrier. At the same time accomplishing the safety purpose of protecting cable that is coming forward from the 1.25 in. back position at the same time as it is swinging away from the zone where near misses might penetrate.

Related Item

• PI 1055

Submitter Information Verification

Submitter Full Name:	David Shapiro
Organization:	Safety First Electrical
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Aug 04 00:11:52 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8537-NFPA 70-2021
Statement:	Section 300.4(A) has been revised to make it clear that no matter what side a stud is measured from, the edge of the hole cannot be closer than 32 mm (¹¼ in.). Cables installed less than 1 ¼ inches from the edge require protection. Enforcement of the code is the responsibility of the AHJ. Universal enforcement of the code is outside of the scope of the NEC.

Public Comment No. 1333-NFPA 70-2021 [Section No. 300.4(E)]

(E) Cables, Raceways, or Boxes Installed in or Under Metal-Corrugated Roof Decking.

A cable, raceway, or box, installed in exposed or concealed locations under metal-corrugated sheet roof decking, shall be installed and supported so there is not less than 38 mm (1½ in.) measured from the lowest surface of the roof decking to the top of the cable, raceway, or box. A cable, raceway, or box shall not be installed in concealed locations in metal-corrugated, sheet decking–type roof.

Informational Note: Roof decking material is often repaired or replaced after the initial raceway or cabling and roofing installation and might be penetrated by screws or other mechanical devices designed to provide "hold down" strength of the waterproof membrane or roof insulating material.

Exception No. 1: Rigid metal conduit and intermediate metal conduit, with ~~malleable iron fittings~~ associated fittings or boxes, shall not be required to comply with 300.4(E).

Exception No. 2: The 38 mm (1½in.) spacing is not required where metal-corrugated sheet roof decking is covered with a minimum thickness 50 mm (2 in.) concrete slab, measured from the top of the corrugated roofing.

Statement of Problem and Substantiation for Public Comment

Malleable Iron fittings are only one type of fitting listed for use with steel conduit/IMC and do not even offer the most physical protection. FR 9408 as accepted excludes man other fittings including standard boxes and possibly couplings. All rigid conduit fittings should be allowed and should not be limited for use in these applications as they are meant to be used with rigid conduit which is allowed in all atmospheric conditions.

Related Item

- FR 9408

Submitter Information Verification

Submitter Full Name: Dale Crawford
Organization: Steel Tube Institute
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 11 20:35:44 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8541-NFPA 70-2021

Statement: Malleable Iron fittings are only one type associated with Rigid Conduit and IMC and there can be arguments made there are better options available that offer superior physical protection. The change to 'associated listed steel or malleable iron covers these other types.

Public Comment No. 755-NFPA 70-2021 [Section No. 300.4(E)]

(E) Cables, Raceways, or Boxes Installed in or Under Metal-Corrugated Roof Decking.

A cable, raceway, or box, installed in exposed or concealed locations under metal-corrugated sheet roof decking, shall be installed and supported so there is not less than 38 mm (1½ in.) measured from the lowest surface of the roof decking to the top of the cable, raceway, or box. A cable, raceway, or box shall not be installed in concealed locations in ~~metal-~~ corrugated, sheet decking–type roof.

Informational Note: Roof decking material is often repaired or replaced after the initial raceway or cabling and roofing installation and might be penetrated by screws or other mechanical devices designed to provide "hold down" strength of the waterproof membrane or roof insulating material.

Exception No. 1: Rigid metal conduit and intermediate metal conduit, with malleable iron fittings or boxes, shall not be required to comply with 300.4(E).

Exception No. 2: The 38 mm (1½in.) spacing is not required where ~~metal-~~ corrugated sheet roof decking is covered with a minimum thickness 50 mm (2 in.) concrete slab, measured from the top of the corrugated roofing.

Statement of Problem and Substantiation for Public Comment

The CMP has not provided evidence that nonmetallic corrugated roof sheathing does not pose this danger. While far less common, it is secured the same way as the metal version. It poses the same risk.

Related Item

• PI 1057 • FR9375

Submitter Information Verification

Submitter Full Name: David Shapiro
Organization: Safety First Electrical
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 04 00:19:17 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: It is not up to a Panel to provide evidence to resolve a public input, it is up to the submitter of the public input to provide substantiation for the proposed change. That being the case, no technical substantiation has been provided as to a problem caused with the current language. This section is meant to prohibit cables, raceways, and boxes from being installed in the space between the metal deck and the roofing material which is not typically found with other types of roofs. Protection from physical damage requirements are outlined in the specific section of each wiring method. The issue that arises with re-roofing metal corrugated roofing is unique and different than those other types of roofing which typically have the original roofing material removed before the new roofing material is installed. Metal corrugated roof decking roofs utilize longer fastening methods in order to comply with hold down requirements. This section is meant to prohibit cables, raceways, and boxes from being installed in the space between the metal deck and the roofing material which is not typically found with other types of roofs. Furthermore, the only change to this section was adding 'metal-corrugated' to the title, as the charging text referenced only metal-corrugated roofing. The title was edited for clarity.

Public Comment No. 1540-NFPA 70-2021 [Section No. 300.5]

300.5 Underground Installations.

(A) Minimum Cover Requirements.

Direct-buried cable, conduit, or other raceways shall be installed to meet the minimum cover requirements of Table 300.5.

Table 300.5 Minimum Cover Requirements, 0 to 1000 Volts ac, 1500 Volts dc, Nominal, Burial in Millimeters (Inches)

	-		Type of Wiring Method or Circuit									
	Column 1 Direct Burial Cables or Conductors		Column 2 ~~Electrical Metallic Tubing,~~ 2 Rigid Metal Conduit, or Intermediate Metal Conduit		Column 3 Electrical Metallic Tubing, 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			
Location of Wiring Method or Circuit	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.		
All locations not specified below	600	24	150	6	450	18	300	12	150[1,2]	6[1,2]		
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	0	0	0	0	0	0	0	0	0		
	-	(in raceway or Type MC or Type MI cable identified for direct burial)	-	-	-	-					(in raceway or Type MC or Type MI cable identified for direct burial)	(in raceway or Type MC or Type MI cable identified for direct burial)
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 is prohibited	450	18	450	18	450	18	450	18	450	18

[1]A lesser depth shall be permitted where specified in the installation instructions of a listed low-voltage lighting system.

[2]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 a 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.

(B) Wet Locations.

The interior of enclosures or raceways installed underground shall be considered to be a wet location. Insulated conductors and cables installed in these enclosures or raceways in underground installations shall comply with 310.10(C).

(C) Underground Cables and Conductors Under Buildings.

Underground cable and conductors installed under a building shall be in a raceway.

Exception No. 1: Type MI cable shall be permitted under a building without installation in a raceway where embedded in concrete, fill, or other masonry in accordance with 332.10(6) or in underground runs where suitably protected against physical damage and corrosive conditions in accordance with 332.10(10).

Exception No. 2: Type MC cable listed for direct burial or concrete encasement shall be permitted under a building without installation in a raceway in accordance with 330.10(A)(5) and in wet locations in accordance with 330.10(A)(11).

(D) Protection from Damage.

Direct-buried conductors and cables shall be protected from damage in accordance with 300.5(D)(1) through (D)(4).

(1) Emerging from Grade.

Direct-buried conductors and cables emerging from grade and specified in Columns 1 and 4 of Table 300.5 shall be protected by enclosures or raceways extending from the minimum cover distance below grade required by 300.5(A) to a point at least 2.5 m (8 ft) above finished grade. In no case shall the protection be required to exceed 450 mm (18 in.) below finished grade.

(2) Conductors Entering Buildings.

Conductors entering a building shall be protected to the point of entrance.

(3) Service Conductors.

Underground service conductors that are not encased in concrete and that are buried 450 mm (18 in.) or more below grade shall have their location identified by a warning ribbon that is placed in the trench at least 300 mm (12 in.) above the underground installation.

(4) Enclosure or Raceway Damage.

Where the enclosure or raceway is subject to physical damage, the conductors shall be installed in electrical metallic tubing, rigid metal conduit, intermediate metal conduit, RTRC-XW, Schedule 80 PVC conduit, or equivalent.

(E) Splices and Taps.

Direct-buried conductors or cables shall be permitted to be spliced or tapped without the use of splice boxes. The splices or taps shall be made in accordance with 110.14(B).

(F) Backfill.

Backfill that contains large rocks, paving materials, cinders, large or sharply angular substances, or corrosive material shall not be placed in an excavation where materials might damage raceways, cables, conductors, or other substructures or prevent adequate compaction of fill or contribute to corrosion of raceways, cables, or other substructures.

Where necessary to prevent physical damage to the raceway, cable, or conductor, protection shall be provided in the form of granular or selected material, suitable running boards, suitable sleeves, or other approved means.

(G) Raceway Seals.

Conduits or raceways through which moisture might contact live parts shall be sealed or plugged at either or both ends. Spare or unused raceways shall also be sealed. Sealants shall be identified for use with the cable insulation, conductor insulation, bare conductor, shield, or other components.

> Informational Note: Presence of hazardous gases or vapors might also necessitate the sealing of underground conduits or raceways entering buildings.

(H) Bushing.

A bushing, or terminal fitting, with an integral bushed opening shall be used at the end of a conduit or other raceway that terminates underground where the conductors or cables emerge as a direct burial wiring method. A seal incorporating the physical protection characteristics of a bushing shall be permitted to be used in lieu of a bushing.

(I) Conductors of the Same Circuit.

All conductors of the same circuit and, where used, the grounded conductor and all equipment grounding conductors shall be installed in the same raceway or cable or shall be installed in close proximity in the same trench.

Exception No. 1: Conductors shall be permitted to be installed in parallel in raceways, multiconductor cables, or direct-buried single conductor cables. Each raceway or multiconductor cable shall contain all conductors of the same circuit, including equipment grounding conductors. Each direct-buried single conductor cable shall be located in close proximity in the trench to the other single conductor cables in the same parallel set of conductors in the circuit, including equipment grounding conductors.

Exception No. 2: Isolated phase, polarity, grounded conductor, and equipment grounding and bonding conductor installations shall be permitted in nonmetallic raceways or cables with a nonmetallic covering or nonmagnetic sheath in close proximity where conductors are paralleled as permitted in 310.10(G), and where the conditions of 300.20(B) are met.

(J) Earth Movement.

Where direct-buried conductors, raceways, or cables are subject to movement by settlement or frost, direct-buried conductors, raceways, or cables shall be arranged so as to prevent damage to the enclosed conductors or to equipment connected to the raceways.

Informational Note: This section recognizes “S” loops in underground direct burial cables and conductors to raceway transitions, expansion fittings in raceway risers to fixed equipment, and, generally, the provision of flexible connections to equipment subject to settlement or frost heaves.

(K) Directional Boring.

Cables or raceways installed using directional boring equipment shall be approved for the purpose.

Statement of Problem and Substantiation for Public Comment

Electrical Metallic Tubing (EMT) should have been included under Column 3 of Table 300.5, which permits “Other Approved Raceways”, instead of Column 2. This was a committee input by CMP3 based on PI 2958 which added EMT to Column 2 of Table 300.50.

Related Item

- FR 9323

Submitter Information Verification

Submitter Full Name:	Megan Hayes
Organization:	Nema
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon Aug 16 12:28:32 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8551-NFPA 70-2021
Statement:	There are other types of EMT aside from galvanized, and not all require supplemental protection. Pointing the reader to 358.10 will help them decide if supplemental protection is needed. EMT has been allowed in direct burial applications. UL 797 states that aluminum EMT needs supplemental corrosion protection for direct burial, but it does not mention that galvanized or stainless require supplemental corrosion protection. The guide card mentions that supplementary corrosion protection is generally required in direct contact with earth, but one cannot assume it is required as it would not be required for stainless conduit. One needs to rely on the UL guide card and Article 358 for EMT.

Public Comment No. 1334-NFPA 70-2021 [Section No. 300.5(A)]

(A) Minimum Cover Requirements.

Direct-buried cable, conduit, or other raceways shall be installed to meet the minimum cover requirements of Table 300.5.

Table 300.5 Minimum Cover Requirements, 0 to 1000 Volts ac, 1500 Volts dc, 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 ~~Electrical Metallic Tubing,~~ 2 Rigid Metal Conduit, or Intermediate Metal Conduit		Column 3 Electrical Metallic Tubing, 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[1,2]	6[1,2]		
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	0	0	0	0	0	0	0	0	0		
	-	(in raceway or Type MC or Type MI cable identified for direct burial)	-	-	-	-					(in raceway or Type MC or Type MI cable identified for direct burial)	(in raceway or Type MC or Type MI cable identified for direct burial)
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 is prohibited	450	18	450	18	450	18	450	18	450	18

[1]A lesser depth shall be permitted where specified in the installation instructions of a listed low-voltage lighting system.

[2]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 a 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.

Statement of Problem and Substantiation for Public Comment

First Revision 9323 added Electrical Metallic Tubing to Column 2 of the table in 300.5 This was done inadvertently and a mistake it should have been added to column 2. As is EMT would only require which only requires 6 inches of cover. Although we agree that EMT should be added to the table for clarity it should be added to the column 3 to keep it consistent with table 305.50 in the new medium voltage article which requires an 18-inch burial depth for EMT.

Related Item

• FR 9323

Submitter Information Verification

Submitter Full Name: Dale Crawford

Organization: Steel Tube Institute

Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 11 21:19:22 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8551-NFPA 70-2021

Statement: There are other types of EMT aside from galvanized, and not all require supplemental protection. Pointing the reader to 358.10 will help them decide if supplemental protection is needed.

EMT has been allowed in direct burial applications. UL 797 states that aluminum EMT needs supplemental corrosion protection for direct burial, but it does not mention that galvanized or stainless require supplemental corrosion protection. The guide card mentions that supplementary corrosion protection is generally required in direct contact with earth, but one cannot assume it is required as it would not be required for stainless conduit. One needs to rely on the UL guide card and Article 358 for EMT.

Public Comment No. 1684-NFPA 70-2021 [Section No. 300.5(A)]

(A) Minimum Cover Requirements.

Direct-buried cable, conduit, or other raceways shall be installed to meet the minimum cover requirements of Table 300.5.

Table 300.5 Minimum Cover Requirements, 0 to 1000 Volts ac, 1500 Volts dc, Nominal, Burial in Millimeters (Inches)

	-	Type of Wiring Method or Circuit										
Location of Wiring Method or Circuit	Column 1 Direct Burial Cables or Conductors		Column ~~2~~ ~~Electrical Metallic Tubing,~~ 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[1,2]	6[1,2]		
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	0	0	0	0	0	0	0	0	0		
	-	(in raceway or Type MC or Type MI cable identified for direct burial)	-	-	-	-					(in raceway or Type MC or Type MI cable identified for direct burial)	(in raceway or Type MC or Type MI cable identified for direct burial)
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 is prohibited	450	18	450	18	450	18	450	18	450	18

[1]A lesser depth shall be permitted where specified in the installation instructions of a listed low-voltage lighting system.

[2]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 a 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.

6. If Electrical Metallic Tubing (EMT) is directly buried, it shall be galvanized and coated with supplementary corrosion protection to the point of emergence above grade.

Statement of Problem and Substantiation for Public Comment

Generally, galvanized steel EMT in contact with soil always would require supplementary corrosion protection. Where galvanized steel EMT without supplementary corrosion protection extends directly from concrete encasement to soil burial, severe corrosive effects are likely to occur on the metal in contact with the soil. Installing EMT in direct contact with soil in violation of the UL Guide Information. The UL Guide information on Electrical Metallic Tubing FJMX (used in the substantiation for the Public Input) reads, "Galvanized or stainless steel EMT installed in concrete on grade or above generally requires no supplementary corrosion protection. Galvanized steel EMT in concrete slab below grade level may require supplementary corrosion protection. Also, consider that there is no requirement that a supplemental equipment grounding conductor be contained in EMT that is directly buried, so if the EMT fails, as it is likely to do, the equipment grounding conductor path is lost.

Related Item

• FR 9323

Submitter Information Verification

Submitter Full Name: Dean Hunter
Organization: Minnesota Department of Labor
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 17 11:45:29 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8551-NFPA 70-2021

Statement: There are other types of EMT aside from galvanized, and not all require supplemental protection. Pointing the reader to 358.10 will help them decide if supplemental protection is needed.

EMT has been allowed in direct burial applications. UL 797 states that aluminum EMT needs supplemental corrosion protection for direct burial, but it does not mention that galvanized or stainless require supplemental corrosion protection. The guide card mentions that supplementary corrosion protection is generally required in direct contact with earth, but one cannot assume it is required as it would not be required for stainless conduit. One needs to rely on the UL guide card and Article 358 for EMT.

Public Comment No. 1764-NFPA 70-2021 [Section No. 300.5(A)]

(A) Minimum Cover Requirements.

Direct-buried cable, conduit, or other raceways shall be installed to meet the minimum cover requirements of Table 300.5.

Table 300.5 Minimum Cover Requirements, 0 to 1000 Volts ac, 1500 Volts dc, Nominal, Burial in Millimeters (Inches)

	- Type of Wiring Method or Circuit											
	Column 1 Direct Burial Cables or Conductors		Column 2 ~~Electrical Metallic Tubing,~~ 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			
Location of Wiring Method or Circuit	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.		
All locations not specified below	600	24	150	6	450	18	300	12	150[1,2]	6[1,2]		
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	0	0	0	0	0	0	0	0	0		
	-	(in raceway or Type MC or Type MI cable identified for direct burial)	-	-	-	-					(in raceway or Type MC or Type MI cable identified for direct burial)	(in raceway or Type MC or Type MI cable identified for direct burial)
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 is prohibited	450	18	450	18	450	18	450	18	450	18

[1]A lesser depth shall be permitted where specified in the installation instructions of a listed low-voltage lighting system.

[2]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 a 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.

Statement of Problem and Substantiation for Public Comment

The panel statement asserts that the current UL directory "recognizes ... Galvanized EMT for direct burial applications." That is incorrect. The actual entry (FJMX) reads as follows: "In general, galvanized steel EMT in contact with soil requires supplementary corrosion protection." This is protection beyond the galvanizing. It is true that such protection can be afforded in the field if the inspecting authority is willing to approve the relatively heroic efforts required, such as laboriously painting the entire length being buried with asphalt paint, but this is rare and generally unrealistic. By way of contrast, compare the equivalent sentence from the Guide Card information on rigid ferrous metal conduit, “Galvanized rigid ferrous metal conduit installed in contact with soil does not generally require supplementary corrosion protection.” The identical wording goes with IMC, and both sentences create a presumption of acceptability for the heavy wall products that is not there for EMT. Further, UL does not evaluate supplementary corrosion protection on EMT for this use. Although EMT may be available with supplementary protection, the Guide Card information on this topic reads: “Galvanized electrical metallic tubing that is provided with a metallic or nonmetallic coating, or a combination of both, has been investigated for resistance to atmospheric corrosion” (emphasis supplied). This means that inspectors are entirely on their own if they recognize any form of supplementary protection with respect to the corrosive influences of soil. And supplementary corrosion protection must always be applied unless there is a solid local record of positive experience, which is very unusual. On balance, EMT should not be used for direct burial absent a solid local track record of benign soil conditions. The addition of EMT in this column without any qualifications will, however inadvertently, encourage generally unsafe applications.

Related Item

- FR-9323

Submitter Information Verification

Submitter Full Name: Frederic Hartwell
Organization: Hartwell Electrical Services, Inc.
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 17 16:58:23 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8551-NFPA 70-2021

Statement: There are other types of EMT aside from galvanized, and not all require supplemental protection. Pointing the reader to 358.10 will help them decide if supplemental protection is needed.

EMT has been allowed in direct burial applications. UL 797 states that aluminum EMT needs supplemental corrosion protection for direct burial, but it does not mention that galvanized or stainless require supplemental corrosion protection. The guide card mentions that supplementary corrosion protection is generally required in direct contact with earth, but one cannot assume it is required as it would not be required for stainless conduit. One needs to rely on the UL guide card and Article 358 for EMT.

Public Comment No. 317-NFPA 70-2021 [Section No. 300.5(A)]

(A) Minimum Cover Requirements.

Direct-buried cable, conduit, or other raceways shall be installed to meet the minimum cover requirements of Table 300.5.

Table 300.5 Minimum Cover Requirements, 0 to 1000 Volts ac, 1500 Volts dc, Nominal, Burial in Millimeters (Inches)

	-	Type of Wiring Method or Circuit										
Location of Wiring Method or Circuit	Column 1 Direct Burial Cables or Conductors		Column 2 Electrical Metallic Tubing, 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[1,2]	6[1,2]		
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	0	0	0	0	0	0	0	0	0		
	-	(in raceway or Type MC or Type MI cable identified for direct burial)	-	-	-	-					(in raceway or Type MC or Type MI cable identified for direct burial)	(in raceway or Type MC or Type MI cable identified for direct burial)
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 is prohibited	450	18	450	18	450	18	450	18	450	18

[1]A lesser depth shall be permitted where specified in the installation instructions of a listed low-voltage lighting system.

[2]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 a 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.

6. If Electrical Metallic Tubing (EMT) is directly buried, it shall be galvanized and coated with supplementary corrosion protection to the point of emergence above grade.

Statement of Problem and Substantiation for Public Comment

The installation of EMT in direct burial applications is presently covered in 358.10(A)(1). It includes an appropriate reference to the installation requirements in 358.10(B). There appropriate corrosion protection is required.
A new 358.10(A)(4) that does not require appropriate corrosion protection has been added to 358.10(A)(4). This addition would be a serious departure from the safety mission of the NEC.
The UL Guide information on Electrical Metallic Tubing FJMX (mentioned in the Public Input but not quoted) reads, "Galvanized or stainless steel EMT installed in concrete on grade or above generally requires no supplementary corrosion protection. Galvanized steel EMT in concrete slab below grade level may require supplementary corrosion protection.

In general, galvanized steel EMT in contact with soil requires supplementary corrosion protection. Where galvanized steel EMT without supplementary corrosion protection extends directly from concrete encasement to soil burial, severe corrosive effects are likely to occur on the metal in contact with the soil."

Installing EMT in direct contact with soil in violation of the UL Guide Information would not only be unwise but can be unsafe. There is no requirement that a supplemental equipment grounding conductor be contained in EMT that is directly buried. If the EMT fails, as it is likely to do, the equipment grounding conductor path is lost. This can leave supplied equipment at an unsafe shock or electrocution hazard.

Many local authorities having jurisdiction prohibit EMT from being directly buried, and for good reason. EMT in the soil has a very poor performance record.

Related Item

• FR-9323

Submitter Information Verification

Submitter Full Name:	Phil Simmons
Organization:	Simmons Electrical Services
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Jul 21 00:09:08 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8551-NFPA 70-2021
Statement:	There are other types of EMT aside from galvanized, and not all require supplemental protection. Pointing the reader to 358.10 will help them decide if supplemental protection is needed. EMT has been allowed in direct burial applications. UL 797 states that aluminum EMT needs supplemental corrosion protection for direct burial, but it does not mention that galvanized or stainless require supplemental corrosion protection. The guide card mentions that supplementary corrosion protection is generally required in direct contact with earth, but one cannot assume it is required as it would not be required for stainless conduit. One needs to rely on the UL guide card and Article 358 for EMT.

Public Comment No. 520-NFPA 70-2021 [New Section after 300.5(D)]

TITLE OF NEW CONTENT

Under ground feeders and branch circuits

Add a new number 5 to read as follows

Under ground Feeders and Branch circuit conductors that are not encased in concrete and that are burried 450mm (18 in) or more below grade shall have their location identified by a warning ribbon that is placed in the trench at least 300mm (12 in) above the under ground installation.

Statement of Problem and Substantiation for Public Comment

Up until this proposal there has not been a requirement to install a warning ribbon above the under ground feeders and branch circuits it is dangerous not to mark the locations of these under ground installations

Related Item

- Public Input No. 1060-NFPA 70-2020 [Section No. 300.5(D)(3)]

Submitter Information Verification

Submitter Full Name:	Paul J Kennedy Jr
Organization:	Town of Andover Massachusetts
Affiliation:	wiring inspector
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Jul 28 16:48:34 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	Feeders and branch circuits have overcurrent protection ahead of them whereas service conductors do not (they may have limited overcurrent protection provided by the utility company). Though it is not required, it is permitted to install warning ribbon above feeders and branch circuits.

Public Comment No. 557-NFPA 70-2021 [Section No. 300.5(D)(3)]

(3) ~~Service Conductors~~ Underground Services, Feeders and Branch Circuits .

Underground ~~service conductors~~ Services, Feeders and Branch circuit conductors that are not encased in concrete and that are buried 450 mm (18 in.) or more below grade shall have their location identified by a warning ribbon that is placed in the trench at least 300 mm (12 in.) above the underground installation.

Statement of Problem and Substantiation for Public Comment

This proposal is being submitted to add protection to underground feeders and branch circuits that can be damaged by persons digging in the area. Warning ribbon/tape properly installed in the trench would serve to worn those doing the excavation, preventing possible personnel injury or death due to contact or flash burns and possible damage to conductors which could lead to power outages and possible fire.

Related Item

- Article 300.5 (D)(3)

Submitter Information Verification

Submitter Full Name: James Colleary
Organization: Colleary Electric
Affiliation: Wiring Inspector, Southborough Massachusetts
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jul 30 11:16:05 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: Feeders and branch circuits have overcurrent protection ahead of them whereas service conductors do not (they may have limited overcurrent protection provided by the utility company). Though it is not required, it is permitted to install warning ribbon above feeders and branch circuits.

Public Comment No. 1778-NFPA 70-2021 [Section No. 300.5(D) [Excluding any Sub-Sections]]

Direct-buried conductors and cables shall be protected from damage in accordance with 300.5(D)(1) through (D)(4). Buried raceways enclosing service conductors shall additionally meet the requirement in 300.5(D)(3).

Statement of Problem and Substantiation for Public Comment

The present literal text only applies the service path marking requirement to direct burial installations. It clearly should apply, and historically did apply prior to reorganization activity, to buried service raceways that are unencased in concrete, which is its own marking. A backhoe operating in the vicinity of a buried PVC service raceway should have the same warning as is now required for direct burial work. The panel statement supporting resolution of PI-4304 agreed with the concept that the marking rule should apply to a raceway, which moves the debate to how the literal text actually reads. The parent text, necessarily setting forth the parameters to which the first-level subdivision will apply, is a single sentence, and the subject of that sentence is "Direct-burial conductors and cables." Therefore, none of the four numbered paragraphs following apply to buried raceways, because once the wiring method is a raceway, the conductors (or cables) within it are by definition not directly buried, and if they are not directly-buried they are not covered by any of the four number paragraphs, including (3) on service work. This is open and shut.

Related Item

- PC-4304

Submitter Information Verification

Submitter Full Name: Frederic Hartwell

Organization: Hartwell Electrical Services, Inc.

Street Address:

City:

State:

Zip:

Submittal Date: Tue Aug 17 18:24:16 EDT 2021

Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8553-NFPA 70-2021

Statement: As indicated in this public comment, the parent text, necessarily setting forth the parameters to which the first-level subdivision will apply, is a single sentence, and the subject of that sentence is "Direct-burial conductors and cables." Therefore, none of the four numbered paragraphs following apply to buried raceways. By removing the words “Direct-buried” from the parent text, the subdivisions will now cover conductors whether they are in a raceway or are direct buried.

Public Comment No. 1542-NFPA 70-2021 [Section No. 300.6]

300.6 Protection Against Corrosion and Deterioration.

Raceways, cable trays, cablebus, auxiliary gutters, cable armor, boxes, cable sheathing, cabinets, ~~meter socket enclosures~~ enclosures (other than surrounding fences or walls) , elbows, couplings, fittings, supports, and support hardware shall be of materials suitable for the environment in which they are to be installed.

(A) Ferrous Metal Equipment.

Ferrous metal raceways, cable trays, cablebus, auxiliary gutters, cable armor, boxes, cable sheathing, cabinets, ~~meter socket enclosures~~ enclosures (other than surrounding fences or walls) , metal elbows, couplings, nipples, fittings, supports, and support hardware shall be suitably protected against corrosion inside and outside (except threads at joints) by a coating of approved corrosion-resistant material. Where corrosion protection is necessary and the conduit is threaded in the field, the threads shall be coated with an approved electrically conductive, corrosion-resistant compound.

Informational Note: Field-cut threads are those threads that are cut in conduit, elbows, or nipples anywhere other than at the factory where the product is listed.

Exception: Stainless steel shall not be required to have protective coatings.

(1) Protected from Corrosion Solely by Enamel.

Where protected from corrosion solely by enamel, ferrous metal raceways, cable trays, cablebus, auxiliary gutters, cable armor, boxes, cable sheathing, cabinets, ~~meter socket enclosures~~ enclosures (other than surrounding fences or walls) , metal elbows, couplings, nipples, fittings, supports, and support hardware shall not be used outdoors or in wet locations as described in 300.6(D).

(2) Organic Coatings on Boxes or Cabinets.

Where boxes, cabinets, ~~or meter socket enclosures~~ enclosures (other than surrounding fences or walls) , have an approved system of organic coatings and are marked “Raintight,” “Rainproof,” or “Outdoor Type,” they shall be permitted outdoors.

(3) In Concrete or in Direct Contact with the Earth.

Ferrous metal raceways, cable armor, boxes, cable sheathing, cabinets, ~~meter socket enclosures~~ enclosures (other than surrounding fences or walls) , elbows, couplings, nipples, fittings, supports, and support hardware shall be permitted to be installed in concrete or in direct contact with the earth, or in areas subject to severe corrosive influences where made of material approved for the condition or where provided with corrosion protection approved for the condition.

(B) Aluminum Metal Equipment.

Aluminum raceways, cable trays, cablebus, auxiliary gutters, cable armor, boxes, cable sheathing, cabinets, ~~meter socket enclosures~~ enclosures (other than surrounding fences or walls) , elbows, couplings, nipples, fittings, supports, and support hardware embedded or encased in concrete or in direct contact with the earth shall be provided with supplementary corrosion protection.

(C) Nonmetallic Equipment.

Nonmetallic raceways, cable trays, cablebus, auxiliary gutters, boxes, cables with a nonmetallic outer jacket and internal metal armor or jacket, cable sheathing, cabinets, ~~meter socket enclosures~~ enclosures (other than surrounding fences or walls) , elbows, couplings, nipples, fittings, supports, and support hardware shall be made of material approved for the condition and shall comply with 300.6(C)(1) and (C)(2) as applicable to the specific installation.

(1) Exposed to Sunlight.

Where exposed to sunlight, the materials shall be listed as sunlight resistant or shall be identified as sunlight resistant.

(2) Chemical Exposure.

Where subject to exposure to chemical solvents, vapors, splashing, or immersion, materials or coatings shall either be inherently resistant to chemicals based on their listing or be identified for the specific chemical reagent.

(D) Indoor Wet Locations.

In portions of dairy processing facilities, laundries, canneries, and other indoor wet locations, and in locations where walls are frequently washed or where there are surfaces of absorbent materials, such as damp paper or wood, the entire wiring system, where installed exposed, including all boxes, cabinets, ~~meter socket enclosures~~ enclosures (other than surrounding fences or walls) , fittings, raceways, and cable used therewith, shall be mounted so that there is at least a 6-mm (¼-in.) airspace between it and the wall or supporting surface.

Exception: Nonmetallic raceways, boxes, and fittings shall be permitted to be installed without the airspace on a concrete, masonry, tile, or similar surface.

Informational Note: In general, areas where acids and alkali chemicals are handled and stored might present such corrosive conditions, particularly when wet or damp. Severe corrosive conditions might also be present in portions of meatpacking plants, tanneries, glue houses, and some stables; in installations immediately adjacent to a seashore and swimming pool areas; in areas where chemical deicers are used; and in storage cellars or rooms for hides, casings, fertilizer, salt, and bulk chemicals.

Statement of Problem and Substantiation for Public Comment

CMP-3 needs to reconsider Public Input 3039. Per 90.3, Article 300 applies generally for Chapters 1 through 4, not just Article 312. Article 300 also applies to Chapter 5 through 7 and is permissible to modified Article 300. Section 110.28 states “enclosures (other than surrounding fences or walls)” and includes a list of enclosures including “meter sockets. “Enclosures (other than surrounding fences or walls)” is the correct reference for 300.6 and is not limited to “meter sockets” and Article 312.

Related Item

• FR 9357

Submitter Information Verification

Submitter Full Name:	Megan Hayes
Organization:	Nema
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon Aug 16 12:38:33 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8560-NFPA 70-2021
Statement:	As indicated by the submitter enclosures are not limited to "meter socket enclosures". Modifying, and adding the text as indicated in this public comment, “enclosures (other than surrounding fences and walls)” will aid in clarity and enforcement. Deleting the Informational Note and adding “anywhere other than at the factory where the product is listed”, makes it very clear that coating threads with an approved electrically conductive, corrosion-resistant compound is required unless the threads are cut at the factory where the product is listed.

Public Comment No. 1431-NFPA 70-2021 [Section No. 300.6(A)(2)]

(2) Organic Coatings on Boxes or Cabinets.

Where boxes, cabinets, or meter socket ~~enclosures, have~~ enclosures have an approved system of organic coatings and are marked “Raintight,” “Rainproof,” or “Outdoor Type,” they shall be permitted outdoors.

Statement of Problem and Substantiation for Public Comment

extraneous comma left as a typo after "enclosures". Delete the comma

Related Item

- FR 9357

Submitter Information Verification

Submitter Full Name: Chad Jones
Organization: Cisco Systems
Street Address:
City:
State:
Zip:
Submittal Date: Fri Aug 13 10:57:07 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8560-NFPA 70-2021

Statement: As indicated by the submitter enclosures are not limited to "meter socket enclosures". Modifying, and adding the text as indicated in this public comment, “enclosures (other than surrounding fences and walls)” will aid in clarity and enforcement.

Deleting the Informational Note and adding “anywhere other than at the factory where the product is listed”, makes it very clear that coating threads with an approved electrically conductive, corrosion-resistant compound is required unless the threads are cut at the factory where the product is listed.

Public Comment No. 664-NFPA 70-2021 [Section No. 300.6(A) [Excluding any Sub-Sections]]

Ferrous metal raceways, cable trays, cablebus, auxiliary gutters, cable armor, boxes, cable sheathing, cabinets, meter socket enclosures, metal elbows, couplings, nipples, fittings, supports, and support hardware shall be suitably protected against corrosion inside and outside (except threads at joints) by a coating of approved corrosion-resistant material. Where corrosion protection is necessary and the conduit is threaded in the field, the threads shall be coated with an approved electrically conductive, corrosion-resistant compound.

~~Informational Note: Field-cut threads are those threads that are cut in conduit, elbows, or nipples anywhere other than at the factory where the product is listed.~~

Exception: Stainless steel shall not be required to have protective coatings.

Statement of Problem and Substantiation for Public Comment

This IN contains a definition, which places it more appropriately in Article 100.

Related Item

- PI 2438

Submitter Information Verification

Submitter Full Name: David Shapiro
Organization: Safety First Electrical
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 03 08:58:18 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8560-NFPA 70-2021

Statement: As indicated by the submitter enclosures are not limited to "meter socket enclosures". Modifying, and adding the text as indicated in this public comment, “enclosures (other than surrounding fences and walls)” will aid in clarity and enforcement.

Deleting the Informational Note and adding “anywhere other than at the factory where the product is listed”, makes it very clear that coating threads with an approved electrically conductive, corrosion-resistant compound is required unless the threads are cut at the factory where the product is listed.

Public Comment No. 586-NFPA 70-2021 [Section No. 300.7(B)]

(B) Expansion, Expansion-Deflection, and Deflection Fittings.

Raceways shall be provided with expansion, expansion-deflection, or deflection fittings where necessary to compensate for thermal expansion, deflection, and contraction.

Informational Note No. 1: Table 352.44(A) and Table 355.44 provide the expansion information for polyvinyl chloride (PVC) and for reinforced thermosetting resin conduit (RTRC), respectively. A nominal number for steel conduit can be determined by multiplying the expansion length in Table 352.44(A) by 0.20. The coefficient of expansion for steel electrical metallic tubing, intermediate metal conduit, and rigid metal conduit is 1.170×10^{-5} (0.0000117 mm per mm of conduit for each °C in temperature change) [0.650×10^{-5} (0.0000065 in. per in. of conduit for each °F in temperature change)].

A nominal number for aluminum conduit and aluminum electrical metallic tubing can be determined by multiplying the expansion length in Table 352.44(A) by 0.40. The coefficient of expansion for aluminum electrical metallic tubing and aluminum rigid metal conduit is 2.34×10^{-5} (0.0000234 mm per mm of conduit for each °C in temperature change) [1.30×10^{-5} (0.000013 in. per in. of conduit for each °F in temperature change)].

~~Informational Note No. 2: See NEMA FB 2.40-2019, *Installation Guidelines for Expansion and Expansion/Deflection Fittings* , for further information on expansion and expansion deflection fittings.~~

Statement of Problem and Substantiation for Public Comment

I believe it would be more helpful for the committees to come up with some guidelines for when to use expansion fittings and when not to, rather than allowing organizations that publish and sell standards to attempt to cram more commercial breaks into the NEC, for an increasingly large list of standards most electricians can't afford to buy. Perhaps what would be more beneficial is if an informative annex could be developed for the next cycle, where some basic considerations for expansion fittings are discussed. Maybe in that annex, a reference to the NEMA standard could exist, for use on more involved designs. Or maybe we should for once come up with rules for when to use expansion fittings on RMC, EMT, and other wiring methods that thus far we have not clearly defined rules for in the same manner as we have for PVC.

Related Item

• First Revision No. 9364-NFPA 70-2021 [Section No. 300.7(B)]

Submitter Information Verification

Submitter Full Name: Josh Weaver
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Sun Aug 01 16:54:24 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: Informational notes are just that, informational, and are in place to provide additional information to the code user. Additionally, the NEMA document is available for free. The NEC is not an instructional manual as referenced in 90.1(A).

Public Comment No. 1315-NFPA 70-2021 [Section No. 300.10]

300.10 Electrical Continuity of Metal Raceways, Cable Armor, and Enclosures.

Metal raceways, cable armor, and other metal enclosures for conductors shall be metallically joined together into a continuous electrical conductor and shall be connected to all boxes, fittings, and cabinets to provide effective electrical continuity. ~~Unless specifically permitted elsewhere in this *Code* , raceways and cable assemblies shall be mechanically secured to boxes, fittings, cabinets, and other enclosures.~~

Exception No. 1: Short sections of raceways used to provide support or protection of cable assemblies from physical damage shall not be required to be made electrically continuous.

Exception No. 2: Equipment enclosures to be isolated, as permitted by 250.96(B), shall not be required to be metallically joined to the metal raceway.

Statement of Problem and Substantiation for Public Comment

The panel statement for PI 3716 correctly states that there is a difference between mechanical continuity and electrical continuity. That is precisely why I submitted PI 3716. If the CMP doesn't want to move the exception they should move the requirement. A companion comment to 300.12 for relocation will be made.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 1317-NFPA 70-2021 [Section No. 300.12]	

Related Item

- PI 3716

Submitter Information Verification

Submitter Full Name:	Ryan Jackson
Organization:	Ryan Jackson
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Aug 11 18:36:33 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	The last sentence in 300.10 points you to the mechanical requirements of 300.12, this is clear as written.

Public Comment No. 758-NFPA 70-2021 [Section No. 300.10]

300.10 Electrical Continuity of Metal Raceways, Cable Armor, and Enclosures.

Metal raceways, cable armor, and other metal enclosures for conductors shall be metallically joined together into a continuous electrical conductor and shall be connected to all boxes, fittings, and cabinets to provide effective electrical continuity. Unless specifically permitted elsewhere in this *Code*, raceways and cable assemblies shall be mechanically secured to boxes, fittings, cabinets, and other enclosures.

Exception No. 1: ~~Short sections~~ Sections of ~~raceways~~ raceway used to ~~provide~~ support or ~~protection of cable assemblies from physical damage~~ protect cable assemblies, that are unlikely to be contacted by people or equipment due to length or location, shall not be required to be made electrically continuous.

Exception No. 2: Equipment enclosures to be isolated, as permitted by 250.96(B), shall not be required to be metallically joined to the metal raceway.

Statement of Problem and Substantiation for Public Comment

Mr. Holt makes a valid point about the arbitrary term "short" being due for removal. At the same time, valid criteria are needed to accomplish the safety purpose it attempted to serve. I suggest some, while also attempting to tighten the language without otherwise changing the meaning.

Related Item

• PI 1735

Submitter Information Verification

Submitter Full Name:	David Shapiro
Organization:	Safety First Electrical
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Aug 04 03:01:46 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	Removing the term ‘short sections of raceway’ could create enforcement problems. There has to be some limiting method to the length of raceway permitted in this exception and different installations may require different lengths of raceways. While the current language limits the length, section 110.2 can be utilized by the authority having jurisdiction to allow lengths as needed for special circumstances. Similarly, the term “unlikely to be contacted by people….” could create enforcement problems based on the interpretation of the AHJ.

Public Comment No. 1611-NFPA 70-2021 [Section No. 300.11(C)]

(C) Raceways Used as Means of Support.

Raceways shall be used only as a means of support for other raceways, cables, or nonelectrical equipment under any of the following conditions:

(1) Where the raceway or means of support is identified as a means of support

(2) Where the raceway contains power supply conductors for electrically controlled equipment and is used to support Class 2, Class 3, or Class ~~3~~ 4 circuit conductors or cables that are solely for the purpose of connection to the equipment control circuits

(3) Where the raceway is used to support boxes or conduit bodies in accordance with 314.23 or to support luminaires in accordance with 410.36(E)

Statement of Problem and Substantiation for Public Comment

See first draft section 726.343.

Related Item

- FR 9606

Submitter Information Verification

Submitter Full Name:	Ryan Jackson
Organization:	Ryan Jackson
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon Aug 16 16:38:53 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	The text of 300.11(C)(2) refers to equipment control circuits. Including Class 4 in this list would be inappropriate as they are not generally control circuits.

Public Comment No. 1317-NFPA 70-2021 [Section No. 300.12]

300.12 Mechanical Continuity — Raceways and Cables.

Raceways, cable armors, and cable sheaths shall be continuous between cabinets, boxes, fittings, or other enclosures or outlets. Unless specifically permitted elsewhere in this *Code* , raceways and cable assemblies shall be mechanically secured to boxes, fittings, cabinets, and other enclosures.

Exception No. 1: Short sections of raceways used to provide support or protection of cable assemblies from physical damage shall not be required to be mechanically continuous.

Exception No. 2: Raceways and cables installed into the bottom of open bottom equipment, such as switchboards, motor control centers, and floor or pad-mounted transformers, shall not be required to be mechanically secured to the equipment.

Statement of Problem and Substantiation for Public Comment

Please see companion public comment to 300.10.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 1315-NFPA 70-2021 [Section No. 300.10]	Companion

Related Item

- PI 3716

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Ryan Jackson
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 11 18:45:53 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: The proposed sentence to be relocated from 300.10 to 300.12 belongs in 300.10 to point the user to 300.12. Electrical continuity, mechanical continuity, and mechanical securement are three different things. You can have mechanical securement and electrical continuity without mechanical continuity. This sentence in best located in 300.10, to eliminate the confusion where the raceway, armor, or enclosure is not mechanically connected to the equipment.

Public Comment No. 757-NFPA 70-2021 [Section No. 300.12]

300.12 Mechanical Continuity — Raceways and Cables.

Raceways, cable armors, and cable sheaths shall be continuous between cabinets, boxes, fittings including conduit bodies , or other enclosures or outlets.

Exception No. 1: Short sections of raceways used to provide support or protection of cable assemblies from physical damage shall not be required to be mechanically continuous.

Exception No. 2: Raceways and cables installed into the bottom of open bottom equipment, such as switchboards, motor control centers, and floor or pad-mounted transformers, shall not be required to be mechanically secured to the equipment.

Statement of Problem and Substantiation for Public Comment

Mr. Ganiere makes a valid a point. Without reading UL 514B an installer or inspector may not recognize conduit bodies are (in the U.S. and Mexico) “fittings.” The Article 100 definition of “conduit body” does not include the word “fitting,” not are conduit bodies included among Article 100's admitedly non-exhaustive examples of fittings.

Related Item

- PI 2035

Submitter Information Verification

Submitter Full Name:	David Shapiro
Organization:	Safety First Electrical
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Aug 04 02:56:56 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8566-NFPA 70-2021
Statement:	Precedent exists in the titles of the neighboring sections. “300.15 Boxes, Conduit Bodies, or Fittings — Where Required. “ “300.16 Raceway or Cable to Open or Concealed Wiring. (A) Box, Conduit Body, or Fitting.” To remain consistent with other section headings, it is appropriate to add ‘conduit bodies’ to this section.

Public Comment No. 1318-NFPA 70-2021 [Section No. 300.14]

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. The 150 mm (6 in.) free conductor ~~is permitted~~ shall be permitted to be spliced or unspliced. 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.

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

Statement of Problem and Substantiation for Public Comment

This edit provides consistency with the rest of the NEC.

Related Item

- FR 9233

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Ryan Jackson
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 11 18:56:39 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Accepted

Resolution: SR-8567-NFPA 70-2021

Statement: The proposed language modification will aid with clarity and consistency and is consistent with other sections of the NEC.

Public Comment No. 1774-NFPA 70-2021 [Section No. 300.14]

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. ~~The 150 mm (6 in.) free conductor is permitted to be spliced or unspliced.~~ 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.

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

Statement of Problem and Substantiation for Public Comment

The present wording of this section resulted from Proposal 3-103 in the 1999 NEC cycle. It was submitted by a task group taken from CMP 3 and CMP 9. I was the leader of the CMP 9 representation on that task group, which was appointed after a controversy erupted during my tenure at Electrical Construction and Maintenance Magazine. We ran a Code Forum discussion, focused on whether the 6-inch rule applied from the face of the box opening, or from the entry point of the wires. At the time, CMP 3 argued for the former, and CMP 9, having recently reevaluated box sizes generally, argued for the latter. The result was the compromise now in the Code. The idea is you measure from the entry point, but the wires have to be long enough to be worked outside the box (defined as 3 in.) and you get a pass if the opening is big enough to get both hands into the box (defined as at least 8 in. by 8 in.). The PI submitter raised the issue of wire damage. Well, problems (generally expressed as a four-letter word) happen. This is why 334.30 now allows an 18-in. spacing from box to the nearest cable support, which allows for undamaged cable to be pulled in to replace damaged conductors without opening the wall. Splicing applied with insufficient room for both hands is asking for future failures, which in turn is why the CMP 3 members on the task group at the time were adamant on a minimum length after emergence from the wall. CMP 3 should not be relaxing this rule without careful attention to the reasons it is worded the way it is. The CMP 3 statement in the 2008 cycle was incorrect.

Related Item

- FR-9233

Submitter Information Verification

Submitter Full Name:	Frederic Hartwell
Organization:	Hartwell Electrical Services, Inc.
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 17 17:37:16 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	It is agreed that things happen, and that adequate conductor length should be provided during the initial installation however, if the conductor is damaged at some point after the initial installation, the individual who did the installation of the wiring should not be penalized with the responsibility for making any necessary corrections. Allowing the conductor to be spliced or unspliced allows for a corrective method after the original installation.

Public Comment No. 1060-NFPA 70-2021 [Section No. 300.15(F)]

(F) Fitting.

A fitting identified for the use shall be permitted in lieu of a box or conduit body where conductors are not spliced or terminated within the fitting. The fitting shall be accessible after installation, ~~unless listed for concealed installation~~ if the fitting is designed as a pull point .

Statement of Problem and Substantiation for Public Comment

This comment is in support of public input 4118, which sought to modify this text. A statement describing the reason for the rejection says that there is no substantiation for the removal and/or modification of the text. It was further stated that if a fitting is not specifically listed for concealment, it should not be concealed.

There doesn't seem to be a substantiation to keep the old text and refuse the public input. UL seems to have no specific listing for fittings listed for concealment. Many of the listed fittings that are used for example, to convert from LFMC to RMC, or from MC to EMT, are nearly the same type of construction as the couplings and locknut style connectors that end up being concealed behind the building surfaces. See examples for links to fittings.

https://www.emerson.com/en-us/catalog/o-zgedney-4q-fm-lt-ozg?fetchFacets=true#facet:&partsFacet:&facetLimit:&productBeginIndex:0&partsBeginIndex:0&orderBy:0&partsOrderBy:&pageView:list&minPrice:&maxPrice:&pageSize:&

https://www.bptfittings.com/store/280-dcx-transition.html

Related Item

• Public Input No. 4118-NFPA 70-2020 [Section No. 300.15(F)]

Submitter Information Verification

Submitter Full Name:	Josh Weaver
Organization:	Josh Weaver
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sat Aug 07 10:57:47 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	Existing text does not need substantiation; that happened when it was placed into the code. This public comment lacks substantiation. The articles for the different wiring methods allow one to use them for exposed or concealed locations and the fittings that are used for these raceways are allowed to be used in the same locations. EMT set screw fittings are listed for exposed or concealed locations because the conduit itself is allowed to be used in those locations. Going from flex to EMT, for example, is made before pulling the conductors in so those fittings are also allowed in concealed locations because both wiring methods are allowed to be used in concealed locations.

Public Comment No. 2166-NFPA 70-2021 [Section No. 300.15(F)]

(F) Fitting.

A fitting identified for the use shall be permitted in lieu of a box or conduit body where conductors are not spliced or terminated within the fitting. The fitting <u>used in lieu of a box or conduit body</u> shall be accessible after installation, unless listed for concealed installation.

Statement of Problem and Substantiation for Public Comment

Pubic inputs 4118 and 4483 were submitted to establish the listing requirement for concealment to where that listing has technical merit and is necessity and to eliminate a broad general application to conduit, EMT or other such fittings. The panel resolved Public Inputs 4118 and 4483 with the following statement:

"The public input did not include technical justification that requires the removal/modification of this text. Fittings must be installed in accordance with Section 110.3(B) and can be concealed if listed for concealment. If a coupling or fitting is not listed for concealment, then it should not be concealed."

There is no argument that 110.3(B) listing and manufacturer's instructions need to be followed. The problem that was being resolved with the 2020 Code change was the misapplication by some using the second sentence of 300.15(F) as a standalone requirement to be applied to all fittings including rigid conduit and EMT couplings and cable transition fittings that do not require any access after the installation is complete. If the whole text of 300.15(F) is taken together, the listing for concealment would be "fittings" used in lieu of a box or conduit body. The revised text clarifies that the fitting used in place of a box or conduit body as provided in the first sentence is the one that must be accessible or allowed to be concealed only if listed for concealment.

Related Item

- PIs 4118 and 4483

Submitter Information Verification

Submitter Full Name: Charles Mello
Organization: Cdcmello Consulting Llc
Street Address:
City:
State:
Zip:
Submittal Date: Thu Aug 19 15:12:04 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: The second sentence in section 300.15(F) is not a standalone sentence and the fittings referenced in the second sentence are the ones permitted in the first sentence. The charging text of 300.10(F) requires a box, unless otherwise permitted in 300.15(A) through (L). As such, the proposed language in this public comment is not needed as the proposed text is already covered in the charging text.

Public Comment No. 1319-NFPA 70-2021 [Section No. 300.15 [Excluding any Sub-Sections]]

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 outlet point, switch point, conductor splice point, conductor junction point, conductor termination point, ~~wiring method transition point,~~ or conductor pull point, unless otherwise permitted in 300.15(A) through (L).

Statement of Problem and Substantiation for Public Comment

Why would I need a box to transition between wiring methods??? A box for changing from PVC to RMC at an underground sweep? This change was made based on a common misunderstanding and misapplication of this section. It has never applied to such a transition, nor should it. The fact that 300.15(F) allows the transition is immaterial, as adding the language about "listed for concealment" was also based on the same misunderstanding of the requirement. The fitting is ALWAYS required to be listed, as indicated in the second sentence of this section. Public Input 3334 should have been accepted as submitted.

Related Item

• PI 3334 • FR 9241

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Ryan Jackson
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 11 18:58:35 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: As indicated in the charging text of section 300.15 a box is required unless otherwise permitted. Clarification that these are conductor splice, termination, junction, and pull points was needed and this first draft revision was created to help eliminate misinterpretations. The wording “wiring method transition points” was added to the end of the new language to provide direction on handling installations where wiring methods change from one type to another. As wiring method transition fittings are covered by 300.15(F), this type of point in the wiring system was added as it must be included in the charging language of 300.15. If we lose wiring methods transition fittings from being covered in the charging paragraph of 300.15 then the enforcement of wiring method transition fittings as being listed for the wiring methods they are used with will no longer apply to these points on the wiring system.

Public Comment No. 1785-NFPA 70-2021 [Section No. 300.17]

300.17 Number and Size of Conductors and Cables in Raceway.

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

Informational Note: See the following sections of this *Code*: intermediate metal conduit, 342.22; rigid metal conduit, 344.22; flexible metal conduit, 348.22; liquidtight flexible metal conduit, 350.22; PVC conduit, 352.22; HDPE conduit, 353.22; RTRC, 355.22; liquidtight nonmetallic flexible conduit, 356.22; electrical metallic tubing, 358.22; flexible metallic tubing, 360.22; electrical nonmetallic tubing, 362.22; cellular concrete floor raceways, 372.22; cellular metal floor raceways, 374.22; metal wireways, 376.22; nonmetallic wireways, 378.22; surface metal raceways, 386.22; surface nonmetallic raceways, 388.22; underfloor raceways, 390.22; fixture wire, 402.7; theaters, 520.6; signs, 600.31(C); elevators, 620.33; audio signal processing, amplification, and reproduction equipment, 640.23(A) and 640.24; Class 1 ~~, Class 2, and~~ circuits, Article 724; Class 2 and Class 3 circuits, Article 725; ~~fire~~ Class 4 circuits, Article 726; fire alarm circuits, Article 760; and optical fiber cables and raceways, Article 770.

Statement of Problem and Substantiation for Public Comment

Chapter 7 underwent some reorganization that pulled Class 1 circuits out of the article with Class 2 and Class 3, and a new Class 4 article was added. This added text, points the reader to the proper sections.

Related Item

- PI 2774 and PI 3740

Submitter Information Verification

Submitter Full Name: Chad Jones
Organization: Cisco Systems
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 17 18:47:32 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8521-NFPA 70-2021

Statement: Chapter 7 was reorganized which relocated Class 1 circuits out of the article with Class 2 and Class 3. Also, a new Class 4 was created. Fire alarm circuits were divided between PLFA and NPLFA. A new article for limited power and fault manages cables was created. The added text will point the code user to the proper code sections.

Public Comment No. 1966-NFPA 70-2021 [Section No. 300.17]

300.17 Number and Size of Conductors and Cables in Raceway.

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

Informational Note: See the following sections of this *Code*: intermediate metal conduit, 342.22; rigid metal conduit, 344.22; flexible metal conduit, 348.22; liquidtight flexible metal conduit, 350.22; PVC conduit, 352.22; HDPE conduit, 353.22; RTRC, 355.22; liquidtight nonmetallic flexible conduit, 356.22; electrical metallic tubing, 358.22; flexible metallic tubing, 360.22; electrical nonmetallic tubing, 362.22; cellular concrete floor raceways, 372.22; cellular metal floor raceways, 374.22; metal wireways, 376.22; nonmetallic wireways, 378.22; surface metal raceways, 386.22; surface nonmetallic raceways, 388.22; underfloor raceways, 390.22; fixture wire, 402.7; theaters, 520.6; signs, 600.31(C); elevators, 620.33; audio signal processing, amplification, and reproduction equipment, 640.23(A) and 640.24; Class 1, Class 2, and Class 3 circuits, Article 725; fire alarm circuits, Article 760; and optical fiber cables and raceways, Article 770.

Additional Proposed Changes

File Name	Description	Approved
CN_382.pdf	70_CN382	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 382 appeared in the First Draft Report.

The Correlating Committee directs the panel to revise the informational note to comply with Section 4.1 of the NEC Style Manual. The entire article is not permitted to be referenced in an informational note.

Related Item

- Correlating Note No. 382

Submitter Information Verification

Submitter Full Name:	CC on NEC-AAC
Organization:	NEC Correlating Committee
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Aug 18 20:48:38 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8521-NFPA 70-2021
Statement:	Chapter 7 was reorganized which relocated Class 1 circuits out of the article with Class 2 and Class 3. Also, a new Class 4 was created. Fire alarm circuits were divided between PLFA and NPLFA. A new article for limited power and fault manages cables was created. The added text will point the code user to the proper code sections.

Correlating Committee Note No. 382-NFPA 70-2021 [Section No. 300.17]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Fri May 07 11:57:31 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs the panel to revise the informational note to comply with Section 4.1 of the NEC Style Manual. The entire article is not permitted to be referenced in an informational note.

FR-9256-NFPA 70-2021

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
0 Not Returned
12 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Johnston, Michael J.

Kendall, David H.

Kovacik, John R.

Manche, Alan

McDaniel, Roger D.

Porter, Christine T.

Williams, David A.

Public Comment No. 907-NFPA 70-2021 [Section No. 300.17]

300.17 Number and Size of Conductors and Cables in Raceway.

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

Informational Note: See the following sections of this *Code*: intermediate metal conduit, 342.22; rigid metal conduit, 344.22; flexible metal conduit, 348.22; liquidtight flexible metal conduit, 350.22; PVC conduit, 352.22; HDPE conduit, 353.22; RTRC, 355.22; liquidtight nonmetallic flexible conduit, 356.22; electrical metallic tubing, 358.22; flexible metallic tubing, 360.22; electrical nonmetallic tubing, 362.22; cellular concrete floor raceways, 372.22; cellular metal floor raceways, 374.22; metal wireways, 376.22; nonmetallic wireways, 378.22; surface metal raceways, 386.22; surface nonmetallic raceways, 388.22; underfloor raceways, 390.22; fixture wire, 402.7; theaters, 520.6; signs, 600.31(C); elevators, 620.33; audio signal processing, amplification, and reproduction equipment, 640.23(A) and 640.24; Class 1, Class 2, and Class 3 circuits, ~~Article~~ ~~725~~ ~~;~~ fire alarm circuits, ~~Article~~ ~~760~~ ~~; and~~ and optical fiber cables and raceways, Article ~~770~~ 722 .

Statement of Problem and Substantiation for Public Comment

The cable requirements for Class 2, Class 3, power-limited fire alarm cable and optical fiber circuits are now located in Article 722. The informational note should reference Article 722 rather than 725, 760 and 770.

Related Item

- FR 9582

Submitter Information Verification

Submitter Full Name:	Susan Stene
Organization:	UL LLC
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Aug 04 16:47:02 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8521-NFPA 70-2021
Statement:	Chapter 7 was reorganized which relocated Class 1 circuits out of the article with Class 2 and Class 3. Also, a new Class 4 was created. Fire alarm circuits were divided between PLFA and NPLFA. A new article for limited power and fault manages cables was created. The added text will point the code user to the proper code sections.

Public Comment No. 1320-NFPA 70-2021 [Section No. 300.18(A)]

(A) Complete Runs.

Raceways other than busways, listed manufactured assemblies ~~as identified~~ in accordance with 604.100, or exposed raceways having hinged or removable covers shall be installed complete between outlet, junction, or splicing points prior to the installation of conductors or cables. Where required to facilitate the installation of utilization equipment, the raceway shall be permitted to be initially installed without a terminating connection at the equipment. Prewired raceway assemblies shall be permitted only where specifically permitted in this *Code* for the applicable wiring method.

Exception: Short sections of raceways used to contain conductors or cable assemblies for protection from physical damage shall not be required to be installed complete between outlet, junction, or splicing points.

Statement of Problem and Substantiation for Public Comment

The word "identified" is defined in Article 100, and is being used incorrectly in this section.

Related Item

- FR 9258

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Ryan Jackson
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 11 19:04:29 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Accepted
Resolution: SR-8570-NFPA 70-2021
Statement: As indicated, identified is a defined term in Article 100 and is not applicable as referenced in this sentence. "In accordance with" is the correct wording and will aid in clarity.

Public Comment No. 1321-NFPA 70-2021 [Section No. 300.25]

300.25 Exit Enclosures (Stair Towers).

Where an exit enclosure is required to ~~be separated from the building~~ have a fire-resistance rating , only electrical wiring methods serving equipment permitted by the authority having jurisdiction in the exit enclosure shall be installed within the exit enclosure.

Exception: Where egress lighting is required on outside exterior doorways from the exit enclosure, luminaires shall be permitted to be supplied from the inside of the exit enclosure.

Informational Note: See NFPA *101*-2021, *Life Safety Code*, 7.1.3.2.1(10)(b), for more information.

Statement of Problem and Substantiation for Public Comment

"Fire-resistance rating" is the term used in the IBC.

Related Item

- FR 9267

Submitter Information Verification

Submitter Full Name:	Ryan Jackson
Organization:	Ryan Jackson
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Aug 11 19:07:12 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Accepted
Resolution:	SR-8571-NFPA 70-2021
Statement:	Fire-resistance rating is a defined term in the building Code and was accepted to add clarity to the section.

Public Comment No. 1879-NFPA 70-2021 [Article 305]

~~**Article 305** Requirements for Wiring Methods and Materials for Systems Rated Over 1000 Volts ac, 1500 Volts dc, Nominal~~

~~**Part I.** General~~

~~**305.1** Scope.~~

~~This article covers wiring methods and materials for wiring installations for systems rated over 1000 volts ac, 1500 volts dc, nominal.~~

~~**305.2** Definitions.~~

~~The definition in this section shall only apply within this article.~~

~~**Outdoor Overhead Conductors.**~~

~~Single conductors, insulated, covered, or bare, installed outdoors on support structures in free air.~~

~~**305.3** Conductors of Different Systems.~~

~~Conductors of circuits rated over 1000 volts ac, 1500 volts dc, nominal, shall not occupy the same equipment wiring enclosure, cable, or raceway with conductors of circuits rated 1000 volts ac, 1500 volts dc, nominal, or less unless otherwise permitted as follows:~~

(1) ~~Where contained within the individual wiring enclosure, primary leads of electric-discharge lamp ballasts insulated for the primary voltage of the ballast shall be permitted to occupy the same luminaire, sign, or outline lighting enclosure as the branch-circuit conductors.~~

(2) ~~Excitation, control, relay, and ammeter conductors used in connection with any individual motor or starter shall be permitted to occupy the same enclosure as the motor-circuit conductors.~~

(3) ~~Conductors of different voltage ratings shall be permitted in motors, transformers, switchgear, switchboards, control assemblies, and similar equipment.~~

(4) ~~If the conductors of each system in a manhole are permanently and effectively separated from the conductors of the other systems and securely fastened to racks, insulators, or other approved supports, conductors of different voltage ratings shall be permitted.~~

~~Conductors having nonshielded insulation and operating at different voltage levels shall not occupy the same enclosure, cable, or raceway.~~

~~**305.4** Conductor Bending Radius.~~

~~The conductor shall not be bent to a radius less than 8 times the overall diameter for nonshielded conductors or 12 times the overall diameter for shielded or lead-covered conductors during or after installation. For multiconductor or multiplexed single-conductor cables having individually shielded conductors, the minimum bending radius shall be 12 times the diameter of the individually shielded conductors or 7 times the overall diameter, whichever is greater.~~

~~**305.5** Protection Against Induction Heating.~~

~~Metallic raceways and associated conductors shall be arranged to avoid heating of the raceway in accordance with 300.20 .~~

~~**305.6** Covers Required.~~

~~Suitable covers shall be installed on all boxes, fittings, and similar enclosures to prevent accidental contact with energized parts or physical damage to parts or insulation.~~

~~**305.7** Wiring Methods.~~

~~Conductors shall be permitted to be installed in accordance with any of the wiring methods identified in Table 305.7.~~

~~Table 305.7 Wiring Methods Permitted for Use in Systems Rated Over 1000 Volts ac, 1500 Volts dc, Nominal~~

~~Wiring Methods Permitted for Use Above 1000 Volts ac, 1500 Volts dc Voltage Levels Reference Pull and junction boxes, conduit bodies, and handhole enclosures Over 1000 Article 305, Part II Metal-clad cable (Type MC) 0–35,000 Article 330 Type P cable 0–2000 Article 337 Intermediate metal conduit (Type IMC) Not specified Article 342 Rigid metal conduit (Type RMC) Not specified Article 344 Rigid polyvinyl chloride conduit~~

~~(Type PVC) Not specified Article 352 Reinforced thermosetting resin conduit (Type RTRC) Not specified Article 355 Electrical metallic tubing (Type EMT) Not specified Article 358 Auxiliary gutters Not specified Article 366 Busway Over 1000 Article 305, Part III Cablebus 0–35,000 Article 370 Cable trays 0–35,000 Article 392 Messenger-supported wiring 0–35,000 Article 396 Outdoor overhead conductors Over 1000 Article 305, Part IV Insulated bus pipe (Type IBP) 0–35,000 ac Article 369~~

~~Exposed runs of Type MV cables, bare conductors, and bare busbars shall be permitted in locations accessible only to qualified persons. Busbars shall be permitted to be either copper or aluminum.~~

~~*Exception: Airfield lighting cable used in series circuits that are powered by regulators and installed in restricted airport lighting vaults shall be permitted as exposed cable installations.*~~

~~Informational Note: An example of a common application is FAA L-824 cables installed as exposed runs within a restricted vault area.~~

~~**305.8** Raceways in Wet Locations Above Grade.~~

~~Where raceways are installed in wet locations above grade, the interior of these raceways shall be considered to be a wet location. Insulated conductors and cables installed in raceways in wet locations above grade shall be either moisture-impervious metal-sheathed or of a type listed for use in wet locations.~~

~~**305.9** Braid-Covered Insulated Conductors — Exposed Installation.~~

~~Exposed runs of braid-covered insulated conductors shall have a flame-retardant braid. If the conductors used do not have this protection, a flame-retardant saturant shall be applied to the braid covering after installation. This treated braid covering shall be stripped back a safe distance at conductor terminals, according to the operating voltage. Where practicable, this distance shall not be less than 25 mm (1 in.) for each kilovolt of the conductor-to-ground voltage of the circuit.~~

~~**305.10** Insulation Shielding.~~

~~Metallic and semiconducting insulation shielding components of shielded cables shall be removed for a distance dependent on the circuit voltage and insulation. Stress reduction means shall be provided at all terminations of factory-applied shielding.~~

~~Metallic shielding components such as tapes, wires, or braids, or combinations of them, shall be connected to an equipment grounding conductor, an equipment grounding busbar, or a grounding electrode.~~

~~**305.11** Moisture or Mechanical Protection for Metal-Sheathed Cables.~~

~~Where cable conductors emerge from a metal sheath and where protection against moisture or physical damage is necessary, the insulation of the conductors shall be protected by a cable sheath terminating device.~~

~~**305.12** Danger Signs.~~

~~Danger signs shall be conspicuously posted at points of access to conductors in all raceway systems and cable systems. The sign(s) shall meet the requirements in 110.21(B), shall be readily visible, and shall state the following:~~

~~DANGER—HIGH VOLTAGE—KEEP OUT~~

~~**305.15** Underground Installations.~~

~~**(A)** General.~~

~~Underground conductors shall be identified for the voltage and conditions under which they are installed. Conductors used for direct-burial applications shall be of a type identified for such use. Underground cables shall be installed in accordance with 305.15(A)(1), (A)(2), or (A)(3), and the installation shall meet the depth requirements of Table 305.15.~~

~~Table 305.15 Minimum Cover Requirements~~

~~- General Conditions (not otherwise specified) Special Conditions (use if applicable) - Column 1 Column 2 Column 3 Column 4 Column 5 Column 6 - Direct-Buried Cables [1] Electrical Metallic Tubing, RTRC, PVC, and HDPE Conduit [2] Rigid Metal Conduit and Intermediate Metal Conduit Raceways Under Buildings or Exterior Concrete Slabs, 100 mm (4 in.) Minimum Thickness [3] Cables in Airport Runways or Adjacent Areas Where Trespass Is Prohibited Areas Subject to Vehicular Traffic, Such as Thoroughfares and Commercial Parking Areas Circuit Voltage mm in. mm in. mm in. mm in. mm in. mm in. Over 1000 V ac, 1500 V dc, through 22 kV 750 30 450 18 150 6 100 4 450 18 600 24 Over 22 kV through 40 kV 900 36 600 24 150 6 100 4 450 18 600 24 Over 40 kV 1000 42 750 30 150 6 100 4 450 18 600 24~~

~~Notes:~~

~~1. Cover shall be defined as the shortest distance in millimeters (inches) 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. Lesser depths shall be permitted where cables and conductors rise for terminations or splices or where access is otherwise required.~~

~~3. Where solid rock prevents compliance with the cover depths specified in this table, the wiring shall be installed in a metal or 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.~~

~~4. In industrial establishments, where conditions of maintenance and supervision ensure that qualified persons will service the installation, the minimum cover requirements for other than rigid metal conduit and intermediate metal conduit shall be permitted to be reduced 150 mm (6 in.) for each 50 mm (2 in.) of concrete or equivalent placed entirely within the trench over the underground installation.~~

~~[1] Underground direct-buried cables that are not encased or protected by concrete and are buried 750 mm (30 in.) or more below grade shall have their location identified by a warning ribbon that is placed in the trench at least 300 mm (12 in.) above the cables.~~

~~[2] Listed by a qualified testing agency as suitable for direct burial without encasement. All other nonmetallic systems shall require 50 mm (2 in.) of concrete or equivalent above conduit in addition to the table depth.~~

~~[3] The slab shall extend a minimum of 150 mm (6 in.) beyond the underground installation, and a warning ribbon or other effective means suitable for the conditions shall be placed above the underground installation.~~

~~**(1)** Shielded Cables and Nonshielded Cables in Metal-Sheathed Cable Assemblies.~~

~~Underground cables, including nonshielded, Type MC and moisture-impervious metal sheath cables, shall have those sheaths grounded through an effective grounding path meeting the requirements of 250.4(A)(5) or 250.4(B)(4). They shall be direct buried or installed in raceways identified for the use.~~

~~**(2)** Industrial Establishments.~~

~~In industrial establishments, where conditions of maintenance and supervision ensure that only qualified persons service the installed cable, nonshielded single-conductor cables with insulation types up to 2000 volts that are listed for direct burial shall be permitted to be directly buried.~~

~~**(3)** Other Nonshielded Cables.~~

~~Other nonshielded cables not covered in 305.15(A)(1) or (A)(2) shall be installed in rigid metal conduit, intermediate metal conduit, or rigid nonmetallic conduit encased in not less than 75 mm (3 in.) of concrete.~~

~~**(B)** Wet Locations.~~

~~The interior of enclosures or raceways installed underground shall be considered to be a wet location. Insulated conductors and cables installed in these enclosures or raceways in underground installations shall be listed for use in wet locations and shall be either moisture-impervious metal-sheathed or of a type listed for use in wet locations. Any connections or splices in an underground installation shall be approved for wet locations.~~

~~**(C)** Protection from Damage.~~

~~Conductors emerging from the ground shall be enclosed in listed raceways. Raceways installed on poles shall be of rigid metal conduit, intermediate metal conduit, RTRC-XW, Schedule 80 PVC conduit, or equivalent, extending from the minimum cover depth specified in Table 305.15 to a point 2.5 m (8 ft) above finished grade. Conductors entering a building shall be protected by an approved enclosure or raceway from the minimum cover depth to the point of entrance. Where direct-buried conductors, raceways, or cables are subject to movement by settlement or frost, they shall be installed to prevent damage to the enclosed conductors or to the equipment connected to the raceways. Metallic enclosures shall be grounded.~~

~~**(D)** Splices.~~

~~Direct burial cables shall be permitted to be spliced or tapped without the use of splice boxes if they are installed using materials suitable for the application. The taps and splices shall be watertight and protected from mechanical damage. Where cables are shielded, the shielding shall be continuous across the splice or tap.~~

~~*Exception: At splices of an engineered cabling system, metallic shields of direct-buried single-conductor cables with maintained spacing between phases shall be permitted to be interrupted and overlapped. Where shields are interrupted and overlapped, each shield section shall be grounded at one point.*~~

~~**(E)** Backfill.~~

~~Backfill containing large rocks, paving materials, cinders, large or sharply angular substances, or corrosive materials shall not be placed in an excavation where materials can damage or contribute to the corrosion of raceways, cables, or other substructures or where it might prevent adequate compaction of fill.~~

~~Protection in the form of granular or selected material or suitable sleeves shall be provided to prevent physical damage to the raceway or cable.~~

~~**(F)** Raceway Seal.~~

~~Where a raceway enters from an underground system, the end within the building shall be sealed with an identified compound to prevent the entrance of moisture.~~

~~Informational Note: Presence of hazardous gases or vapors might also necessitate sealing of underground conduits or raceways entering buildings.~~

~~**Part II.** Pull and Junction Boxes, Conduit Bodies, and Handhole Enclosures~~

~~**305.20** General.~~

~~**(A)** Pull and Junction Boxes.~~

~~Where pull and junction boxes are used on systems over 1000 volts ac, 1500 volts dc, the installation shall comply with the requirements of Part II of this article and with the following general requirements of Article 314:~~

(1) ~~Part I, 314.2; 314.3; and 314.4~~

(2) ~~Part II, 314.15; 314.17; 314.20; 314.23(A), (B), or (G); 314.28(B); and 314.29~~

(3) ~~Part III, 314.40(A) and (C); and 314.41~~

~~**(B)** Conduit Bodies.~~

~~Where conduit bodies are used on systems over 1000 volts ac, 1500 volts dc, the installation shall comply with the requirements of Part II of this article and with the following general requirements of Article 314:~~

(1) ~~Part I, 314.4~~

(2) ~~Part II, 314.15; 314.17; 314.23(A), (E), or (G); 314.28(A)(3); and 314.29~~

(3) ~~Part III, 314.40(A) and 314.41~~

~~**(C)** Handhole Enclosures.~~

~~Where handhole enclosures are used on systems over 1000 volts ac, 1500 volts dc, the installation shall comply with the requirements of Part II of this article and with the following general requirements of Article 314:~~

(1) ~~Part I, 314.3 and 314.4~~

(2) ~~Part II, 314.15; 314.17; 314.23(G); 314.28(B); 314.29; and 314.30~~

~~**305.21** Size of Pull and Junction Boxes, Conduit Bodies, and Handhole Enclosures.~~

~~Pull and junction boxes and handhole enclosures shall provide approved space and dimensions for the installation of conductors and shall comply with the specific requirements of this section. Conduit bodies shall be permitted if they meet the dimensional requirements for boxes.~~

~~**(A)** For Straight Pulls.~~

~~The length of the box shall not be less than 48 times the outside diameter, over sheath, of the largest shielded or lead-covered conductor or cable entering the box. The length shall not be less than 32 times the outside diameter of the largest nonshielded conductor or cable.~~

~~**(B)** For Angle or U Pulls.~~

~~**(1)** Distance to Opposite Wall.~~

~~The distance between each cable or conductor entry inside the box and the opposite wall of the box shall not be less than 36 times the outside diameter, over sheath, of the largest cable or conductor. This distance shall be increased for additional entries by the amount of the sum of the outside diameters, over sheath, of all other cables or conductor entries through the same wall of the box.~~

~~*Exception No. 1: Where a conductor or cable entry is in the wall of a box opposite a removable cover, the distance from that wall to the cover shall be permitted to be not less than the bending radius for the conductors in accordance with 305.4.*~~

~~*Exception No. 2: Where cables are nonshielded and not lead covered, the distance of 36 times the outside diameter shall be permitted to be reduced to 24 times the outside diameter.*~~

~~**(2)** Distance Between Entry and Exit.~~

~~The distance between a cable or conductor entry and its exit from the box shall not be less than 36 times the outside diameter, over sheath, of that cable or conductor.~~

~~*Exception: Where cables are nonshielded and not lead covered, the distance of 36 times the outside diameter shall be permitted to be reduced to 24 times the outside diameter.*~~

~~**(C)** Removable Sides.~~

~~One or more sides of any pull box shall be removable.~~

~~**305.22** Construction and Installation Requirements.~~

~~**(A)** Corrosion Protection.~~

~~Boxes shall be made of material inherently resistant to corrosion or shall be suitably protected, both internally and externally, by enameling, galvanizing, plating, or other means.~~

~~**(B)** Passing Through Partitions.~~

~~Suitable bushings, shields, or fittings having smooth, rounded edges shall be provided where conductors or cables pass through partitions and at other locations where necessary.~~

~~**(C)** Complete Enclosure.~~

~~Boxes shall provide a complete enclosure for the contained conductors or cables.~~

~~**(D)** Wiring is Accessible.~~

~~Boxes and conduit bodies shall be installed so that the conductors are accessible without removing any fixed part of the building or structure. Working space shall be provided in accordance with 110.34.~~

~~**(E)** Suitable Covers.~~

~~Boxes shall be closed by suitable covers securely fastened in place. Underground box covers that weigh over 45 kg (100 lb) shall be considered meeting this requirement. Covers for boxes shall be permanently marked with the following readily visible on the outside of the box cover in block type and at least 13 mm ($^1/_2$ in.) in height:~~

~~DANGER — HIGH VOLTAGE — KEEP OUT.~~

~~**(F)** Suitable for Expected Handling.~~

~~Boxes and their covers shall be capable of withstanding the handling to which they are likely to be subjected.~~

~~**Part III.** Busways~~

~~**305.32** Adjacent and Supporting Structures.~~

~~Metal-enclosed busways shall be installed so that any temperature rise from induced circulating currents in adjacent ferrous metal parts will not be hazardous to personnel or constitute a fire hazard.~~

~~**305.33** Barriers and Seals.~~

~~**(A)** Vapor Seals.~~

~~Busway runs that have sections located both inside and outside of buildings shall have a vapor seal at the building wall to prevent interchange of air between indoor and outdoor sections.~~

~~*Exception: Vapor seals shall not be required in forced-cooled bus.*~~

~~**(B)** Fire Barriers.~~

~~Fire barriers shall be provided where fire walls, floors, or ceilings are penetrated.~~

~~Informational Note: See 300.21 for information concerning the spread of fire or products of combustion.~~

~~**305.34** Drain Facilities.~~

~~Drain plugs, filter drains, or similar methods shall be provided to remove condensed moisture from low points in busway runs.~~

~~**305.35** Ventilated Bus Enclosures.~~

~~Ventilated busway enclosures shall be installed in accordance with Part III of Article 110 and 490.24.~~

~~**305.36** Terminations and Connections.~~

~~Where bus enclosures terminate at machines cooled by flammable gas, seal-off bushings, baffles, or other means shall be provided to prevent accumulation of flammable gas in the busway enclosures.~~

~~All conductor termination and connection hardware shall be accessible for installation, connection, and maintenance.~~

~~**305.37** Switches.~~

~~Switching devices or disconnecting links provided in the busway run shall have the same momentary rating as the busway. Disconnecting links shall be plainly marked to be removable only when the bus is de-energized. Switching devices that are not load-break shall be interlocked to prevent operation under load, and disconnecting link enclosures shall be interlocked to prevent access to energized parts.~~

~~**305.38** Wiring 1000 Volts or Less, Nominal.~~

~~Secondary control devices and wiring that are provided as part of the metal-enclosed bus run shall be insulated by fire-retardant barriers from all primary circuit elements with the exception of short lengths of wire, such as at instrument transformer terminals.~~

~~**305.39** Expansion Fittings.~~

~~Flexible or expansion connections shall be provided in long, straight runs of bus to allow for temperature expansion or contraction, or where the busway run crosses building vibration insulation joints.~~

~~**305.40** Neutral Conductor.~~

~~Neutral bus, where required, shall be sized to carry all neutral load current, including harmonic currents, and shall have adequate momentary and short-circuit current ratings consistent with system requirements.~~

~~**305.41** Grounding.~~

~~Metal-enclosed busways shall be grounded.~~

~~**305.42** Marking.~~

~~Each busway run shall be provided with a permanent nameplate on which the following information is provided:~~

(1) ~~Rated voltage.~~

(2) ~~Rated continuous current. If the bus is forced-cooled, both the normal forced-cooled rating and the self-cooled (not forced-cooled) rating for the same temperature rise shall be given.~~

(3) ~~Rated frequency.~~

(4) ~~Rated impulse withstand voltage.~~

(5) ~~Rated 60-Hz withstand voltage (dry).~~

(6) ~~Rated momentary current.~~

(7) ~~Manufacturer's name or trademark.~~

~~Informational Note: See IEEE C37.23-2015, *IEEE Standard for Metal-Enclosed Bus* , for construction and testing requirements for metal-enclosed bus assemblies.~~

~~**Part IV.** Outdoor Overhead Conductors~~

~~**305.50** Uses Permitted.~~

~~Outdoor overhead conductors as covered in Part IV of this article shall be permitted only for systems rated over 1000 volts ac, 1500 volts dc, nominal, as follows:~~

(1) ~~Outdoors in free air~~

(2) ~~For service conductors, feeders, or branch circuits~~

~~Informational Note: See IEEE C2, *National Electrical Safety Code*, and ANSI/IEEE 3001.2, *Recommended Practice for Evaluating the Electrical Service Requirements of Industrial and Commercial Power Systems*, for additional information on outdoor overhead conductors covered by Part IV of this article.~~

~~**305.51** Support.~~

~~**(A)** Conductors.~~

~~Documentation of the engineered design by a licensed professional engineer engaged primarily in the design of such systems and the spacing between conductors shall be available upon request of the authority having jurisdiction and shall include the following:~~

(1) ~~Applied voltage~~

(2) ~~Conductor size~~

(3) ~~Distance between support structures~~

(4) ~~Type of structure~~

(5) ~~Wind/ice loading~~

(6) ~~Surge protection~~

~~**(B)** Structures.~~

~~Structures of wood, metal, or concrete, or combinations of those materials shall be provided for support of overhead conductors. Documentation of the engineered design by a licensed professional engineer engaged primarily in the design of such systems and the installation of each support structure shall be available upon request of the authority having jurisdiction and shall include the following:~~

(1) ~~Soil conditions~~

(2) ~~Foundations and structure settings~~

(3) ~~Weight of all supported conductors and equipment~~

(4) ~~Weather loading and other conditions such as, but not limited to, ice, wind, temperature, and lightning~~

(5) ~~Angle where change of direction occurs~~

(6) ~~Spans between adjacent structures~~

(7) ~~Effect of dead-end structures~~

(8) ~~Strength of guy wires and guy anchors~~

(9) ~~Structure size and material(s)~~

(10) ~~Hardware~~

~~**(C)** Insulators.~~

~~Insulators used to support conductors shall be rated for all of the following:~~

(1) ~~Applied phase-to-phase voltage~~

(2) ~~Mechanical strength required for each individual installation~~

(3) ~~Impulse withstand BIL in accordance with Table 490.24~~

~~Informational Note: The lists in 305.51(A), (B), and (C) are not all-inclusive.~~

Statement of Problem and Substantiation for Public Comment

After bringing this proposed new article into compliance with the NEC Style Manual (through a Correlating Committee direction), which requires articles to be developed on a "specific topic" most of the later parts had to be restored to their original articles. For example, Parts II, III, and IV were the over 1000-volt provisions derived from other articles covering those specific topics (junction and pull boxes, busways, and outdoor overhead conductors), which clearly violates the NEC Style Manual. Section and Table 305.7 is totally incomplete and inaccurate in that the references to the later parts in proposed Article 305 will be nonexistent. The Correlating Committee took appropriate action and directed that all those parts be restored to their respective locations within the articles covering those specific topics. What is left is essentially Part II of former Article 300, so this new proposed article is unnecessary. In fact, moving Part II of current Article 300 creates correlation and scope issues with Article 300. This proposed revision was also not technically substantiated. There were no externally developed public inputs over the last several cycles indicating there was a problem. These changes resulted from an internally formed task group, but evidence of a problem is missing and the disposition of multiple NEC Code Making Panels on related Public Inputs clearly shows that majority of the Code Making panels resolved these efforts. There is nothing to be gained by relocating Part II of Article 300 into a separate article, other than duplication of general requirements for wiring methods and materials. A voltage range does not constitute a "specific topic" as the requirement for new articles is provided in Section 2.1.3 of the NEC Style Manual. Nothing has been provided that warrants a new article to solve a problem that does not exist currently.

Related Item

• FR 7818

Submitter Information Verification

Submitter Full Name:	Agnieszka Golriz
Organization:	NECA
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Aug 18 13:30:41 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	Addressing medium voltage in the NEC in a more comprehensive manner is a work in progress. It is acknowledged that this will be a long-term task to complete, but with changes to the 2023 NEC, that work is underway. The additional information on MV installations would provide the electrical industry, including inspectors, with more guidance in terms of medium voltage installations. The effort is about code ease of use, which will lead to more and improved requirements. There would be an increased level of safety by including more information on medium voltage installations, as there is more of a likelihood of an individual in the electrical industry applying the requirements if those requirements are included and are easier to locate. The removal of parts from Article 305 does not mean those parts are not MV related. The parts originally identified for relocation were chosen due to their existing segregation of MV related requirements, as opposed to other Chapter 3 articles where MV was more integrated into the requirements. The idea behind Table 305.7 is to identify the location of the MV requirements for each wiring method, and this can still be accomplished by adjusting the specifications for the 3 parts that would remain in their respective articles. It appears that the Correlating Committee Public Comment to remove from 305 parts that are retained in MV sections under other panels was about purview and not a referendum on the concept or a position regarding the Style Manual. There is no Style Manual rule that would indicate that a voltage range does not constitute a specific topic. In support of this position, we point to Article 490, which has been in the NEC as an Article for "Equipment over 1000 Volts, Nominal" for decades, and the newly created Article 311 in the 2020 NEC, which is segregates conductors and cables based on a voltage range. Lastly, Table 305.7 has been modified and moved to allow style manual compliance and updated to make it accurate. If it is incomplete, please use the process to help fill out the missing parts.

Public Comment No. 1493-NFPA 70-2021 [Section No. 305.1]

305.1 Scope.

This article covers wiring methods and materials for wiring installations for systems rated over 1000 volts ac, 1500 volts dc, nominal.

- *Informational Note: In addition to training and qualified persons such as licensed professional engineers regularly engaged in the practice of designing high-voltage systems, consultation with other standards and design guides, such as those produced by IEEE, may be necessary to produce or maintain a high voltage installation that is free from hazards associated with the use of electricity.*

Statement of Problem and Substantiation for Public Comment

NEC lacks much of the necessary standard minimum rules that one would be expected to adhere to in order to produce a safe installation. Currently we have solar and wind farm substations that are customer owned and that are connecting at voltages of 230 kV and possibly higher. Many standards are applicable to producing an electrically safe installation in this scenario. It can't be said that compliance with the National Electrical Code is the sufficient or even that it is the primary means of achieving an installation that is essentially free from hazards associated with electricity (90.1B). It is necessary to reference other standards to create an installation that is essentially free from the hazards associated with the use of electricity.

While there is generally a prohibition of new material at the public comment stage, this circumstance seems different. The committees have taken a large amount of material, some of it new and much of it not, and put it here in an article that the public is now able to review and comment on for the first time. This note indicating the necessity to incorporate additional non-NEC standards is important for safety.

Related Item

• Committee Input No. 9609-NFPA 70-2021 [Global Input]

Submitter Information Verification

Submitter Full Name: Josh Weaver
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Sun Aug 15 16:06:00 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: The NEC is not intended as a design specification or an instruction manual for untrained persons.

Public Comment No. 1335-NFPA 70-2021 [Section No. 305.7]

305.7 Wiring Methods.

Conductors shall be permitted to be installed in accordance with any of the wiring methods identified in Table 305.7.

Table 305.7 Wiring Methods Permitted for Use in Systems Rated Over 1000 Volts ac, 1500 Volts dc, Nominal

Wiring Methods Permitted for Use Above 1000 Volts ac, 1500 Volts dc	Voltage Levels	Reference
Pull and junction boxes, conduit bodies, and handhole enclosures	Over 1000	Article 305, Part II
Metal-clad cable (Type MC)	0–35,000	Article 330
Type P cable	0–2000	Article 337
Intermediate metal conduit (Type IMC)	~~Not specified~~ Over 1000	Article 342
Rigid metal conduit (Type RMC)	~~Not specified~~ Over 1000	Article 344
Rigid polyvinyl chloride conduit (Type PVC)	~~Not specified~~ Over 1000	Article 352
Reinforced thermosetting resin conduit (Type RTRC)	~~Not specified~~ Over 1000	Article 355
Electrical metallic tubing (Type EMT)	~~Not specified~~ Over 1000	Article 358
Auxiliary gutters	~~Not specified~~ Over 1000	Article 366
Busway	Over 1000	Article 305, Part III
Cablebus	0–35,000	Article 370
Cable trays	0–35,000	Article 392
Messenger-supported wiring	0–35,000	Article 396
Outdoor overhead conductors	Over 1000	Article 305, Part IV
Insulated bus pipe (Type IBP)	0–35,000 ac	Article 369

Exposed runs of Type MV cables, bare conductors, and bare busbars shall be permitted in locations accessible only to qualified persons. Busbars shall be permitted to be either copper or aluminum.

Exception: Airfield lighting cable used in series circuits that are powered by regulators and installed in restricted airport lighting vaults shall be permitted as exposed cable installations.

Informational Note: An example of a common application is FAA L-824 cables installed as exposed runs within a restricted vault area.

Statement of Problem and Substantiation for Public Comment

First revision 9609 the global input to create the medium voltage article states that voltages for conduits are unspecified. Leaving the table this way will cause alot of questions in the industry about whether or not conduit can be used in medium voltage applications. Table 305.7 should state that conduits/tubings are all allowed to be used in systems with voltages above 1000 Vac. Adding this to the table in 305 will keep the medium voltage article consistent with article 300 which still states that all conduits can be used in systems above and below 1000 Vac.

Related Item

- First revision 9609

Submitter Information Verification

Submitter Full Name: Dale Crawford
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Street Address:
City:
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Zip:
Submittal Date: Wed Aug 11 21:50:16 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8493-NFPA 70-2021

Statement: “Not specified” may lead to confusion or interpretation. Replacing “Not specified” with “Over 1000” removes this problem. Since the table title is “…for Use in Systems Rated Over 1000 Volts…”, all the minimum voltages are changed from 0 to 1000. This is intended to remove any confusion about permission below 1000V.

Also, the table is relocated to a new section, “Other Articles” to comply with the style manual section 2.5 concerning references to whole articles.

Public Comment No. 587-NFPA 70-2021 [Section No. 305.51(B)]

(B) Structures.

~~Structures of wood, metal, or concrete, or combinations of those materials shall be provided for support of overhead conductors.~~ Documentation of the engineered design by a licensed professional engineer engaged primarily in the design of such systems and the installation of each support structure shall be available upon request of the authority having jurisdiction and shall include the following:

(1) Soil conditions

(2) Foundations and structure settings

(3) Weight of all supported conductors and equipment

(4) Weather loading and other conditions such as, but not limited to, ice, wind, temperature, and lightning

(5) Angle where change of direction occurs

(6) Spans between adjacent structures

(7) Effect of dead-end structures

(8) Strength of guy wires and guy anchors

(9) Structure size and material(s)

(10) Hardware

Statement of Problem and Substantiation for Public Comment

I am proposing this new section have the sentence "Structures of wood, metal, or concrete, or combinations of those materials shall be provided for support of overhead conductors." be removed for 2 reasons. Firstly, there's no need to require that overhead outdoor medium voltage conductors be supported by structures as there's no way they wouldn't be. If the rule was to require dedicated structures, this might make sense. But requiring structures would not seem needed. Secondly, as for requiring specific materials, this might create needless restrictions on structures that are as it is being designed by licensed professional engineers, who should be able to assess suitability of material types. Fiberglass cross arms on poles is becoming more common, and there's no need to prohibit those. Rather than adding fiberglass to the allowed list, it might be better to strike the list so we don't needlessly exclude some other proven material.

Related Item

• This is for 305.51B. The text in Terraview is formatted to indicate new, but no public input appears. Unable to reference as a result.

Submitter Information Verification

Submitter Full Name:	Josh Weaver
Organization:	[Not Specified]
Street Address:	
City:	
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Submittal Date:	Sun Aug 01 19:33:43 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected

Resolution: Saying that something doesn’t need to be stated because there is no way that it would be done any other way is not technical substantiation. In fact, it’s a challenge to the users of the Code to find alternate ways. The text is not being deleted as the requirement must be stated. If fiberglass is an acceptable support material, data would need submitted in the Public Input stage along with technical substantiation and a request to add it to the list in the Code.

Public Comment No. 1128-NFPA 70-2021 [Section No. 590.4(F)]

(F) Lamp Protection.

~~All~~ Unless the luminaire is listed and labeled for the application, all lamps for general illumination shall be protected from accidental contact or breakage by a ~~suitable luminaire or~~ lampholder with a guard.

Informational note: See ANSI/UL 1088, Temporary Lighting Strings, for further information regarding lamps and lighting equipment intended for temporary installation at construction sites and similar locations.

Metal guarded sockets shall not be used unless the metal guard is connected to the circuit equipment grounding conductor.

Statement of Problem and Substantiation for Public Comment

The Scope statement of UL 1088 is: "1.1 These requirements cover temporary lighting strings rated not more than 20 A, 125 V, intended for indoor and outdoor use to provide temporary illumination during the period of construction, remodeling, maintenance, repair, or demolition of buildings or structures, or similar activities, in accordance with the Canadian Electrical Code (CE Code), Part I, CSA C22.1, Section 76, and the U.S. National Electrical Code (NEC), ANSI/NFPA 70, Article 590." UL 1088 was revised in 2014 to allow unguarded, non-replaceable (LED) lamps when tested for crush and impact resistance, and when no exposed surfaces exceed 90 C. These are the same safety features provided by the traditional lamp guard – protection against breakage and contact with hot surfaces.

UL 1088 requires any metal guarded socket that is provided to be bonded to the supply cord grounding conductor (clause 18.1.4), as proposed by this first revision. However, the Code should also permit newer temporary lighting string constructions incorporating energy efficient LED arrays or modules that do not require a lamp guard where compliance with the listing standard provides for comparable levels of safety.

Related Item

• FR 9460

Submitter Information Verification

Submitter Full Name: Joseph Frederic
Organization: Underwriters Labs Inc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 09 17:08:29 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: FR 9460 was to clear up confusion on the "grounded/grounding" of a metal shell. The code does permit newer temporary lighting strings. Metal guarded sockets are not required, however, if they are utilized, they must be grounded.

Public Comment No. 279-NFPA 70-2021 [Section No. 590.8(A)]

(A) Where Reused.

Where overcurrent protective devices that have been previously used are installed in a temporary installation, these overcurrent protective devices shall be examined ~~to~~ by the installer and the authority having jurisdiction to ensure these devices have been properly installed, properly maintained, and there is no evidence of impending failure.

Statement of Problem and Substantiation for Public Comment

It is unclear as to who is qualified to examine the Overcurrent Protective devices. Is it the manufacturer? Is it the installer? Is it the AHJ? According to the Eaton website on this code, they specify that it is the installer and the AHJ. However, their words are not enforceable. This clarifies that and allows the AHJ to determine if the Overcurrent protection devices are safe for reuse in a temporary capacity.

Related Item

• https://www.eaton.com/us/en-us/company/news-insights/for-safetys-sake-blog/the-NEC-2020-code-review.html

Submitter Information Verification

Submitter Full Name: Madison Gabriel DeBell
Organization: [Not Specified]
Street Address:
City:
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Submittal Date: Mon Jul 19 15:13:53 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: The proposed added language in this public comment is unnecessary. The installer should check their work and the authority having jurisdiction is responsible for enforcing compliance.

Public Comment No. 1860-NFPA 70-2021 [Section No. 722.1]

722.1 Scope.

This article covers the general requirements for the installation of single- and multiple-conductor cables used in Class 2 and Class 3 power-limited circuits, Class 4 fault managed power circuits, power -limited fire alarm (PLFA) circuits, and optical fiber installations. Parts I and V of this article provide the general cable requirements for power-limited and fault managed circuit conductors and cables. Part II covers additional cable requirements specifically for Class 2 and Class 3 circuits. Part III covers additional cable requirements specifically for fire alarm systems. Part IV covers additional cable requirements specifically for optical fiber cables.

Statement of Problem and Substantiation for Public Comment

The consolidation of chapter 7 cabling did not include Class 4 cables. This PC edits the scope to include Class 4 cables and other PCs will call for the deletion of material in 726 that is redundant to 722. This PC adds Class 4 and fault managed power circuits to the scope of 722.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 1780-NFPA 70-2021 [Section No. 726.203]	

Related Item

- PI 3740 and PI 3671

Submitter Information Verification

Submitter Full Name:	Chad Jones
Organization:	Cisco Systems
Street Address:	
City:	
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Zip:	
Submittal Date:	Wed Aug 18 11:46:15 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8387-NFPA 70-2021
Statement:	Section 722.1 was revised to include fault-managed (Class 4) power circuits. The text relating to the “Parts” was removed since it is no longer relevant now that Parts II, III and IV have been deleted.

Public Comment No. 2117-NFPA 70-2021 [Section No. 722.2]

722.2 Definitions.

The definitions in this section shall apply only within this article.

Abandoned Cable.

Installed Class 2, Class 3, Class 4, and PLTC cable that is not terminated at equipment and not identified for future use with a tag.

General-Purpose Cables, Cable Routing Assemblies, and Raceways.

General-purpose cables, cable routing assemblies, and raceways are suitable for general purpose applications and are resistant to the spread of fire.

Cables for Limited Use.

Cables that are intended to be used with protection such as a raceway or for specific restricted applications.

Plenum Cable, Cable Routing Assemblies, and Raceways.

Cables, cable routing assemblies, and raceways that have adequate fire-resistant and low smoke-producing characteristics and are suitable for use in ducts, plenums, and other spaces used for environmental air.

Riser Cable, Cable Routing Assemblies, and Raceways.

Cables, cable routing assemblies, and raceways that have fire-resistant characteristics capable of preventing the carrying of fire from floor to floor and are suitable for use in a vertical run in a shaft or from floor to floor.

Under Carpet Cable.

Cables that are intended to be used under carpeting, floor covering, modular tiles, and planks.

Statement of Problem and Substantiation for Public Comment

Class 4 needs incorporated into the new 722 cable section. This is one of many PCs to facilitate that.

Related Item

- PI 3740 and PI 3671

Submitter Information Verification

Submitter Full Name: Chad Jones
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City:
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Zip:
Submittal Date: Thu Aug 19 12:50:14 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR
Resolution: SR-8641-NFPA 70-2021
Statement: All definitions are being moved to Article 100 to comply with the NEC Style Manual.

Public Comment No. 1777-NFPA 70-2021 [Section No. 722.3(F)]

(F) Instrumentation Tray Cable.

Circuits wired using instrument tray cable shall comply with ~~341~~ 335 .1 ~~, 341.10, 341.12, 341.24, 341.80, 341.100, and 341.120.~~ and 335.4 through 335.9

Statement of Problem and Substantiation for Public Comment

this used to refer to 727, that got moved to 335. The sections were not renumbered in the move, there is no section after 335.10. I have changed the text to mirror what was in the 2020 code, but replacing 727 with 335.

Related Item

- PI 3671

Submitter Information Verification

Submitter Full Name:	Chad Jones
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Street Address:	
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Submittal Date:	Tue Aug 17 18:18:21 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8390-NFPA 70-2021
Statement:	The references were updated to reflect the move of the requirements from Article 341 to Article 335.

Public Comment No. 1795-NFPA 70-2021 [Section No. 722.3(M)]

(M) Temperature Limitation of Class 2, Class 3, and Class ~~3~~ 4 Cables.

The requirements of 310.14(A)(3) on the temperature limitation of conductors shall apply to power-limited circuit cables and fault managed power cables .

Statement of Problem and Substantiation for Public Comment

another PC recommends to delete 726.3 (L) as the requirements were moved to 722. But this section in 722 made no mention of Class 4. This changes adds Class 4 to the Class 2 and 3 requirements.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 1780-NFPA 70-2021 [Section No. 726.203]	

Related Item

• PI 3740 and PI 3671

Submitter Information Verification

Submitter Full Name:	Chad Jones
Organization:	Cisco Systems
Street Address:	
City:	
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Submittal Date:	Tue Aug 17 19:26:00 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8392-NFPA 70-2021
Statement:	“Class 2 and Class 3, and PLTC” were deleted since this requirement applies to all cables in Article 722. Fault-managed power cables” was added since Class 4 circuits are fault-limited but not power limited.

Public Comment No. 1794-NFPA 70-2021 [Section No. 722.3(N)]

(N) Identification of Equipment Grounding Conductors.

Section 250.119 shall apply.

Exception 1 : Conductors with green insulation shall be permitted to be used as ungrounded signal conductors.

Exception 2: Cables that do not contain an equipment grounding conductor shall be permitted to use a conductor with green or green with one or more yellow stripes insulation for other than equipment grounding purposes.

Statement of Problem and Substantiation for Public Comment

This text was carefully crafted for Class 2, 3, and 4 cables where you may find multiple pairs of conductors in one cable. These cables shall not have and ECG if they have conductors with green insulation in their bunch that are not ECG. This existing text (726.203(M)) is recommended to be deleted by another PC and therefore I am recommending adding a second exception to cover cables as I couldn't find an eloquent way to combine this with the existing exception on conductors.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 1780-NFPA 70-2021 [Section No. 726.203]	

Related Item

- PI 3740 and PI 3671

Submitter Information Verification

Submitter Full Name:	Chad Jones
Organization:	Cisco Systems
Street Address:	
City:	
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Submittal Date:	Tue Aug 17 19:17:48 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8393-NFPA 70-2021
Statement:	Section 722.3(N) was reworded for clarity. Added parts to the Articles referenced in 722.3(O) to comply with the NEC style manual. A pointer was added to 722.3(O) for Class 4 cables.

Public Comment No. 1593-NFPA 70-2021 [Sections 722.3(N), 722.3(O)]

Sections 722.3(N), 722.3(O)

~~**(N)** Identification of Equipment Grounding Conductors.~~

~~Section 250.119 shall apply.~~

~~*Exception: Conductors with green insulation shall be permitted to be used as ungrounded signal conductors.*~~

~~**(O)** Specific Requirements.~~

~~As appropriate, the installation of wires and cables shall also comply with the requirements of the following:~~

(1) ~~Class 2 and Class 3 cables — Article 725~~

(2) ~~Fire alarm cables — Article 760~~

(3) ~~Optical fiber cables — Article 770~~

Statement of Problem and Substantiation for Public Comment

250.119 already applies. Unlike Article 300, there is no general deletion of the requirements in 722.3. Subdivision O is a style manual violation.

Related Item

- FR 9582

Submitter Information Verification

Submitter Full Name:	Ryan Jackson
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City:	
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Zip:	
Submittal Date:	Mon Aug 16 15:53:22 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8393-NFPA 70-2021
Statement:	Section 722.3(N) was reworded for clarity. Added parts to the Articles referenced in 722.3(O) to comply with the NEC style manual. A pointer was added to 722.3(O) for Class 4 cables.

Public Comment No. 2119-NFPA 70-2021 [Section No. 722.3(O)]

(O) Specific Requirements.

As appropriate, the installation of wires and cables shall also comply with the requirements of the following:

(1) Class 2 and Class 3 cables — Article 725

(2) Class 4 cables — Article 726

(3) Fire alarm cables — Article 760

(4) Optical fiber cables — Article 770

Statement of Problem and Substantiation for Public Comment

Class 4 needs incorporated into the new 722 cable section. This is one of many PCs to facilitate that.

Related Item

• PI 3740 and PI 3671

Submitter Information Verification

Submitter Full Name:	Chad Jones
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Submittal Date:	Thu Aug 19 12:54:19 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8393-NFPA 70-2021
Statement:	Section 722.3(N) was reworded for clarity. Added parts to the Articles referenced in 722.3(O) to comply with the NEC style manual. A pointer was added to 722.3(O) for Class 4 cables.

Public Comment No. 1591-NFPA 70-2021 [Section No. 722.12]

~~**722.12** Uses Not Permitted.~~

~~Cables shall not be installed in any hazardous (classified) location, except as permitted by other articles of this *Code* .~~

~~Informational Note: See Articles 500 through 516 and Article 517, Part IV for information on hazardous locations.~~

Statement of Problem and Substantiation for Public Comment

This is already required, with or without this text. Furthermore, the whole article references are style manual violations.

Related Item

• FR 9582

Submitter Information Verification

Submitter Full Name:	Ryan Jackson
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Zip:	
Submittal Date:	Mon Aug 16 15:49:46 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8395-NFPA 70-2021
Statement:	Maintaining the requirement in Article 722.12(A) makes it clear that Class 4 cables are not exempt from Haz Loc requirements. The reference to the full articles has been changed to specific references in compliance with the NEC Style Manual. Section 722.12(B) was included to limit the use of Class 4 cables to Class 4 circuits unless the cable is listed for multiple purposes.

Public Comment No. 1029-NFPA 70-2021 [Section No. 722.24(A)]

(A) General.

Cables shall be installed in a ~~neat~~ knowledgable and ~~workmanlike~~ skillful 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, hangers, cable ties listed and identified for securement and support, or similar fittings, designed and installed so as not to damage the cable. The installation shall conform to 300.4 and 300.11.

A bushing shall be installed where cables emerge from raceway used for mechanical support or protection in accordance with 300.15(C).

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 300.22(C).

Informational Note No. 1: See NFPA 90A-2021, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, for discrete combustible components installed in accordance with 300.22(C).

Informational Note No. 2: Paint, plaster, cleaners, abrasives, corrosive residues, or other contaminants could result in an undetermined alteration of cable properties.

Statement of Problem and Substantiation for Public Comment

“Neat and workmanlike” finally is being removed from the Code. Should it be replaced by “professional and skillful,” as in 110.12 of the First Draft? Professionals are evaluated in terms of Knowledge, Skills, and Abilities (KSAs), per NFPA 1078. So “skillful” seems redundant–if “professional” really is necessary. Aside from appearance, it is not clear that there is an additional, critical element to professionalism beyond compliance and skillful installation.

When inspecting, we evaluate relevant knowledge by seeing whether the installation shows understanding of the relevant products and standards.

We are concerned with abilities only in terms of how they are demonstrated in the way knowledge and skills were applied. For example, “fine motor” abilities may be needed to use torque screwdrivers, but we’re not interested in the abilities as stand-alone qualities, just in the way installations demonstrate their application to that fine skill.

A sloppy splice may be less than neat, but the critical factor is whether it is performed skillfully enough to avoid damaging the conductors or losing strands; to keep them tightly bound so as to avoid high impedance or in fact risking that they come loose; and to keep them all adequately insulated. So skillful installation is a critical element, to complement compliance with the letter of the Code and knowledge of the products.

While professional appearance is nice, in general requiring it goes beyond the Code’s purpose described in 90.1. Because neatness is an additional subjective element, we should minimize its use as a criterion. Where neatness, or “professional appearance” is particularly important to safety, we have more specific language, such as “legible” as in 110.21(B)(2) Exception, 110.22, 225.52 (B) Exception, and 300.45, or “clearly legible” as in 410.140 and 620.52(B).

Related Item

- PI3671

Submitter Information Verification

Submitter Full Name: David Shapiro

Organization: Safety First Electrical

Street Address:

City:

State:

Zip:

Submittal Date:	Thu Aug 05 20:47:36 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	“Neat” and “workmanlike” refer to the quality of the installation which is what this paragraph deals with. “Knowledgeable” and “skillful” refer to the technical expertise of the installer.

Public Comment No. 1592-NFPA 70-2021 [Section No. 722.24(A)]

(A) General.

Cables ~~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, hangers, cable ties listed and identified for securement and support, or similar fittings, designed and installed so as not to damage the cable. The installation shall conform to 300.4 and 300.11.

A bushing shall be installed where cables emerge from raceway used for mechanical support or protection in accordance with 300.15(C).

~~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 300.22(C).~~

Informational Note No. ~~1: See NFPA 90A-2021,~~ ~~*Standard for the Installation of Air-Conditioning and Ventilating Systems*~~ ~~, for discrete combustible components installed in accordance with 300.22(C). Informational Note No.~~ 2: Paint, plaster, cleaners, abrasives, corrosive residues, or other contaminants could result in an undetermined alteration of cable properties.

Statement of Problem and Substantiation for Public Comment

The material marked for deletion is redundant.

Related Item

• FR 9582

Submitter Information Verification

Submitter Full Name:	Ryan Jackson
Organization:	Ryan Jackson
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon Aug 16 15:51:33 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	Section 722.24(A) was reviewed and no redundancies were identified. The submitter did not provide any substantiation regarding why he believes the text is redundant.

Public Comment No. 111-NFPA 70-2021 [Section No. 722.24(B)]

(B) Support of Cables.

Cables shall not be strapped, taped, or attached by any means to the exterior of any conduit or other raceway as a means of support.

Exception No. 1: Class 2 circuit conductors or cables shall be permitted to be installed as permitted by 300.11(C)(2).

Exception No. 2: ~~Overhead (~~ Refer to Section 770133(D) for the exception on overhead (aerial) spans of optical fiber ~~cables shall be permitted to be attached to the exterior of a raceway-type mast intended for the attachment and support of such cables~~ cable .

Statement of Problem and Substantiation for Public Comment

Article 770 provides the requirements and exceptions for the installation of optical fiber cable. To maintain good usability of the NEC these requirements/exceptions should remain in Article 770.

Related Item

- PI 4138

Submitter Information Verification

Submitter Full Name: William McCoy
Organization: Telco Sales, Inc.
Street Address:
City:
State:
Zip:
Submittal Date: Sun Jul 04 11:42:03 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: Optical fiber cables are included in Article 722 and therefore the exception should remain in 722 as is.

Public Comment No. 1594-NFPA 70-2021 [Section No. 722.24(B)]

(B) Support of Cables.

Cables shall not be strapped, taped, or attached by any means to the exterior of any conduit or other raceway as a means of support.

Exception No. 1: ~~Class 2 circuit conductors~~ Conductors or cables shall be permitted to be installed as permitted by 300.11(C)(2).

Exception No. 2: Overhead (aerial) spans of optical fiber cables shall be permitted to be attached to the exterior of a raceway-type mast intended for the attachment and support of such cables.

Statement of Problem and Substantiation for Public Comment

If the revisions in the first draft version of 300.11(C) continue to pass, this section needs to be correlated.

Related Item

- FR 9582

Submitter Information Verification

Submitter Full Name:	Ryan Jackson
Organization:	Ryan Jackson
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon Aug 16 15:55:35 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	Section 300.11(C)(2) is specifically about Class 2 circuits so this needs to be specified so it is not applied to other cables covered by Article 722.

Public Comment No. 1-NFPA 70-2021 [Section No. 722.135(A)]

(A) Listing.

Cables installed in buildings shall be listed and installed in accordance with the limitations of the listing .

Statement of Problem and Substantiation for Public Comment

Section 110.3(B) which requires that equipment be installed in accordance with the listing. Explicit requirements for cables are needed because the definition of equipment in Article 100 doesn't include cables.

Related Item

- PC 646

Submitter Information Verification

Submitter Full Name:	David Kiddoo
Organization:	CCCA
Affiliation:	CCCA
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Jun 29 07:04:12 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	Proper installation and use of different listed cables are already covered by the NEC. The definition of equipment includes "fittings and the like" that is intended to cover cabling.

Public Comment No. 1596-NFPA 70-2021 [Section No. 722.140(A)]

(A) Class 1 Wiring Methods and Materials.

It shall be permitted to use Class 1 wiring methods for Class 2 and Class 3 circuits. Separation from electric light, power, Class 1, non-power-limited fire alarm circuit conductors, and ~~edium~~ medium -power network-powered broadband communications cables shall comply with 722.141.

Exception: The ampacity adjustment factors given in 310.15(C)(1) shall not apply.

Statement of Problem and Substantiation for Public Comment

Correcting a typo.

Related Item

• FR 9582

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Ryan Jackson
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 16 16:01:07 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected
Resolution: Section 722.140 has been relocated to 725.130. The text in 725.130(A) is correct.

Public Comment No. 1595-NFPA 70-2021 [Section No. 722.140(B)]

(B) Class 2 and Class 3 Wiring Methods and Materials.

Cables on the load side of the power source shall be ~~insulated~~ listed and marked in accordance with 722.179 and shall be installed in accordance with 722.135.

Exception No. 1: See 620.21 for wiring methods for elevators and similar equipment.

Exception No. 2: Other wiring methods and materials installed in accordance with 722.3 shall be permitted to extend or replace the conductors and cables described in 722.179 and permitted by 722.140(B).

Exception No. 3: Bare Class 2 conductors shall be permitted as part of a listed intrusion protection system where installed in accordance with the listing instructions for the system.

Statement of Problem and Substantiation for Public Comment

722.179 contains listing and marking requirements, not insulation requirements.

Related Item

- FR 9582

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Ryan Jackson
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 16 15:58:34 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8497-NFPA 70-2021

Statement: The revision to section 725.130 adds and corrects references to align with the reinstatement of installation criteria for Class 2 and Class 3 systems into Article 725 from Article 722.

Public Comment No. 1538-NFPA 70-2021 [Section No. 722.141(H)]

(H) Where Protected.

Class 2 and Class 3 circuits shall be permitted to be installed together with the conductors of electric light, power, Class 1, non-power-limited fire alarm and medium-power network-powered broadband communications circuits where they are installed using Class 1 wiring methods in accordance with ~~725~~ 724 ~~.46 and where they are protected by an approved method.~~ 24 and 724.46.

Statement of Problem and Substantiation for Public Comment

Correcting Clause Reference to 724.46. Adding reference to 724.24 in lieu of “protected by an approved method”, which is vague and ambiguous. NEMA understands this new sub-clause H to allow the intermingling of class 2 circuits using class 1 methods, previously referred to as “reclassified” class 2, with electric light and power conductors as was previously allowed by 725.130(A) exception 2 .

Related Item

• FR 9582

Submitter Information Verification

Submitter Full Name:	Megan Hayes
Organization:	Nema
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon Aug 16 12:23:42 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8498-NFPA 70-2021
Statement:	The installation requirements of 725.136 and 725.139 have been added back into Article 725 and removed from Article 722. The requirements have been editorially revised removing the unnecessary use of “permitted to be” and changed to “shall not be” as directed by the CC.

Public Comment No. 46-NFPA 70-2021 [Sections 722.160, 722.161, 722.162]

Sections 722.160, 722.161, 722.162

~~**722.160** Raceways, Cable Routing Assemblies, and Cable Trays for Optical Fiber Cables.~~

~~**(A)** Types of Raceways.~~

~~Optical fiber cables shall be permitted to be installed in any raceway that complies with 722.160(A)(1), (A)(2), or (A)(3).~~

~~**(1)** Raceways Recognized in Chapter 3.~~

~~Optical fiber cables shall be permitted to be installed in any raceway included in Chapter 3. The raceways shall be installed in accordance with the requirements of Chapter 3.~~

~~**(2)** Communications Raceways.~~

~~Optical fiber cables shall be permitted to be installed in listed communications raceways selected in accordance with Table 800.154(b).~~

~~**(3)** Innerduct for Optical Fiber Cables.~~

~~Listed plenum communications raceway, listed riser communications raceway, and listed general-purpose communications raceway selected in accordance with Table 800.154(b) shall be permitted to be installed as innerduct in any type of listed raceway permitted in Chapter 3.~~

~~**(B)** Raceway Fill for Optical Fiber Cables.~~

~~Raceway fill for optical fiber cables shall comply with either 722.160(B)(1) or (B)(2).~~

~~**(1)** Without Electric Light or Power Conductors.~~

~~Where optical fiber cables are installed in raceway without electric light or power conductors, the raceway fill requirements of Chapters 3 and 9 shall not apply.~~

~~**(2)** Nonconductive Optical Fiber Cables with Electric Light or Power Conductors.~~

~~Where nonconductive optical fiber cables are installed with electric light or power conductors in a raceway, the raceway fill requirements of Chapters 3 and 9 shall apply.~~

~~**(C)** Cable Routing Assemblies.~~

~~Optical fiber cables shall be permitted to be installed in listed cable routing assemblies selected in accordance with Table 800.154(c).~~

~~**(D)** Cable Trays.~~

~~Optical fiber cables shall be permitted to be installed in metal or listed nonmetallic cable tray systems.~~

~~**722.161** Grounding.~~

~~Non-current-carrying conductive members of optical fiber cables shall be bonded to a grounded equipment rack or enclosure or grounded in accordance with the grounding methods specified by 770.100(B)(2).~~

~~**722.162** Installation of Optical Fibers and Electrical Conductors.~~

~~**(A)** In Cable Trays and Raceways.~~

~~Conductive optical fiber cables contained in an armored or metal-clad-type sheath and nonconductive optical fiber cables shall be permitted to occupy the same cable tray or raceway with conductors for electric light, power, Class 1, non-power-limited fire alarm, Type ITC, or medium-power network-powered broadband communications circuits operating at 1000 volts or less. Conductive optical fiber cables without an armored or metal-clad-type sheath shall not be permitted to occupy the same cable tray or raceway with conductors for electric light, power, Class 1, non-power-limited fire alarm, Type ITC, or medium-power network-powered broadband communications circuits, unless all of the conductors of electric light, power, Class 1, non-power-limited fire alarm, and medium-power network-powered broadband communications circuits are separated from all of the optical fiber cables by a permanent barrier or listed divider.~~

~~**(B)** In Cabinets, Outlet Boxes, and Similar Enclosures.~~

~~Nonconductive optical fiber cables shall not be permitted to occupy the same cabinet, outlet box, panel, or similar enclosure housing the electrical terminations of an electric light, power, Class 1, non-power-limited fire alarm or medium-power network-powered broadband communications circuit unless one or more of the following conditions exist:~~

(1) ~~The nonconductive optical fiber cables are functionally associated with the electric light, power, Class 1, non-power-limited fire alarm or medium-power network-powered broadband communications circuit.~~

(2) ~~The conductors for electric light, power, Class 1, non-power-limited fire alarm, Type ITC, or medium-power network-powered broadband communications circuits operate at 1000 volts or less.~~

(3) ~~The nonconductive optical fiber cables and the electrical terminations of electric light, power, Class 1, non-power-limited fire alarm or medium-power network-powered broadband communications circuit are installed in factory- or field-assembled control centers.~~

(4) ~~The nonconductive optical fiber cables are installed in an industrial establishment where conditions of maintenance and supervision ensure that only qualified persons service the installation.~~

~~When optical fibers are within the same composite cable for electric light, power, Class 1, non-power-limited fire alarm, or medium-power network-powered broadband communications circuits operating at 1000 volts or less, they shall be permitted to be installed only where the functions of the optical fibers and the electrical conductors are associated.~~

~~Optical fibers in composite optical fiber cables containing only current-carrying conductors for electric light, power, or Class 1 circuits rated 1000 volts or less shall be permitted to occupy the same cabinet, cable tray, outlet box, panel, raceway, or other termination enclosure with conductors for electric light, power, or Class 1 circuits operating at 1000 volts or less.~~

~~Optical fibers in composite optical fiber cables containing current-carrying conductors for electric light, power, or Class 1 circuits rated over 1000 volts shall be permitted to occupy the same cabinet, cable tray, outlet box, panel, raceway, or other termination enclosure with conductors for electric light, power, or Class 1 circuits in industrial establishments, where conditions of maintenance and supervision ensure that only qualified persons service the installation.~~

~~**(C)** With Other Circuits.~~

~~Optical fibers shall be permitted in the same cable, and conductive and nonconductive optical fiber cables shall be permitted in the same raceway, cable tray, box, enclosure, or cable routing assembly, with conductors of any of the following:~~

(1) ~~Class 2 and Class 3 remote-control, signaling, and power-limited circuits in compliance with Article 645 or Parts I and III of Article 725~~

(2) ~~Power-limited fire alarm systems in compliance with Parts I and III of Article 760~~

(3) ~~Communications circuits in compliance with Parts I and V of Article 805~~

(4) ~~Community antenna television and radio distribution systems in compliance with Parts I and V of Article 820~~

(5) ~~Low-power network-powered broadband communications circuits in compliance with Parts I and V of Article 830~~

Statement of Problem and Substantiation for Public Comment

Article 770 Optical Fiber Cables covers the installation of optical fiber cables and this information should not be transferred to Article 722. Leaving all requirements for Optical Fiber Cables in Article 770 promotes usability of the National Electrical Code. Plus, the application of optical fiber cables is not restricted to power-limited circuits.

Related Item

• PI 4138

Submitter Information Verification

Submitter Full Name: William McCoy
Organization: Telco Sales, Inc.

Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Jun 30 11:06:31 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8439-NFPA 70-2021
Statement:	Per the direction of the CC, technology specific installation requirements have been put back into Articles 725, 760, and 770.

Public Comment No. 1427-NFPA 70-2021 [Section No. 722.179(A)(9)]

(9) Limited Power (LP) Cable.

Class 2 and Class 3 LP cables shall be listed as suitable for carrying power and data up to a specified current limit for each conductor without exceeding the temperature rating of the cable. The cables shall be marked with the suffix "-LP (XXA)" where XXA designates the current ~~limit is in~~ limit in amperes per conductor.

Informational Note: An example of the marking on 23 AWG, 4-pair, Class 2 cable rated 75°C with an LP current rating of 0.6 amperes per conductor is "CL2-LP(0.6A) ~~(75°C) 23~~ 75°C 23 AWG 4-pair."

Statement of Problem and Substantiation for Public Comment

722.179(A)(9): editorial: extra word "is" in the sentence: "where XAA designates the current is in amperes" should be: "where XAA designates the current in amperes"
informational note: parenthesis around 75C need to be deleted. should be exactly as in 725.179 "CL2-LP(0.6A) 75C 23 AWG..."

Related Item

- FR 9582

Submitter Information Verification

Submitter Full Name: Chad Jones
Organization: Cisco Systems
Street Address:
City:
State:
Zip:
Submittal Date: Fri Aug 13 10:27:20 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR
Resolution: SR-8455-NFPA 70-2021
Statement: The extraneous "is" was removed.

The cable marking in the informational note was corrected to remove the parenthesis.

Public Comment No. 1030-NFPA 70-2021 [Section No. 724.24]

724.24 Mechanical Execution of Work.

Class 1 circuits shall be installed in a ~~neat~~ knowledgeable and ~~workmanlike~~ skillful manner. Cables and conductors installed exposed on the surfaces of ceilings and sidewalls shall be supported by the building structure such that the cable will not be damaged by normal building use. Such cables shall be supported by straps, staples, hangers, cable ties, or similar fittings that are designed and installed to not damage the cable. The installation shall also comply with the requirements of 300.4 and 300.11.

Informational Note: Paint, plaster, cleaners, abrasives, corrosive residues, or other contaminants can result in an undetermined alteration of Class 1 cable properties.

Statement of Problem and Substantiation for Public Comment

“Neat and workmanlike” appropriately no longer will be found in 110.12. What then: professional and skillful? Professionals are evaluated in terms of Knowledge, Skills, and Abilities (KSAs), per NFPA 1078. So “skillful” seems redundant–if “professional” really is necessary. Aside from appearance, it is not clear that there is an additional, critical element to professionalism beyond compliance and skillful installation.

When inspecting, we evaluate relevant knowledge by seeing whether the installation shows knowledge of the relevant products and standards; 110.3(A) and (B) address this. We are concerned with abilities only in terms of how they are demonstrated in the way knowledge and skills were applied. For example, “fine motor” capability is needed to use torque screwdrivers, but we’re not interested in the abilities as stand-alones, just as they are applied to that particular motor skill.

A sloppy splice may be less than neat, but the critical factor is whether it is skillful enough to avoid damaging the conductors or losing strands; to keep them tightly bound so as to avoid high impedance or in fact risking that they come loose; and to keep them all adequately insulated. So skillful installation is a critical element, to complement compliance with the letter of the Code.

While professional appearance is nice, in general requiring it goes beyond the Code’s purpose described in 90.1. Because neatness is an additional subjective element, we should minimize its use as a criterion. Where neatness, or “professional appearance” is particularly important to safety, we have more specific language, such as “legible” as in 110.21(B)(2) Exception, 225.52 (B) Exception, and 300.45, or “clearly legible” as in 410.140 and 620.52(B). So far, no additional element to the term “professional” has been described in the public discussion.

Related Item

- PI3671

Submitter Information Verification

Submitter Full Name: David Shapiro
Organization: Safety First Electrical
Street Address:
City:
State:
Zip:
Submittal Date: Thu Aug 05 20:54:49 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: “Neat” and “workmanlike” refer to the quality of the installation which is what this paragraph deals with. “Knowledgeable” and “skillful” refer to the technical expertise of the installer.

Public Comment No. 179-NFPA 70-2021 [Section No. 724.40]

724.~~40~~ 40 Power-Limited Class 1 Circuits.

Power- limited Class 1 circuits shall be supplied from a source with a rated output of not more than 30 volts and 1000 volt-amperes.

(A) Class 1 Transformers.

Transformers used to supply Class 1 circuits shall comply with the requirements of the applicable sections of Parts I and II of Article 450.

(B) Other Class 1 Power Sources.

Power sources other than transformers shall be protected by overcurrent devices rated at not more than 167 percent of the volt-ampere rating of the source divided by the rated voltage. The overcurrent devices shall not be interchangeable with overcurrent devices of higher ratings. The overcurrent device shall be permitted to be an integral part of the power supply.

To comply with the 1000 volt-ampere limitation of 724.41, the maximum output (VA_{max}) of power sources other than transformers shall be limited to 2500 volt-amperes, and the product of the maximum current (I_{max}) and maximum voltage (V_{max}) shall not exceed 10,000 volt-amperes. These ratings shall be determined with any overcurrent-protective device bypassed.

VA_{max} is the maximum volt-ampere output after one minute of operation regardless of load and with overcurrent protection bypassed, if used. Current-limiting impedance shall not be bypassed when determining VA_{max}.

I_{max} is the maximum output current under any noncapacitive load, including short circuit, and with overcurrent protection bypassed, if used. Current-limiting impedance should not be bypassed when determining I_{max}. Where a current-limiting impedance listed for the purpose or as part of a listed product is used in combination with a stored energy source, such as a storage battery, to limit the output current, I_{max} limits apply after 5 seconds.

$V_{max}$is the maximum output voltage regardless of load with rated input applied.

Statement of Problem and Substantiation for Public Comment

The proposed text re-establishes the 2020 NEC text for power-limited class 1 circuits for clarity purposes. PC 178 which is tied to this public comment re-establishes class 1 remote-control and signaling circuits back into the code in a new 724.41.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 178-NFPA 70-2021 [New Section after 724.40(B)]	Class 1 remote-control and signaling circuits

Related Item

• FR 9591 • FR 9602

Submitter Information Verification

Submitter Full Name:	Brian Baughman
Organization:	Generac Power Systems Inc.
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Fri Jul 09 11:15:22 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8462-NFPA 70-2021
Statement:	The title of Article 724 is changed to make it clear that Class 1 circuits are power-limited and that Class 1 remote-control and signaling circuits are included. The Panel recognizes that titles of Articles are the purview of the Correlating Committee.

Public Comment No. 178-NFPA 70-2021 [New Section after 724.40(B)]

724.41 Class 1 Remote-Control and Signaling Circuits.

These circuits shall not exceed 600 volts. The power output of the source shall not be required to be limited.

Statement of Problem and Substantiation for Public Comment

The removal of Class 1 remote-control and signaling circuits is detrimental to the installation of motor control circuits and optional standby control circuits which have utilized these types of Class 1 circuits for years without any safety issues in the field. Articles 210 and 215 do not adequately address these types of circuits because they do not meet the definition of a branch circuit in Article 100. The required provisions for AFCI and/or GFCI protection on these types of circuits for optional standby generators in Articles 210.8 and 210.12 could be detrimental to the operation of the circuit and the equipment controlled due to nuisance tripping. The electronics in generator controllers and transfer equipment are not evaluated to operate on AFCI and/or GCFI overcurrent devices. The addition of these types of circuits back into the new Article 724 will prevent the unnecessary installation hardship on the installer and the equipment manufacturers.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 179-NFPA 70-2021 [Section No. 724.40]	

Related Item

• FR 9591 • FR 9602

Submitter Information Verification

Submitter Full Name: Brian Baughman
Organization: Generac Power Systems Inc.
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jul 09 10:41:32 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8464-NFPA 70-2021

Statement: A new section 300.26 was added providing classifications including class 2 and class 3 circuits and non-power limited remote- control and signaling circuits.

An informational note is also added to 725.1 to direct the user of the Code to a new section 300.26 on Remote-control and Signaling Circuits Classification. This improves usability of the Code.

Public Comment No. 1948-NFPA 70-2021 [Section No. 724.43]

724.43 Class 1 Circuit Overcurrent Protection.

Overcurrent protection for conductors 14 AWG and larger shall be provided in accordance with the conductor ampacity, without applying the ampacity adjustment and correction factors specified in 310.~~14~~ 15 to the ampacity calculation. Overcurrent protection shall not exceed 7 amperes for 18 AWG conductors and 10 amperes for 16 AWG.

Exception: Where other articles of this Code permit or require other overcurrent protection.

Statement of Problem and Substantiation for Public Comment

The ampacity correction and adjustment factors are located in section 310.15.

Related Item

• No First Draft changes related to this, so understand if it isn't addressed at this time. Just bringing it to your attention.

Submitter Information Verification

Submitter Full Name: Dave Watson
Organization: Southwire
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 18 17:46:32 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Accepted
Resolution: SR-8465-NFPA 70-2021
Statement: Panel 3 checked the reference and 310.15 is correct.

Public Comment No. 180-NFPA 70-2021 [Section No. 724.46]

724.46 Class 1 Circuit Wiring Methods.

Class 1 circuits shall be installed in accordance with Part I of Article 300 and the wiring methods from the appropriate articles in ~~Chapter 3~~ this *Code* .

Exception No. 1: The requirements of 724.48 through 724.51 shall be permitted to apply in installations of Class 1 circuits.

Exception No. 2: Methods permitted or required by other articles of this Code shall apply to installations of Class 1 circuits.

Statement of Problem and Substantiation for Public Comment

The NEC style manual prohibits a reference to an entire Chapter so the reference to Chapter 3 is removed for clarity purposes.

Related Item

• FR 9591 • FR 9602

Submitter Information Verification

Submitter Full Name:	Brian Baughman
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Submittal Date:	Fri Jul 09 11:23:05 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8496-NFPA 70-2021
Statement:	Referring to the entire code is not in compliance with the style manual. The panel changed the reference to include 300.2 through 300.26.

Public Comment No. 1598-NFPA 70-2021 [Article 725]

Article 725 Class 2 and Class 3 Power-Limited Circuits

Part I. General

725.1 Scope.

This article covers power-limited circuits, including power-limited remote control and signaling circuits, that are not an integral part of a device or of utilization equipment.

Informational Note: The circuits described herein are characterized by usage and electrical power limitations that differentiate them from electric light and power circuits; therefore, alternative requirements to those of Chapters 1 through 4 are given with regard to minimum wire sizes, ampacity adjustment and correction factors, overcurrent protection, insulation requirements, and wiring methods and materials.

~~725.~~

~~**725.3** Other Articles.~~

~~In addition to the requirements of this article, circuits and equipment shall comply with the articles or sections listed in 725.3(A) through (E). Only those sections of Article 300 referenced in this article shall apply to Class 2 and Class 3 circuits.~~

~~**(A)** Spread of Fire or Products of Combustion.~~

~~Installation of Class 2 and Class 3 circuits shall comply with 300.21 .~~

~~**(B)** Ducts, Plenums, and Other Air-Handling Spaces.~~

~~Class 2 and Class 3 circuits installed in ducts, plenums, or other space used for environmental air shall comply with 300.22 .~~

~~**(C)** Motor Control Circuits.~~

~~Motor control circuits tapped from the load side of the motor branch-circuit protective device(s) as specified in 430.72(A) shall comply with Part IV of Article 430.~~

~~**(D)** Identification of Equipment Grounding Conductors.~~

~~Equipment grounding conductors shall be identified in accordance with 250.119 .~~

~~**(E)** Cables for Class 2 and Class 3 Circuits.~~

~~The listing and installation of cables for Class 2 and Class 3 circuits shall comply with Article 722, Parts I, II, and V.~~

~~**725.12** Uses Not Permitted.~~

~~Cables and equipment shall not be installed in any hazardous (classified) location, except as permitted by other articles of this *Code* .~~

~~Informational Note: Hazardous locations are covered in Articles 500 through 516 and in Article 517, Part IV.~~

~~**725.21** Access to Electrical Equipment Behind Panels Designed to Allow Access.~~

~~Access to electrical equipment shall not be denied by an accumulation of wires and cables that prevents removal of panels, including suspended ceiling panels.~~

~~**725.24** Mechanical Execution of Work.~~

~~**(A)** General.~~

~~Class 2 and Class 3 circuits shall be installed in a neat and workmanlike manner. Cables and conductors 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 supported by straps, staples, hangers, cable ties listed and identified for securement and support, or similar fittings designed and installed so as not to damage the cable. The installation shall also comply with 300.4 and 300.11.~~

~~**(B)**~~

~~Circuit integrity (CI) cable shall be supported at a distance not exceeding 610 mm (24 in.). Cable shall be secured to the noncombustible surface of the building structure. Cable supports and fasteners shall be steel.~~

> ~~Informational Note: Paint, plaster, cleaners, abrasives, corrosive residues, or other contaminants can result in an undetermined alteration of Class 2, Class 3, and PLTC cable properties.~~

30 Class 2 and Class 3 Circuit Identification.

Class 2 and Class 3 circuits shall be ~~identified~~ marked at terminal and junction locations in a manner that prevents unintentional interference with other circuits during testing and servicing.

725.31 Safety-Control Equipment.

Where damage to power-limited circuits can result in a failure of safety-control equipment that would introduce a direct fire or life hazard, the power-limited circuits shall be installed in accordance with 724.31. Room thermostats, water temperature regulating devices, and similar controls used in conjunction with electrically controlled household heating and air conditioning shall not be considered safety-control equipment.

Part II. Class 2 and Class 3 Circuits

725.60 Power Sources for Class 2 and Class 3 Circuits.

(A) Power Source.

The power source for a Class 2 or a Class 3 circuit shall be as follows:

> Informational Note No. 1: Informational Note Figure 725.60 illustrates the relationships between Class 2 or Class 3 power sources, their supply, and the Class 2 or Class 3 circuits.
>
> Informational Note No. 2: Table 11(A) and Table 11(B) in Chapter 9 provide the requirements for listed Class 2 and Class 3 power sources.

(1) A listed Class 2 or Class 3 transformer

(2) A listed Class 2 or Class 3 power supply

(3) Other listed equipment marked to identify the Class 2 or Class 3 power source

Exception No. 1 to (3): Thermocouples shall not require listing as a Class 2 power source.

Exception No. 2 to (3): Limited power circuits of listed equipment where these circuits have energy levels rated at or below the limits established in Chapter 9, Table 11(A) and Table 11(B).

> Informational Note No. 3: Examples of other listed equipment are as follows:
>
> (1) A circuit card listed for use as a Class 2 or Class 3 power source where used as part of a listed assembly
>
> (2) A current-limiting impedance, listed for the purpose, or part of a listed product, used in conjunction with a non-power-limited transformer or a stored energy source, for example, storage battery, to limit the output current
>
> (3) A thermocouple
>
> (4) Limited voltage/current or limited impedance secondary communications circuits of listed industrial control equipment

(4) Listed audio/video, information technology (computer), communications, and industrial equipment limited-power circuits

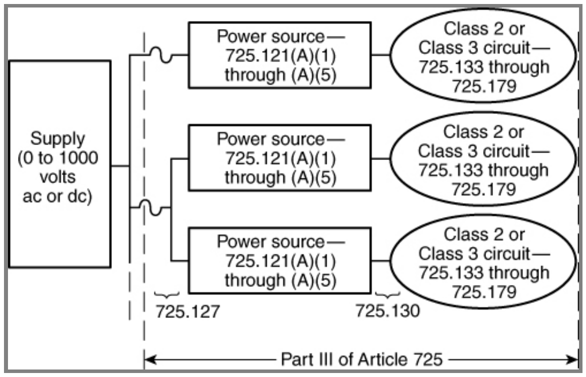
> Informational Note No. 4: One way to determine applicable requirements for listing of information technology (computer) equipment is to refer to UL 60950-1-2011, *Standard for Safety of Information Technology Equipment*. Another way to determine applicable requirements for listing of audio/video, information technology, and communications equipment is to refer to UL 62368-1-2014, *Safety of audio/video, information and communication technology equipment*. Typically such circuits are used to interconnect data circuits for the purpose of exchanging information data. One way to determine applicable requirements for listing of industrial equipment is to refer to UL 61010-2-201, *Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 2-201: Particular requirements for control equipment*, and/or UL 61800-5-1, *Adjustable speed electrical power drive systems — Part 5-1: Safety requirements — Electrical, thermal and energy.*

(5) A battery source or battery source system that is listed and identified as Class 2

(B) Interconnection of Power Sources.

Class 2 or Class 3 power sources shall not have the output connections paralleled or otherwise interconnected unless listed for such interconnection.

Figure Informational Note Figure 725.60 Class 2 and Class 3 Circuits.



(C) Marking.

The equipment supplying the circuits shall be durably marked where plainly visible to indicate each circuit that is a Class 2 or Class 3 circuit. The power sources for limited power circuits in 725.60(A)(3), limited power circuits for listed audio/video equipment, listed information technology equipment, listed communications equipment, and listed industrial equipment in 725.60(A)(4) shall have a label indicating the maximum voltage and rated current output per conductor for each connection point on the power source. Where multiple connection points have the same rating, a single label shall be permitted to be used.

Informational Note No. 1: Rated current for power sources covered in 725.144 is the output current per conductor the power source is designed to deliver to an operational load at normal operating conditions, as declared by the manufacturer.

Informational Note No. 2: An example of a label is “52V @ 0.433A, 57V MAX” for an IEEE 802.3 compliant Class 8 power source.

725.127 Wiring Methods on Supply Side of the Class 2 or Class 3 Power Source.

Conductors and equipment on the supply side of the power source shall be installed in accordance with the appropriate requirements of Chapters 1 through 4.

Exception: The input leads of a transformer or other power source supplying Class 2 and Class 3 circuits shall be permitted to be smaller than 14 AWG but not smaller than 18 AWG if they are protected by an overcurrent device rated not over 20 amperes, are not over 305 mm (12 in.) long, and have insulation that complies with 724.49(B).

725.130 Wiring Methods and Materials on Load Side of the Class 2 or Class 3 Power Source.

Parts I, II, and V of Article 722 shall apply to wiring methods and materials on the load side of the Class 2 or Class 3 power source.

~~**(A)** Class 1 Wiring Methods and Materials.~~

~~It shall be permitted to use Class 1 wiring methods for Class 2 and Class 3 circuits. Separation from electric light, power, Class 1, non-power-limited fire alarm circuit conductors, and medium-power network-powered broadband communications cables shall comply with 722.141.~~

~~*Exception: The ampacity adjustment factors given in 310.15(C)(1) shall not apply.*~~

~~**(B)** Class 2 and Class 3 Wiring Methods and Materials.~~

~~Conductors on the load side of the power source shall be insulated in accordance with 722.143 and shall be installed in accordance with 722.135.~~

~~*Exception No. 1: As provided for in 620.21 for elevators and similar equipment.*~~

~~Exception No. 2: Other wiring methods and materials installed in accordance with~~

725.

~~3 shall be permitted to extend or replace the conductors and cables described in 725.179 and permitted by 725.130(B) .~~

~~*Exception No. 3: Bare Class 2 conductors shall be permitted as part of a listed intrusion protection system where installed in accordance with the listing instructions for the system.*~~

~~725.~~

144 Bundling of 4-Pair Cables Transmitting Power and Data.

Sections 725.144(A) and (B) shall apply to Class 2 and Class 3 circuits that transmit power and data to a powered device over listed 4-pair (8 conductor) cabling. Section 300.11 and Parts I and III of Article 725 shall apply to Class 2 and Class 3 circuits that transmit power and data. The conductors that carry power for the data circuits shall be copper. The current in the power circuit shall not exceed the current limitation of the connectors.

Informational Note No. 1: One example of the use of cables that transmit power and data is the connection of closed-circuit TV cameras (CCTV).

Informational Note No. 2: The 8P8C connector is in widespread use with powered communications systems. IEC 60603-7-2008, *Connectors for electronic equipment — Part 7-1: Detail specification for 8-way, unshielded, free and fixed connectors,* specifies these connectors to have a current-carrying capacity per contact of 1.0 amperes maximum at 60°C (149°F). See IEC 60603-7 for more information on current-carrying capacity at higher and lower temperatures.

Informational Note No. 3: The requirements of Table 725.144 were derived for carrying power and data over 4-pair copper balanced twisted pair cabling. This type of cabling is described in ANSI/TIA 568-C.2-2009, *Commercial Building Telecommunications Cabling Standard — Part 2: Balanced Twisted-Pair Telecommunications Cabling and Components*.

Informational Note No. 4: See TIA-TSB-184-A-2017, *Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling*, for information on installation and management of balanced twisted pair cabling supporting power delivery.

Informational Note No. 5: See ANSI/NEMA C137.3-2017, *American National Standard for Lighting Systems — Minimum Requirements for Installation of Energy Efficient Power over Ethernet (PoE) Lighting Systems*, for information on installation of cables for PoE lighting systems.

Informational Note No. 6: Rated current for power sources covered in 725.144 is the output current per conductor the power source is designed to deliver to an operational load at normal operating conditions, as declared by the manufacturer. In the design of these systems, the actual current in a given conductor might vary from the rated current per conductor by as much as 20 percent. An increase in current in one conductor is offset by a corresponding decrease in current in one or more conductors of the same cable.

(A) Use of Class 2 or Class 3 Cables to Transmit Power and Data.

Where Types CL3P, CL2P, CL3R, CL2R, CL3, or CL2 transmit power and data, the rated current per conductor of the power source shall not exceed the ampacities in Table 725.144 at an ambient temperature of 30°C (86°F). For ambient temperatures above 30°C (86°F), the correction factors in Table 310.15(B)(1)(1) or in Equation 310.15(B) shall apply.

Exception: Compliance with Table 725.144 shall not be required for installations where conductors are 24 AWG or larger and the rated current per conductor of the power source does not exceed 0.3 amperes.

Informational Note: One example of the use of Class 2 cables is a network of closed-circuit TV cameras using 24 AWG, 60°C rated, Type CL2R, Category 5e balanced twisted-pair cabling.

(B) Use of Class 2-LP or Class 3-LP Cables to Transmit Power and Data.

Types CL3P-LP, CL2P-LP, CL3R-LP, CL2R-LP, CL3-LP, or CL2-LP shall be permitted to supply power to equipment from a power source with a rated current per conductor up to the marked current limit located immediately following the suffix “-LP” and shall be permitted to transmit data to the equipment. Where the number of bundled LP cables is 192 or less and the selected ampacity of the cables in accordance with Table 725.144 exceeds the marked current limit of the cable, the ampacity determined from the table shall be permitted to be used. For ambient temperatures above 30°C (86°F), the correction factors of Table 310.15(B)(1)(1) or Equation 310.15(B) shall apply. The Class 2-LP and Class 3-LP cables shall comply with the following, as applicable:

(1) Cables with the suffix “-LP” shall be permitted to be installed in bundles, raceways, cable trays, communications raceways, and cable routing assemblies.

(2) Cables with the suffix “-LP” and a marked current limit shall follow the substitution hierarchy of 722.135(E) for the cable type without the suffix “-LP” and without the marked current limit.

(3) System design shall be permitted by qualified persons under engineering supervision.

Informational Note: An example of the marking on a 23 AWG, 4-pair, Class 2 cable rated 75°C with an LP current rating of 0.6 amperes per conductor is “CL2-LP(0.6A) 75°C AWG 4-pair”. See 722.179(A)(9).

Table 725.144 Ampacities of Each Conductor in Amperes in 4-Pair Class 2 or Class 3 Balanced Twisted-Pair Cables Based on Copper Conductors at an Ambient Temperature of 30°C (86°F) with All Conductors in All Cables Carrying Current, 60°C (140°F), 75°C (167°F), and 90°C (194°F) Rated Cables

	-	Number of 4-Pair Cables in a Bundle															
	-	1–7			8–19			20–37			38–61			62–91			
	-	Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Te
AWG	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	7
26	1.00	1.23	1.42	0.71	0.87	1.02	0.55	0.68	0.78	0.46	0.57	0.67	0.45	0.55	0.64	NA	I
24	1.19	1.46	1.69	0.81	1.01	1.17	0.63	0.78	0.91	0.55	0.67	0.78	0.46	0.56	0.65	0.40	0.4
23	1.24	1.53	1.78	0.89	1.11	1.28	0.77	0.95	1.10	0.66	0.80	0.93	0.58	0.71	0.82	0.45	0.5
22	1.50	1.86	2.16	1.04	1.28	1.49	0.77	0.95	1.11	0.66	0.82	0.96	0.62	0.77	0.89	0.53	0.6

Notes:

1. For bundle sizes over 192 cables, or for conductor sizes smaller than 26 AWG, ampacities shall be permitted to be determined by qualified personnel under engineering supervision.

2. Where only half of the conductors in each cable are carrying current, the values in the table shall be permitted to be increased by a factor of 1.4.

Informational Note No. 1: Elevated cable temperatures can reduce a cable's data transmission performance. For information on practices for 4-pair balanced twisted pair cabling, see TIA-TSB-184-A and 6.4.7, 6.6.3, and Annex G of ANSI/TIA-568-C.2, which provide guidance on adjustments for operating temperatures between 20°C and 60°C.

Informational Note No. 2: The per-contact current rating of connectors can limit the maximum allowable current below the ampacity shown in Table 725.144.

Part IV. Listing Requirements

725.160 Listing and Marking of Equipment for Power and Data Transmission.

The listed power source for circuits intended to provide power and data over Class 2 cables to remote equipment shall be as specified in 725.60(A)(1), (A)(2), (A)(3), or (A)(4). In accordance with 725.60(B), the power sources shall not have the output connections paralleled or otherwise interconnected, unless listed for such interconnection. Powered devices connected to a circuit supplying data and power shall be listed. Marking of equipment output connections shall be in accordance with 725.60(C).

725.179 Listing and Marking of Limited Power (LP) Cables.

LP cables shall be listed as suitable for carrying power and data up to a specified current limit for each conductor without exceeding the temperature rating of the cable. The cables shall be marked with the suffix “-LP (XXA)” where XXA designates the current limit in amperes per conductor.

Informational Note: An example of the marking on a 23 AWG, 4-pair, Class 2 cable rated 75°C with an LP current rating of 0.6 amperes per conductor is “CL2-LP(0.6A) 75°C 23 AWG 4-pair.”

Statement of Problem and Substantiation for Public Comment

This material is now addressed in Article 722, so there is no need for it here. I apologize if I missed something obvious.

Related Item

- FR 9562

Submitter Information Verification

Submitter Full Name:	Ryan Jackson
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Submittal Date:	Mon Aug 16 16:08:54 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	The Panel reviewed Articles 722, 725, 726, 760 and 770 and made sure the requirements were moved and located properly.

Public Comment No. 712-NFPA 70-2021 [Section No. 725.1]

725.1 Scope.

This article covers power-limited circuits, including power-limited remote control and signaling circuits, that are not an integral part of a device or of utilization equipment.

Informational Note: The circuits described herein are characterized by usage and electrical power limitations that differentiate them from electric light and power circuits; therefore, alternative requirements to those of Chapters 1 through 4 are given with regard to minimum wire sizes, ampacity adjustment and correction factors, overcurrent protection, insulation requirements, and wiring methods and materials.

Additional Proposed Changes

File Name	Description	Approved
3_CN_378.pdf	3 CN378	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 378 appeared in the First Draft Report on First Revision No. 9562.

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and requests that the Panel review references to entire Chapters and compliance with 4.1.4 of the NEC Style Manual which prohibits references to entire Articles. A reference to an entire Article is not permitted, as the reference is too broad. As references to entire Chapters, which comprises multiple Articles, is logically also prohibited.

Related Item

- First Revision No. 9562

Submitter Information Verification

Submitter Full Name:	CC on NEC-AAC
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Submittal Date:	Tue Aug 03 13:13:55 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8499-NFPA 70-2021
Statement:	An Informational Note No. 2 was added to direct the user of the Code to a new section 300.26 on Remote-control and Signaling Circuits Classification. This improves usability of the Code. This action addresses the concerns of the Correlating Committee as stated in PC 666 to clarify the use and application of the terms remote-control, branch circuit and signaling circuit, branch circuit as it applies to the new Article 724.

Correlating Committee Note No. 378-NFPA 70-2021 [Section No. 725.1]

Submitter Information Verification

Committee: NEC-P03

Submittal Date: Fri May 07 11:41:59 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and requests that the Panel review references to entire Chapters and compliance with 4.1.4 of the NEC Style Manual which prohibits references to entire Articles. A reference to an entire Article is not permitted, as the reference is too broad. As references to entire Chapters, which comprises multiple Articles, is logically also prohibited.

First Revision No. 9562-NFPA 70-2021 [Section No. 725.1]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
0 Not Returned
12 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Johnston, Michael J.
Kendall, David H.
Kovacik, John R.
Manche, Alan
McDaniel, Roger D.
Porter, Christine T.
Williams, David A.

Public Comment No. 1031-NFPA 70-2021 [Section No. 725.24(A)]

(A) General.

Class 2 and Class 3 circuits shall be installed in a ~~neat~~ knowledgable and ~~workmanlike~~ skillful manner. Cables and conductors 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 supported by straps, staples, hangers, cable ties listed and identified for securement and support, or similar fittings designed and installed so as not to damage the cable. The installation shall also comply with 300.4 and 300.11.

Statement of Problem and Substantiation for Public Comment

“Neat and workmanlike” appropriately no longer will be found in 110.12. What then: professional and skillful? Professionals are evaluated in terms of Knowledge, Skills, and Abilities (KSAs), per NFPA 1078. So “skillful” seems redundant–if “professional” really is necessary. Aside from appearance, it is not clear that there is an additional, critical element to professionalism beyond compliance and skillful installation.

When inspecting, we evaluate relevant knowledge by seeing whether the installation shows knowledge of the relevant products and standards; 110.3(A) and (B) address this. We are concerned with abilities only in terms of how they are demonstrated in the way knowledge and skills were applied. For example, “fine motor” capability is needed to use torque screwdrivers, but we’re not interested in the abilities as stand-alones, just as they are applied to that particular motor skill.

A sloppy splice may be less than neat, but the critical factor is whether it is skillful enough to avoid damaging the conductors or losing strands; to keep them tightly bound so as to avoid high impedance or in fact risking that they come loose; and to keep them all adequately insulated. So skillful installation is a critical element, to complement compliance with the letter of the Code.

While professional appearance is nice, in general requiring it goes beyond the Code’s purpose described in 90.1. Because neatness is an additional subjective element, we should minimize its use as a criterion. Where neatness, or “professional appearance” is particularly important to safety, we have more specific language, such as “legible” as in 110.21(B)(2) Exception, 225.52 (B) Exception, and 300.45, or “clearly legible” as in 410.140 and 620.52(B). So far, no additional element to the term “professional” has been described in the public discussion.

Related Item

- PI 3671

Submitter Information Verification

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Submittal Date:	Thu Aug 05 21:00:13 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	“Neat” and “workmanlike” refer to the quality of the installation which is what this paragraph deals with. “Knowledgeable” and “skillful” refer to the technical expertise of the installer.

Public Comment No. 531-NFPA 70-2021 [Section No. 725.24(A)]

(A) General.

Class 2 and Class 3 circuits shall be installed in a neat and workmanlike manner. Cables and conductors 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 supported by straps, staples, hangers~~, cable~~ ; cable ties listed and identified for securement and support~~, or~~ ; or similar fittings designed and installed so as not to damage the cable. The installation shall also comply with 300.4 and 300.11.

Statement of Problem and Substantiation for Public Comment

The intent of this public comment is to harmonize the cable securing and supporting requirements for Class 1, Class 2, and Class 3 circuits with the securing and supporting requirements for cable wirings methods in Chapter 3. Sections 320.30, 330.30, 334.30, and 337.30 require cable ties to be "listed and identified for securement and support". This specific language is being added to 725.24 to ensure the same listing and securement requirement for cable ties also applies to cable ties used to support Class 1, Class 2, and Class 3 circuits.
The removal of the semicolons from the initial proposal may lead some to mis-interrupt the requirement to mean that staples and straps are also required to be listed for securement and support. We would suggest that the semicolons be added into the clause to assure clarity that only cable ties are meant to be listed for securement and support.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 530-NFPA 70-2021 [Section No. 760.24(A)]	
Public Comment No. 528-NFPA 70-2021 [Section No. 800.24(A)]	
Public Comment No. 527-NFPA 70-2021 [Section No. 770.24(A)]	

Related Item

• NO FR is listed in the second revision report

Submitter Information Verification

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Submittal Date:	Thu Jul 29 11:02:08 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8422-NFPA 70-2021
Statement:	The text was edited to make it clear that the listing requirement only applies to cable ties. This PC 531 was originally associated with 725.24(A). Since the parts of this section associated with cable ties was moved to 722.24(A) the revisions were made in 722.24(A).

Public Comment No. 1081-NFPA 70-2021 [Section No. 725.144]

725.144 Bundling of 4~~-Pair~~ Cables Transmitting Power and Data.

Sections 725.144(A) and (B) shall apply to Class 2 and Class 3 circuits that transmit power and data to a powered device over listed ~~4-pair (8 conductor)~~ cabling. Section 300.11 and Parts I and III of Article 725 shall apply to Class 2 and Class 3 circuits that transmit power and data. The conductors that carry power for the data circuits shall be copper. The current in the power circuit shall not exceed the current limitation of the connectors.

Informational Note No. 1: One example of the use of cables that transmit power and data is the connection of closed-circuit TV cameras (CCTV).

Informational Note No. 2: The 8P8C connector is in widespread use with powered communications systems. IEC 60603-7-2008, *Connectors for electronic equipment — Part 7-1: Detail specification for 8-way, unshielded, free and fixed connectors,* specifies these connectors to have a current-carrying capacity per contact of 1.0 amperes maximum at 60°C (149°F). See IEC 60603-7 for more information on current-carrying capacity at higher and lower temperatures.

Informational Note No. 3: The requirements of Table 725.144 were derived for carrying power and data over 4-pair copper balanced twisted pair cabling. This type of cabling is described in ANSI/TIA 568-C.2-2009, *Commercial Building Telecommunications Cabling Standard — Part 2: Balanced Twisted-Pair Telecommunications Cabling and Components*.

Informational Note No. 4: See TIA-TSB-184-A-2017, *Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling*, for information on installation and management of balanced twisted pair cabling supporting power delivery.

Informational Note No. 5: See ANSI/NEMA C137.3-2017, *American National Standard for Lighting Systems — Minimum Requirements for Installation of Energy Efficient Power over Ethernet (PoE) Lighting Systems*, for information on installation of cables for PoE lighting systems.

Informational Note No. 6: Rated current for power sources covered in 725.144 is the output current per conductor the power source is designed to deliver to an operational load at normal operating conditions, as declared by the manufacturer. In the design of these systems, the actual current in a given conductor might vary from the rated current per conductor by as much as 20 percent. An increase in current in one conductor is offset by a corresponding decrease in current in one or more conductors of the same cable.

(A) Use of <u>4-Pair</u> Class 2 or Class 3 Cables to Transmit Power and Data.

Where Types CL3P, CL2P, CL3R, CL2R, CL3, or CL2 transmit power and data, the rated current per conductor of the power source shall not exceed the ampacities in Table 725.144 at an ambient temperature of 30°C (86°F). For ambient temperatures above 30°C (86°F), the correction factors in Table 310.15(B)(1)(1) or in Equation 310.15(B) shall apply.

Exception: Compliance with Table 725.144 shall not be required for installations where conductors are 24 AWG or larger and the rated current per conductor of the power source does not exceed 0.3 amperes.

Informational Note: One example of the use of Class 2 cables is a network of closed-circuit TV cameras using 24 AWG, 60°C rated, Type CL2R, Category 5e balanced twisted-pair cabling.

(B) Use of Class 2-LP or Class 3-LP Cables to Transmit Power and Data.

Types CL3P-LP, CL2P-LP, CL3R-LP, CL2R-LP, CL3-LP, or CL2-LP shall be permitted to supply power to equipment from a power source with a rated current per conductor up to the marked current limit located immediately following the suffix "-LP" and shall be permitted to transmit data to the equipment. Where the number of bundled LP cables is 192 or less and the selected ampacity of the cables in accordance with Table 725.144 exceeds the marked current limit of the cable, the ampacity determined from the table shall be permitted to be used. For ambient temperatures above 30°C (86°F), the correction factors of Table 310.15(B)(1)(1) or Equation 310.15(B) shall apply. The Class 2-LP and Class 3-LP cables shall comply with the following, as applicable:

(1) Cables with the suffix "-LP" shall be permitted to be installed in bundles, raceways, cable trays, communications raceways, and cable routing assemblies.

(2) Cables with the suffix "-LP" and a marked current limit shall follow the substitution hierarchy of 722.135(E) for the cable type without the suffix "-LP" and without the marked current limit.

(3) System design shall be permitted by qualified persons under engineering supervision.

Informational Note: An example of the marking on a 23 AWG, 4-pair, Class 2 cable rated 75°C with an LP current rating of 0.6 amperes per conductor is "CL2-LP(0.6A) 75°C AWG 4-pair". See 722.179(A)(9).

Table 725.144 Ampacities of Each Conductor in Amperes in 4-Pair Class 2 or Class 3 Balanced Twisted-Pair Cables Based on Copper Conductors at an Ambient Temperature of 30°C (86°F) with All Conductors in All Cables Carrying Current, 60°C (140°F), 75°C (167°F), and 90°C (194°F) Rated Cables

	Number of 4-Pair Cables in a Bundle																
	1–7			8–19			20–37			38–61			62–91				
	Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Te	
AWG	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	7
26	1.00	1.23	1.42	0.71	0.87	1.02	0.55	0.68	0.78	0.46	0.57	0.67	0.45	0.55	0.64	NA	I
24	1.19	1.46	1.69	0.81	1.01	1.17	0.63	0.78	0.91	0.55	0.67	0.78	0.46	0.56	0.65	0.40	0.4
23	1.24	1.53	1.78	0.89	1.11	1.28	0.77	0.95	1.10	0.66	0.80	0.93	0.58	0.71	0.82	0.45	0.5
22	1.50	1.86	2.16	1.04	1.28	1.49	0.77	0.95	1.11	0.66	0.82	0.96	0.62	0.77	0.89	0.53	0.6

Notes:

1. For bundle sizes over 192 cables, or for conductor sizes smaller than 26 AWG, ampacities shall be permitted to be determined by qualified personnel under engineering supervision.

2. Where only half of the conductors in each cable are carrying current, the values in the table shall be permitted to be increased by a factor of 1.4.

Informational Note No. 1: Elevated cable temperatures can reduce a cable's data transmission performance. For information on practices for 4-pair balanced twisted pair cabling, see TIA-TSB-184-A and 6.4.7, 6.6.3, and Annex G of ANSI/TIA-568-C.2, which provide guidance on adjustments for operating temperatures between 20°C and 60°C.

Informational Note No. 2: The per-contact current rating of connectors can limit the maximum allowable current below the ampacity shown in Table 725.144.

Statement of Problem and Substantiation for Public Comment

The text proposed by the first revision is not accurate, as Section 725.144 is not limited to 4-pair cables. 725.144 states that Section 300.11 (securing and supporting of cables) and Parts I and III of Article 725 apply to circuits that carry power and data. These requirements are not limited to 4-pair cables. It is accurate to acknowledge that 725.144(A) and Table 725.144 only apply to 4-pair cables; however, this is clearly stated in the title of the Table. In contrast, 725.144(B) covers the use of "LP" rated cables for bundled cables transmitting power and data. The "LP" designation is covered in UL 13, which is not limited to 4-pair cables. The scope of UL 13 states: "These requirements cover 60 – 250°C (140 – 482°F) single- and multiple-conductor power-limited circuit cables for use as fixed wiring within buildings (some are also marked for direct burial) principally for Class 3 and Class 2 circuits as described in Article 725 and other applicable parts of the National Electrical Code (NEC)." Section 44A of UL 13 covers the Cable Heating Test – For Cables Marked -LP (XX) and does not restrict the test or the marking to only 4-pair cables. Revising the parent language in 725.144 is not correct, and creates a conflict with 725.144(B). If additional clarity is needed then the title of 725.144 should be "Bundling of Cables Transmitting Power and Data" and the title of 725.144(A) should be "Use of 4-pair Class 2 or Class 3 Cables to Transmit Power and Data".

Related Item

- FR 9458

Submitter Information Verification

Submitter Full Name: Randolph Ivans
Organization: UL LLC
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 09 10:55:53 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8479-NFPA 70-2021

Statement: Only Section 725.144(A) is limited to 4-pair cables, not the entire Section.

This second revision makes it clear that 725.144(A) and Table 725.144 only apply to 4-pair cables. This is also stated in the title of the referenced Table.

725.144(B) covers the use of “LP” rated cables for bundled cables transmitting power and data. The “LP” designation is covered in UL 13, which does not limit this rating to 4-pair cables.

This second revision fixes an omission error in the example of an LP cable marking.

Public Comment No. 1920-NFPA 70-2021 [Section No. 725.144]

725.144 Bundling of 4~~-Pair~~ Cables Transmitting Power and Data.

~~Sections 725.144(A) and (B) shall apply to Class 2 and Class 3 circuits that transmit power and data to a powered device over listed 4-pair (8 conductor) cabling.~~ Section 300.11 and Parts I and III of Article 725 shall apply to Class 2 and Class 3 circuits that transmit power and data. The conductors that carry power for the data circuits shall be copper. The current in the power circuit shall not exceed the current limitation of the connectors.

Sections 725.144(A) and (B) shall apply to Class 2 and Class 3 circuits that transmit power and data to a powered device over listed 4-pair (8 conductor) cabling.

Informational Note No. 1: One example of the use of cables that transmit power and data is the connection of closed-circuit TV cameras (CCTV).

Informational Note No. 2: The 8P8C connector is in widespread use with powered communications systems. IEC 60603-7-2008, *Connectors for electronic equipment — Part 7-1: Detail specification for 8-way, unshielded, free and fixed connectors,* specifies these connectors to have a current-carrying capacity per contact of 1.0 amperes maximum at 60°C (149°F). See IEC 60603-7 for more information on current-carrying capacity at higher and lower temperatures.

Informational Note No. 3: The requirements of Table 725.144 were derived for carrying power and data over 4-pair copper balanced twisted pair cabling. This type of cabling is described in ANSI/TIA 568-C.2-2009, *Commercial Building Telecommunications Cabling Standard — Part 2: Balanced Twisted-Pair Telecommunications Cabling and Components*.

Informational Note No. 4: See TIA-TSB-184-A-2017, *Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling*, for information on installation and management of balanced twisted pair cabling supporting power delivery.

Informational Note No. 5: See ANSI/NEMA C137.3-2017, *American National Standard for Lighting Systems — Minimum Requirements for Installation of Energy Efficient Power over Ethernet (PoE) Lighting Systems*, for information on installation of cables for PoE lighting systems.

Informational Note No. 6: Rated current for power sources covered in 725.144 is the output current per conductor the power source is designed to deliver to an operational load at normal operating conditions, as declared by the manufacturer. In the design of these systems, the actual current in a given conductor might vary from the rated current per conductor by as much as 20 percent. An increase in current in one conductor is offset by a corresponding decrease in current in one or more conductors of the same cable.

(A) Use of Class 2 or Class 3 Cables to Transmit Power and Data.

Where Types CL3P, CL2P, CL3R, CL2R, CL3, or CL2 transmit power and data, the rated current per conductor of the power source shall not exceed the ampacities in Table 725.144 at an ambient temperature of 30°C (86°F). For ambient temperatures above 30°C (86°F), the correction factors in Table 310.15(B)(1)(1) or in Equation 310.15(B) shall apply.

Exception: Compliance with Table 725.144 shall not be required for installations where conductors are 24 AWG or larger and the rated current per conductor of the power source does not exceed 0.3 amperes.

Informational Note: One example of the use of Class 2 cables is a network of closed-circuit TV cameras using 24 AWG, 60°C rated, Type CL2R, Category 5e balanced twisted-pair cabling.

(B) Use of Class 2-LP or Class 3-LP Cables to Transmit Power and Data.

Types CL3P-LP, CL2P-LP, CL3R-LP, CL2R-LP, CL3-LP, or CL2-LP shall be permitted to supply power to equipment from a power source with a rated current per conductor up to the marked current limit located immediately following the suffix "-LP" and shall be permitted to transmit data to the equipment. Where the number of bundled LP cables is 192 or less and the selected ampacity of the cables in accordance with Table 725.144 exceeds the marked current limit of the cable, the ampacity determined from the table shall be permitted to be used. For ambient temperatures above 30°C (86°F), the correction factors of Table 310.15(B)(1)(1) or Equation 310.15(B) shall apply. The Class 2-LP and Class 3-LP cables shall comply with the following, as applicable:

(1) Cables with the suffix "-LP" shall be permitted to be installed in bundles, raceways, cable trays, communications raceways, and cable routing assemblies.

(2) Cables with the suffix "-LP" and a marked current limit shall follow the substitution hierarchy of 722.135(E) for the cable type without the suffix "-LP" and without the marked current limit.

(3) System design shall be permitted by qualified persons under engineering supervision.

Informational Note: An example of the marking on a 23 AWG, 4-pair, Class 2 cable rated 75°C with an LP current rating of 0.6 amperes per conductor is "CL2-LP(0.6A) 75°C AWG 4-pair". See 722.179(A)(9).

Table 725.144 Ampacities of Each Conductor in Amperes in 4-Pair Class 2 or Class 3 Balanced Twisted-Pair Cables Based on Copper Conductors at an Ambient Temperature of 30°C (86°F) with All Conductors in All Cables Carrying Current, 60°C (140°F), 75°C (167°F), and 90°C (194°F) Rated Cables

	-	Number of 4-Pair Cables in a Bundle															
	-	1–7			8–19			20–37			38–61			62–91			
	-	Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			T
AWG	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	7
26	1.00	1.23	1.42	0.71	0.87	1.02	0.55	0.68	0.78	0.46	0.57	0.67	0.45	0.55	0.64	NA	I
24	1.19	1.46	1.69	0.81	1.01	1.17	0.63	0.78	0.91	0.55	0.67	0.78	0.46	0.56	0.65	0.40	0.4
23	1.24	1.53	1.78	0.89	1.11	1.28	0.77	0.95	1.10	0.66	0.80	0.93	0.58	0.71	0.82	0.45	0.5
22	1.50	1.86	2.16	1.04	1.28	1.49	0.77	0.95	1.11	0.66	0.82	0.96	0.62	0.77	0.89	0.53	0.6

Notes:

1. For bundle sizes over 192 cables, or for conductor sizes smaller than 26 AWG, ampacities shall be permitted to be determined by qualified personnel under engineering supervision.

2. Where only half of the conductors in each cable are carrying current, the values in the table shall be permitted to be increased by a factor of 1.4.

Informational Note No. 1: Elevated cable temperatures can reduce a cable's data transmission performance. For information on practices for 4-pair balanced twisted pair cabling, see TIA-TSB-184-A and 6.4.7, 6.6.3, and Annex G of ANSI/TIA-568-C.2, which provide guidance on adjustments for operating temperatures between 20°C and 60°C.

Informational Note No. 2: The per-contact current rating of connectors can limit the maximum allowable current below the ampacity shown in Table 725.144.

Statement of Problem and Substantiation for Public Comment

Ballot comments on FR 9458-NFPA 70-2021 suggested that some of the requirements of 725.144 apply beyond 4-pair cable. I agree.
For this reason, the proposal changes the title of 725.144. While it is tempting to reverse the change in the FR, that would make Section 725.144(A), which only speaks to 4-pair cable apply to all cable constructions.

If one alternately read 725.144(A) (and the ampacity table) to only apply to 4-pair cable, it would leave the only way to use class 2/3 cables can carry data and power subject to 725.144(B). Since class 2 cables are primarily designed for power (and the addition of data really doesn't do anything – except introduce some new cable constructions) this has the unintended impact of requiring all class 2 cables to be LP.

While we would preferably ALLOW (but not require) LP cables for other than 4 pair cabling (something I don't object to), I can't think of a way to do that with the current construction of the article without also introducing ampacity tables for those cables, or referencing them elsewhere in the code. Since such tables would be new matter, I would not attempt it on a public comment. Without such tables, and without the proposed change, Sections 725.144(A) and (B) apply to ALL class 2 / 3 cables, or, as stated earlier, that LP cables woudl be required. One would desire allowing non-LP, non-4-pair LP cables to carry data and power. THis is allowed by the proposed change; however, I don’t see a way to directly reference the optional use of LP cables for non-4-pair at the moment.

Related Item

• FR 9458-NFPA 70-2021

Submitter Information Verification

Submitter Full Name:	George Zimmerman
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Affiliation:	Ethernet Alliance
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Aug 18 16:19:48 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8479-NFPA 70-2021
Statement:	Only Section 725.144(A) is limited to 4-pair cables, not the entire Section. This second revision makes it clear that 725.144(A) and Table 725.144 only apply to 4-pair cables. This is also stated in the title of the referenced Table. 725.144(B) covers the use of “LP” rated cables for bundled cables transmitting power and data. The “LP” designation is covered in UL 13, which does not limit this rating to 4-pair cables. This second revision fixes an omission error in the example of an LP cable marking.

Public Comment No. 2209-NFPA 70-2021 [Section No. 725.144]

725.144 Bundling of 4-Pair Cables Transmitting Power and Data.

Sections 725.144(A) and (B) shall apply to Class 2 and Class 3 circuits that transmit power and data to a powered device over listed 4-pair (8 conductor) cabling on the customer side of the Communication Service Point . Section 300.11 and Parts I and III of Article 725 shall apply to Class 2 and Class 3 circuits that transmit power and data. The conductors that carry power for the data circuits shall be copper. The current in the power circuit shall not exceed the current limitation of the connectors.

Informational Note No. 1: One example of the use of cables that transmit power and data is the connection of closed-circuit TV cameras (CCTV).

Informational Note No. 2: The 8P8C connector is in widespread use with powered communications systems. IEC 60603-7-2008, *Connectors for electronic equipment — Part 7-1: Detail specification for 8-way, unshielded, free and fixed connectors,* specifies these connectors to have a current-carrying capacity per contact of 1.0 amperes maximum at 60°C (149°F). See IEC 60603-7 for more information on current-carrying capacity at higher and lower temperatures.

Informational Note No. 3: The requirements of Table 725.144 were derived for carrying power and data over 4-pair copper balanced twisted pair cabling. This type of cabling is described in ANSI/TIA 568-C.2-2009, *Commercial Building Telecommunications Cabling Standard — Part 2: Balanced Twisted-Pair Telecommunications Cabling and Components*.

Informational Note No. 4: See TIA-TSB-184-A-2017, *Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling*, for information on installation and management of balanced twisted pair cabling supporting power delivery.

Informational Note No. 5: See ANSI/NEMA C137.3-2017, *American National Standard for Lighting Systems — Minimum Requirements for Installation of Energy Efficient Power over Ethernet (PoE) Lighting Systems*, for information on installation of cables for PoE lighting systems.

Informational Note No. 6: Rated current for power sources covered in 725.144 is the output current per conductor the power source is designed to deliver to an operational load at normal operating conditions, as declared by the manufacturer. In the design of these systems, the actual current in a given conductor might vary from the rated current per conductor by as much as 20 percent. An increase in current in one conductor is offset by a corresponding decrease in current in one or more conductors of the same cable.

(A) Use of Class 2 or Class 3 Cables to Transmit Power and Data.

Where Types CL3P, CL2P, CL3R, CL2R, CL3, or CL2 transmit power and data, the rated current per conductor of the power source shall not exceed the ampacities in Table 725.144 at an ambient temperature of 30°C (86°F). For ambient temperatures above 30°C (86°F), the correction factors in Table 310.15(B)(1)(1) or in Equation 310.15(B) shall apply.

Exception: Compliance with Table 725.144 shall not be required for installations where conductors are 24 AWG or larger and the rated current per conductor of the power source does not exceed 0.3 amperes.

Informational Note: One example of the use of Class 2 cables is a network of closed-circuit TV cameras using 24 AWG, 60°C rated, Type CL2R, Category 5e balanced twisted-pair cabling.

(B) Use of Class 2-LP or Class 3-LP Cables to Transmit Power and Data.

Types CL3P-LP, CL2P-LP, CL3R-LP, CL2R-LP, CL3-LP, or CL2-LP shall be permitted to supply power to equipment from a power source with a rated current per conductor up to the marked current limit located immediately following the suffix “-LP” and shall be permitted to transmit data to the equipment. Where the number of bundled LP cables is 192 or less and the selected ampacity of the cables in accordance with Table 725.144 exceeds the marked current limit of the cable, the ampacity determined from the table shall be permitted to be used. For ambient temperatures above 30°C (86°F), the correction factors of Table 310.15(B)(1)(1) or Equation 310.15(B) shall apply. The Class 2-LP and Class 3-LP cables shall comply with the following, as applicable:

(1) Cables with the suffix “-LP” shall be permitted to be installed in bundles, raceways, cable trays, communications raceways, and cable routing assemblies.

(2) Cables with the suffix “-LP” and a marked current limit shall follow the substitution hierarchy of 722.135(E) for the cable type without the suffix “-LP” and without the marked current limit.

(3) System design shall be permitted by qualified persons under engineering supervision.

Informational Note: An example of the marking on a 23 AWG, 4-pair, Class 2 cable rated 75°C with an LP current rating of 0.6 amperes per conductor is “CL2-LP(0.6A) 75°C AWG 4-pair”. See 722.179(A)(9).

Table 725.144 Ampacities of Each Conductor in Amperes in 4-Pair Class 2 or Class 3 Balanced Twisted-Pair Cables Based on Copper Conductors at an Ambient Temperature of 30°C (86°F) with All Conductors in All Cables Carrying Current, 60°C (140°F), 75°C (167°F), and 90°C (194°F) Rated Cables

	Number of 4-Pair Cables in a Bundle																
	1–7			8–19			20–37			38–61			62–91				
	Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Te	
AWG	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	7
26	1.00	1.23	1.42	0.71	0.87	1.02	0.55	0.68	0.78	0.46	0.57	0.67	0.45	0.55	0.64	NA	I
24	1.19	1.46	1.69	0.81	1.01	1.17	0.63	0.78	0.91	0.55	0.67	0.78	0.46	0.56	0.65	0.40	0.4
23	1.24	1.53	1.78	0.89	1.11	1.28	0.77	0.95	1.10	0.66	0.80	0.93	0.58	0.71	0.82	0.45	0.5
22	1.50	1.86	2.16	1.04	1.28	1.49	0.77	0.95	1.11	0.66	0.82	0.96	0.62	0.77	0.89	0.53	0.6

Notes:

1. For bundle sizes over 192 cables, or for conductor sizes smaller than 26 AWG, ampacities shall be permitted to be determined by qualified personnel under engineering supervision.

2. Where only half of the conductors in each cable are carrying current, the values in the table shall be permitted to be increased by a factor of 1.4.

Informational Note No. 1: Elevated cable temperatures can reduce a cable's data transmission performance. For information on practices for 4-pair balanced twisted pair cabling, see TIA-TSB-184-A and 6.4.7, 6.6.3, and Annex G of ANSI/TIA-568-C.2, which provide guidance on adjustments for operating temperatures between 20°C and 60°C.

Informational Note No. 2: The per-contact current rating of connectors can limit the maximum allowable current below the ampacity shown in Table 725.144.

Statement of Problem and Substantiation for Public Comment

This public comment is picking up an item that was missed in a request to establishing a Communication Service Point as requested by the Correlating Committee Task Group in Public Input 1764 and numerous public inputs submitted by second Correlating Committee Task Group chaired by David Hittinger. The public inputs were introduced to address Correlation and usability issues that currently make installation and enforcement of communications infrastructure difficult and burdensome. The panel statement acknowledged there is difficulty in understanding this area of the NEC but assumed the misunderstanding was only about “the appropriate article to use for a given communication installation.” The committee makes a further statement that there “is not a single point for communication installations that is analogous to the electrical power service point.” This statement further acknowledges the challenge of this “point” being a moving target without it being defined and understood by all parties in the electrical infrastructure installation, maintenance, and enforcement community.

The NEC provides a long-standing and proven structure through the establishment of a Utility Service Point for implementation of safety requirements and support of well understood regulation boundaries that supports jurisdictional bounds to ensure qualified workers are installing the system on both sides of the boundary. However, that boundary is missing or a moving target for communication installations. In modern electrical infrastructure installations, communications are now an integral aspect of our connected electrical infrastructure and no longer stands independent from the electrical infrastructure. As the NEC contemplates Cybersecurity requirements and critical energy and load management, the dependence on communication clearly exists today and clarity to ensure a safe, reliable, and resilient system becomes a must by making sure the service point it clearly identified.

Related Item

- PC 2175

Submitter Information Verification

Submitter Full Name:	Alan Manche
Organization:	Schneider Electric
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Aug 19 16:45:01 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	Section 90.2(B)(4) already states: “This Code does not cover the following: ….(4)Installations of communications equipment under the exclusive control of communications utilities located outdoors or in building spaces used exclusively for such installations.” In buildings, once cabling is outside of these “spaces”, the NEC would apply whether the cables are on the customer side or the service side of the Communication Service Point. At this time there is no definition for “communication service point” in the NEC.

Public Comment No. 2192-NFPA 70-2021 [Section No. 725.144(A)]

(A) Use of Class 2 or Class 3 Cables to Transmit Power and Data.

Where Types CL3P, CL2P, CL3R, CL2R, CL3, or CL2 transmit power and data, the rated current per conductor of the power source shall not exceed the ampacities in Table 725.144 at an ambient temperature of 30°C (86°F). For ambient temperatures above 30°C (86°F), the correction factors in Table 310.15(B)(1)(1) or in Equation 310.15(B) shall apply.

Exception: Compliance with Table 725.144 shall not be required for installations where conductors are 24 AWG or larger and the rated current per conductor of the power source does not exceed 0.3 amperes <u>as these circuits are not considered bundle-limited Class 2 Circuits nor bundle-limited Class 3 Circuits</u> .

Informational Note: One example of the use of Class 2 cables is a network of closed-circuit TV cameras using 24 AWG, 60°C rated, Type CL2R, Category 5e balanced twisted-pair cabling.

Statement of Problem and Substantiation for Public Comment

Some Authorities Having Jurisdiction have identified Table 725.144 compliance as the key differentiator between 4-pair cable installations that require permitting and inspection versus those legacy types that have traditionally been exempt. The lack of a defined term for circuits that are subject to a bundle limit in the NEC makes setting corresponding policies in local regulations cumbersome. The NFPA defining a term here would help with education, inspection, and adoption of the code.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 2200-NFPA 70-2021 [Definitions (100): Class 2 Cir... to Class 3 Cir...]	Definition of introduced term.
Public Comment No. 2200-NFPA 70-2021 [Definitions (100): Class 2 Cir... to Class 3 Cir...]	

Related Item

• PI 4683-NFPA 70-2020 • PI 4695-NFPA 70-2020

Submitter Information Verification

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Affiliation: Entertainment Services and Technology Association (ESTA)
Street Address:
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Submittal Date: Thu Aug 19 16:17:11 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: Bundle limited is not a defined term and the panel does not see the need to use or define the term.

Public Comment No. 1429-NFPA 70-2021 [Section No. 725.144(B)]

(B) Use of Class 2-LP or Class 3-LP Cables to Transmit Power and Data.

Types CL3P-LP, CL2P-LP, CL3R-LP, CL2R-LP, CL3-LP, or CL2-LP shall be permitted to supply power to equipment from a power source with a rated current per conductor up to the marked current limit located immediately following the suffix “-LP” and shall be permitted to transmit data to the equipment. Where the number of bundled LP cables is 192 or less and the selected ampacity of the cables in accordance with Table 725.144 exceeds the marked current limit of the cable, the ampacity determined from the table shall be permitted to be used. For ambient temperatures above 30°C (86°F), the correction factors of Table 310.15(B)(1)(1) or Equation 310.15(B) shall apply. The Class 2-LP and Class 3-LP cables shall comply with the following, as applicable:

(1) Cables with the suffix “-LP” shall be permitted to be installed in bundles, raceways, cable trays, communications raceways, and cable routing assemblies.

(2) Cables with the suffix “-LP” and a marked current limit shall follow the substitution hierarchy of 722.135(E) for the cable type without the suffix “-LP” and without the marked current limit.

(3) System design shall be permitted by qualified persons under engineering supervision.

Informational Note: An example of the marking on a 23 AWG, 4-pair, Class 2 cable rated 75°C with an LP current rating of 0.6 amperes per conductor is “CL2-LP(0.6A) 75°C 23 AWG 4-pair”. See 722.179(A)(9).

Table 725.144 Ampacities of Each Conductor in Amperes in 4-Pair Class 2 or Class 3 Balanced Twisted-Pair Cables Based on Copper Conductors at an Ambient Temperature of 30°C (86°F) with All Conductors in All Cables Carrying Current, 60°C (140°F), 75°C (167°F), and 90°C (194°F) Rated Cables

	Number of 4-Pair Cables in a Bundle																		
	1–7			8–19			20–37			38–61			62–91				
	Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Te	
AWG	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	7
26	1.00	1.23	1.42	0.71	0.87	1.02	0.55	0.68	0.78	0.46	0.57	0.67	0.45	0.55	0.64	NA	I
24	1.19	1.46	1.69	0.81	1.01	1.17	0.63	0.78	0.91	0.55	0.67	0.78	0.46	0.56	0.65	0.40	0.4
23	1.24	1.53	1.78	0.89	1.11	1.28	0.77	0.95	1.10	0.66	0.80	0.93	0.58	0.71	0.82	0.45	0.5
22	1.50	1.86	2.16	1.04	1.28	1.49	0.77	0.95	1.11	0.66	0.82	0.96	0.62	0.77	0.89	0.53	0.6

Notes:

1. For bundle sizes over 192 cables, or for conductor sizes smaller than 26 AWG, ampacities shall be permitted to be determined by qualified personnel under engineering supervision.

2. Where only half of the conductors in each cable are carrying current, the values in the table shall be permitted to be increased by a factor of 1.4.

Informational Note No. 1: Elevated cable temperatures can reduce a cable's data transmission performance. For information on practices for 4-pair balanced twisted pair cabling, see TIA-TSB-184-A and 6.4.7, 6.6.3, and Annex G of ANSI/TIA-568-C.2, which provide guidance on adjustments for operating temperatures between 20°C and 60°C.

Informational Note No. 2: The per-contact current rating of connectors can limit the maximum allowable current below the ampacity shown in Table 725.144.

Statement of Problem and Substantiation for Public Comment

Editorial: informational note after item 3 is missing '23' in the example marking. "75C AWG" should be "75C 23 AWG"

Related Item

• FR 9543

Submitter Information Verification

Submitter Full Name:	Chad Jones
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Submittal Date:	Fri Aug 13 10:36:46 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8479-NFPA 70-2021
Statement:	Only Section 725.144(A) is limited to 4-pair cables, not the entire Section. This second revision makes it clear that 725.144(A) and Table 725.144 only apply to 4-pair cables. This is also stated in the title of the referenced Table. 725.144(B) covers the use of “LP” rated cables for bundled cables transmitting power and data. The “LP” designation is covered in UL 13, which does not limit this rating to 4-pair cables. This second revision fixes an omission error in the example of an LP cable marking.

Public Comment No. 2156-NFPA 70-2021 [Section No. 725.144 [Excluding any Sub-Sections]]

Sections 725.144(A) and (B) shall apply to Class 2 and Class 3 circuits that transmit power and data to a powered device ~~over listed 4-pair (8 conductor) cabling~~ . Section 300.11 and Parts I and III of Article 725 shall apply to Class 2 and Class 3 circuits that transmit power and data. The conductors that carry power for the data circuits shall be copper. The current in the power circuit shall not exceed the current limitation of the connectors.

Informational Note No. 1: One example of the use of cables that transmit power and data is the connection of closed-circuit TV cameras (CCTV).

Informational Note No. 2: The 8P8C connector is in widespread use with powered communications systems. IEC 60603-7-2008, *Connectors for electronic equipment — Part 7-1: Detail specification for 8-way, unshielded, free and fixed connectors,* specifies these connectors to have a current-carrying capacity per contact of 1.0 amperes maximum at 60°C (149°F). See IEC 60603-7 for more information on current-carrying capacity at higher and lower temperatures.

Informational Note No. 3: The requirements of Table 725.144 were derived for carrying power and data over 4-pair copper balanced twisted pair cabling. This type of cabling is described in ANSI/TIA 568-C.2-2009, *Commercial Building Telecommunications Cabling Standard — Part 2: Balanced Twisted-Pair Telecommunications Cabling and Components*.

Informational Note No. 4: See TIA-TSB-184-A-2017, *Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling*, for information on installation and management of balanced twisted pair cabling supporting power delivery.

Informational Note No. 5: See ANSI/NEMA C137.3-2017, *American National Standard for Lighting Systems — Minimum Requirements for Installation of Energy Efficient Power over Ethernet (PoE) Lighting Systems*, for information on installation of cables for PoE lighting systems.

Informational Note No. 6: Rated current for power sources covered in 725.144 is the output current per conductor the power source is designed to deliver to an operational load at normal operating conditions, as declared by the manufacturer. In the design of these systems, the actual current in a given conductor might vary from the rated current per conductor by as much as 20 percent. An increase in current in one conductor is offset by a corresponding decrease in current in one or more conductors of the same cable.

Statement of Problem and Substantiation for Public Comment

The added text narrows the scope of the table and may add confusion to its use.
This table is not limited to 4 pair cable. There are "LP" rated cables covered in UL 13 that may not be 4 pair cables. Also, the use of the term 'listed' can be interpreted that this section only applies to -LP listed. The use of this table is not limited to -LP cables.

Related Item

• FR 9458

Submitter Information Verification

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Submittal Date: Thu Aug 19 14:24:22 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8479-NFPA 70-2021
Statement:	Only Section 725.144(A) is limited to 4-pair cables, not the entire Section. This second revision makes it clear that 725.144(A) and Table 725.144 only apply to 4-pair cables. This is also stated in the title of the referenced Table. 725.144(B) covers the use of “LP” rated cables for bundled cables transmitting power and data. The “LP” designation is covered in UL 13, which does not limit this rating to 4-pair cables. This second revision fixes an omission error in the example of an LP cable marking.

Public Comment No. 1430-NFPA 70-2021 [Section No. 725.179]

~~**725.179** Listing and Marking of Limited Power (LP) Cables.~~

~~LP cables shall be listed as suitable for carrying power and data up to a specified current limit for each conductor without exceeding the temperature rating of the cable. The cables shall be marked with the suffix "-LP (XXA)" where XXA designates the current limit in amperes per conductor.~~

~~Informational Note: An example of the marking on a 23 AWG, 4-pair, Class 2 cable rated 75°C with an LP current rating of 0.6 amperes per conductor is "CL2-LP(0.6A) 75°C 23 AWG 4-pair."~~

Statement of Problem and Substantiation for Public Comment

This section is 100% duplicated in 722.179(A)(9), as FR9582 moved this text there. 725.179 should be deleted.

Related Item

- FR 9582

Submitter Information Verification

Submitter Full Name: Chad Jones
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Submittal Date: Fri Aug 13 10:41:50 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Accepted
Resolution: SR-8480-NFPA 70-2021
Statement: This second revision deletes a redundant requirement. This material was moved to Article 722 and Article 722 is referenced in 725.3(E).

Public Comment No. 1083-NFPA 70-2021 [Section No. 726.1]

726.1 Scope.

This article covers the installation of wiring, systems and equipment ~~of~~ , including utilization equipment, using fault-managed power (FMP) ~~systems, including utilization equipment incorporating parts of these systems~~ .

Informational Note No. 1: See Article 100 for definitions related to this section.

Informational Note No. 2: Class 4 power systems consist of a Class 4 power transmitter and a Class 4 power receiver connected by a cabling system. These systems are characterized by monitoring the circuit for faults and controlling the power transmitted to ensure the energy and power delivered into any fault is limited. Class 4 systems differ from Class 1, Class 2, and Class 3 systems in that they are not limited for power delivered to an appropriate load. They are power limited with respect to risk of shock and fire between the Class 4 transmitter and Class 4 receiver.

Informational Note No. 3: The circuits described in this article are characterized by monitoring and control systems that differentiate them from electric light and power circuits; therefore, alternative requirements to those of Chapters 1 through 4 are given ~~regarding minimum wire sizes, ampacity adjustment and correction factors, overcurrent protection, insulation requirements, and wiring methods and materials~~ .

Statement of Problem and Substantiation for Public Comment

The proposed wording makes it clear that the installation of systems is included and simplifies the wording for utilization equipment that uses this technology. The informational note 3 does not require a detailed list of alternative requirements as these can evolve and change over time. It is clearer to just say that alternative requirements are provided.

Related Item

- FR 9606

Submitter Information Verification

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Submittal Date:	Mon Aug 09 11:22:59 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8290-NFPA 70-2021
Statement:	This action adds clarity to the requirement that the installation of systems and utilization equipment is included. (PC 1083)

Informational Note 1 is expanded to inform the reader of the Code what definitions relating to this technology can be found in Article 100. Tray cable not included because there is no Class 4 tray cable. (PC 1775)

Informational Note 2 is revised to change power to current to make it more technically correct. (PC

1729)

Informational Note 3 is modeled after 725.1 for consistency except the detailed list of alternative requirements is omitted as unnecessary.

In PC709, the correlating committee directs the panel to review the need and location of informational notes in the scope. Because this is a new technology, the informational notes provide useful information and direction to the user of the Code as it applies to this technology.

Public Comment No. 1517-NFPA 70-2021 [Section No. 726.1]

726.1 Scope.

This article covers the installation of wiring and equipment of fault-managed power (FMP) systems in occupancies other than dwelling units , including utilization equipment incorporating parts of these systems.

Informational Note No. 1: See Article 100 for definitions related to this section.

Informational Note No. 2: Class 4 power systems consist of a Class 4 power transmitter and a Class 4 power receiver connected by a cabling system. These systems are characterized by monitoring the circuit for faults and controlling the power transmitted to ensure the energy and power delivered into any fault is limited. Class 4 systems differ from Class 1, Class 2, and Class 3 systems in that they are not limited for power delivered to an appropriate load. They are power limited with respect to risk of shock and fire between the Class 4 transmitter and Class 4 receiver.

Informational Note No. 3: The circuits described in this article are characterized by monitoring and control systems that differentiate them from electric light and power circuits; therefore, alternative requirements to those of Chapters 1 through 4 are given regarding minimum wire sizes, ampacity adjustment and correction factors, overcurrent protection, insulation requirements, and wiring methods and materials.

Statement of Problem and Substantiation for Public Comment

Class 4 equipment is not currently designed for dwelling unit installation. Dwellings have unique branch circuit and receptacle requirements. The UL 1400-1 product safety standard has no interoperability testing requirements for residential appliances, HVAC equipment or any additional loads, cord/plug connectivity, or other residential hazards are addressed in this new article. Without more details on how the installation could be made safely and without potential interoperability issues in a residential environment, dwellings should not be included at this time.

Related Item

• FR 9606 • PC 1518

Submitter Information Verification

Submitter Full Name: Keith Waters
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Submittal Date: Mon Aug 16 08:58:56 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR
Resolution: SR-8261-NFPA 70-2021
Statement: The application of class 4 systems in a dwelling unit environment has not been adequately studied at this time.

Public Comment No. 1729-NFPA 70-2021 [Section No. 726.1]

726.1 Scope.

This article covers the installation of wiring and equipment of fault-managed power (FMP) systems, including utilization equipment incorporating parts of these systems.

Informational Note No. 1: See Article 100 for definitions related to this section.

Informational Note No. 2: Class 4 power systems consist of a Class 4 power transmitter and a Class 4 power receiver connected by a Class 4 cabling system. These systems are characterized by monitoring the circuit for faults and controlling the ~~power transmitted~~ current sourced to ensure the energy ~~and power~~ delivered into any fault is limited. Class 4 systems differ from Class 1, Class 2, and Class 3 systems in that they are not limited for power delivered to an appropriate load. They are ~~power limited with respect to risk of shock and fire~~ current limited for faults between the Class 4 transmitter and Class 4 receiver.

Informational Note No. 3: The circuits described in this article are characterized by monitoring and control systems that differentiate them from electric light and power circuits; therefore, alternative requirements to those of Chapters 1 through 4 are given regarding minimum wire sizes, ampacity adjustment and correction factors, overcurrent protection, insulation requirements, and wiring methods and materials.

Statement of Problem and Substantiation for Public Comment

Added Class 4 before 'cabling system' as these systems MUST use Class 4 cabling.
This was written with an assumption on how these systems work. Subsequent work on the listing standard reveals that the current is the defining factor for all faults, hence it is proper to replace power with current.
Further, the systems operate on a current and time basis (you are allowed XXXmA of current for YYmsec). This timing aspect makes it inappropriate to speak of the power but instead the energy when not specifically talking about the current.

Related Item

• PI 3740

Submitter Information Verification

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Submittal Date: Tue Aug 17 15:23:10 EDT 2021

Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8290-NFPA 70-2021

Statement: This action adds clarity to the requirement that the installation of systems and utilization equipment is included. (PC 1083)

Informational Note 1 is expanded to inform the reader of the Code what definitions relating to this technology can be found in Article 100. Tray cable not included because there is no Class 4 tray cable. (PC 1775)

Informational Note 2 is revised to change power to current to make it more technically correct. (PC 1729)

Informational Note 3 is modeled after 725.1 for consistency except the detailed list of alternative requirements is omitted as unnecessary.

In PC709, the correlating committee directs the panel to review the need and location of informational notes in the scope. Because this is a new technology, the informational notes provide useful information and direction to the user of the Code as it applies to this technology.

Public Comment No. 1775-NFPA 70-2021 [Section No. 726.1]

726.1 Scope.

This article covers the installation of wiring and equipment of fault-managed power (FMP) systems, including utilization equipment incorporating parts of these systems.

Informational Note No. 1: See Article 100 for definitions ~~related to this section~~ of *Fault Managed Power (FMP), Class 4 Circuit, Class 4 Device, Class 4 Power System, Class 4 Receiver, Class 4 Transmitter, Class 4 Tray Cable (CL4TC),* and *Class 4 Utilization Equipment* .

Informational Note No. 2: Class 4 power systems consist of a Class 4 power transmitter and a Class 4 power receiver connected by a cabling system. These systems are characterized by monitoring the circuit for faults and controlling the power transmitted to ensure the energy and power delivered into any fault is limited. Class 4 systems differ from Class 1, Class 2, and Class 3 systems in that they are not limited for power delivered to an appropriate load. They are power limited with respect to risk of shock and fire between the Class 4 transmitter and Class 4 receiver.

Informational Note No. 3: The circuits described in this article are characterized by monitoring and control systems that differentiate them from electric light and power circuits; therefore, alternative requirements to those of Chapters 1 through 4 are given regarding minimum wire sizes, ampacity adjustment and correction factors, overcurrent protection, insulation requirements, and wiring methods and materials.

Statement of Problem and Substantiation for Public Comment

I've listed all the 726 related definitions for the reader so they can get familiar with the terms before reading the code.

Related Item

- PI 3740

Submitter Information Verification

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Committee:	NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8290-NFPA 70-2021

Statement: This action adds clarity to the requirement that the installation of systems and utilization equipment is included. (PC 1083)

Informational Note 1 is expanded to inform the reader of the Code what definitions relating to this technology can be found in Article 100. Tray cable not included because there is no Class 4 tray cable. (PC 1775)

Informational Note 2 is revised to change power to current to make it more technically correct. (PC 1729)

Informational Note 3 is modeled after 725.1 for consistency except the detailed list of alternative requirements is omitted as unnecessary.

In PC709, the correlating committee directs the panel to review the need and location of informational notes in the scope. Because this is a new technology, the informational notes provide useful information and direction to the user of the Code as it applies to this technology.

Public Comment No. 1902-NFPA 70-2021 [Section No. 726.121]

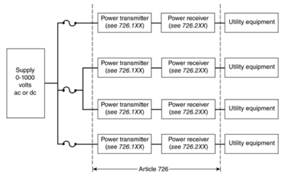
726.121 Power Sources for Class 4 Circuits.

The power source shall be a listed Class 4 power transmitter or listed Class 4 power transmitter/receiver system and shall provide the protections in accordance with 726.121(A) and (B). Class 4 circuits shall be supplied from a power source (transmitter) that has a peak voltage output of not more than 450 volts dc line to line or 225 volts dc line to ground.

Informational Note No. 1: Informational Note Figure 726.121 illustrates the relationships between Class 4 power transmitters (power sources), Class 4 power transmitters (power sources) supplies, Class 4 circuits, Class 4 power receivers, and utilization equipment.

Informational Note No. 2: See UL ### 1400 -1, ~~*Standard for Class 4 Power Systems*~~ *Outline for Fault-Managed Power Systems – Part 1: General Requirements* , for information on determining applicable requirements for the listing of Class 4 power systems.

Figure Informational Note Figure 726.121 Class 4 Circuits.



(A) Fault Energy and Power Limitations.

For listing purposes, under the conditions specified in 726.121(B), the energy available into a fault shall be limited according to the requirements of the following:

(1) A Class 4 power source shall provide protection of personnel against the risk of electric shock by de-energizing the circuit or a portion thereof, or limiting the current, within an established period of time.

Informational Note No. 1: This time requirement provides an equivalent level of protection from electric shock as Class 2 circuits.

(2) The maximum power that can be delivered into a fault between conductors or between any conductor and ground shall not exceed 100 volt-amperes, measured after 5 seconds.

Informational Note No. 2: This requirement reduces the risk of fire due to resistive heating.

(3) A Class 4 power source shall provide protection from the effects of arc faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc fault is detected.

Informational Note No. 3: This requirement reduces the risk of fire due to arcing.

(B) Fault Management.

A listed transmitter shall interrupt an energized circuit within the limits of 726.121(A) when any of the following conditions occur:

(1) An abnormal condition such as abnormal voltage, current, waveform, or load condition is identified in the system

(2) A short circuit occurs

(3) Human skin contacts energized parts

(4) A ground-fault condition exists

(5) An overcurrent condition exists

(6) Intentional shorting of the line at the receiving or transmitting end to force de-energization for purposes of maintenance or repair occurs

(7) A malfunction of the monitoring or control system occurs

Additional Proposed Changes

File Name	Description	Approved
PC_1902_Attachment_C_Randolph_Ivans.pdf	UL 1400-1 & -2 Table of Contents, Normative References & Content References	

Statement of Problem and Substantiation for Public Comment

This comment was developed by the participants of a research and development project group assembled by UL to develop safety requirements for Fault Managed Power Systems (FMPS) to reduce the risks of electric shock and fire and facilitate the design, production and use of products that are physically safe. This project is intended to support the First Revision that adds Class 4 circuits to the 2023 National Electrical Code© (NEC©) as a new Article 726. Participant companies include (in alphabetical order) ATIS, Belden, Chemours, Cisco, CommScope, Corning, Daiken, Enersys (formerly Alpha Technologies), Hubbell, Leviton, Panduit, Schneider Electric, Southwire, Superior Essex, Voltserver, and UL. Participation in the project is broad-based and includes representation of those with knowledge and experience in electrical safety, installation, code enforcement, and wire and cable. Participation in the project alone does not imply 100% agreement among the participant companies or individual members with the developed requirements.

The Scope of Work for the project is to develop a fault managed power safety system framework that can be recommended to installation code bodies, that is technically coordinated with existing and new product safety standards, and that enables “listing” of equipment identified for the purpose.

1) Research of pre-existing written and electronic materials
2) Gap analysis of existing codes and standards
3) Study of safety risks and creation of risk mitigation requirements
4) Specifications for cabling, connectivity and equipment
5) Development of new UL Standards encompassing new equipment, components and cables for Class 4 systems and components

During the course of this project, participants conducted research on topics that ranged from electric shock and arc-energy to grounding of separately derived systems. Refer to Attachment 5 for examples of papers and standards used for this research. In addition, significant input was sought from the participating companies to utilize their expertise and experience and aid in the practical resolution of the issues.

As a result of this work, drafts of two new outlines of investigation (standards) have been prepared; UL 1400-1, Outline for Fault-Managed Power Systems – Part 1: General Requirements, and UL 1400-2, Outline for Fault-Managed Power Systems – Part 2: Requirements for Class 4 Cables. Refer to Attachments 1 and 2 for the Table of Contents for these new standards.

These standards are technically coordinated with existing standards while incorporating the requirements necessary to deal with the advanced technology of Class 4 systems. UL 1400-1 is written as a supplement to UL 62368-1, Audio/video, information and communication technology equipment - Part 1: Safety requirements, leveraging the technical expertise of this internationally harmonized standard based on the hazard-based safety engineering (HBSE) principles. UL 1400-2 is based on UL 13, Power-Limited Circuit Cables, and contains all of the requirements necessary to evaluate Class 4 cables. Attachments 3 and 4 identify the normative standard references incorporated into the requirements.

UL’s outline of investigations (standards) describe the requirements used to evaluate products and systems with detailed technical content addressing potential risks and their mitigation. They provide standardized, vendor-neutral and uniform solutions and procedures.

Related Item

• FR 9606 • PC 1904 • PC 1905 • PC 1906 • PC 2165

Submitter Information Verification

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Submittal Date: Wed Aug 18 15:10:17 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8348-NFPA 70-2021

Statement: This second revision makes the following changes.

“As a part of a” replaced “or” in the first sentence as a class 4 power transmitter/receiver pair is not a power source. Redundant text was deleted in Informational Note 1.

Peak voltage was added to address systems that operate with voltages other than dc. (PC 1732, PC 1084)

The line-to-ground voltage was deleted to accommodate systems that employ an asymmetric high resistance ground

scheme. The panel noted that Class 4 cables will be listed for the full 450 volts on all current carrying conductors. (PC 1516)

Adds the correct number (UL 1400-1) and title for the referenced standard in Informational Note 2. (PC 1902, PC 1732, PC 1256)

The figure was revised to show a case where the Class 4 receiver is built into the utilization equipment.

ATTACHMENT 1
Table of Contents for UL 1400-1,
Outline for Fault-Managed Power Systems – Part 1: General Requirements

Table of Contents

ATTACHMENT 2
Table of Contents for UL 1400-2,
Outline for Fault-Managed Power Systems – Part 2: Requirements for Class 4 Cables

CONTENTS

INTRODUCTION

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ATTACHMENT 3
Normative Standards Referenced in UL 1400-1

- UL 991, *Tests for Safety-Related Controls Employing Solid-State Devices*
- UL 1998, *Software in Programmable Components*
- UL 60730-1, *Automatic Electrical Controls – Part 1: General Requirements*
- UL: 62368-1, *Audio/video, information and communication technology equipment - Part 1: Safety requirements*
- IEC 60479-1, *Effects of current on human beings and livestock – Part 1: General aspects*
- IEC 60479-2, *Effects of current on human beings and livestock – Part 2: Special aspects*
- IEC 61508-1, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 1: General Requirements*
- IEC 61508-2, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 2: Requirements for Electrical/Electronic/Programmable Electronic Safety-Related Systems*
- IEC 61508-3, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 3: Software Requirements*
- IEC 61508-4, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 4: Definitions and Abbreviations*
- IEC 61508-5, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 5: Examples of Methods for the Determination of Safety Integrity Levels*
- IEC 61508-6, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 6: Guidelines on the Application of IEC 61508-2 and IEC 61508-3*
- IEC 61508-7, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 7: Overview of Techniques and Measures*
- IEC 62061, *Safety of Machinery – Functional Safety of Safety-Related Electrical, Electronic and Programmable Electronic Control Systems*
- ISO 13849-1, *Safety of Machinery - Safety-Related Parts of Control Systems - Part 1: General Principles for Design*
- ISO 13849-2, *Safety of Machinery - Safety-Related Parts of Control Systems - Part 2: Validation*
- ATIS-0600040, *Fault Managed Power Distribution Technologies – Human Contact Fault Analysis*

ATTACHMENT 4
Normative Standards Referenced in UL 1400-2

- UL 13, *Power-Limited Circuit Cables*
- UL 444, *Communications Cables*
- UL1581, *Reference Standard for Electrical Wires, Cables, and Flexible Cords*
- UL 1651, *Optical Fiber Cable*
- UL1666 **,** *Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts*
- UL2556, *Wire and Cable Test Methods*
- NFPA 262, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*

ATTACHMENT 5
Examples of papers and standards consulted during the development of requirements

- "Electric Shock Hazard Considerations for Fault Managed Power Distribution Technologies"
  -Hai Jiang, Ph.D. P.E. & Alex Di Sciullo Jones
- "The Establishment of Energy-Based Test Criteria for Fault-Managed Power Distribution Technologies" -Paul W. Brazis, Jr., PhD
- "On Extending the Td−Ib Curve b Limit For Td Shorter Than 10ms." Rev. A0.4. 11/23/2020"
  - Dr. Francisco Paz
- "DC Arc-fault Testing to Support Photovoltaic Arc-fault Protection Device Requirements" October 8, 2013
  - David A. Dini, P.E. and Paul W. Brazis Jr., PhD

- IEC 60479-1, *Effects of current on human beings and livestock – Part 1: General aspects*
- IEC 60479-2, *Effects of current on human beings and livestock – Part 2: Special aspects*
- ATIS-0600040 (Draft), *Fault Managed Power Distribution Technologies – Human Contact Fault Analysis*
- UL 489I, *Outline for Solid State Molded-Case Circuit Breakers*
- UL 943, *Ground-Fault Circuit-Interrupters*
- UL 1699B, *Photovoltaic (PV) DC Arc-Fault Circuit Protection*
- UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*
- UL 1778, *Uninterruptible Power Systems*
- UL 2271, *Batteries for Use In Light Electric Vehicle (LEV) Applications*
- UL 60730-1, *Automatic Electrical Controls – Part 1: General Requirements, Annex H*
- UL: 62368-1, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

Public Comment No. 1085-NFPA 70-2021 [Section No. 726.121(A)]

(A) Fault Energy and Power Limitations.

For listing purposes, under the conditions specified in 726.121(B), the energy available into a fault shall be limited according to the requirements of the following:

(1) A Class 4 power source shall provide protection of personnel against the risk of electric shock by de-energizing the circuit or a portion thereof, or limiting the current, within an established period of time.

Informational Note No. 1: This ~~time~~ requirement provides ~~an equivalent level of~~ acceptable protection from electric shock ~~as Class 2 circuits~~ .

(2) The maximum power that can be delivered into a fault between conductors or between any conductor and ground shall not exceed 100 volt-amperes, measured after 5 seconds.

Informational Note No. 2: This requirement reduces the risk of fire due to resistive heating.

(3) A Class 4 power source shall provide protection from the effects of arc faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc fault is detected.

Informational Note No. 3: This requirement reduces the risk of fire due to arcing.

Statement of Problem and Substantiation for Public Comment

The stated requirement is not only a time requirement, but rather a combination of the level of current and the duration (time).
Electric shock is a complex subject. "Electric Shock" is a term that can relate to perception (I can feel it), reaction (it surprises me and I jump), involuntary reaction (a current causes muscles to contract/react involuntarily), inability to let-go (muscles contract and I can't let go of the energized part) and ventricular fibrillation. Class 4 and Class 2 circuits have not been compared for all of these possible "electric shock" phenomena, therefore it is not correct to say that they are equivalent in all areas. Class 4 circuits will provide protection against let-go and ventricular fibrillation like a Class 2 circuit. The suggested wording is derived from the definition of a Class 2 circuit in Article 100:
"Class 2 Circuit - The portion of the wiring system between the load side of a Class 2 power source and the connected equipment. Due to its power limitations, a Class 2 circuit considers
safety from a fire initiation standpoint and provides acceptable protection from electric shock."

Related Item

• FR 9606

Submitter Information Verification

Submitter Full Name: Randolph Ivans
Organization: UL LLC
Street Address:
City:
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Submittal Date: Mon Aug 09 11:45:06 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR
Resolution: SR-8327-NFPA 70-2021

Statement:	Section 726.121(A) has been deleted and combined with current 726.121(B). The list of faults was removed as this is appropriately handled by the listing standard to include series faults.

Public Comment No. 1520-NFPA 70-2021 [Section No. 726.121(A)]

(A) Fault Energy and Power Limitations.

For listing purposes, under the conditions specified in 726.121(B), the energy available into a fault shall be limited according to the requirements of the following:

(1) A Class 4 power source shall provide protection of personnel against the risk of electric shock by de-energizing the circuit or a portion thereof, or limiting the current, within an established period of time.

Informational Note No. 1: This time requirement provides an equivalent level of protection from electric shock as Class 2 circuits.

(2) The maximum power that can be delivered into a fault between conductors or between any conductor and ground shall not exceed ~~100~~ 15 volt-amperes, measured after 5 seconds.

Informational Note No. 2: This requirement reduces the risk of fire due to resistive heating.

(3) A Class 4 power source shall provide protection from the effects of arc faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc fault is detected.

Informational Note No. 3: This requirement reduces the risk of fire due to arcing.

Additional Proposed Changes

File Name	Description	Approved
2017_Holm_DC_Glowing_Materials_-_Shea_-_Final_5_June_2017.pdf	Technical Paper detailing issues with DC fire ignition at levels currently showing in FR 9606	

Statement of Problem and Substantiation for Public Comment

The attached publication discusses the issues in using 100 VA, the potential for fire ignition in 12Vdc circuits with available power sources well below 100VA. Glowing connections can be created in the range of 5 to 15W at voltages as low as 12Vdc that have temperatures well above the ignition temperatures of commonly used insulators and other organic materials.The 100W limit is currently in this FR, but I don't think that this number took into account glowing connections. 100W (or 100VA) seems like some arbitrary number. Is there any research available to support this value other than just saying it is in the code? It would be helpful for me to see the measurements/data and conditions from previously published work that justifies the 100W value.

At higher system voltages, the likelihood of series arcing increases and the higher the power in the arc since a higher system voltage will support a longer arc (arc length (voltage) and arc current determine arc power). The higher the arc power, the greater the likelihood of fire ignition. With a 12V system it is difficult to sustain an arc of any significant length, but at 450V the arc can become relatively long and sustained, especially in a DC system since there are no zero crossing, creating a significant fire (and burn) hazard. Series arcing as well as glowing connections both pose a serious fire hazard at the system voltages and currents for Class 4 systems. Series arcing is currently addressed in NEC 210.12 by using AFCI's. Note that there are no 100VA tests in the UL1699 standard for AFCI's. Glowing connections are not directly addressed in the standard but may be protected if a ground fault is created or if series arcing occurs as a result of the glowing connection and detected by the AFCI.

Related Item

• FR 9606

Submitter Information Verification

Submitter Full Name: Keith Waters
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Submittal Date: Mon Aug 16 09:36:22 EDT 2021

Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

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Statement: Section 726.121(A) has been deleted and combined with current 726.121(B).

The list of faults was removed as this is appropriately handled by the listing standard to include series faults.

Glowing Connections in DC Circuits

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Abstract – **Measurements have been conducted to show that glowing connections can occur in DC circuits at voltages as low as 12V$_{dc}$. Properties of glowing connections for dc circuit conditions for a variety of electrically conductive materials is presented. Results reveal glowing connection characteristics for commonly used conductor material found in electrical circuits (copper and steel) for 12V, 24V, and 48V DC circuits up to 10A. It was found that material type has a pronounced effect on the glowing voltage, with copper oxides having a negative temperature coefficient (NTC) of resistance and iron oxides having a flat (zero temperature coefficient-ZTC) to slight positive temperature coefficient (PTC) of resistance. There is also a discussion on the influence of oxide resistivity, circuit polarity, and circuit conditions on DC glowing connection properties.**

Keywords: glowing contact, loose connection, DC, oxide, oxidation, resistivity, conductivity, glowing

I. INTRODUCTION

With the growing interest in DC power systems, especially in automobiles, LED lighting, photovoltaic (PV) arrays, battery storage, and DC drives for example, it is of general interest to determine if loose electrical connections in these systems can produce glowing connections, like AC circuits, and if so, how do they compare. Also, can glowing connections be produced at low voltage such as 12Vdc?

Glowing connections can form from loose electrical connections that have arced with current flow [1, 2]. The arcing connection can form metal oxides at the connection interface resulting in a resistive or semi-conductive layer that can result in a significant voltage drop at the interface. This voltage drop can be high enough for the interface to glow with an orange incandescence [3]. This overheated joint can pose a fire hazard due to the high conductor temperatures 1100°C to 1400°C created at the glowing point [4]. This high temperature point source can result in temperature over 300°C several inches away from the glow along the length of a conductor [5]. This heat, conducted down a wire, can cause wire insulation or other organic insulating materials to char and potentially ignite creating the fire hazard [6-8]. The importance of studying glowing connections can be used to understand the causes of electrical fires and to minimize their occurrence by better understanding the causes to produce designs that minimize the risk of an electrical fire.

To date virtually all the loose electrical glowing connection research has been made using AC circuits [1-8]. Japanese researchers Hagimoto et al. [9] and Kinoshita et al. [10] are the only researchers known to have some measurements showing DC glowing connections but have not documented the associated waveforms or experimental details. It has not been demonstrated if DC circuits, especially at voltages as low as 12V$_{dc}$, could produce glowing connections and subsequently have the same fire hazard potential as AC circuits.

It is expected that the same factors controlling AC glow initiation and sustainability will be found to control DC glowing (i.e. oxide formation at the connection interface) [4]. This work characterizes DC glowing connections for commonly used DC circuit voltages (i.e. 12V, 24V, and 48V) over a current range up to 10A$_{dc}$ including the effect of polarity for asymmetric wire conductor materials.

II. BACKGROUND

Glowing connections can form at the interface of an electrical connection and are characterized by an incandescent orange glow of molten metal oxide as opposed to I^{2}R resistive heating [2,4,6]. The distinguishing characteristic between a glow and a resistive voltage drop is the non-linear behavior of the oxide resistivity on the glowing connection property. The effect of material oxide at a connection interface will be further explored in this work. In the case of a glowing copper connection, the voltage drop across the connection would increase with a decrease in current. It would also be associated with an orange incandescent visible glow. Simply having a loose joint with a high resistance may result in a voltage drop on the order of 100's of mV's or less. Rather, glowing, associated with molten metal oxides at temperatures on the order of 1100°C to 1500°C, depending on material, has voltage drops on the order of 0.5 to 10 volts.

A glowing connection can occur from an unintended loose connection that arcs under load. Oftentimes glowing

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connections are associated with either vibratory applications (e.g. washing machines) or the repeated action of plugging and unplugging an appliance in an outlet with loose wires (e.g. duplex receptacles or other electrical fixtures) that had improperly torqued wires which become loose over time [5,11]. This action can provide enough motion that, over time, the make/break action can create arcing at the connection interface, creating metal oxide(s) that may lead to a glowing condition.

It is known for AC circuits that depending on the material, it may take 1000's of arcing cycles and just the proper alignment of the wires to condition the conductors (i.e. create metal oxide) to form a glowing connection [6]. However, with steel conductors, the glow can occur with only a few or as little as one make/break operation [3,4,6].

Table 1 shows the oxides that can form during arcing for both copper and steel (music) wires. Some of the minor constituent components that make up steel were not part of the oxides but rather only the iron was assumed to form oxides.

Table 1. Relevant metal and oxide melting points expected in an electrical connection using copper and/or steel materials. Music wire is used as the steel conductor made per ASTM A228 (Fe/C(0.7-1%)/Mn(0.2-0.6%)). Potential intermetallic oxides are not listed. (d: decomposes) Values from www.wikipedia.com, and [12,13].

Oxide or Metal		Melting Temp. (°C)	Boiling Temp. (°C)
Cu	Reddish-brown	1083	2562
Cu_2O	Red	1235	1800
CuO	Black	1326	2000
FeO	Black	1360-1424	3414
Fe_2O_3	Red	1475-1565	1850d
Fe	Silvery-gray	1538	2862
Fe_3O_4	Brownish-black	1583-1597	2623

Typical DC circuits involve PV arrays, energy storage batteries, and LED lighting circuits. PV arrays can consist of many electrical connections that connect PV panels together to form a larger array. These electrical connectors can be subjected to harsh environmental factors such as UV light exposure from the sun, thermal expansion/contraction of connectors from cyclic heating/cooling from the sun, current flow, and seasonal weather changes, rain, wind, ice/snow, animals gnawing insulation, environmental pollution in the air. Many factors can contribute to the deterioration of an electrical connection, especially in an outdoor environment.

III. EXPERIMENT

This section details the experimental setup used to create DC glowing connections, acquire waveforms, and images.

Glowing contacts were produced using the circuit and fixture shown in Figs. 1 and 2. Two different current limiting DC power supplies were used to provide adjustable DC power. One 30V/10A supply (Wanptek KPS3010D) was used to provide 12V and 24V with $C_{internal}$ = 4,000µF and $R_{internal}$=25.5mΩ. A second supply 60V/5A (Wanptek KPS605D) was used to provide 48V/5A with $C_{internal}$ = 1544µF and $R_{internal}$ = 39mΩ. Each supply had adjustable current-limiting and voltage regulation features but still produced overcurrent transients. For example, because of the internal capacitance in the power supply, a transient current peak of 81A_p was measured upon closing the wire connection. The power supply current limit was set to 10A. This high peak transient, occurring during the make operation, caused the wire conductors to oxidized more quickly as compared to a lower current. Current waveforms were measured using a DC current sensor (Eaton EDCB400SP) having 10 turns of circuit conductor looped through the current sensor to provide a 10X signal since the current range was well below the upper probe range of 400A.

Wire conductor conditioning (oxidation) was performed by manually turning the threaded bolt (seen in Fig. 2) connected to the conductor until the wires touched and current flowed. Initially, a make/break action was performed rapidly (~3 Hz) to condition the wire surfaces by creating a metal oxide from the heat of the plasma during arcing. Either the wires were touched end-to-end to form a butt joint or were overlapped and slid along each other to create an oxide layer.

A glowing condition began to form when the voltage V_{glow} began to increase and there was a change of arcing color from blue to orange, indicating oxide vaporization rather than pure metal vaporization.

The current was set by adjusting the current limit setting of the power supply to the desired value. Two different procedures were used to measure glowing voltage. The first method was to manually sweep the current over the full range of the power supply and record the glowing voltage and current waveforms during this sweep time (either 10s or 25s) using a Nicolet Multipro. A Tektronix P6139A 10X voltage probe was used to measure the glowing voltage. The second method, a current step method, was performed by fixing the current for about 30 seconds, enough time for the glow to stabilize, then measure the glowing voltage with a DVM and the current from the power supply display. The current was then adjusted and the process repeated over the desired current range.

The three different open circuit voltages used (12V, 24V, and 48V) affected the arcing intensity during the make conditioning process but were found to not affect the glowing voltage value. The power supply open circuit voltage determined the charge in the internal capacitance in the DC power supply. This charge affected the transient current peak during the making operation. The total circuit inductance, including the 10 turns of wire around the current sensor, measured L = 10.5μH. This inductance did not produce any significant over-voltages during the wire conditioning process. A maximum di/dt of 0.63A/μs was measured during the making operation. These results imply that only the inrush current due to the internal capacitance of the power supply used in this work affected the wire conditioning process. An external resistor, R, was not used. R represented the resistance of the connection wire (~ 20mΩ).

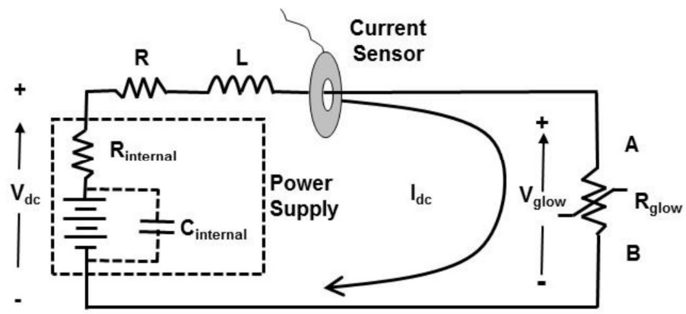


Figure 1. Circuit used to produce DC glowing connections.

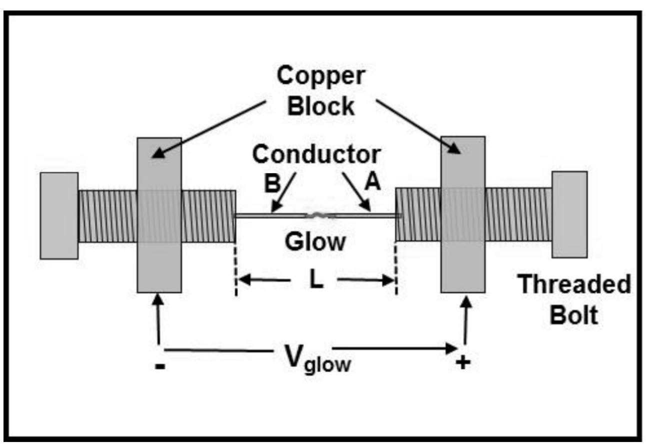


Figure 2. Sketch showing fixture used to create DC glowing connections.

Figure 3 shows a photograph of the test setup and fixture used to create the DC glowing connections. Wire conductors, held in place by a set screw, could easily be replaced as necessary. Electrical connections were made at the copper blocks.

IV. RESULTS

Two examples of typical waveforms, used to illustrate the differences between copper and steel conductors, are shown in Figs. 4 and 5. Figure 6 shows a photograph of the DC glowing connection for symmetrical Cu/Cu and Fe/Fe connections.

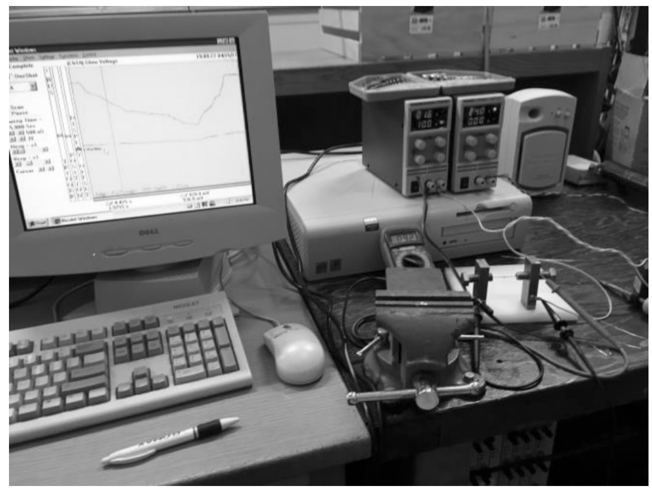


Figure 3. Photograph of the DC glowing connection fixture and instrumentation.

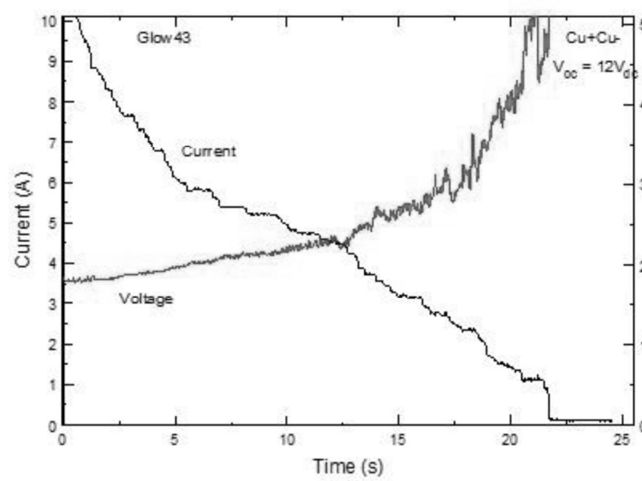


Figure 4. Glowing connection waveforms for copper/copper connection (Cu+/Cu-) showing NTC effect.

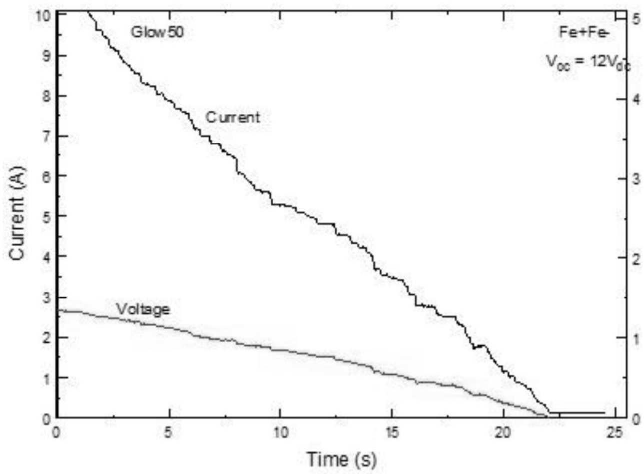
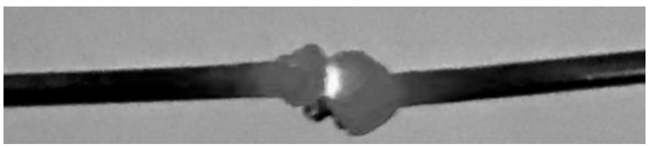


Figure 5. Glowing connection waveforms for steel/steel connection (Fe+/Fe-) showing a slight PTC effect.



(a).

(b).

Figure 6. Glowing connection photos for (a) steel/steel (Fe+/Fe-) and (b) copper/copper (Cu+/Cu-) connections.

These results are for symmetrical material combinations where figures 7 and 8 show typical examples of asymmetrical or mixed conductor materials. In this case, the anode material determined the glowing voltage wave shape (i.e. NTC or PTC characteristic).

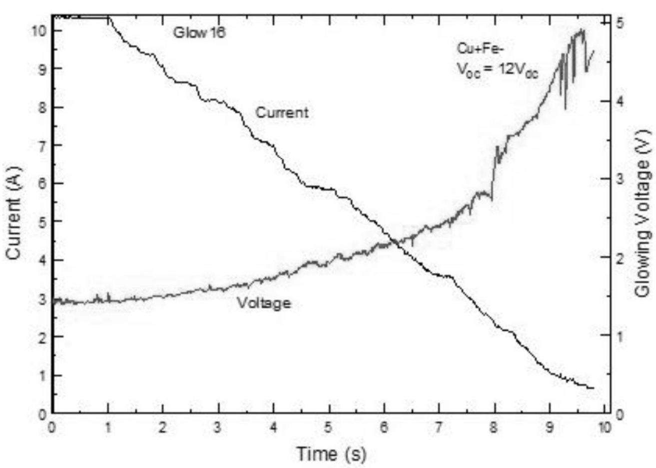


Figure 7. Glowing connection waveforms for copper/steel connection showing strong NTC effect (copper anode).

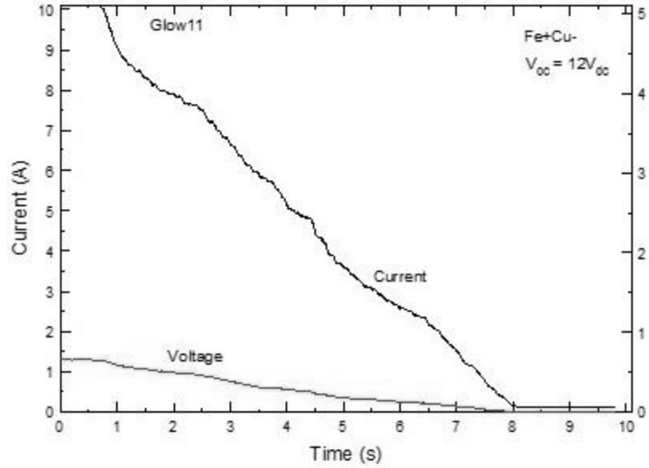


Figure 8. Glowing connection waveforms for steel/copper with steel (Fe) anode showing slight PTC behavior.

An overlay of multiple trials to show repeatability is illustrated in Fig. 9 and corresponding power in Fig. 10.

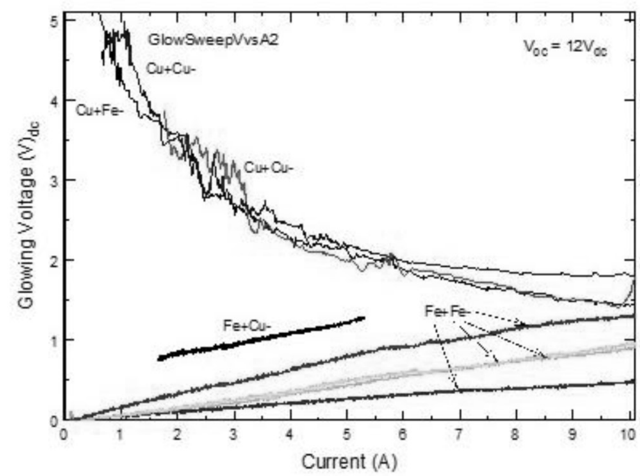


Figure 9. Glowing connection waveforms of material combinations that show repeatability of measurements.

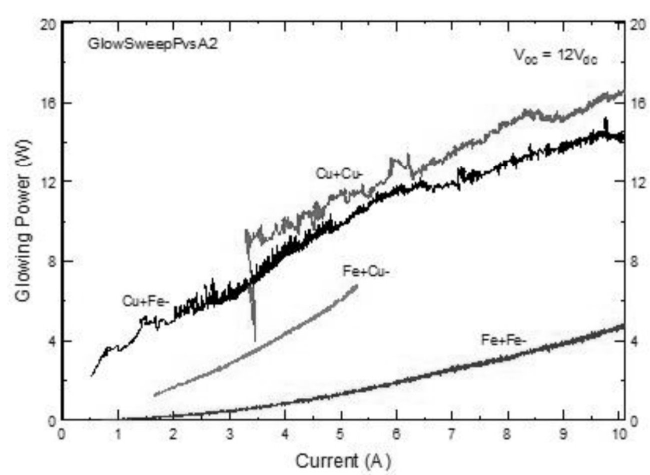


Figure 10. DC glowing connection power dissipation.

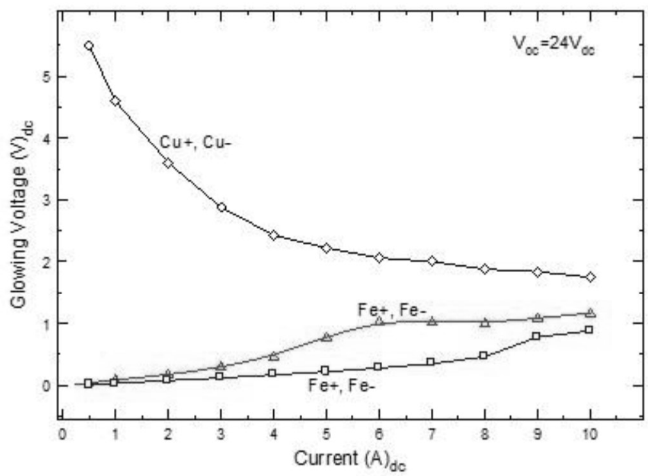


Figure 11. Glowing connection voltages, for symmetrical material connections, obtained from step method.

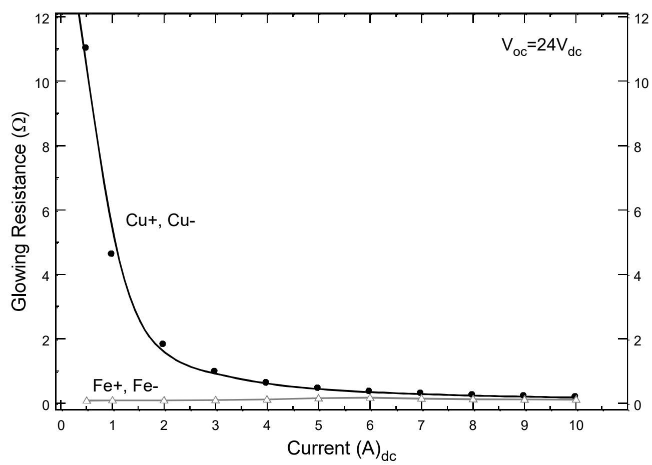


Figure 12. Glowing connection resistance, for symmetrical material connections, obtained using step method results.

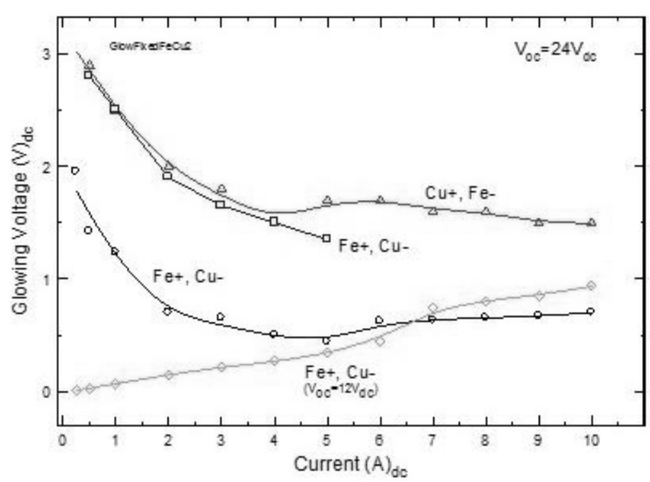


Figure 13. Glowing connection voltages, for asymmetrical material connections, obtained using step method. Notice combination of NTC and PTC effects.

Figures 11-13 show glowing connection voltage and resistance obtained using the step method previously described. The asymmetrical wire combinations, seen in Fig. 13, do not show a polarity dependence since sometimes the results show PTC behavior and sometimes NTC.

V. DISCUSSION

When testing the asymmetrical conductor combination of Fe+/Cu-, see Fig. 12, sometimes the resulting plot would have a PTC shape, like (Fe+Fe-) characteristics, and sometimes NTC (Cu+/Cu-). It is postulated that the glowing voltage plot vs current could show this behavior due to material transfer from the cathode to the anode during the arcing phase. This would result in the interface becoming symmetrical (i.e. having the same oxide type on the anode and cathode) thus explaining the NTC effect sometimes measured for the Fe+Cu- wire combination.

Available temperature versus resistivity curves for copper oxides (CuO and Cu_2O) and iron oxides (FeO and Fe_3O_4) are shown in Fig. 14. The steel-steel wires will be discussed first followed by copper-copper.

It has been observed that when steel-to-steel wires were used, glowing could be easily initiated even when the wires were at room temperature. Also, even after the steel wires was separated for some time, the glow can be reinitiated quite easily. If an interface was glowing and the current reduced to zero, the glow will reinitiate and current will flow again when the current control on the power supply was increased, assuming the connection at the wire interface was not broken. This behavior is explained by the low room temperature resistivity of iron oxide, FeO and Fe_3O_4. as seen in Fig. 14. The resistivity of these oxides is such that at room temperature (i.e. 293°C) they will produce a sufficiently low resistance through the oxide layer at the interface that current will be able to easily flow.

Using the well know formula for resistance, assuming a cylindrical geometry, the interfacial resistance can be estimated using equation 2.

$$R=\rho(T)L/A \qquad (2)$$

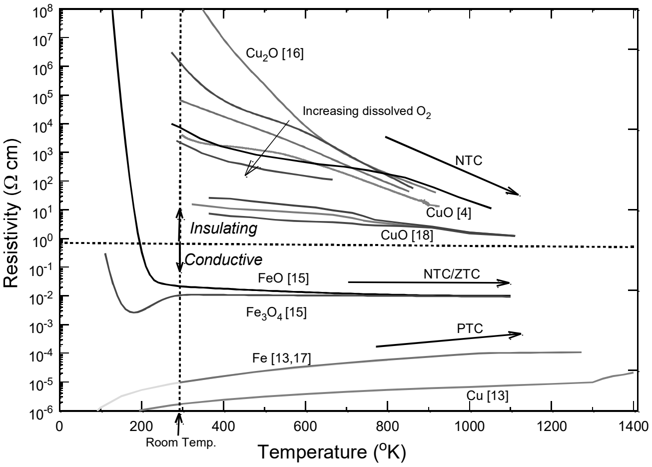


Figure 14. Measured oxide and metal resistivity as a function of temperature for copper and iron metals [4, 14-18]. Arrows associated with corresponding materials indicate the type of temperature coefficient of resistivity (i.e. either PTC (metals) or (NTC or ZTC) oxides).

$A=\pi r^2$ where r is the wire radius of 0.040cm (0.016"), and L is the oxide thickness (estimated at 0.01cm from images of glow). Using these values and 0.1Ωcm for iron oxide (FeO) resistivity at room temperature from, Fig. 14, gives an interfacial resistance value of 0.2Ω. This value will result in a voltage drop of 2V at 10A (very close to the measured voltage drop at 10A). As the current increases from zero, the temperature of the glowing connection increases due to the increasing power (I^2R_{glow}) generated at the glowing connection. Fe_3O_4 and FeO both have a flat to slight NTC of resistance over room temperature up to the highest available temperature (1100°C). This flat response produces a linear increase in power (Fig. 10).

For copper wires, copper oxides (Cu_2O and CuO) form between the arcing copper wires. These oxides have relatively high resistivity (~10^1-10^6Ωcm) near room temperature, making them essentially insulating at the voltages in this work. Also, the copper oxide (Cu_2O) resistivity greatly depends on excess (Nonstoichiometric ratio) of oxygen as seen in Fig. 14. This insulating property at room temperature was confirmed during testing. If a copper-copper glowing connection was broken and not quickly reestablished to a glowing condition, while the oxide was still hot, the interface cooled down and became insulating and current flow could not be reestablished. The copper oxide layer then had to be broken through to allow metal-to-metal contact to initiate arcing to create more oxides at a temperature such that the resistivity of the oxide will be low enough to support continuous current flow. This would explain why it is so much more difficult to establish a glowing connection with copper-to-copper connections than with steel.

The effective NTC of resistivity of the oxides produce a negative feedback on glowing power. This explains why a glow can remain stable over a wide current range (0.5A–10A) even with changes in current over this range. For decreasing current, the voltage of the copper oxide interface increases because of a lower oxide temperature thus, the power dissipated in the connection remains linear. Likewise, as the current increases the oxide resistance decreases to maintain a consistent power with current fluctuations. The non-linear effect of the oxide resistivity with temperature produces a linear power response rather than the familiar exponential response for a constant resistance (i.e. $P=I^2R$) thus producing stabilizing conditions for glowing. As seen from the power curves in Fig. 10, the power dissipated in the interface of a glowing connection is linear with current because of the non-linear behavior of the oxide resistivity at the connection interface.

With increasing currents and corresponding increasing power dissipated at the interface, the glow will eventually extinguish due to the interface becoming unstable and burning open due to the vaporization of the interfacial oxides (refer to Table 1 for oxide vaporization values). Cu_2O and CuO have vaporization temperatures of 1800°C and 2000°C, respectively.

This can explain the difficulty in sustaining a glow at higher currents for copper wires since the interface temperature is above the oxide vaporization temperature thus not allowing a stable interface to be formed or sustained. However, when using steel wire, glowing can be sustained at currents higher than copper wire because iron oxide, FeO, has a higher vaporization temperature, 3414°C, than the copper oxides (2000°C) thus allowing for higher currents and resulting higher interface temperatures before the interface connection becomes unstable and burns open.

VI. CONCLUSION

Glowing phenomena is a result of the resistive nature of the metal oxides that can form at the interface of a loose connection. Copper oxides show a strong negative temperature coefficient (NTC) of resistance, typical of a semiconductor, and can be stable over the current range of 0.25A to $10A_{dc}$. Steel (Fe) conductors also show a relatively flat PTC of resistance. When one connection is made from copper and the other steel, glowing voltage was dependent on which material was the anode. However, oftentimes material transfer can occur from one conductor to another, making a symmetrical conductor pair and thus changing the glowing voltage behavior from anode material dependency to symmetrical material behavior.

DC circuits can produce glowing phenomena in loose connections like AC circuits. The open circuit voltage does not affect glowing connections until it becomes so low that the supply voltage limits the glowing voltage. However, having a capacitive energy storage element, like the one in the power supply used in this work, can lead to increased arcing intensity due to high transient current inrush, which accelerates the rate of oxide production at the connection interface. Circuit inductance can also contribute to the increased arcing intensity if the inductance and switching rate of change of current produces arc voltage greater than the system voltage. For this study, a $12V_{dc}$ circuit produced sufficient metal oxides to create a glowing connection.

This data suggests that even though circuit voltages are low as compared to typical residential AC voltages (i.e. $120V_{rms}$) a glowing connection can still be formed in DC circuits at low DC voltages. Also, the power dissipation in DC circuits was comparable to similar circuits using AC. Thus, LV DC connections can pose an electrical fire threat like AC connections.

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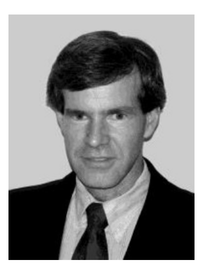
AUTHOR BIOGRAPHY



John J. Shea (M’89-SM’97) received the Ph.D. degree in electrical engineering from the State University of New York at Buffalo in 1989. He is currently a Scientific Advisor with Schneider-Electric where he is involved in the research and development of advanced circuit protection technology. He presently holds 72 patents on various arc interruption and power distribution component designs, written 30 journal articles and 30 conference proceedings, is the 2008 Holm Scientific Awardee, member of the Holm conference operating and technical committee, and the 2013, 2010, 2006, and 2002 IEEE Erle Shobert Prize paper recipient, Armington and E.O Forester service award recipient and senior member of IEEE.

Public Comment No. 1599-NFPA 70-2021 [Section No. 726.121(A)]

(A) Fault Energy and Power Limitations.

~~For listing purposes, under~~ Under the conditions specified in 726.121(B), the energy available into a fault shall be limited according to the requirements of the following:

(1) A Class 4 power source shall provide protection of personnel against the risk of electric shock by de-energizing the circuit or a portion thereof, or limiting the current, within an established period of time.

Informational Note No. 1: This time requirement provides an equivalent level of protection from electric shock as Class 2 circuits.

(2) The maximum power that can be delivered into a fault between conductors or between any conductor and ground shall not exceed 100 volt-amperes, measured after 5 seconds.

Informational Note No. 2: This requirement reduces the risk of fire due to resistive heating.

(3) A Class 4 power source shall provide protection from the effects of arc faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc fault is detected.

Informational Note No. 3: This requirement reduces the risk of fire due to arcing.

Statement of Problem and Substantiation for Public Comment

If we are truly writing this for listing purposes then it belongs in a product standard, not an installation standard.

Related Item

• FR 9606

Submitter Information Verification

Submitter Full Name:	Ryan Jackson
Organization:	Ryan Jackson
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon Aug 16 16:15:08 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	This language “for listing purposes” mirrors the text just prior to Chapter 9, Table 11A where the Class 2/3 listing requirements are located.

Public Comment No. 1766-NFPA 70-2021 [Section No. 726.121(A)]

(A) Fault Energy and Power Limitations.

For listing purposes, under the conditions specified in 726.121(B), the ~~energy~~ current available into a fault shall be limited ~~according to the requirements of the following:~~

(1) ~~A Class 4 power source shall provide protection of personnel against the risk of electric shock by de-energizing the circuit or a portion thereof, or limiting the current, within an established period of time.~~

~~Informational Note No. 1: This time requirement provides an equivalent level of protection from electric shock as Class 2 circuits.~~

(2) ~~The maximum power that can be delivered into a fault between conductors or between any conductor and ground shall not exceed 100 volt-amperes, measured after 5 seconds.~~

~~Informational Note No. 2: This requirement reduces the risk of fire due to resistive heating.~~

(3) ~~A Class 4 power source shall provide protection from the effects of arc faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc fault is detected.~~

~~Informational Note No. 3: This requirement reduces the risk of fire due to arcing.~~

by the Class 4 Transmitter as specified in the listing standard.

Statement of Problem and Substantiation for Public Comment

This text is very tutorial in nature, and that was likely the point for the first draft (trying to educate so that people would support). Having participated in developing the listing standard, it is evident that some of this was based on assumptions. The listing standard tests look for a current for a duration as the acceptable shock hazard. These requirements limit the energy available to line-to-line and line-to-ground faults based on UL shock expert recommendations. The acceptable fault current/time durations are (will be) spelled out in the listing document and they don't match the assumptions made when writing this text - and you can't really compare them as this was written to model Class 2 language where Class 4 systems are a completely different animal. Therefore, I have revised the text to remove any tutorial aspects and instead referred to the listing standard.
Tutorial information should be in the handbook and I will be happy to help write that section. I agree that this topic will need some tutorial but the Code is the wrong place for it.

Related Item

• PI 3740

Submitter Information Verification

Submitter Full Name: Chad Jones
Organization: Cisco Systems
Street Address:
City:
State:
Zip:

Submittal Date: Tue Aug 17 17:06:45 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8327-NFPA 70-2021
Statement:	Section 726.121(A) has been deleted and combined with current 726.121(B). The list of faults was removed as this is appropriately handled by the listing standard to include series faults.

Public Comment No. 2084-NFPA 70-2021 [Section No. 726.121(A)]

(A) Fault Energy and Power Limitations.

For listing purposes, under the conditions specified in 726.121(B), the energy available into a fault shall be limited according to the requirements of the following:

(1) A Class 4 power source shall provide protection of personnel against the risk of electric shock by de-energizing the circuit or a portion thereof, or limiting the current, within an established period of time.

Informational Note No. 1: This time requirement provides an equivalent level of protection from electric shock as Class 2 circuits.

(2) The maximum power that can be delivered into a fault between conductors or between any conductor and ground or into a series fault on a single conductor shall not exceed 100 volt-amperes, measured after 5 seconds.

Informational Note No. 2: This requirement reduces the risk of fire due to resistive heating.

(3) A Class 4 power source shall provide protection from the effects of arc faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc fault is detected.

Informational Note No. 3: This requirement reduces the risk of fire due to arcing.

Statement of Problem and Substantiation for Public Comment

Class 4 circuits are intended to be fault managed and limit the amount of energy into any fault in the circuit (per 726.1 Informational Note 2). To make Class 4 systems fire safety equivalent to a Class 2 circuit, the 100VA limit that is currently considered to be acceptable protection for fire in 726.121 (A) for conductor-to-conductor resistive faults, should also be applied to series resistive faults. Series resistive faults are just as likely to occur wherever the power dissipated between the transmitter and receiver exceeds 100VA, due to common events such as a loose connection or damaged cable. Unlike Class 2 circuits that “guarantee” a 100VA limit at the source of power, a fault managed system without series resistive fault detection could provide hundreds or thousands of VA into a series resistive fault, which is a fire risk significantly greater than existing Class 2 circuits. A Class 4 system without a series 100VA limit should not be allowed to be installed using the wiring practices within Article 726 (no conduit, etc) and should require chapter 3 methods.

Related Item

• FR 9606-NFPA 70-2021

Submitter Information Verification

Submitter Full Name:	Stanley Mlyniec
Organization:	VoltServer
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Aug 19 11:24:41 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8327-NFPA 70-2021

Statement:	Section 726.121(A) has been deleted and combined with current 726.121(B). The list of faults was removed as this is appropriately handled by the listing standard to include series faults.

Public Comment No. 1086-NFPA 70-2021 [Section No. 726.121(B)]

(B) Fault Management.

A listed transmitter shall interrupt an energized circuit within the limits of 726.121(A) when any of the following conditions occur:

(1) An abnormal condition such as abnormal voltage, current, waveform, or load condition is identified in the system

(2) A short circuit occurs

(3) Human skin contacts energized parts

(4) A ground-fault condition exists

(5) An overcurrent condition exists

(6) Intentional shorting of the line at the receiving or transmitting end to force de-energization for purposes of maintenance or repair occurs

(7) A malfunction of the monitoring or control system occurs

(8) Any other condition that presents an unacceptable risk of fire or electric shock

Statement of Problem and Substantiation for Public Comment

Because of the complexity of these systems, it is not practical for the NEC to state all of the criteria and limits for these systems. The Panel chose to create a list of desirable protections and then to rely on the Safety Standard to address those protections with criteria and limits. This is a similar approach as that used for AFCIs in 210.12. Since this is a new technology, there is always the risk that unforeseen conditions could present the risk of electric shock or fire. The addition of item 8 allows for the Safety Standard and/or the certification agency to address potentially hazardous conditions that might not be specifically mentioned in the original 1 through 7 list of items.

Related Item

• FR 9606

Submitter Information Verification

Submitter Full Name: Randolph Ivans

Organization: UL LLC

Street Address:

City:

State:

Zip:

Submittal Date: Mon Aug 09 11:59:09 EDT 2021

Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8341-NFPA 70-2021

Statement: (B) was changed to (A) to accommodate the deletion of section (A)

The list has been updated to reflect the behaviors outlined in the listing standard that are critical for safety. (PC 1771)

Editorial changes were made for clarity. (PC 1600)

The addition of new item 6 allows for the Safety Standard and/or the certification agency to address potentially hazardous conditions that might not be specifically mentioned in the original list of items. (PC 1086)

The original item 6 is deleted. (PC 1911)

Public Comment No. 1600-NFPA 70-2021 [Section No. 726.121(B)]

(B) Fault Management.

A listed transmitter shall interrupt an energized circuit within the limits of 726.121(A) when any of the following conditions occur:

(1) An abnormal condition such as abnormal voltage, current, waveform, or load condition is identified in the system

(2) A short circuit ~~occurs~~

(3) Human skin contacts energized parts

(4) A ground-fault condition exists

(5) An overcurrent condition exists

(6) Intentional shorting of the line at the receiving or transmitting end to force de-energization for purposes of maintenance or repair ~~occurs~~

(7) A malfunction of the monitoring or control system ~~occurs~~

Statement of Problem and Substantiation for Public Comment

Editorial.

Related Item

- FR 9606

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Ryan Jackson
Street Address:
City:
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Submittal Date: Mon Aug 16 16:17:29 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8341-NFPA 70-2021

Statement: (B) was changed to (A) to accommodate the deletion of section (A)

The list has been updated to reflect the behaviors outlined in the listing standard that are critical for safety. (PC 1771)

Editorial changes were made for clarity. (PC 1600)

The addition of new item 6 allows for the Safety Standard and/or the certification agency to address potentially hazardous conditions that might not be specifically mentioned in the original list of items. (PC 1086)

The original item 6 is deleted. (PC 1911)

Public Comment No. 1771-NFPA 70-2021 [Section No. 726.121(B)]

(B) Fault Management.

A listed transmitter shall interrupt an energized circuit within the limits of 726.121(A) when any of the following conditions occur on the circuit between the transmitter and the receiver :

(1) An abnormal condition such as abnormal voltage, current, waveform, or load condition indicative of a fault is identified in the system

(2) A short circuit occurs

(3) ~~Human skin contacts energized parts~~ A line-to-ground or line-to-line current which exceeds the shock hazard safety limit specified in the listing standard

(4) A ground-fault condition ~~exists~~ exists which exceeds the shock hazard safety limit specified in the listing standard

(5) An overcurrent condition exists

(6) Intentional shorting of the line at the receiving or transmitting end to force de-energization for purposes of maintenance or repair occurs

(7) A malfunction of the monitoring or control system ~~occurs~~ occurs which compromises safe operation

Statement of Problem and Substantiation for Public Comment

first sentence: Text was added to the end of the first sentence to illuminate that the protection of Class 4 systems only occur on the circuit between the transmitter and receiver.
one: Made it clear that there may be abnormal conditions that aren't indicative of a fault and that a system will only protect for faults (i.e. there is a lower current threshold below which there is no hazard).
three: Human skin contact implies someone touches this and the system would fault off. A person could be isolated and not cause sufficient body current to force a fault. The text has been revised to describe exactly what these systems do.
four: Added text to set a limit to the ground fault current. There is a threshold below which ground fault current is not harmful.
seven: Clarified that the malfunction compromises safe operation.

Related Item

• PI 3740

Submitter Information Verification

Submitter Full Name:	Chad Jones
Organization:	Cisco Systems
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 17 17:18:25 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8341-NFPA 70-2021
Statement:	(B) was changed to (A) to accommodate the deletion of section (A) The list has been updated to reflect the behaviors outlined in the listing standard that are critical for

safety. (PC 1771)

Editorial changes were made for clarity. (PC 1600)

The addition of new item 6 allows for the Safety Standard and/or the certification agency to address potentially hazardous conditions that might not be specifically mentioned in the original list of items. (PC 1086)

The original item 6 is deleted. (PC 1911)

Public Comment No. 1911-NFPA 70-2021 [Section No. 726.121(B)]

(B) Fault Management.

A listed transmitter shall interrupt an energized circuit within the limits of 726.121(A) when any of the following conditions occur:

(1) An abnormal condition such as abnormal voltage, current, waveform, or load condition is identified in the system

(2) A short circuit occurs

(3) Human skin contacts energized parts

(4) A ground-fault condition exists

(5) An overcurrent condition exists

(6) ~~Intentional shorting of the line at the receiving or transmitting end to force de-energization for purposes of maintenance or repair occurs~~

(7) A malfunction of the monitoring or control system occurs

Statement of Problem and Substantiation for Public Comment

It is bad practice to recommend intentionally shorting lines as a means of de-energization to allow "live" maintenance. Standard disconnect methods such as powering down the class 4 transmitter or a specific class 4 circuit when a circuit is being serviced is recommended. This does not mean the circuit is in anyway unsafe and cannot support short circuit per 726.122 (B) (2) but simply that intentionally shorting electrical conductors is bad practice.

Related Item

• FR 9606-NFPA 70-2021

Submitter Information Verification

Submitter Full Name: Stanley Mlyniec

Organization: VoltServer

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 18 15:48:56 EDT 2021

Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8341-NFPA 70-2021

Statement: (B) was changed to (A) to accommodate the deletion of section (A)

The list has been updated to reflect the behaviors outlined in the listing standard that are critical for safety. (PC 1771)

Editorial changes were made for clarity. (PC 1600)

The addition of new item 6 allows for the Safety Standard and/or the certification agency to address potentially hazardous conditions that might not be specifically mentioned in the original list of items. (PC 1086)

The original item 6 is deleted. (PC 1911)

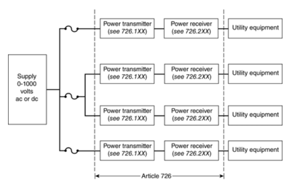
Public Comment No. 1084-NFPA 70-2021 [Section No. 726.121 [Excluding any Sub-Sections]]

The power source shall be a listed Class 4 power transmitter or listed Class 4 power transmitter/receiver system and shall provide the protections in accordance with 726.121(A) and (B). Class 4 circuits shall be supplied from a power source (transmitter) that has a ~~peak~~ voltage output of not more than 450 volts peak or dc line to line or 225 volts peak or dc line to ground.

Informational Note No. 1: Informational Note Figure 726.121 illustrates the relationships between Class 4 power transmitters (power sources), Class 4 power transmitters (power sources) supplies, Class 4 circuits, Class 4 power receivers, and utilization equipment.

Informational Note No. 2: See UL ###-1, *Standard for Class 4 Power Systems*, for information on determining applicable requirements for the listing of Class 4 power systems.

Figure Informational Note Figure 726.121 Class 4 Circuits.



Statement of Problem and Substantiation for Public Comment

Not all of these systems operate on dc. Some existing systems use pulses and there is no reason why other waveforms could not be used in the future.

Related Item

- FR 9606

Submitter Information Verification

Submitter Full Name: Randolph Ivans
Organization: UL LLC
Street Address:
City:
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Submittal Date: Mon Aug 09 11:37:38 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8348-NFPA 70-2021

Statement: This second revision makes the following changes.

"As a part of a" replaced "or" in the first sentence as a class 4 power transmitter/receiver pair is not a power source. Redundant text was deleted in Informational Note 1.

Peak voltage was added to address systems that operate with voltages other than dc. (PC 1732, PC 1084)

The line-to-ground voltage was deleted to accommodate systems that employ an asymmetric high resistance ground

scheme. The panel noted that Class 4 cables will be listed for the full 450 volts on all current carrying conductors. (PC 1516)

Adds the correct number (UL 1400-1) and title for the referenced standard in Informational Note 2. (PC 1902, PC 1732, PC 1256)

The figure was revised to show a case where the Class 4 receiver is built into the utilization equipment.

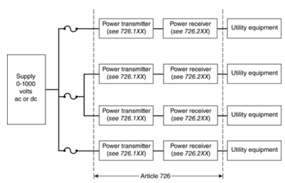
Public Comment No. 1256-NFPA 70-2021 [Section No. 726.121 [Excluding any Sub-Sections]]

The power source shall be a listed Class 4 power transmitter or listed Class 4 power transmitter/receiver system and shall provide the protections in accordance with 726.121(A) and (B). Class 4 circuits shall be supplied from a power source (transmitter) that has a peak voltage output of not more than 450 volts dc line to line or 225 volts dc line to ground.

Informational Note No. 1: Informational Note Figure 726.121 illustrates the relationships between Class 4 power transmitters (power sources), Class 4 power transmitters (power sources) supplies, Class 4 circuits, Class 4 power receivers, and utilization equipment.

Informational Note No. 2: See UL ### 14000 -1, *Standard for Class 4 Power Systems*, for information on determining applicable requirements for the listing of Class 4 power systems.

Figure Informational Note Figure 726.121 Class 4 Circuits.



Statement of Problem and Substantiation for Public Comment

The use of "#####" is indicative of a placeholder of a standard under develop and given the complexity of changes being made around Class 1 - 4 circuits within Chapter 7, potential oversights can occur. As Article 726 is needed within the industries using Class 4 power, rather than remove the note, we are requesting a correction to the proper designator. As neither have been formally published at the time of submission, we have included the last known designation we are aware of: UL 14000-1, Standard for Class 4 Power Systems being developed in parallel with UL 14000-2 Standard for Class 4 Power Cable. Our information suggest that both of these documents will be published prior to formal approval of this version of the NEC n June of 2022.

Additionally, both UL standards given their nature should be included within Informative Annex A.

Related Item

- FR-9606

Submitter Information Verification

Submitter Full Name:	Jeff Silveira
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Affiliation:	BICSI
Street Address:	
City:	
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Submittal Date:	Wed Aug 11 13:56:23 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8348-NFPA 70-2021

Statement: This second revision makes the following changes.

“As a part of a” replaced “or” in the first sentence as a class 4 power transmitter/receiver pair is not a power source. Redundant text was deleted in Informational Note 1.

Peak voltage was added to address systems that operate with voltages other than dc. (PC 1732, PC 1084)

The line-to-ground voltage was deleted to accommodate systems that employ an asymmetric high resistance ground

scheme. The panel noted that Class 4 cables will be listed for the full 450 volts on all current carrying conductors. (PC 1516)

Adds the correct number (UL 1400-1) and title for the referenced standard in Informational Note 2. (PC 1902, PC 1732, PC 1256)

The figure was revised to show a case where the Class 4 receiver is built into the utilization equipment.

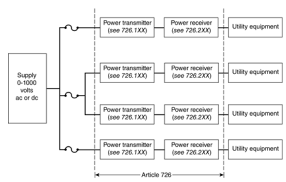
Public Comment No. 1516-NFPA 70-2021 [Section No. 726.121 [Excluding any Sub-Sections]]

The power source shall be a listed Class 4 power transmitter or listed Class 4 power transmitter/receiver system and shall provide the protections in accordance with 726.121(A) and (B). Class 4 circuits shall be supplied from a power source (transmitter) that has a peak voltage output of not more than 450 volts dc line to line or 225 volts dc line to ground for systems that employ a symmetric high resistance midpoint ground reference scheme . For systems that employ an asymmetric high resistance ground scheme (i.e., to prevent the wiring and connectors from going to a positive voltage referenced to ground, in order to prevent corrosion), the power source (i.e., transmitter) are limited to not more than 450 volts DC line to line and line to ground.

Informational Note No. 1: Informational Note Figure 726.121 illustrates the relationships between Class 4 power transmitters (power sources), Class 4 power transmitters (power sources) supplies, Class 4 circuits, Class 4 power receivers, and utilization equipment.

Informational Note No. 2: See UL ###-1, *Standard for Class 4 Power Systems*, for information on determining applicable requirements for the listing of Class 4 power systems.

Figure Informational Note Figure 726.121 Class 4 Circuits.



Additional Proposed Changes

File Name	Description	Approved
NFPA2023_726_High_Resistance_asymetric_ground.pdf	Comment on Class 4 section 726	

Statement of Problem and Substantiation for Public Comment

In order to prevent the wiring and cabling from corrosion, the wire and connector voltage needs to be negative. By allowing the voltage to go negative for a asymmetric high resistance ground reference schemes, will prevent corrosion and provide a long lifetime system. It also is as safe as the symmetric midpoint high resistance ground scheme is, since the line to ground fault current is limited by the reference high resistance (bith systems having similar high resistance paths to ground).

Related Item

- corrosion

Submitter Information Verification

Submitter Full Name: Ronald Nordin
Organization: Panduit
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 16 07:18:05 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8348-NFPA 70-2021
Statement:	This second revision makes the following changes.

"As a part of a" replaced "or" in the first sentence as a class 4 power transmitter/receiver pair is not a power source. Redundant text was deleted in Informational Note 1.

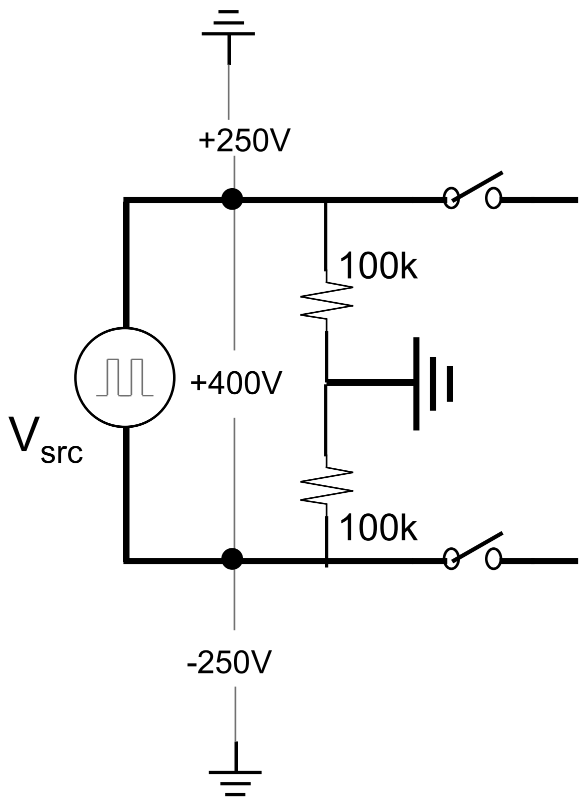
Peak voltage was added to address systems that operate with voltages other than dc. (PC 1732, PC 1084)

The line-to-ground voltage was deleted to accommodate systems that employ an asymmetric high resistance ground

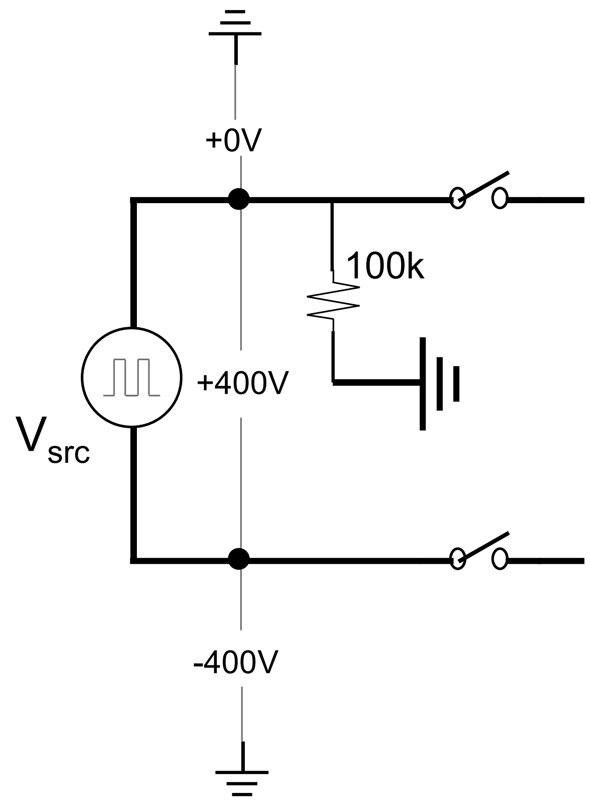
scheme. The panel noted that Class 4 cables will be listed for the full 450 volts on all current carrying conductors. (PC 1516)

Adds the correct number (UL 1400-1) and title for the referenced standard in Informational Note 2. (PC 1902, PC 1732, PC 1256)

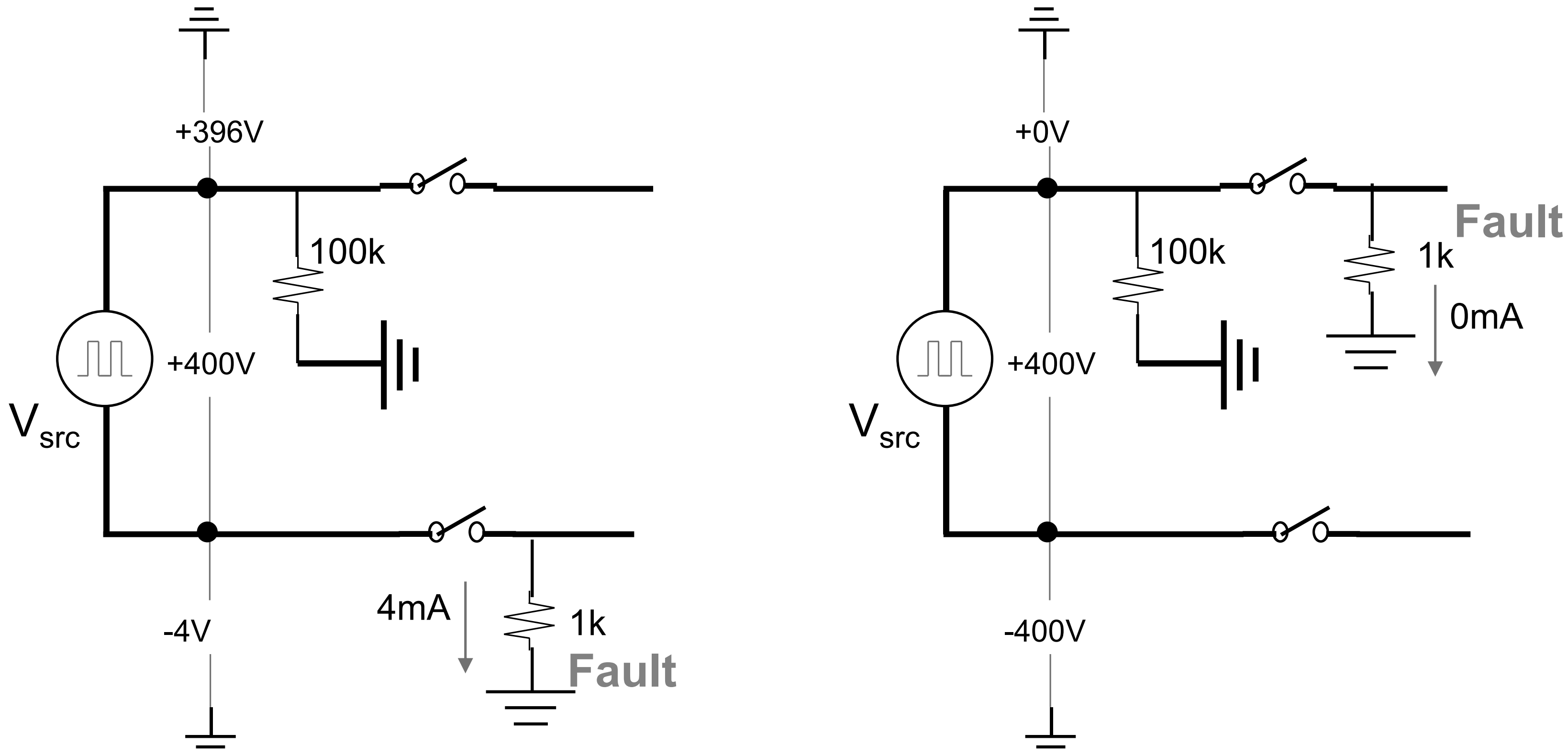
The figure was revised to show a case where the Class 4 receiver is built into the utilization equipment.



Symmetric high resistance
midpoint ground reference



Corrosion Protected Asymmetric
high resistance ground reference



Corrosion Protected Asymmetric high resistance ground reference scheme in a fault condition (note that for faults to ground are limited by the series resistance to ground thereby ensuring that the fault current never exceeds the 25-mA threshold)

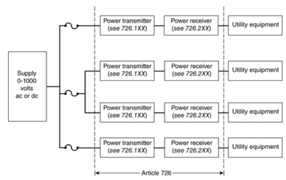
Public Comment No. 1732-NFPA 70-2021 [Section No. 726.121 [Excluding any Sub-Sections]]

The power source shall be a listed Class 4 power transmitter or listed Class 4 power transmitter/receiver system and shall provide the protections in accordance with 726.121(A) and (B). Class 4 circuits shall be supplied from a power source (transmitter) that has a peak voltage output of not more than 450 volts ~~dc~~ peak or dc line to line or 225 volts peak or dc line to ground.

Informational Note No. 1: Informational Note Figure 726.121 illustrates the relationships between Class 4 power transmitters (power sources), Class 4 power transmitters (power sources) supplies, Class 4 circuits, Class 4 power receivers, and utilization equipment.

Informational Note No. 2: See UL ### 1400 -1, *Standard for Class 4 Power Systems*, for information on determining applicable requirements for the listing of Class 4 power systems.

Figure Informational Note Figure 726.121 Class 4 Circuits.



Statement of Problem and Substantiation for Public Comment

As written, the text assumes these are DC systems and precludes AC systems. Adding peak allows other waveforms than DC while still capping the voltage at 450V (leaving no room for 'RMS interpretations'). Also, the UL listing standard will be UL 1400-1 for the equipment and 1400-2 for the cabling.

Related Item

- PI 3740

Submitter Information Verification

Submitter Full Name:	Chad Jones
Organization:	Cisco Systems
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 17 15:29:28 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8348-NFPA 70-2021
Statement:	This second revision makes the following changes. “As a part of a” replaced “or” in the first sentence as a class 4 power transmitter/receiver pair is not a power source. Redundant text was deleted in Informational Note 1. Peak voltage was added to address systems that operate with voltages other than dc. (PC 1732, PC 1084)

The line-to-ground voltage was deleted to accommodate systems that employ an asymmetric high resistance ground

scheme. The panel noted that Class 4 cables will be listed for the full 450 volts on all current carrying conductors. (PC 1516)

Adds the correct number (UL 1400-1) and title for the referenced standard in Informational Note 2. (PC 1902, PC 1732, PC 1256)

The figure was revised to show a case where the Class 4 receiver is built into the utilization equipment.

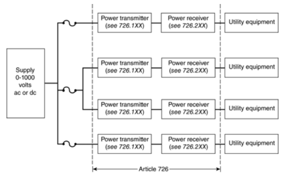
Public Comment No. 1740-NFPA 70-2021 [Section No. 726.121 [Excluding any Sub-Sections]]

The power source shall be a listed Class 4 power transmitter or listed Class 4 power transmitter/receiver system and shall provide the protections in accordance with 726.121(A) and (B). Class 4 circuits shall be supplied from a power source (transmitter) that has a peak voltage output of not more than 450 volts dc line to line or 225 volts dc line to ground.

Informational Note No. 1: Informational Note Figure 726.121 illustrates the relationships between Class 4 power transmitters (power sources), Class 4 power transmitters (power sources) supplies, Class 4 circuits, Class 4 power receivers, and utilization equipment.

Informational Note No. 2: See UL ###-1, *Standard for Class 4 Power Systems*, for information on determining applicable requirements for the listing of Class 4 power systems.

Figure Informational Note Figure 726.121 Class 4 Circuits.



Statement of Problem and Substantiation for Public Comment

In Figure Informational Note Figure 726.121 there are 'TBDs'
726.1XX should be 726.121(A) & (B). Do we also add 726.124(A)?
As for 726.2XX - we do not have a specific Class 4 receiver section. We could point the reader to 726.122 and 726.124(B).

Related Item

- PI 3740

Submitter Information Verification

Submitter Full Name: Chad Jones
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Submittal Date: Tue Aug 17 15:51:15 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8348-NFPA 70-2021

Statement: This second revision makes the following changes.

"As a part of a" replaced "or" in the first sentence as a class 4 power transmitter/receiver pair is not a power source. Redundant text was deleted in Informational Note 1.

Peak voltage was added to address systems that operate with voltages other than dc. (PC 1732, PC 1084)

The line-to-ground voltage was deleted to accommodate systems that employ an asymmetric high resistance ground

scheme. The panel noted that Class 4 cables will be listed for the full 450 volts on all current carrying conductors. (PC 1516)

Adds the correct number (UL 1400-1) and title for the referenced standard in Informational Note 2. (PC 1902, PC 1732, PC 1256)

The figure was revised to show a case where the Class 4 receiver is built into the utilization equipment.

Public Comment No. 1602-NFPA 70-2021 [Section No. 726.122]

726.122 Class 4 Loads.

Outputs of a Class 4 receiver and power outputs of Class 4 utilization equipment shall be considered a separately derived system ~~and shall be subject to requirements in Chapters 1 through 4~~ .

Informational Note: Class 4 utilization equipment that does not provide power outputs is not subject to these requirements.

Exception: A Class 4 receiver with limited-power circuit outputs shall be permitted to meet the requirements of Parts I ~~thru~~ through IV of Article 725.

Statement of Problem and Substantiation for Public Comment

Compliance with Chapters 1-4 is not optional, and "thru" should be not used in formal writing.

Related Item

- FR 9606

Submitter Information Verification

Submitter Full Name: Ryan Jackson
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Submittal Date: Mon Aug 16 16:19:33 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR
Resolution: SR-8314-NFPA 70-2021
Statement: The reference to Chapters 1 through 4 is deleted. These chapters would automatically apply to separately derived systems. Separately derived systems only apply to circuits used to supply a feeder or a branch circuit. The exception has been revised to comply with the Style Manual.

Public Comment No. 1910-NFPA 70-2021 [Section No. 726.122]

726.122 Class 4 Loads.

Outputs of a Class 4 receiver and power outputs of Class 4 utilization equipment shall be considered a separately derived system and shall be subject to requirements in Chapters 1 through 4 4 if the outputs are used as a supply for a feeder and/or to branch circuit(s) .

Informational Note: Class 4 utilization equipment that does not provide power outputs is not subject to these requirements.

Exception: A Class 4 receiver with limited-power circuit outputs shall be permitted to meet the requirements of Parts I thru IV of Article 725.

Statement of Problem and Substantiation for Public Comment

The outputs of a Class 4 receiver should be treated similarly to the outputs of a standalone Uninterruptible Power Supply (UPS) and not subject to all Chapter 1 – 4 requirements unless the outputs are used as a feeder and/or branch circuit. Many receivers will power load devices in close proximity to the receiver itself, similar to a UPS powering a workstation or server. One example of a requirement that should not be applied to a receiver used in this manner is the requirement to bond the grounding conductor to the nearest metal water pipe [250.104 (D)-(1)].

Related Item

- FR 9606-NFPA 70-2021

Submitter Information Verification

Submitter Full Name: Stanley Mlyniec
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Street Address:
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Submittal Date: Wed Aug 18 15:47:39 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8314-NFPA 70-2021

Statement: The reference to Chapters 1 through 4 is deleted. These chapters would automatically apply to separately derived systems. Separately derived systems only apply to circuits used to supply a feeder or a branch circuit. The exception has been revised to comply with the Style Manual.

Public Comment No. 1603-NFPA 70-2021 [Section No. 726.124]

726.124 Class 4 Marking.

~~**(A)** Class 4 Transmitter Marking.~~

The equipment supplying the Class 4 circuits, Class 4 receivers, and Class 4 utilization equipment shall be durably marked where plainly visible to indicate each circuit that is a Class 4 circuit. ~~The~~ Where the Class 4 receiver or Class 4 utilization equipment has user-accessible outputs, each output shall be durably marked where plainly visible.These marking shall also include the maximum voltage and current output for each connection point. Where multiple connection points have the same rating, a single label shall be permitted to be used.

Informational Note: An example of marking is "Class 4: +/–190V, 5A" for a Class 4 transmitter capable of delivering 1.9 kW from 380 volts line to line.

~~**(B)** Class 4 Receiver Marking.~~

~~A Class 4 receiver or Class 4 utilization equipment shall be durably marked where plainly visible to indicate each circuit that is a Class 4 circuit. The marking shall also include the maximum input voltage and current for each connection point. Where the Class 4 receiver or Class 4 utilization equipment has user-accessible outputs, each output shall be durably marked where plainly visible. The marking shall also include the maximum output voltage and current for each connection point. Where multiple connection points have the same rating, a single label shall be permitted to be used.~~

Statement of Problem and Substantiation for Public Comment

These two paragraphs can be consolidated into one without sacrificing usability or clarity.

Related Item

- FR 9606

Submitter Information Verification

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Submittal Date: Mon Aug 16 16:22:55 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: The current text intentionally separates transmitters and receivers for reader clarity. Additionally, the transmitter and receiver have different marking requirements, necessitating separate statements. This parallels how other power sources and loads are handled in other parts of the Code.

Public Comment No. 1087-NFPA 70-2021 [Section No. 726.124(B)]

(B) Class 4 Receiver Marking.

(1) Class 4 Circuits. A Class 4 receiver or Class 4 utilization equipment shall be durably marked where plainly visible to indicate each circuit that is a Class 4 circuit. The marking shall also include the maximum input voltage and current for each connection point.

(2) Output Terminals and Socket-Outlets. Where the Class 4 receiver or Class 4 utilization equipment ~~has user-accessible outputs~~ has output terminals or socket-outlets for providing power to other equipment , each output shall be durably marked where plainly visible. The marking ~~shall also include~~ shall include the maximum output voltage and current for each connection point. Where multiple connection points have the same rating, a single label shall be permitted to be used.

Statement of Problem and Substantiation for Public Comment

The proposed wording separates and clarifies the marking requirements for the input Class 4 terminals and the output terminals or socket outlets that provide power to other equipment. The output ports should be marked with a rating whether or not they are user accessible. This is consistent with the marking requirements for Class 2 circuits in 725.121(C).

"725.121(C) Marking. The power sources for limited power circuits in 725.121(A)(3), limited power circuits for listed audio/video equipment, listed information technology equipment, listed communications equipment, and listed industrial equipment in 725.121(A)(4) shall have a label indicating the maximum voltage and maximum current or maximum voltage and nominal current output per conductor for each connection point on the power source. Where multiple connection points have the same rating, a single label shall be permitted to be used. For equipment with a rated current per conductor less than 0.3 amperes, the effective date shall be January 1, 2021."

Related Item

- FR 9606

Submitter Information Verification

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Submittal Date: Mon Aug 09 12:13:12 EDT 2021

Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution:

Statement: This second revision separates and clarifies the marking requirements for the input Class 4 terminals of the receiver and the output terminals or socket outlets of the receiver that provide power to other equipment. The output ports should be marked with a rating whether or not they are user accessible. This is consistent with the marking requirements for Class 2 circuits in 725.121(C). (PC 1087)

If providing Class 2 or Class 3 circuits, the outputs need to be marked in accordance with Part II of Article 725. (PC 1697)

Public Comment No. 1697-NFPA 70-2021 [Section No. 726.124(B)]

(B) Class 4 Receiver Marking.

A Class 4 receiver or Class 4 utilization equipment shall be durably marked where plainly visible to indicate each circuit that is a Class 4 circuit. The marking shall also include the maximum input voltage and current for each connection point. Where the Class 4 receiver or Class 4 utilization equipment has user-accessible outputs, each output shall be durably marked where plainly visible. The marking shall also include the maximum output voltage and current for each connection point. Where multiple connection points have the same rating, a single label shall be permitted to be used. The output marking shall also include the listing mark for the output circuit.

Statement of Problem and Substantiation for Public Comment

The output of the receiver will be required to meet the appropriate product safety standard for the specific output. An example would be if the receiver is a class 2 power supply and would need to be marked to the appropriate UL listing. Another example could be if it is a low voltage dc circuit and would have to be listed per the requirements for a separately derived system.

Related Item

- FR 9606

Submitter Information Verification

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Submittal Date:	Tue Aug 17 12:49:25 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	
Statement:	This second revision separates and clarifies the marking requirements for the input Class 4 terminals of the receiver and the output terminals or socket outlets of the receiver that provide power to other equipment. The output ports should be marked with a rating whether or not they are user accessible. This is consistent with the marking requirements for Class 2 circuits in 725.121(C). (PC 1087) If providing Class 2 or Class 3 circuits, the outputs need to be marked in accordance with Part II of Article 725. (PC 1697)

Public Comment No. 1259-NFPA 70-2021 [Section No. 726.170]

726.170 Listing of Equipment for Class 4 Systems.

The active components of a Class 4 system shall be listed as a Class 4 device. The Class 4 transmitter and Class 4 receiver combination or Class 4 transmitter and Class 4 utilization equipment combination shall be listed as a system to confirm interoperability.

Informational Note: See UL ### 14000 -1, *Standard for Class 4 Power Systems*, for information on determining applicable requirements for the listing of Class 4 power systems.

Statement of Problem and Substantiation for Public Comment

The use of "#####" is indicative of a placeholder of a standard under develop and given the complexity of changes being made around Class 1 - 4 circuits within Chapter 7, potential oversights can occur. As Article 726 is needed within the industries using Class 4 power, rather than remove the note, we are requesting a correction to the proper designator. As neither have been formally published at the time of submission, we have included the last known designation we are aware of: UL 14000-1, Standard for Class 4 Power Systems being developed in parallel with UL 14000-2 Standard for Class 4 Power Cable. Our information suggest that both of these documents will be published prior to formal approval of this version of the NEC n June of 2022.

Additionally, both UL standards given their nature should be included within Informative Annex A.

Related Item

• FR-9606

Submitter Information Verification

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Submittal Date: Wed Aug 11 14:19:09 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8317-NFPA 70-2021

Statement: This second revision adds the correct number (UL 1400-1) and title for the referenced standard in Informational Note 1. (PC 1904, PC 1259, PC 1773)

The text was revised to make it clear that dependent devices need to be identified as part of the listing information but that each combination of dependent devices does not require a separate identification and listing. An informational note 2 providing an example is added for clarity. (PC 1912)

Public Comment No. 1773-NFPA 70-2021 [Section No. 726.170]

726.170 Listing of Equipment for Class 4 Systems.

The active components of a Class 4 system shall be listed as a Class 4 device. The Class 4 transmitter and Class 4 receiver combination or Class 4 transmitter and Class 4 utilization equipment combination shall be listed as a system to confirm interoperability.

Informational Note: See UL ### 1400 -1, *Standard for Class 4 Power Systems*, for information on determining applicable requirements for the listing of Class 4 power systems.

Statement of Problem and Substantiation for Public Comment

The UL listing standard for Class 4 equipment is UL 1400-1

Related Item

- PI 3740

Submitter Information Verification

Submitter Full Name: Chad Jones
Organization: Cisco Systems
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Submittal Date: Tue Aug 17 17:30:07 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8317-NFPA 70-2021

Statement: This second revision adds the correct number (UL 1400-1) and title for the referenced standard in Informational Note 1. (PC 1904, PC 1259, PC 1773)

The text was revised to make it clear that dependent devices need to be identified as part of the listing information but that each combination of dependent devices does not require a separate identification and listing. An informational note 2 providing an example is added for clarity. (PC 1912)

Public Comment No. 1904-NFPA 70-2021 [Section No. 726.170]

726.170 Listing of Equipment for Class 4 Systems.

The active components of a Class 4 system shall be listed as a Class 4 device. The Class 4 transmitter and Class 4 receiver combination or Class 4 transmitter and Class 4 utilization equipment combination shall be listed as a system to confirm interoperability.

Informational Note: See UL ~~###~~ 1400 -1, ~~*Standard for Class 4 Power Systems*~~ *Outline for Fault-Managed Power Systems – Part 1: General Requirements* , for information on determining applicable requirements for the listing of Class 4 power systems.

Additional Proposed Changes

File Name	Description	Approved
PC_1904_Attachment_C_Randolph_Ivans.pdf	UL 1400-1 & -2 Table of Contents, Normative references and Content Resources	

Statement of Problem and Substantiation for Public Comment

This comment was developed by the participants of a research and development project group assembled by UL to develop safety requirements for Fault Managed Power Systems (FMPS) to reduce the risks of electric shock and fire and facilitate the design, production and use of products that are physically safe. This project is intended to support the First Revision that adds Class 4 circuits to the 2023 National Electrical Code© (NEC©) as a new Article 726. Participant companies include (in alphabetical order) ATIS, Belden, Chemours, Cisco, CommScope, Corning, Daiken, Enersys (formerly Alpha Technologies), Hubbell, Leviton, Panduit, Schneider Electric, Southwire, Superior Essex, Voltserver, and UL. Participation in the project is broad-based and includes representation of those with knowledge and experience in electrical safety, installation, code enforcement, and wire and cable. Participation in the project alone does not imply 100% agreement among the participant companies or individual members with the developed requirements.

The Scope of Work for the project is to develop a fault managed power safety system framework that can be recommended to installation code bodies, that is technically coordinated with existing and new product safety standards, and that enables "listing" of equipment identified for the purpose.

1) Research of pre-existing written and electronic materials
2) Gap analysis of existing codes and standards
3) Study of safety risks and creation of risk mitigation requirements
4) Specifications for cabling, connectivity and equipment
5) Development of new UL Standards encompassing new equipment, components and cables for Class 4 systems and components

During the course of this project, participants conducted research on topics that ranged from electric shock and arc-energy to grounding of separately derived systems. Refer to Attachment 5 for examples of papers and standards used for this research. In addition, significant input was sought from the participating companies to utilize their expertise and experience and aid in the practical resolution of the issues.

As a result of this work, drafts of two new outlines of investigation (standards) have been prepared; UL 1400-1, Outline for Fault-Managed Power Systems – Part 1: General Requirements, and UL 1400-2, Outline for Fault-Managed Power Systems – Part 2: Requirements for Class 4 Cables. Refer to Attachments 1 and 2 for the Table of Contents for these new standards.

These standards are technically coordinated with existing standards while incorporating the requirements necessary to deal with the advanced technology of Class 4 systems. UL 1400-1 is written as a supplement to UL 62368-1, Audio/video, information and communication technology equipment - Part 1: Safety requirements, leveraging the technical expertise of this internationally harmonized standard based on the hazard-based safety engineering (HBSE) principles. UL 1400-2 is based on UL 13, Power-Limited Circuit Cables, and contains all of the requirements necessary to evaluate Class 4 cables. Attachments 3 and 4 identify the normative standard references incorporated into the requirements.

UL's outline of investigations (standards) describe the requirements used to evaluate products and systems with detailed technical content addressing potential risks and their mitigation. They provide standardized, vendor-neutral and uniform solutions and procedures.

Related Item

• FR 9606 • PC 1902 • PC 1905 • PC 1906 • PC 2165

Submitter Information Verification

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Submittal Date: Wed Aug 18 15:24:21 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8317-NFPA 70-2021

Statement: This second revision adds the correct number (UL 1400-1) and title for the referenced standard in Informational Note 1. (PC 1904, PC 1259, PC 1773)

The text was revised to make it clear that dependent devices need to be identified as part of the listing information but that each combination of dependent devices does not require a separate identification and listing. An informational note 2 providing an example is added for clarity. (PC 1912)

ATTACHMENT 1
Table of Contents for UL 1400-1,
Outline for Fault-Managed Power Systems – Part 1: General Requirements

Table of Contents

ATTACHMENT 2
Table of Contents for UL 1400-2,
Outline for Fault-Managed Power Systems – Part 2: Requirements for Class 4 Cables

CONTENTS

MARKINGS

ATTACHMENT 3
Normative Standards Referenced in UL 1400-1

- UL 991, *Tests for Safety-Related Controls Employing Solid-State Devices*
- UL 1998, *Software in Programmable Components*
- UL 60730-1, *Automatic Electrical Controls – Part 1: General Requirements*
- UL: 62368-1, *Audio/video, information and communication technology equipment - Part 1: Safety requirements*
- IEC 60479-1, *Effects of current on human beings and livestock – Part 1: General aspects*
- IEC 60479-2, *Effects of current on human beings and livestock – Part 2: Special aspects*
- IEC 61508-1, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 1: General Requirements*
- IEC 61508-2, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 2: Requirements for Electrical/Electronic/Programmable Electronic Safety-Related Systems*
- IEC 61508-3, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 3: Software Requirements*
- IEC 61508-4, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 4: Definitions and Abbreviations*
- IEC 61508-5, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 5: Examples of Methods for the Determination of Safety Integrity Levels*
- IEC 61508-6, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 6: Guidelines on the Application of IEC 61508-2 and IEC 61508-3*
- IEC 61508-7, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 7: Overview of Techniques and Measures*
- IEC 62061, *Safety of Machinery – Functional Safety of Safety-Related Electrical, Electronic and Programmable Electronic Control Systems*
- ISO 13849-1, *Safety of Machinery - Safety-Related Parts of Control Systems - Part 1: General Principles for Design*
- ISO 13849-2, *Safety of Machinery - Safety-Related Parts of Control Systems - Part 2: Validation*
- ATIS-0600040, *Fault Managed Power Distribution Technologies – Human Contact Fault Analysis*

ATTACHMENT 4
Normative Standards Referenced in UL 1400-2

- UL 13, *Power-Limited Circuit Cables*
- UL 444, *Communications Cables*
- UL1581, *Reference Standard for Electrical Wires, Cables, and Flexible Cords*
- UL 1651, *Optical Fiber Cable*
- UL1666 **,** *Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts*
- UL2556, *Wire and Cable Test Methods*
- NFPA 262, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*

ATTACHMENT 5
Examples of papers and standards consulted during the development of requirements

- “Electric Shock Hazard Considerations for Fault Managed Power Distribution Technologies”
  -Hai Jiang, Ph.D. P.E. & Alex Di Sciullo Jones
- “The Establishment of Energy-Based Test Criteria for Fault-Managed Power Distribution Technologies” -Paul W. Brazis, Jr., PhD
- “On Extending the Td−Ib Curve b Limit For Td Shorter Than 10ms.” Rev. A0.4. 11/23/2020”
  - Dr. Francisco Paz
- “DC Arc-fault Testing to Support Photovoltaic Arc-fault Protection Device Requirements” October 8, 2013
  - David A. Dini, P.E. and Paul W. Brazis Jr., PhD

- IEC 60479-1, *Effects of current on human beings and livestock – Part 1: General aspects*
- IEC 60479-2, *Effects of current on human beings and livestock – Part 2: Special aspects*
- ATIS-0600040 (Draft), *Fault Managed Power Distribution Technologies – Human Contact Fault Analysis*
- UL 489I, *Outline for Solid State Molded-Case Circuit Breakers*
- UL 943, *Ground-Fault Circuit-Interrupters*
- UL 1699B, *Photovoltaic (PV) DC Arc-Fault Circuit Protection*
- UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*
- UL 1778, *Uninterruptible Power Systems*
- UL 2271, *Batteries for Use In Light Electric Vehicle (LEV) Applications*
- UL 60730-1, *Automatic Electrical Controls – Part 1: General Requirements, Annex H*
- UL: 62368-1, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

Public Comment No. 1912-NFPA 70-2021 [Section No. 726.170]

726.170 Listing of Equipment for Class 4 Systems.

The active components of a Class 4 system shall be listed as a Class 4 device. ~~The~~ Class 4 ~~transmitter and Class 4 receiver combination or Class 4 transmitter and Class 4 utilization equipment combination~~ Devices shall be listed ~~as a system to confirm interoperability~~ for the use as part of the same identified Class 4 system .

Informational Note: See UL ###-1, *Standard for Class 4 Power Systems*, for information on determining applicable requirements for the listing of Class 4 power systems.

Statement of Problem and Substantiation for Public Comment

Requiring devices to be listed "as a system" would create confusion with respect to device model numbers. Typically, a listing is tied to a specific model and/or part number. If each combination was required to be listed this could result in an unmanageable number of model and/or part numbers. It is sufficient to test and confirm interoperability as part of the NRTL listing process but not require that the listing to be for the system as a whole. This is the same concept behind 411.4(A) for Low-Voltage Lighting systems which states "The luminaires, power supply, and luminaire fittings (including the exposed bare conductors) of an exposed bare conductor lighting system shall be listed for the use as part of the same identified lighting system."

Related Item

• FR 9606-NFPA 70-2021

Submitter Information Verification

Submitter Full Name: Stanley Mlyniec
Organization: VoltServer
Street Address:
City:
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Zip:
Submittal Date: Wed Aug 18 15:49:36 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR
Resolution: SR-8317-NFPA 70-2021
Statement: This second revision adds the correct number (UL 1400-1) and title for the referenced standard in Informational Note 1. (PC 1904, PC 1259, PC 1773)

The text was revised to make it clear that dependent devices need to be identified as part of the listing information but that each combination of dependent devices does not require a separate identification and listing. An informational note 2 providing an example is added for clarity. (PC 1912)

Public Comment No. 1780-NFPA 70-2021 [Section No. 726.203]

726.203 Other Articles.

In addition to the requirements of this article, circuits and equipment shall comply with the requirements in 726.3(A) through (N). Only those sections of Article 300 referenced in this article shall apply to Class 4 power systems.

~~**(A)** Number and Size of Conductors in Raceway.~~

~~The number and size of conductors shall comply with the requirements of 300.17.~~

~~**(B)** Spread of Fire or Products of Combustion.~~

~~Installation of Class 4 circuits shall comply with the requirements of 300.21.~~

~~**(C)** Ducts, Plenums, and Other Air-Handling Spaces.~~

~~Class 4 circuits installed in ducts, plenums, and other spaces used for environmental air shall comply with the requirements of 300.22.~~

~~**(D)** Cable Trays.~~

~~Cable tray installations shall comply with the requirements of Parts I and II of Article 392.~~

~~**(E)** Instrumentation Tray Cable.~~

~~Instrumentation tray cable (Type ITC) installations shall comply with the requirements of 727.1 and 727.4 through 727.9.~~

~~**(F)** Raceways Exposed to Different Temperatures.~~

~~Installations shall comply with the requirements of 300.7(A).~~

~~**(G)** Bushing.~~

~~Bushings shall be installed where cables emerge from raceways used for mechanical support or protection in accordance with 300.15(C).~~

~~**(H)** Installation of Conductors With Other Systems.~~

~~Installation of conductors with other systems shall comply with the requirements of 300.8.~~

~~**(I)** Corrosive, Damp, or Wet Locations.~~

~~Class 4 cables installed in corrosive, damp, or wet locations shall comply with the applicable requirements of 110.11, 300.5(B), 300.6, 300.9, and 310.10(F).~~

~~(~~

J)_ Cable Routing Assemblies.

Class 4 and Type CL4TC cables shall be permitted to be installed in plenum cable routing assemblies, riser cable routing assemblies, and general-purpose cable routing assemblies selected in accordance with Table 800.154(c), listed in accordance with 800.182, and installed in accordance with 800.110(C) and 800.113.

(K) Communications Raceways.

Where the requirements applicable to electrical nonmetallic tubing (ENT) apply, Class 4 and Type CL4TC cables shall be permitted to be installed in plenum communications raceways, riser communications raceways, and general-purpose communications raceways selected in accordance with Table 800.154(b), listed in accordance with 800.182, and installed in accordance with 800.113 and 362.24 through 362.56.

~~**(L)** Temperature Limitation of Class 4 Cables.~~

~~The requirements of 310.14(A)(3) on the temperature limitation of conductors shall apply to Class 4 cables.~~

~~**(M)** Identification of Equipment Grounding Conductors.~~

~~Equipment grounding conductors shall be identified in accordance with 250.119.~~

~~*Exception: Class 4 cables that do not contain an equipment grounding conductor shall be permitted to use a conductor with green or green with one or more yellow stripes insulation for other than equipment grounding purposes.*~~

Statement of Problem and Substantiation for Public Comment

delete text covered in other sections:
covered in 722.3: A, B, C, D, F, H, I, L, and M

726.203(E) was recommended deleted by another PC (1779)

726.203(G) covered in 722.24(A)

726.203(J) & (K) do not match what's in 722. Therefore, leaving them in 726.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 1784-NFPA 70-2021 [Sections 726.203(J), 726.203(K)]	
Public Comment No. 1794-NFPA 70-2021 [Section No. 722.3(N)]	
Public Comment No. 1795-NFPA 70-2021 [Section No. 722.3(M)]	
Public Comment No. 1860-NFPA 70-2021 [Section No. 722.1]	

Related Item

- PI 3671 and PI 3740

Submitter Information Verification

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Submittal Date:	Tue Aug 17 18:30:02 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8356-NFPA 70-2021
Statement:	The requirements have been removed from 726.203 as these cable installation requirements are now addressed by Article 722.

Public Comment No. 1779-NFPA 70-2021 [Section No. 726.203(E)]

~~(E) Instrumentation Tray Cable.~~

~~Instrumentation tray cable (Type ITC) installations shall comply with the requirements of 727.1 and 727.4 through 727.9.~~

Statement of Problem and Substantiation for Public Comment

ITC is allowed for 150V or less and 5A or less, and the conductor insulation is only required to be 300V. This doesn't match the requirements for Class 4 cable to have a 450V rating. It was an oversight to include ITC in the list of other articles for FMP. Therefore, I've deleted.

Related Item

- PI 3740

Submitter Information Verification

Submitter Full Name:	Chad Jones
Organization:	Cisco Systems
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 17 18:24:26 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8356-NFPA 70-2021
Statement:	The requirements have been removed from 726.203 as these cable installation requirements are now addressed by Article 722.

Public Comment No. 1798-NFPA 70-2021 [Section No. 726.203(E)]

~~**(E)** Instrumentation Tray Cable.~~

~~Instrumentation tray cable (Type ITC) installations shall comply with the requirements of 727.1 and 727.4 through 727.9.~~

Statement of Problem and Substantiation for Public Comment

ITC cable does not meet the voltage requirements for class 4 installations since sources can be as high as 400V and ITC cable is only rated to 300V according to 335.6. This appears to be a copy and paste error. Additionally, if it were kept, the references are wrong, as ITC is now in Chapter 3.

Related Item

- FR 9606-NFPA 70-2021 (new article 726)

Submitter Information Verification

Submitter Full Name:	George Zimmerman
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Affiliation:	Ethernet Alliance
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City:	
State:	
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Submittal Date:	Tue Aug 17 19:53:26 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8356-NFPA 70-2021
Statement:	The requirements have been removed from 726.203 as these cable installation requirements are now addressed by Article 722.

Public Comment No. 1784-NFPA 70-2021 [Sections 726.203(J), 726.203(K)]

Sections 726.~~203~~ 3 (~~J~~ A), 726.~~203~~ 3 (~~K~~ B)

(~~J~~ A) Cable Routing Assemblies.

Class 4 and Type CL4TC cables shall be permitted to be installed in plenum cable routing assemblies, riser cable routing assemblies, and general-purpose cable routing assemblies selected in accordance with Table 800.154(c), listed in accordance with 800.182, and installed in accordance with 800.110(C) and 800.113.

(~~K~~ B) Communications Raceways.

Where the requirements applicable to electrical nonmetallic tubing (ENT) apply, Class 4 and Type CL4TC cables shall be permitted to be installed in plenum communications raceways, riser communications raceways, and general-purpose communications raceways selected in accordance with Table 800.154(b), listed in accordance with 800.182, and installed in accordance with 800.113 and 362.24 through 362.56.

Statement of Problem and Substantiation for Public Comment

Moving these back to 726.3 and 're-lettering' to A and B.
These sections don't quite match what's in 722(K) and (L), therefore recommending to leave them in 726.
Alternately, we could modify 722 to incorporate the Class 4 specific material.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 1780-NFPA 70-2021 [Section No. 726.203]	

Related Item

- PI 3740 and PI 3671

Submitter Information Verification

Submitter Full Name:	Chad Jones
Organization:	Cisco Systems
Street Address:	
City:	
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Zip:	
Submittal Date:	Tue Aug 17 18:41:11 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8356-NFPA 70-2021
Statement:	The requirements have been removed from 726.203 as these cable installation requirements are now addressed by Article 722.

Public Comment No. 1896-NFPA 70-2021 [New Section after 726.203(M)]

TITLE OF NEW CONTENT

(N) Ampacity . The ampacity of Class 4 cables shall meet the requirements in 310.15 based on temperature rating of the Class 4 cable for conductors in sizes 16 - 6 AWG. For conductors sized 24 - 17 AWG, the cable shall be rated for the intended ampacity as evidenced by the marking FMP-XXA, where XX is the maximum allowable ampacity permitted.

Statement of Problem and Substantiation for Public Comment

Class 4 cables are intended to carry current as indicated in 726.1, Informational Note 3. Currently, Article 726 does not contain ampacity requirements. Testing of a variety of 18-24 AWG cables in a typical bundle size of 37 cables has shown that these cables can overheat when carrying currents expected with Class 4 systems. Because of the wide variety of cable constructions expected to be used with these systems (2-pair, 8-pair, shielded, unshielded, with and without optical fiber, etc.) it is not practical to create ampacity tables for these size conductors. The FMP-XXA designation ensures that the cables have been tested and are able to carry the marked current safely.

This comment was developed by the participants of a research and development project group assembled by UL to develop safety requirements for Fault Managed Power Systems (FMPS) to reduce the risks of electric shock and fire and facilitate the design, production and use of products that are physically safe. This project is intended to support the First Revision that adds Class 4 circuits to the 2023 National Electrical Code© (NEC©) as a new Article 726. Participant companies include (in alphabetical order) ATIS, Belden, Chemours, Cisco, CommScope, Corning, Daiken, Enersys (formerly Alpha Technologies), Hubbell, Leviton, Panduit, Schneider Electric, Southwire, Superior Essex, Voltserver, and UL. Participation in the project is broad-based and includes representation of those with knowledge and experience in electrical safety, installation, code enforcement, and wire and cable. Participation in the project alone does not imply 100% agreement among the participant companies or individual members with the developed requirements.

Related Item

- FR 9606

Submitter Information Verification

Submitter Full Name:	Susan Stene
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City:	
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Zip:	
Submittal Date:	Wed Aug 18 14:02:31 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8470-NFPA 70-2021

Statement: Class 4 systems are power systems and Class 4 cables are intended to carry current. Article 726 does not currently contain ampacity requirements. Testing of a variety of 18-24 AWG cables in a typical bundle size of 37 cables has shown that these cables can overheat when carrying expected currents. Varying cable constructions (2-pair, 8-pair, shielded, unshielded, with and without optical fiber, etc.) make it impractical to create ampacity tables for conductors in this AWG range. The FMP-XXA designation ensures that the cables have been tested and are able to carry the marked current safely.

The requirement is added as new 726.144 to align with Article 725 numbering for similar ampacity requirements.

Public Comment No. 1786-NFPA 70-2021 [Section No. 726.212]

726.~~212~~ 12 Uses Not Permitted.

(A) Hazardous (Classified) Locations.

Cables shall not be installed in any hazardous (classified) location, except as permitted by other articles of this *Code*.

Informational Note: Hazardous locations are covered in Articles 500 through 516 and in Part IV of Article 517.

(B) Other Applications.

Class 4 cables shall not be permitted for any applications that are not part of a Class 4 distribution system.

Exception: Use of CL4 cable for other applications shall be permitted if the cable has multiple listings.

Statement of Problem and Substantiation for Public Comment

This section has been renumber to 726.12 to move it to Part I of the 726 article, the proper place for this text. This mirrors 725.
This text was moved out to the 'cabling section' by the Panel in FR because it was assumed it would be covered in 722. If this is deleted from 726 because it is covered in 722, then 725.12 should also be deleted.

Related Item

- PI 3740 and PI 3671

Submitter Information Verification

Submitter Full Name:	Chad Jones
Organization:	Cisco Systems
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 17 18:55:12 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8356-NFPA 70-2021
Statement:	The requirements have been removed from 726.203 as these cable installation requirements are now addressed by Article 722.

Public Comment No. 1607-NFPA 70-2021 [Section No. 726.212(A)]

~~**(A)** Hazardous (Classified) Locations.~~

~~Cables shall not be installed in any hazardous (classified) location, except as permitted by other articles of this *Code* .~~

~~Informational Note: Hazardous locations are covered in Articles 500 through 516 and in Part IV of Article 517.~~

Statement of Problem and Substantiation for Public Comment

This material is not needed. Furthermore, it is not complete as written because it only applies to Class 4 cables and not Class 4 equipment. It is also a violation of the style manual.

Related Item

- FR 9606

Submitter Information Verification

Submitter Full Name:	Ryan Jackson
Organization:	Ryan Jackson
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon Aug 16 16:30:31 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8297-NFPA 70-2021
Statement:	It is important that Article 726 point the user to the hazardous location criteria. Relocating these requirements to 726.12 maintains consistency with Article 725 and Article 760. The requirement has been revised to comply with the Style Manual.

Public Comment No. 1088-NFPA 70-2021 [Section No. 726.212(B)]

(B) Other Applications.

Class 4 cables shall not be permitted for any applications that are not part of a Class 4 distribution system.

Exception: Use of CL4 cable for other applications shall be permitted if the cable ~~has multiple listings~~ is listed as suitable for the other applications .

Statement of Problem and Substantiation for Public Comment

"Multiple Listings" can have different meanings depending on the certification / listing agency. The proposed wording makes it clear that the cable shall be listed as suitable for the other applications, not just carry a "multiple listing".

Related Item

- FR 9606

Submitter Information Verification

Submitter Full Name:	Randolph Ivans
Organization:	UL LLC
Street Address:	
City:	
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Submittal Date:	Mon Aug 09 12:30:21 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8297-NFPA 70-2021
Statement:	It is important that Article 726 point the user to the hazardous location criteria. Relocating these requirements to 726.12 maintains consistency with Article 725 and Article 760. The requirement has been revised to comply with the Style Manual.

Public Comment No. 1787-NFPA 70-2021 [Section No. 726.221]

726.~~221~~ 21 Access to Electrical Equipment Behind Panels Designed to Allow Access.

Access to electrical equipment shall not be denied by an accumulation of wires and cables preventing the removal of panels, including suspended ceiling panels.

Statement of Problem and Substantiation for Public Comment

This section has been renumber to 726.21 to move it to Part I of the 726 article, the proper place for this text. This mirrors 725.
This text was moved out to the 'cabling section' by the Panel in FR because it was assumed it would be covered in 722. If this is deleted from 726 because it is covered in 722, then 725.21 should also be deleted.

Related Item

- PI 3740 and PI 3671

Submitter Information Verification

Submitter Full Name: Chad Jones
Organization: Cisco Systems
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 17 18:59:40 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR
Resolution: SR-8248-NFPA 70-2021
Statement: The information in 726.221 is a duplication of what is covered in Article 722.

Public Comment No. 1032-NFPA 70-2021 [Section No. 726.224]

726.224 Mechanical Execution of Work.

CL4 cables shall be installed in a ~~neat~~ knowledgable and ~~workmanlike~~ skillful manner. Cables and conductors installed exposed on the surfaces of ceilings and sidewalls shall be supported by the building structure such that the cable will not be damaged by normal building use. Such cables shall be supported by straps, staples, hangers, cable ties, or similar fittings that are designed and installed to not damage the cable. The installation shall also comply with the requirements of 300.4 and 300.11.

Informational Note: Paint, plaster, cleaners, abrasives, corrosive residues, or other contaminants can result in an undetermined alteration of CL4 cable properties.

Statement of Problem and Substantiation for Public Comment

"Neat and workmanlike" appropriately no longer will be found in 110.12. What then: professional and skillful? Professionals are evaluated in terms of Knowledge, Skills, and Abilities (KSAs), per NFPA 1078. So "skillful" seems redundant–if "professional" really is necessary. Aside from appearance, it is not clear that there is an additional, critical element to professionalism beyond compliance and skillful installation.

When inspecting, we evaluate relevant knowledge by seeing whether the installation shows knowledge of the relevant products and standards; 110.3(A) and (B) address this. We are concerned with abilities only in terms of how they are demonstrated in the way knowledge and skills were applied. For example, "fine motor" capability is needed to use torque screwdrivers, but we're not interested in the abilities as stand-alones, just as they are applied to that particular motor skill.

A sloppy splice may be less than neat, but the critical factor is whether it is skillful enough to avoid damaging the conductors or losing strands; to keep them tightly bound so as to avoid high impedance or in fact risking that they come loose; and to keep them all adequately insulated. So skillful installation is a critical element, to complement compliance with the letter of the Code.

While professional appearance is nice, in general requiring it goes beyond the Code's purpose described in 90.1. Because neatness is an additional subjective element, we should minimize its use as a criterion. Where neatness, or "professional appearance" is particularly important to safety, we have more specific language, such as "legible" as in 110.21(B)(2) Exception, 225.52 (B) Exception, and 300.45, or "clearly legible" as in 410.140 and 620.52(B). So far, no additional element to the term "professional" has been described in the public discussion.

Related Item

- PI3671

Submitter Information Verification

Submitter Full Name:	David Shapiro
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Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Aug 05 21:02:19 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	"Neat" and "workmanlike" refer to the quality of the installation which is what this paragraph deals with. "Knowledgeable" and "skillful" refer to the technical expertise of the installer.

Public Comment No. 1789-NFPA 70-2021 [Section No. 726.224]

726.~~224~~ 24 Mechanical Execution of Work.

~~CL4 cables~~ Class 4 equipment shall be installed in a neat and workmanlike manner. ~~Cables and conductors installed exposed on the surfaces of ceilings and sidewalls shall be supported by the building structure such that the cable will not be damaged by normal building use. Such cables shall be supported by straps, staples, hangers, cable ties, or similar fittings that are designed and installed to not damage the cable. The~~ The installation shall also comply with the requirements of 300.4 and 300.11.

Informational Note: Paint, plaster, cleaners, abrasives, corrosive residues, or other contaminants can result in an undetermined alteration of ~~CL4 cable~~ Class 4 cable properties.

Statement of Problem and Substantiation for Public Comment

This section has been renumber to 726.24 to move it to Part I of the 726 article, the proper place for this text. This mirrors 725. Also, the text has been modified to match what is recommended for 725.24(A).
This text was moved out to the 'cabling section' by the Panel in FR because it was assumed it would be covered in 722. If this is deleted from 726 because it is covered in 722, then 725.24 should also be deleted.

Related Item

- PI 3740 and PI 3671

Submitter Information Verification

Submitter Full Name:	Chad Jones
Organization:	Cisco Systems
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 17 19:03:04 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8368-NFPA 70-2021
Statement:	This second revision removes cables from this section since cables are now in Article 722 and mechanical execution of work for cables is in 722.24 The text is revised to reflect that it covers equipment, not cables, and to align with the 725.24 text. This section is renumbered and relocated to Part I as 726.24 to align it with Article 725 numbering. The note is deleted since it only applies to cables.

Public Comment No. 1089-NFPA 70-2021 [Section No. 726.225]

726.225 Abandoned Cables.

The accessible portion of abandoned Class 4 ~~and CL4TC~~ cables shall be removed. Where cables are identified for future use with a tag, the tag shall be of sufficient durability to withstand the environment involved.

Statement of Problem and Substantiation for Public Comment

It is not anticipated that there will be Class 4 Tray Cables (CL4TC).

Related Item

- FR 9606

Submitter Information Verification

Submitter Full Name: Randolph Ivans
Organization: UL LLC
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 09 12:35:35 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR
Resolution: SR-8294-NFPA 70-2021
Statement: The information in 726.225 is a duplication of what is covered in Article 722.

Public Comment No. 1790-NFPA 70-2021 [Section No. 726.225]

~~**726.225** Abandoned Cables.~~

~~The accessible portion of abandoned Class 4 and CL4TC cables shall be removed. Where cables are identified for future use with a tag, the tag shall be of sufficient durability to withstand the environment involved.~~

Statement of Problem and Substantiation for Public Comment

This text is duplicated in 722 and therefore is not required in 726. Therefore, deleted.

Related Item

- PI 3671 and PI 3740

Submitter Information Verification

Submitter Full Name:	Chad Jones
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Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 17 19:06:23 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8294-NFPA 70-2021
Statement:	The information in 726.225 is a duplication of what is covered in Article 722.

Public Comment No. 1608-NFPA 70-2021 [Section No. 726.228]

726.228 ~~Noninterchangeability~~ Noninterchangeable .

Receptacles, cord connectors, and attachment plugs used on Class 4 distribution systems shall be constructed so that they are not interchangeable with other receptacles, cord connectors, and attachment plugs.

Statement of Problem and Substantiation for Public Comment

Edit to use a real word.

Related Item

- FR 9606

Submitter Information Verification

Submitter Full Name:	Ryan Jackson
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Street Address:	
City:	
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Zip:	
Submittal Date:	Mon Aug 16 16:32:48 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8718-NFPA 70-2021
Statement:	Section 760.130(A) adds listing requirements since Class 4 systems limit the current available into a fault but not the transmitted voltage and current, these devices need to be evaluated, rated and listed for their intended use. (PC 1946, PC 1791) Section 726.228 has been moved to 726.130(B) and the title changed to Non-interchangeability. The requirement has been reworded to make it clear that terminals and connectors shall not be interchangeable with those used with power limited systems. (PC 1608, PC 1969) Section 726.233 is moved to 726.130(C) to include all requirements for terminals and connectors in one Section for clarity and usability.

Public Comment No. 1969-NFPA 70-2021 [Section No. 726.228]

726.228 Noninterchangeability.

Receptacles, cord connectors, and attachment plugs used on Class 4 distribution ~~systems shall be constructed so that they are not interchangeable with other receptacles, cord connectors, and attachment plugs~~ systems on the same premise shall be of such design as to not be likely interchanged with other systems .

Statement of Problem and Substantiation for Public Comment

The existing 726.228 would require proprietary connectors for all Class 4 circuits and their construction would be required to not be interchangeable with any other receptacle, cord connector or attachment plug anywhere. This is too broad. Restricting the non-interchangeability requirement to a given premise would meet the objective of not allowing class 4 systems to mistakenly be connected to another system (or visa versa). This is similar to Article 406.4 (F) “Noninterchangeable Types. Receptacles connected to circuits that have different voltages, frequencies, or types of current (ac or dc) on the same premises shall be of such design that the attachment plugs used on these circuits are not interchangeable.”

Related Item

• FR 9606-NFPA 70-2021

Submitter Information Verification

Submitter Full Name:	Stanley Mlyniec
Organization:	VoltServer
Street Address:	
City:	
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Submittal Date:	Wed Aug 18 20:52:34 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8718-NFPA 70-2021
Statement:	Section 760.130(A) adds listing requirements since Class 4 systems limit the current available into a fault but not the transmitted voltage and current, these devices need to be evaluated, rated and listed for their intended use. (PC 1946, PC 1791) Section 726.228 has been moved to 726.130(B) and the title changed to Non-interchangeability. The requirement has been reworded to make it clear that terminals and connectors shall not be interchangeable with those used with power limited systems. (PC 1608, PC 1969) Section 726.233 is moved to 726.130(C) to include all requirements for terminals and connectors in one Section for clarity and usability.

Public Comment No. 1791-NFPA 70-2021 [Sections 726.228, 726.233]

Sections 726.~~228, 726.233~~

~~726.228~~

130 Terminals and Connectors

(A) Noninterchangeability.

Receptacles, cord connectors, and attachment plugs used on Class 4 distribution systems shall be constructed so that they are not interchangeable with other receptacles, cord connectors, and attachment plugs.

~~**726.233**~~ (B) Guarding.

Any junctions and mating connectors shall be constructed and installed to guard against inadvertent contact with live parts by persons.

Statement of Problem and Substantiation for Public Comment

These two sections have been combined into one section titled Terminals and Connectors. They are then renumbered to 726.130 so that they come at the end of Part II.

This text was moved out to the 'cabling section' by the Panel in FR because it was assumed it would be covered in 722. This was an error.

Related Item

- PI 3740

Submitter Information Verification

Submitter Full Name: Chad Jones
Organization: Cisco Systems
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 17 19:09:00 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8718-NFPA 70-2021

Statement: Section 760.130(A) adds listing requirements since Class 4 systems limit the current available into a fault but not the transmitted voltage and current, these devices need to be evaluated, rated and listed for their intended use. (PC 1946, PC 1791)

Section 726.228 has been moved to 726.130(B) and the title changed to Non-interchangeability. The requirement has been reworded to make it clear that terminals and connectors shall not be interchangeable with those used with power limited systems. (PC 1608, PC 1969)

Section 726.233 is moved to 726.130(C) to include all requirements for terminals and connectors in one Section for clarity and usability.

Public Comment No. 1946-NFPA 70-2021 [Sections 726.228, 726.233]

Sections 726.228, 726.233

726.~~228~~ ~~Noninterchangeability.~~ **~~228~~ ~~Connecting Hardware~~**

(**A) Listing.** Connecting hardware used on Class 4 distribution systems shall be listed.

(B) Noninterchangeability. Receptacles, cord connectors, and attachment plugs used on Class 4 distribution systems shall be constructed so that they are not interchangeable with

~~other~~

receptacles, cord connectors, and attachment plugs of other Class systems .

~~726.233~~ (C) Guarding . ~~Any junctions and mating connectors shall be constructed and installed to guard against inadvertent contact with live parts by persons.~~

Statement of Problem and Substantiation for Public Comment

Even though Class 4 systems limit the energy available into a fault condition, they are still capable of transmitting hundreds of watts of power. Connectors should be listed and evaluated as being suitable for this application. Rearranging the paragraphs adds clarity and increases the usability of the Code.

Related Item

- FR 9606

Submitter Information Verification

Submitter Full Name: Randolph Ivans
Organization: UL LLC
Street Address:
City:
State:
Zip:

Submittal Date: Wed Aug 18 17:41:06 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8718-NFPA 70-2021

Statement: Section 760.130(A) adds listing requirements since Class 4 systems limit the current available into a fault but not the transmitted voltage and current, these devices need to be evaluated, rated and listed for their intended use. (PC 1946, PC 1791)

Section 726.228 has been moved to 726.130(B) and the title changed to Non-interchangeability. The requirement has been reworded to make it clear that terminals and connectors shall not be interchangeable with those used with power limited systems. (PC 1608, PC 1969)

Section 726.233 is moved to 726.130(C) to include all requirements for terminals and connectors in one Section for clarity and usability.

Public Comment No. 1518-NFPA 70-2021 [Sections 726.335(K), 726.335(L)]

Sections 726.335(K), 726.335(L)

~~**(K)** Multifamily Dwellings.~~

~~The following cables shall be permitted to be installed in multifamily dwellings in locations other than those covered in 726.135(B) through (I):~~

(1) ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables~~

(2) ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables installed in the following:~~

  (3) ~~Plenum communications raceways~~

  (4) ~~Plenum cable routing assemblies~~

  (5) ~~Riser communications raceways~~

  (6) ~~Riser cable routing assemblies~~

  (7) ~~General-purpose communications raceways~~

  (8) ~~General-purpose cable routing assemblies~~

(9) ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC wires and cables installed in raceways recognized in Chapter 3~~

~~**(L) One- and Two-Family Dwellings.**~~

~~The following cables shall be permitted to be installed in one- and two-family dwellings in locations other than those covered in 726.135(B) through (I):~~

(1) ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables~~

(2) ~~Types Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables installed in the following:~~

  (3) ~~Plenum communications raceways~~

  (4) ~~Plenum cable routing assemblies~~

  (5) ~~Riser communications raceways~~

  (6) ~~Riser cable routing assemblies~~

  (7) ~~General-purpose communications raceways~~

  (8) ~~General-purpose cable routing assemblies~~

(9) ~~Type CL4, Type CL4R, Type CL4P, and Type CL4TC cables installed in raceways recognized in Chapter 3~~

Statement of Problem and Substantiation for Public Comment

Class 4 equipment is not currently designed for dwelling unit installation. Dwellings have unique branch circuit and receptacle requirements. The UL 1400-1 product safety standard has no interoperability testing requirements for residential appliances, HVAC equipment or any additional loads, cord/plug connectivity, or other residential hazards are addressed in this new article. Without more details on how the installation could be made safely and without potential interoperability issues in a residential environment, dwellings should not be included at this time. Section 726.335 (K) should be removed since it specifies use in multifamily dwellings. Section 726.335(L) should be removed since it specifies use in One- and Two-Family Dwellings.

Related Item

• FR9606 • PC 1517

Submitter Information Verification

Submitter Full Name:	Keith Waters
Organization:	Schneider Electric
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon Aug 16 09:06:02 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8273-NFPA 70-2021
Statement:	The information in 726.335 is a duplication of what is covered in Article 722, Table 722.135(B). Article 726 as modified in the scope no longer applies to dwelling units and therefore the deletion of 726.335(K) and (L) dealing with dwelling units as part of the entire deletion of 726.335 removes any conflict with the scope.

Public Comment No. 1908-NFPA 70-2021 [Section No. 726.339(B)]

(B) Class 4 Circuits With Class 2, Class 3, or Communications Circuits.

Conductors of one or more Class 4 circuits shall be permitted within the same ~~cable,~~ enclosure, raceway, or cable routing assembly as conductors of Class 2, Class 3, or communications circuits~~ if the insulation of the Class 2, Class 3, or communications circuit conductors in the cable, enclosure, raceway, or cable routing assembly is at least that required for Class 4 circuits.~~

Statement of Problem and Substantiation for Public Comment

Class 4 circuits should be insulated in a way that prevents them from interacting with surrounding circuits regardless of the enclosure, raceway, or cable routing assembly they share. An interaction between Class 4 cables and neighboring Class 2 cables, Class 3 cables, or communications circuits would only occur in the case of a double-fault at the same location and between separate but co-located cables which is highly unlikely and does not need to be codified.

Related Item

- CL4 cables

Submitter Information Verification

Submitter Full Name:	Wayne Hopkinson
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City:	
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Zip:	
Submittal Date:	Wed Aug 18 15:35:37 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8471-NFPA 70-2021
Statement:	These sections were originally numbered to place them at the end of the new article in anticipation of them being moved to the new Article 722 for cables. The correlating committee directed that material that is specific to articles 725, 726, 760 and 770 remain in those articles so this material is not being moved. These Sections are being renumbered to better integrate them into Article 726 and to align the numbering with that of Article 725 for similar content. Conductors in the same cable should always be insulated for the highest voltage in the cable to withstand that voltage in the event of an insulation failure. Class 4 cables are jacketed and together with the protection afforded by the Class 4 circuit provide protection against electric shock so requiring other cables in enclosures, raceways or cable routing assemblies to be rated for the Class 4 voltages is unnecessary.

Public Comment No. 1909-NFPA 70-2021 [Section No. 726.339(B)]

(B) Class 4 Circuits With Class 2, Class 3, or Communications Circuits.

Conductors of one or more Class 4 circuits shall be permitted within the same cable, enclosure, raceway, or cable routing assembly as conductors of Class 2, Class 3, or ~~communications circuits if the insulation of the Class 2, Class 3, or communications circuit conductors in the cable, enclosure, raceway, or cable routing assembly is at least that required for Class 4 circuits~~ Communication circuits .

Statement of Problem and Substantiation for Public Comment

Class 4 circuits are fault managed and functionally equivalent to a class 2 circuit in terms of shock and fire safety and therefore it is not necessary to require class 2, class 3 or communication circuits to have a class 4 insulation. Class 3 circuits are functionally more hazardous (less safe) than class 4 circuits, however, class 4 cable insulation is rated to a higher voltage rating and thus are protected from class 3 circuit hazards.

Related Item

- FR 9606-NFPA 70-2021

Submitter Information Verification

Submitter Full Name: Stanley Mlyniec
Organization: VoltServer
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 18 15:38:28 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8471-NFPA 70-2021

Statement: These sections were originally numbered to place them at the end of the new article in anticipation of them being moved to the new Article 722 for cables. The correlating committee directed that material that is specific to articles 725, 726, 760 and 770 remain in those articles so this material is not being moved.

These Sections are being renumbered to better integrate them into Article 726 and to align the numbering with that of Article 725 for similar content.

Conductors in the same cable should always be insulated for the highest voltage in the cable to withstand that voltage in the event of an insulation failure. Class 4 cables are jacketed and together with the protection afforded by the Class 4 circuit provide protection against electric shock so requiring other cables in enclosures, raceways or cable routing assemblies to be rated for the Class 4 voltages is unnecessary.

Public Comment No. 1091-NFPA 70-2021 [Section No. 726.379(C)]

(C) Type CL4.

Type CL4 cables shall be marked as Type CL4 and be listed as suitable for general-purpose use, with the exception of risers, ducts, plenums, and other spaces used for environmental air, and shall be listed as resistant to the spread of fire.

Informational Note No. 1: ~~One~~ See UL 2556, *Wire and Cable Test Methods,* for one method of defining *resistant to the spread of fire* . One method is to demonstrate that the cables do not spread fire to the top of the tray in the UL flame exposure, vertical tray flame test ~~in ANSI/UL 1685-2010,~~ ~~*Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*~~ . The smoke measurements in the test method are not applicable.

Informational Note No. 2: ~~Another method~~ See UL 2556, *Wire and Cable Test Methods* for another method of defining *resistant to the spread of fire.* This alternative method is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the CSA vertical flame test for cables in cable trays~~, as described in CSA C22 .2 No. 0.3-M-2001,~~ ~~*Test Methods for Electrical Wires and Cables*~~ ~~.~~

Statement of Problem and Substantiation for Public Comment

Updates the references to the correct UL Standard. The CSA standard previously referenced is now replaced with a trinational standard (US/Canada/Mexico)The US reference for this standard is UL 2556.

Related Item

- FR 9606

Submitter Information Verification

Submitter Full Name: Randolph Ivans
Organization: UL LLC
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 09 12:48:17 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8450-NFPA 70-2021

Statement: This action updates the references to the correct UL Standard. The CSA standard previously referenced is now replaced with a trinational standard (US/Canada/Mexico). The US reference for this standard is UL 2556.

This second revision is based on PC 1091 for Section No. 726.379(C) which is now relocated to 722.179(A)(3)

Public Comment No. 1090-NFPA 70-2021 [Section No. 726.379(D)]

~~**(D)** Type CL4TC.~~

~~Type CL4TC nonmetallic-sheathed tray cable shall be marked as Type CL4TC, shall be listed as being suitable for cable trays, and shall consist of a factory assembly of two or more insulated conductors under a nonmetallic jacket. The insulated conductors shall be at least 24 AWG copper (solid or stranded). Insulation on conductors shall be rated for 450 volts dc. The cable core shall be two or more parallel conductors, one or more group assemblies of twisted or parallel conductors, or a combination of both. A metallic shield or a metallized foil shield with drain wire(s) shall be permitted to be applied over the cable core, over groups of conductors, or both. The cable shall be listed as resistant to the spread of fire. The outer jacket shall be a sunlight- and moisture-resistant nonmetallic material. Type CL4TC cable used in a wet location shall be listed for use in wet locations or have a moisture-impervious metal sheath.~~

~~*Exception: Where a smooth metallic sheath, continuous corrugated metallic sheath, or nonmetallic jacket with interlocking tape armor is provided, an overall nonmetallic jacket shall not be required. On metallic-sheathed cable without an overall nonmetallic jacket, the information required in 310.8 shall be located on the nonmetallic jacket under the sheath.*~~

~~Informational Note No. 1: One method of defining *resistant to the spread of fire* is that the cables do not spread fire to the top of the tray in the UL flame exposure, vertical tray flame test in ANSI/UL 1685-2010 , *Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables* . The smoke measurements in the test method are not applicable.~~

~~Informational Note No. 2: Another method of defining *resistant to the spread of fire* is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the CSA vertical tray flame test for cables in cable trays, as described in CSA C22.2 No. 0.3-M-2001 , *Test Methods for Electrical Wires and Cables* .~~

Statement of Problem and Substantiation for Public Comment

It is not anticipated that there will be Class 4 Tray Cable (CL4TC).

Related Item

- FR 9606

Submitter Information Verification

Submitter Full Name: Randolph Ivans
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City:
State:
Zip:
Submittal Date: Mon Aug 09 12:43:06 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR
Resolution: SR-8305-NFPA 70-2021
Statement: Except for 726.379(D), the information in 726.379 is a duplication of what is covered in Article 722. Section 726.379(D) has been deleted and not included in 722 because there will not be a CL4 tray cable.

Public Comment No. 1092-NFPA 70-2021 [Section No. 726.379(E)(5)]

(5) Cabling.

~~Cables~~ If the listing of a Class 4 system is contingent on specific cable properties, cables shall comply with ~~any requirements provided in~~ all requirements identified as part of the listing of the system.

Informational Note: Excessive cable lengths can result in higher capacitance which could affect the safety of the circuit. See UL ###-2, *Standard for Class 4 Power Systems*, for information on determining applicable requirements for the listing of Class 4 power systems.

Statement of Problem and Substantiation for Public Comment

The proposed wording clarifies the requirement.

Related Item

- FR 9606

Submitter Information Verification

Submitter Full Name:	Randolph Ivans
Organization:	UL LLC
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City:	
State:	
Zip:	
Submittal Date:	Mon Aug 09 12:59:00 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	This change is no longer relevant to Article 726. No change was made to the moved text as it appears in 722.179(A)(16)(5). The proposed wording does not improve the clarity of the requirement. The requirement is clear as presently written.

Public Comment No. 1793-NFPA 70-2021 [Section No. 726.379(E)(5)]

(5) Cabling.

Cables shall comply with any requirements provided in the listing of the system.

Informational Note: Excessive cable lengths can result in higher capacitance which could affect the safety of the circuit. See UL ### 1400 -2, *Standard for Class 4 Power Systems*, for information on determining applicable requirements for the listing of Class 4 power systems.

Statement of Problem and Substantiation for Public Comment

UL 1400-2 is the Class 4 cable listing standard.

Related Item

- PI 3740

Submitter Information Verification

Submitter Full Name: Chad Jones
Organization: Cisco Systems
Street Address:
City:
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Zip:
Submittal Date: Tue Aug 17 19:15:28 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8459-NFPA 70-2021

Statement: Section 722.179(A)(16) has been added to Article 722 to address Class 4 cable construction. The panel notes that the correct reference is UL 1400-1 as stated, not UL 1400-2 since the requirement is related to Class 4 systems, not just the cable.

Public Comment No. 1906-NFPA 70-2021 [Section No. 726.379(E)(5)]

(5) Cabling.

Cables shall comply with any requirements provided in the listing of the system.

Informational Note: Excessive cable lengths can result in higher capacitance which could affect the safety of the circuit. See UL ~~###~~ 1400 - ~~2~~ 1 , ~~*Standard for Class 4 Power Systems*~~ *Outline for Fault-Managed Power Systems – Part 1: General Requirements* , for information on determining applicable requirements for the listing of Class 4 power systems.

Additional Proposed Changes

File Name	Description	Approved
PC_1906_Attachment_C_Randolph_Ivans.pdf	UL 1400-1 & -2 Table of Contents, Normative References and Content Resources	

Statement of Problem and Substantiation for Public Comment

This comment was developed by the participants of a research and development project group assembled by UL to develop safety requirements for Fault Managed Power Systems (FMPS) to reduce the risks of electric shock and fire and facilitate the design, production and use of products that are physically safe. This project is intended to support the First Revision that adds Class 4 circuits to the 2023 National Electrical Code© (NEC©) as a new Article 726. Participant companies include (in alphabetical order) ATIS, Belden, Chemours, Cisco, CommScope, Corning, Daiken, Enersys (formerly Alpha Technologies), Hubbell, Leviton, Panduit, Schneider Electric, Southwire, Superior Essex, Voltserver, and UL. Participation in the project is broad-based and includes representation of those with knowledge and experience in electrical safety, installation, code enforcement, and wire and cable. Participation in the project alone does not imply 100% agreement among the participant companies or individual members with the developed requirements.

The Scope of Work for the project is to develop a fault managed power safety system framework that can be recommended to installation code bodies, that is technically coordinated with existing and new product safety standards, and that enables "listing" of equipment identified for the purpose.

1) Research of pre-existing written and electronic materials
2) Gap analysis of existing codes and standards
3) Study of safety risks and creation of risk mitigation requirements
4) Specifications for cabling, connectivity and equipment
5) Development of new UL Standards encompassing new equipment, components and cables for Class 4 systems and components

During the course of this project, participants conducted research on topics that ranged from electric shock and arc-energy to grounding of separately derived systems. Refer to Attachment 5 for examples of papers and standards used for this research. In addition, significant input was sought from the participating companies to utilize their expertise and experience and aid in the practical resolution of the issues.

As a result of this work, drafts of two new outlines of investigation (standards) have been prepared; UL 1400-1, Outline for Fault-Managed Power Systems – Part 1: General Requirements, and UL 1400-2, Outline for Fault-Managed Power Systems – Part 2: Requirements for Class 4 Cables. Refer to Attachments 1 and 2 for the Table of Contents for these new standards.

These standards are technically coordinated with existing standards while incorporating the requirements necessary to deal with the advanced technology of Class 4 systems. UL 1400-1 is written as a supplement to UL 62368-1, Audio/video, information and communication technology equipment - Part 1: Safety requirements, leveraging the technical expertise of this internationally harmonized standard based on the hazard-based safety engineering (HBSE) principles. UL 1400-2 is based on UL 13, Power-Limited Circuit Cables, and contains all of the requirements necessary to evaluate Class 4 cables. Attachments 3 and 4 identify the normative standard references incorporated into the requirements.

UL's outline of investigations (standards) describe the requirements used to evaluate products and systems with detailed technical content addressing potential risks and their mitigation. They provide standardized, vendor-neutral and uniform solutions and procedures.

Related Item

• FR 9606 • PC 1902 • PC 1904 • PC 1905 • PC 2165

Submitter Information Verification

Submitter Full Name:	Randolph Ivans
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Street Address:	
City:	
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Submittal Date:	Wed Aug 18 15:32:34 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8459-NFPA 70-2021
Statement:	Section 722.179(A)(16) has been added to Article 722 to address Class 4 cable construction. The panel notes that the correct reference is UL 1400-1 as stated, not UL 1400-2 since the requirement is related to Class 4 systems, not just the cable.

ATTACHMENT 1
Table of Contents for UL 1400-1,
Outline for Fault-Managed Power Systems – Part 1: General Requirements

Table of Contents

ATTACHMENT 2
Table of Contents for UL 1400-2,
Outline for Fault-Managed Power Systems – Part 2: Requirements for Class 4 Cables

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ATTACHMENT 3
Normative Standards Referenced in UL 1400-1

- UL 991, *Tests for Safety-Related Controls Employing Solid-State Devices*
- UL 1998, *Software in Programmable Components*
- UL 60730-1, *Automatic Electrical Controls – Part 1: General Requirements*
- UL: 62368-1, *Audio/video, information and communication technology equipment - Part 1: Safety requirements*
- IEC 60479-1, *Effects of current on human beings and livestock – Part 1: General aspects*
- IEC 60479-2, *Effects of current on human beings and livestock – Part 2: Special aspects*
- IEC 61508-1, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 1: General Requirements*
- IEC 61508-2, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 2: Requirements for Electrical/Electronic/Programmable Electronic Safety-Related Systems*
- IEC 61508-3, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 3: Software Requirements*
- IEC 61508-4, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 4: Definitions and Abbreviations*
- IEC 61508-5, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 5: Examples of Methods for the Determination of Safety Integrity Levels*
- IEC 61508-6, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 6: Guidelines on the Application of IEC 61508-2 and IEC 61508-3*
- IEC 61508-7, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 7: Overview of Techniques and Measures*
- IEC 62061, *Safety of Machinery – Functional Safety of Safety-Related Electrical, Electronic and Programmable Electronic Control Systems*
- ISO 13849-1, *Safety of Machinery - Safety-Related Parts of Control Systems - Part 1: General Principles for Design*
- ISO 13849-2, *Safety of Machinery - Safety-Related Parts of Control Systems - Part 2: Validation*
- ATIS-0600040, *Fault Managed Power Distribution Technologies – Human Contact Fault Analysis*

ATTACHMENT 4
Normative Standards Referenced in UL 1400-2

- UL 13, *Power-Limited Circuit Cables*
- UL 444, *Communications Cables*
- UL1581, *Reference Standard for Electrical Wires, Cables, and Flexible Cords*
- UL 1651, *Optical Fiber Cable*
- UL1666 **,** *Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts*
- UL2556, *Wire and Cable Test Methods*
- NFPA 262, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*

ATTACHMENT 5
Examples of papers and standards consulted during the development of requirements

- "Electric Shock Hazard Considerations for Fault Managed Power Distribution Technologies"
  -Hai Jiang, Ph.D. P.E. & Alex Di Sciullo Jones
- "The Establishment of Energy-Based Test Criteria for Fault-Managed Power Distribution Technologies" -Paul W. Brazis, Jr., PhD
- "On Extending the $Td{-}Ib$ Curve b Limit For Td Shorter Than 10ms." Rev. A0.4. 11/23/2020"
  - Dr. Francisco Paz
- "DC Arc-fault Testing to Support Photovoltaic Arc-fault Protection Device Requirements" October 8, 2013
  - David A. Dini, P.E. and Paul W. Brazis Jr., PhD
- IEC 60479-1, *Effects of current on human beings and livestock – Part 1: General aspects*
- IEC 60479-2, *Effects of current on human beings and livestock – Part 2: Special aspects*
- ATIS-0600040 (Draft), *Fault Managed Power Distribution Technologies – Human Contact Fault Analysis*
- UL 489I, *Outline for Solid State Molded-Case Circuit Breakers*
- UL 943, *Ground-Fault Circuit-Interrupters*
- UL 1699B, *Photovoltaic (PV) DC Arc-Fault Circuit Protection*
- UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*
- UL 1778, *Uninterruptible Power Systems*
- UL 2271, *Batteries for Use In Light Electric Vehicle (LEV) Applications*
- UL 60730-1, *Automatic Electrical Controls – Part 1: General Requirements, Annex H*
- UL: 62368-1, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

Public Comment No. 1892-NFPA 70-2021 [Section No. 726.379(G)]

(G) Optional Markings.

Cables shall be permitted to be surface marked to indicate special characteristics of the cable materials ~~.~~

~~Informational Note No. 1: These markings include~~

including , but

~~are~~

not limited to, markings for limited smoke, halogen free, low smoke and halogen free, and sunlight resistant. .

Informational Note No. ~~2~~ 1 : Some examples of optional markings are “ST1” to indicate limited-smoke characteristics in accordance with UL 2556, *Wire and Cable Test Methods*; “HF” to indicate halogen-free as described in UL 2885, *Outline of Investigation for Acid Gas, Acidity and Conductivity of Combusted Materials and Assessment of Halogens*; and “LSHF” to indicate halogen-free and low-smoke characteristics in accordance with IEC 61034-2, *Measurement of smoke density of cables burning under defined conditions — Part 2: Test procedure and requirements*.

Statement of Problem and Substantiation for Public Comment

Informational Note No. 1 contains requirements which is a violation of the NEC Style Manual. Relocating it with the requirement preserves this information and achieves NEC Style Manual Compliance.

Related Item

- FR 9606

Submitter Information Verification

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Zip:	
Submittal Date:	Wed Aug 18 13:48:27 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	The informational note contains examples of possible markings, not requirements for markings and is therefore appropriate to remain in the informational note.

Public Comment No. 1792-NFPA 70-2021 [Section No. 726.379 [Excluding any Sub-Sections]]

Cables for Class 4 power systems shall be Type CL4, Type CL4R, or Type CL4P and shall be listed for Class 4 distribution system use. CL4 cables installed as wiring methods within buildings shall be listed as resistant to the spread of fire and other criteria in accordance with 726.179(A) through (D), shall be constructed in accordance with 726.179(E), shall be marked in accordance with 726.179(F), and shall be permitted to be marked in accordance with 726.179(G).

Informational Note: See UL ### 1400 -2, *Standard for Class 4 Power Systems*, for information on determining applicable requirements for the listing of Class 4 power systems.

Statement of Problem and Substantiation for Public Comment

UL 1400-2 is the Class 4 cable listing standard.

Related Item

- PI 3740

Submitter Information Verification

Submitter Full Name:	Chad Jones
Organization:	Cisco Systems
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 17 19:14:17 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8448-NFPA 70-2021
Statement:	Since Article 722 includes Class 4 cables additional subsections are needed to be added to 722.179(A) and references changed to include those subsections. Informational note 4 was added to include the appropriate standard for Class 4 cables.

Public Comment No. 1905-NFPA 70-2021 [Section No. 726.379 [Excluding any Sub-Sections]]

Cables for Class 4 power systems shall be Type CL4, Type CL4R, or Type CL4P and shall be listed for Class 4 distribution system use. CL4 cables installed as wiring methods within buildings shall be listed as resistant to the spread of fire and other criteria in accordance with 726.179(A) through (D), shall be constructed in accordance with 726.179(E), shall be marked in accordance with 726.179(F), and shall be permitted to be marked in accordance with 726.179(G).

Informational Note: See UL ~~###~~ 1400 -2, ~~*Standard for Class 4 Power Systems*~~ *Outline for Fault-Managed Power Systems – Part 2: Requirements for Class 4 Cables* , for information on determining applicable requirements for the listing of Class 4 power systems.

Additional Proposed Changes

File Name	Description	Approved
PC_1905_Attachment_C_Randolph_Ivans.pdf	UL 1400-1 & -2 Table of Contents, Normative References and Content Resources	

Statement of Problem and Substantiation for Public Comment

This comment was developed by the participants of a research and development project group assembled by UL to develop safety requirements for Fault Managed Power Systems (FMPS) to reduce the risks of electric shock and fire and facilitate the design, production and use of products that are physically safe. This project is intended to support the First Revision that adds Class 4 circuits to the 2023 National Electrical Code© (NEC©) as a new Article 726. Participant companies include (in alphabetical order) ATIS, Belden, Chemours, Cisco, CommScope, Corning, Daiken, Enersys (formerly Alpha Technologies), Hubbell, Leviton, Panduit, Schneider Electric, Southwire, Superior Essex, Voltserver, and UL. Participation in the project is broad-based and includes representation of those with knowledge and experience in electrical safety, installation, code enforcement, and wire and cable. Participation in the project alone does not imply 100% agreement among the participant companies or individual members with the developed requirements.

The Scope of Work for the project is to develop a fault managed power safety system framework that can be recommended to installation code bodies, that is technically coordinated with existing and new product safety standards, and that enables “listing” of equipment identified for the purpose.

1) Research of pre-existing written and electronic materials
2) Gap analysis of existing codes and standards
3) Study of safety risks and creation of risk mitigation requirements
4) Specifications for cabling, connectivity and equipment
5) Development of new UL Standards encompassing new equipment, components and cables for Class 4 systems and components

During the course of this project, participants conducted research on topics that ranged from electric shock and arc-energy to grounding of separately derived systems. Refer to Attachment 5 for examples of papers and standards used for this research. In addition, significant input was sought from the participating companies to utilize their expertise and experience and aid in the practical resolution of the issues.

As a result of this work, drafts of two new outlines of investigation (standards) have been prepared; UL 1400-1, Outline for Fault-Managed Power Systems – Part 1: General Requirements, and UL 1400-2, Outline for Fault-Managed Power Systems – Part 2: Requirements for Class 4 Cables. Refer to Attachments 1 and 2 for the Table of Contents for these new standards.

These standards are technically coordinated with existing standards while incorporating the requirements necessary to deal with the advanced technology of Class 4 systems. UL 1400-1 is written as a supplement to UL 62368-1, Audio/video, information and communication technology equipment - Part 1: Safety requirements, leveraging the technical expertise of this internationally harmonized standard based on the hazard-based safety engineering (HBSE) principles. UL 1400-2 is based on UL 13, Power-Limited Circuit Cables, and contains all of the requirements necessary to evaluate Class 4 cables. Attachments 3 and 4 identify the normative standard references incorporated into the requirements.

UL’s outline of investigations (standards) describe the requirements used to evaluate products and systems with detailed technical content addressing potential risks and their mitigation. They provide standardized, vendor-neutral and uniform solutions and procedures.

Related Item

• FR 9606 • PC1902 • PC 1904 • PC 1906 • PC 2165

Submitter Information Verification

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Street Address:	
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State:	
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Submittal Date:	Wed Aug 18 15:29:33 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8448-NFPA 70-2021
Statement:	Since Article 722 includes Class 4 cables additional subsections are needed to be added to 722.179(A) and references changed to include those subsections. Informational note 4 was added to include the appropriate standard for Class 4 cables.

ATTACHMENT 1
Table of Contents for UL 1400-1,
Outline for Fault-Managed Power Systems – Part 1: General Requirements

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ATTACHMENT 2
Table of Contents for UL 1400-2,
Outline for Fault-Managed Power Systems – Part 2: Requirements for Class 4 Cables

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Normative Standards Referenced in UL 1400-1

- UL 991, *Tests for Safety-Related Controls Employing Solid-State Devices*
- UL 1998, *Software in Programmable Components*
- UL 60730-1, *Automatic Electrical Controls – Part 1: General Requirements*
- UL: 62368-1, *Audio/video, information and communication technology equipment - Part 1: Safety requirements*
- IEC 60479-1, *Effects of current on human beings and livestock – Part 1: General aspects*
- IEC 60479-2, *Effects of current on human beings and livestock – Part 2: Special aspects*
- IEC 61508-1, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 1: General Requirements*
- IEC 61508-2, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 2: Requirements for Electrical/Electronic/Programmable Electronic Safety-Related Systems*
- IEC 61508-3, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 3: Software Requirements*
- IEC 61508-4, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 4: Definitions and Abbreviations*
- IEC 61508-5, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 5: Examples of Methods for the Determination of Safety Integrity Levels*
- IEC 61508-6, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 6: Guidelines on the Application of IEC 61508-2 and IEC 61508-3*
- IEC 61508-7, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 7: Overview of Techniques and Measures*
- IEC 62061, *Safety of Machinery – Functional Safety of Safety-Related Electrical, Electronic and Programmable Electronic Control Systems*
- ISO 13849-1, *Safety of Machinery - Safety-Related Parts of Control Systems - Part 1: General Principles for Design*
- ISO 13849-2, *Safety of Machinery - Safety-Related Parts of Control Systems - Part 2: Validation*
- ATIS-0600040, *Fault Managed Power Distribution Technologies – Human Contact Fault Analysis*

ATTACHMENT 4
Normative Standards Referenced in UL 1400-2

- UL 13, *Power-Limited Circuit Cables*
- UL 444, *Communications Cables*
- UL1581, *Reference Standard for Electrical Wires, Cables, and Flexible Cords*
- UL 1651, *Optical Fiber Cable*
- UL1666 **,** *Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts*
- UL2556, *Wire and Cable Test Methods*
- NFPA 262, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*

ATTACHMENT 5
Examples of papers and standards consulted during the development of requirements

- "Electric Shock Hazard Considerations for Fault Managed Power Distribution Technologies"
  -Hai Jiang, Ph.D. P.E. & Alex Di Sciullo Jones

- "The Establishment of Energy-Based Test Criteria for Fault-Managed Power Distribution Technologies" -Paul W. Brazis, Jr., PhD

- "On Extending the Td−Ib Curve b Limit For Td Shorter Than 10ms." Rev. A0.4. 11/23/2020"
  - Dr. Francisco Paz

- "DC Arc-fault Testing to Support Photovoltaic Arc-fault Protection Device Requirements" October 8, 2013
  - David A. Dini, P.E. and Paul W. Brazis Jr., PhD

- IEC 60479-1, *Effects of current on human beings and livestock – Part 1: General aspects*

- IEC 60479-2, *Effects of current on human beings and livestock – Part 2: Special aspects*

- ATIS-0600040 (Draft), *Fault Managed Power Distribution Technologies – Human Contact Fault Analysis*

- UL 489I, *Outline for Solid State Molded-Case Circuit Breakers*

- UL 943, *Ground-Fault Circuit-Interrupters*

- UL 1699B, *Photovoltaic (PV) DC Arc-Fault Circuit Protection*

- UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*

- UL 1778, *Uninterruptible Power Systems*

- UL 2271, *Batteries for Use In Light Electric Vehicle (LEV) Applications*

- UL 60730-1, *Automatic Electrical Controls – Part 1: General Requirements, Annex H*

- UL: 62368-1, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

Public Comment No. 121-NFPA 70-2021 [New Article after 760]

ARTICLE 761- Single- and Multiple-Station Alarms and Household Signaling Systems

Commentary: As a fire inspector, I have noticed that many electricians are aware that new or renovated residences need to have smoke and/or carbon monoxide alarms, but do not know necessarily where these devices should and should not be installed. In my state, we have adopted NFPA 72, presently the 2016 edition. Most electricians do not seem to be aware of the intricacies of the other code and oftentimes will not purchase or research NFPA 72, and ultimately fail their inspections merely because of improper alarm placement. It would appear the only mention of NFPA 72 in the NEC is under an informational note under article 210, branch circuits. I would like to see a short article created, article 761, so that is is directly after fire alarm systems. The intent of the article would be to cover where the alarms should be installed by copying key points of NFPA 72, chapter 29.

Statement of Problem and Substantiation for Public Comment

Residential smoke and/or carbon monoxide alarm placement is not covered by the NEC. Many times electricians will place alarms in improper locations which could lead to improper performance, as well as being a code violation (if adopted by the AHJ). A new article, 761, would adopt the key points of NFPA 72, chapter 29 versus an informational note to refer to this standard.

Related Item

- https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards /detail?code=72

Submitter Information Verification

Submitter Full Name: Michael Mastro

Organization: [Not Specified]

Street Address:

City:

State:

Zip:

Submittal Date: Mon Jul 05 16:32:18 EDT 2021

Committee: NEC-P03

Committee Statement

Committee Action: Rejected

Resolution: There is already a reference to NFPA 72 in 760.1. All of this information is covered in NFPA 72 Chapter 29 and duplication here is not necessary. Installers should be aware of all of the standards and codes needed for an installation and meet the licensing requirements of local jurisdictions. Submitter did not provide the proposed content of the new article.

Public Comment No. 713-NFPA 70-2021 [Section No. 760.1]

760.1 Scope.

This article covers the installation of wiring and equipment of fire alarm systems, including all circuits controlled and powered by the fire alarm system.

Informational Note No. 1: Fire alarm systems include fire detection and alarm notification, guard's tour, sprinkler waterflow, and sprinkler supervisory systems. Circuits controlled and powered by the fire alarm system include circuits for the control of building systems safety functions, elevator capture, elevator shutdown, door release, smoke doors and damper control, fire doors and damper control, and fan shutdown, but only where these circuits are powered by and controlled by the fire alarm system. See *NFPA 72*-2019, *National Fire Alarm and Signaling Code*, for further information on the installation and monitoring for integrity requirements for fire alarm systems.

Informational Note No. 2: Class 1, 2, and 3 circuits are defined in Articles 724 and 725.

Additional Proposed Changes

File Name	Description	Approved
3_CN_379.pdf	3 CN379	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 379 appeared in the First Draft Report on First Revision No. 9583.

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and the Correlating Committee directs that Informational Note No. 1 be revised to comply with 4.1.3 of the Style Manual and Informational Note No. 2 be revised to comply with 4.1.4 of the Style Manual.

Related Item

- First Revision No. 9583

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 03 13:17:18 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8488-NFPA 70-2021

Statement: Rearrange INF 1. Break into 1 and 2 Update reference to 2022. It is necessary to refer to the entire NFPA 72. There is no way to break down references to NFPA 72 referring to individual chapters and sections would create more confusion. Deleted Informational Note No. 2 as it is unnecessary.

Correlating Committee Note No. 379-NFPA 70-2021 [Section No. 760.1]

Submitter Information Verification

Committee: NEC-P03

Submittal Date: Fri May 07 11:47:40 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and the Correlating Committee directs that Informational Note No. 1 be revised to comply with 4.1.3 of the Style Manual and Informational Note No. 2 be revised to comply with 4.1.4 of the Style Manual.

First Revision No. 9583-NFPA 70-2021 [Section No. 760.1]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
0 Not Returned
12 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Johnston, Michael J.
Kendall, David H.
Kovacik, John R.
Manche, Alan
McDaniel, Roger D.
Porter, Christine T.
Williams, David A.

Public Comment No. 1616-NFPA 70-2021 [Section No. 760.3]

760.3 Other Articles.

Circuits and equipment shall comply with 760.3(A) through (O). Only those sections of Article 300 referenced in this article shall apply to fire alarm systems.

(A) Spread of Fire or Products of Combustion.

Installation of fire alarm circuits shall comply with 300.21.

(B) Ducts, Plenums, and Other Air-Handling Spaces.

Power-limited and non-power-limited fire alarm cables installed in ducts, plenums, or other spaces used for environmental air shall comply with 300.22.

Exception No. 1: Power-limited fire alarm cables selected in accordance with Table 760.154 and installed in accordance with 760.135(B) and 300.22(B), Exception shall be permitted to be installed in ducts specifically fabricated for environmental air.

Exception No. 2: Power-limited fire alarm cables selected in accordance with Table 760.154 and installed in accordance with 760.135(C) shall be permitted to be installed in other spaces used for environmental air (plenums).

(

~~C) Hazardous (Classified) Locations.~~

~~Articles 500 through 516 and Article 517, Part IV, where installed in hazardous (classified) locations.~~

~~**(D)** Corrosive, Damp, or Wet Locations.~~

~~Fire alarm circuits and equipment installed in corrosive, damp, or wet locations shall comply with 110.11 , 300.5(B) , 300.6 , 300.9 , and 310.10(F) .~~

(

~~E) Building Control Circuits.~~

~~Article 725, where building control circuits (e.g., elevator capture, fan shutdown) are associated with the fire alarm system.~~

~~(~~

~~**F)** Optical Fiber Cables.~~

~~Where optical fiber cables are utilized for fire alarm circuits, the cables shall be installed in accordance with Article 770.~~

~~**(G)** Installation of Conductors with Other Systems.~~

~~Installations shall comply with 300.8 .~~

~~**(H)** Raceways or Sleeves Exposed to Different Temperatures.~~

~~Installations shall comply with 300.7(A) .~~

~~**(I)** Vertical Support for Fire-Resistive Cables and Conductors.~~

~~Vertical installations of circuit integrity (CI) cables and conductors installed in a raceway or conductors and cables of fire-resistive cable systems shall be installed in accordance with 300.19 .~~

~~**(J)** Installation of Cables and Conductors in Raceway.~~

~~The number and size of cables and conductors shall comply with 300.17 .~~

~~**(K)** Bushing.~~

~~A bushing shall be installed where cables emerge from raceway used for mechanical support or protection in accordance with 300.15(C) .~~

~~**(L)** Cable Routing Assemblies.~~

~~Power-limited fire alarm cables shall be permitted to be installed in plenum cable routing assemblies, riser cable routing assemblies, and general-purpose cable routing assemblies selected in accordance with Table 800.154(c) , listed in accordance with 800.182 , and installed in accordance with 800.110(C) and 800.113 .~~

~~**(M)** Communications Raceways.~~

~~Power-limited fire alarm cables shall be permitted to be installed in plenum communications raceways, riser communications raceways, and general-purpose communications raceways selected in accordance with Table 800.154(b) , listed in accordance with 800.182 , and installed in accordance with 800.113 and 362.24 through 362.56 , where the requirements applicable to electrical nonmetallic tubing apply.~~

~~**(N)** Temperature Limitations of Power-Limited and Non–Power-Limited Fire Alarm Cables.~~

~~The requirements of 310.14(A)(3) on the temperature limitation of conductors shall apply to power-limited fire alarm cables and non–power-limited fire alarms cables.~~

~~**(O)** Identification of Equipment Grounding Conductors.~~

~~Equipment grounding conductors shall be identified in accordance with 250.119 .~~

~~*Exception: Conductors with green insulation shall be permitted to be used as ungrounded signal conductors for Types FPLP, FPLR, FPL, and substitute cables installed in accordance with 760.154(A) .*~~

Statement of Problem and Substantiation for Public Comment

Subdivision C is not needed, and E violates the style manual. I apologize that I have no recommendation for what E should say, now that 722 and 725 both exist.

Related Item

• PI 3327

Submitter Information Verification

Submitter Full Name: Ryan Jackson

Organization: Ryan Jackson

Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon Aug 16 16:50:05 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	No justification is provided for the suggested changes. Reference to complete articles is permitted in XXX.3 Sections. Redundancies have been removed as part of the review of Articles 722 and 760.

Public Comment No. 1033-NFPA 70-2021 [Section No. 760.24(A)]

(A) General.

Fire alarm circuits shall be installed in a ~~neat workmanlike~~ knowledgable and skillful manner. Cables and conductors 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 supported by hardware, including straps, staples, hangers, cable ties listed and identified for securement and support, or similar fittings designed and installed so as not to damage the cable. The installation shall also comply with 300.4 and 300.11.

Informational Note: Paint, plaster, cleaners, abrasives, corrosive residues, or other contaminants might result in an undetermined alteration of PLFA and NPLFA cable properties.

Statement of Problem and Substantiation for Public Comment

"Neat and workmanlike" appropriately no longer will be found in 110.12. What then: professional and skillful? Professionals are evaluated in terms of Knowledge, Skills, and Abilities (KSAs), per NFPA 1078. So "skillful" seems redundant–if "professional" really is necessary. Aside from appearance, it is not clear that there is an additional, critical element to professionalism beyond compliance and skillful installation.

When inspecting, we evaluate relevant knowledge by seeing whether the installation shows knowledge of the relevant products and standards; 110.3(A) and (B) address this. We are concerned with abilities only in terms of how they are demonstrated in the way knowledge and skills were applied. For example, "fine motor" capability is needed to use torque screwdrivers, but we're not interested in the abilities as stand-alones, just as they are applied to that particular motor skill.

A sloppy splice may be less than neat, but the critical factor is whether it is skillful enough to avoid damaging the conductors or losing strands; to keep them tightly bound so as to avoid high impedance or in fact risking that they come loose; and to keep them all adequately insulated. So skillful installation is a critical element, to complement compliance with the letter of the Code.

While professional appearance is nice, in general requiring it goes beyond the Code's purpose described in 90.1. Because neatness is an additional subjective element, we should minimize its use as a criterion. Where neatness, or "professional appearance" is particularly important to safety, we have more specific language, such as "legible" as in 110.21(B)(2) Exception, 225.52 (B) Exception, and 300.45, or "clearly legible" as in 410.140 and 620.52(B). So far, no additional element to the term "professional" has been described in the public discussion.

Related Item

- PI 3993

Submitter Information Verification

Submitter Full Name:	David Shapiro
Organization:	Safety First Electrical
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Aug 05 21:04:55 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	"Neat" and "workmanlike" refer to the quality of the installation which is what this paragraph deals with. "Knowledgeable" and "skillful" refer to the technical expertise of the installer.

Public Comment No. 1432-NFPA 70-2021 [Section No. 760.24(A)]

(A) General.

Fire alarm circuits shall be installed in a neat workmanlike manner. Cables and conductors 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 supported by hardware, including straps, staples, hangers, <u>and</u> cable ties,<u> </u> listed and identified for securement and support, or similar fittings designed and installed so as not to damage the cable. The installation shall also comply with 300.4 and 300.11.

Informational Note: Paint, plaster, cleaners, abrasives, corrosive residues, or other contaminants might result in an undetermined alteration of PLFA and NPLFA cable properties.

Statement of Problem and Substantiation for Public Comment

Editorial: Missing an "AND" and a comma: "staples, hangers, cable ties listed and identified" should be: "staples, hangers, AND cable ties COMMA listed and identified"

Related Item

- FR 9523

Submitter Information Verification

Submitter Full Name:	Chad Jones
Organization:	Cisco Systems
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Fri Aug 13 11:01:36 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8594-NFPA 70-2021
Statement:	Reworded to clarify the requirement for listing applies to cable ties.

Public Comment No. 530-NFPA 70-2021 [Section No. 760.24(A)]

(A) General.

Fire alarm circuits shall be installed in a neat workmanlike manner. Cables and conductors 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 supported by hardware, including straps, staples, hangers~~,~~ ; cable ties listed and identified for securement and support~~, or~~ ; or similar fittings designed and installed so as not to damage the cable. The installation shall also comply with 300.4 and 300.11.

Informational Note: Paint, plaster, cleaners, abrasives, corrosive residues, or other contaminants might result in an undetermined alteration of PLFA and NPLFA cable properties.

Statement of Problem and Substantiation for Public Comment

The intent of this public comment is to harmonize the cable securing and supporting requirements for fire alarm circuits with the securing and supporting requirements for cable wirings methods in Chapter 3. Sections 320.30, 330.30, 334.30, and 337.30 require cable ties to be “listed and identified for securement and support”. This specific language is being added to 760.24 to ensure the same listing and securement requirement for cable ties also applies to cable ties used to support fire alarm circuits.
The removal of the semicolons from the initial proposal may lead some to mis-interrupt the requirement to mean that staples and straps are also required to be listed for securement and support. We would suggest that the semicolons be added into the clause to assure clarity that only cable ties are meant to be listed for securement and support.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 527-NFPA 70-2021 [Section No. 770.24(A)]	
Public Comment No. 528-NFPA 70-2021 [Section No. 800.24(A)]	
Public Comment No. 531-NFPA 70-2021 [Section No. 725.24(A)]	

Related Item

• FR no. 8883-NFPA 70-2018

Submitter Information Verification

Submitter Full Name:	charles McGaughy
Organization:	ABB
Affiliation:	ABB Installation Products Inc
Street Address:	
City:	
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Zip:	
Submittal Date:	Thu Jul 29 10:54:37 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8594-NFPA 70-2021
Statement:	Reworded to clarify the requirement for listing applies to cable ties.

Public Comment No. 353-NFPA 70-2021 [Section No. 760.35(B)]

(B) Power-Limited Fire Alarm (PLFA) Circuits.

See Parts I and III.

760.36 Cybersecurity, Cyberweapon, Electromagnetic Pulse (EMP), Geomagnetic Disturbance (GMD), and Intentional Electromagnetic Interference (IEMI) Protection. Fire alarm systems shall comply with either of the following:

(1) The system shall be identified for cybersecurity, cyberweapon, EMP, GMD, and IEMI protection.

(2) A cybersecurity, cyberweapon, EMP, GMD, and IEMI protection failure modes effects analysis assessment shall be conducted to determine system vulnerabilities.

The identification or assessment shall be reviewed when the system configuration changes and at not more than 5-year intervals. Documentation of the identification or assessment shall be made available to those authorized to inspect, operate, and maintain the system.

Statement of Problem and Substantiation for Public Comment

This Public Comment is a follow-up to PI 761, PI 3080, FR 8801, PI 763, and PI 4024. It does not require cybersecurity, cyberweapon, EMP, GMD, or IEMI protection, but rather calls for the fire alarm system to be identified for these threats or for a threat assessment to be completed. While the NEC® is not ready to mandate protection requirements, an assessment would show system vulnerabilities. Acceptance of this Public Comment would at least bring the subject to the attention of owners, design engineers, electrical inspectors, and insurance companies, and set the table for requirements in future editions of the NEC® (or other NFPA standards). The format for this Public Comment is based upon the cybersecurity requirements found in FR 8801, which offers an assessment as an alternate for requiring protection.

PI 761 provided technical substantiation to require Electromagnetic Pulse (EMP) Protection for our critical infrastructure. While it appears that the NEC(R) is not ready to actually require EMP protection at this time, the security of our country is at stake. An EMP is fairly well understood as an extremely powerful electromagnetic wave that can impress 50,000 volts per meter on every piece of electrical equipment, destroying everything that is unprotected. An EMP is often associated with a nuclear explosion, but that is not the only cause of electromagnetic damage. A Geomagnetic Disturbance (GMD) is caused by a sunspot. While the EMP would be created by one of our adversaries, the sun spot is an act of God. These types of events can instantly initiate millions of fires in our unprotected electrical systems, overwhelming our fire-fighting capabilities. If millions of fires weren't bad enough, the unprotected electrical equipment would be damaged or completely destroyed, subjecting the country to years of blackout. Government intelligence studies, now unclassified, have predicted that from 66% to 90% of our population would die within one year due to a lack of food, clean water, and medicine if a significant EMP or GMD were to occur if the country's electrical infrastructure remains unprotected. The final threat listed is an Intentional Electromagnetic Interference (IEMI). It is easily created by utilizing off-the-shelf parts, available for purchase on the internet, that will fit into a van. While much less powerful than a significant EMP or GMD, twenty vans, equipped with bench-made IEMI devices and scattered throughout the country, can shut down major industries and major parts of the country for weeks, if not months, through a coordinated attack, similar to 9/11, by targeting key industries/vulnerabilities. In conclusion, these threats to our unprotected electrical infrastructure, and therefor to our entire country, are absolutely real, and must be addressed.

PI 4024 provided significant substantiation for the need to protect critical infrastructure against cyber attack for equipment connected to the internet. However, equipment does not need to be connected to the internet in order to be damaged or destroyed by cyber threats. Equipment can be damaged by cyber weapons such as malicious computer worms that attack SCADA systems. A great example is the Stuxnet worm that destroyed the centrifuges in Iran. Thus, this Public Comment deletes the PI 4024 reference to the internet and adds cyberweapon to the list of threats that need to be either protected against or assessed.

Related Item

• PI 4024	• PI 3055	• FR 7947	• PI 4026	• PI 763	• FR 8801	• PI 3080	• FR 8880	• FR 8917	• PI 2888	• FR 8914	• PI 3083	• PI 3087

Submitter Information Verification

Submitter Full Name:	Vincent Saporita
Organization:	Saporita Consulting
Affiliation:	Saporita Consulting
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sat Jul 24 23:08:15 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	Requirements for cybersecurity, cyberweapons, electromagnetic pulse (EMP), geomagnetic disturbance (GMD), and intentional electromagnetic interference (IEMI) cover a broad range of concerns that would be more appropriately addressed in a separate document.

Public Comment No. 48-NFPA 70-2021 [Section No. 760.124]

760.124 Circuit Marking.

The equipment supplying PLFA circuits shall be durably marked where plainly visible to indicate each circuit that is a power-limited fire alarm circuit.

~~Informational Note: See 760.130(A) , Exception No. 3, where a power-limited circuit is to be reclassified as a non–power-limited circuit.~~

Statement of Problem and Substantiation for Public Comment

760.124(A) Exception No. 3 has been deleted by FR 9552

Related Item

- FR 9552

Submitter Information Verification

Submitter Full Name: Robert Jones
Organization: Independent Electrical Contrac
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jun 30 13:55:58 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Accepted
Resolution: SR-8595-NFPA 70-2021
Statement: This Informational Note is no longer needed based on other changes made during the first revision regarding reclassifying circuits.

Public Comment No. 702-NFPA 70-2021 [Section No. 760.130(A)]

(A) NPLFA Wiring Methods and Materials.

The use of NPLFA wiring methods in accordance with 760.46, 760.49, or 760.53 for PLFA circuits shall be permitted. Conductors shall be solid or stranded copper. Separation from electric light, power, Class 1, non-power-limited fire alarm circuit conductors, and medium-power network-powered broadband communications cables shall comply with 760.136.

Exception: The ampacity adjustment factors specified in 310.15(C)(1) shall not apply.

Additional Proposed Changes

File Name	Description	Approved
3_CN_370.pdf	3 CN370	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 370 appeared in the First Draft Report on First Revision No. 9552.

The Correlating Committee directs the Panel to review the language in 760.130(A) in accordance with section 3.1.2 of the NEC Style Manual. The phrase "The use of NPLFA wiring methods in accordance ... " does not clearly provide permission or establish required direction for the user.

The Panel may want to consider language similar to this: "NPLFA wiring methods shall be permitted when used in accordance with ... ".

Related Item

• First Revision No. 9552

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC

Organization: NEC Correlating Committee

Street Address:

City:

State:

Zip:

Submittal Date: Tue Aug 03 12:33:36 EDT 2021

Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8695-NFPA 70-2021

Statement: References have been updated. Section 760.130(A) was revised to clearly provide permission or establish direction for the user. The existing 760.130(3) was deleted as it is covered by Article 722. The new 760.130(3) and 760.130(4) were added to Article 760 as they are specific to power-limited fire alarm circuits.

Correlating Committee Note No. 370-NFPA 70-2021 [Section No. 760.130(A)]

Submitter Information Verification

Committee: NEC-P03

Submittal Date: Fri May 07 10:57:08 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs the Panel to review the language in 760.130(A) in accordance with section 3.1.2 of the NEC Style Manual. The phrase “The use of NPLFA wiring methods in accordance…” does not clearly provide permission or establish required direction for the user.

The Panel may want to consider language similar to this: “NPLFA wiring methods shall be permitted when used in accordance with…”.

First Revision No. 9552-NFPA 70-2021 [Section No. 760.130(A)]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
0 Not Returned
12 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Johnston, Michael J.

Kendall, David H.

Kovacik, John R.

Manche, Alan

McDaniel, Roger D.

Porter, Christine T.

Williams, David A.

Public Comment No. 2-NFPA 70-2021 [Section No. 760.135(A)]

(A) Listing.

PLFA cables installed in buildings shall be listed and installed in accordance with the limitations of the listing ..

Statement of Problem and Substantiation for Public Comment

Section 110.3(B) which requires that equipment be installed in accordance with the listing. Explicit requirements for cables are needed because the definition of equipment in Article 100 doesn't include cables.

Related Item

- PI 647

Submitter Information Verification

Submitter Full Name:	David Kiddoo
Organization:	CCCA
Affiliation:	CCCA
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Jun 29 08:13:17 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	Proper installation and use of different listed cables are already covered by the NEC. The definition of equipment includes "fittings and the like" that is intended to cover cabling.

Public Comment No. 710-NFPA 70-2021 [Section No. 760.176]

760.176 Listing and Marking of NPLFA Cables.

Non-power-limited fire alarm cables installed as wiring within buildings shall be listed in accordance with 760.176(A) and (B) and as being resistant to the spread of fire in accordance with 760.176(C) through (F), and shall be marked in accordance with 760.176(G). Cable used in a wet location shall be listed for use in wet locations or have a moisture-impervious metal sheath. Non-power-limited fire alarm cables shall have a temperature rating of not less than 60°C (140°F). Non-power-limited fire alarm cables shall be permitted to contain optical fibers.

Informational Note: See UL 1425, *Standard for Cables for Non-Power-Limited Fire-Alarm Circuits*, for information on non-power-limited fire alarm cables.

(A) NPLFA Conductor Materials.

Conductors shall be 18 AWG or larger solid or stranded copper.

(B) Insulated Conductors.

Insulation on conductors shall be rated for the system voltage and not less than 600 V. Insulated conductors 14 AWG and larger shall be one of the types listed in Table 310.4(1) or one that is identified for this use. Insulated conductors 18 AWG and 16 AWG shall be in accordance with 760.49.

(C) Type NPLFP.

Type NPLFP non-power-limited fire alarm cable for use in other space used for environmental air shall be listed as being suitable for use in other space used for environmental air as described in 300.22(C) and shall also be listed as having adequate fire-resistant and low smoke–producing characteristics.

Informational Note: One method of defining a cable that is low-smoke producing cable and fire-resistant cable is that the cable exhibits a maximum peak optical density of 0.50 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.52 m (5 ft) or less when tested in accordance with NFPA 262-2019, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*.

(D) Type NPLFR.

Type NPLFR non–power-limited fire alarm riser cable shall be listed as being suitable for use in a vertical run in a shaft or from floor to floor and shall also be listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor.

Informational Note: One method of defining fire-resistant characteristics capable of preventing the carrying of fire from floor to floor is that the cables pass ANSI/UL 1666-2012, *Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts*.

(E) Type NPLF.

Type NPLF non–power-limited fire alarm cable shall be listed as being suitable for general-purpose fire alarm use, with the exception of risers, ducts, plenums, and other space used for environmental air, and shall also be listed as being resistant to the spread of fire.

Informational Note: One method of defining *resistant to the spread of fire* is that the cables do not spread fire to the top of the tray in the "UL Flame Exposure, Vertical Tray Flame Test" in ANSI/UL 1685-2010, *Standard for Safety for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*. The smoke measurements in the test method are not applicable.

Another method of defining *resistant to the spread of fire* is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the CSA "Vertical Flame Test — Cables in Cable Trays," as described in CSA C22.2 No. 0.3-M-2001, *Test Methods for Electrical Wires and Cables*.

(F) Fire Alarm Circuit Integrity (CI) Cable, Fire-Resistive Cable System, or Electrical Circuit Protective System.

Cables that are used for survivability of critical circuits under fire conditions shall be listed and meet the requirements of 760.176(F)(1), (F)(2), or (F)(3).

Informational Note: See 12.4.3 and 12.4.4 of *NFPA 72*-2019, *National Fire Alarm and Signaling Code*, for fire alarm circuit integrity (CI) cable, fire-resistive cable systems, or electrical circuit protective systems that might be used for fire alarm circuits to comply with the survivability requirements to maintain the circuit's electrical function during fire conditions for a defined period of time.

(1) Circuit Integrity (CI) Cables.

Circuit integrity (CI) cables specified in 760.176(C), (D), and (E) and used for survivability of critical circuits shall be marked for an additional classification using the suffix "-CI." In order to maintain its listed fire-resistive rating, CI cables shall only be installed in free air in accordance with 760.24(B). CI cables shall only be permitted to be installed in a raceway where specifically listed and marked as part of an electrical circuit protective fire-resistive cable system as covered in 760.176(F)(2). CI cables shall only be permitted to be installed in a raceway where specifically listed and marked as part of an electrical circuit protective system as covered in 760.176(F)(2).

Informational Note: One method of defining CI cable is by establishing a rating when tested in accordance with UL 2196, *Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables*, as specified in UL 1425, *Cables for Non-Power-Limited Fire-Alarm Circuits*. UL guide information for non-power-limited fire alarm circuits (HNHT) contains information for identifying the cable and its installation limitations to maintain the fire-resistive rating.

(2) Fire-Resistive Cable Systems.

Cables specified in 760.176(C), (D), (E), and (F)(1) that are part of a fire-resistive cable system shall be identified with the system identifier and hourly rating marked on the protectant or the smallest unit container and installed in accordance with the listing of the system.

Informational Note: One method of defining a fire-resistive cable system is by establishing a rating when tested in accordance with UL 2196, *Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables*. UL guide information for electrical circuit integrity systems (FHIT) contains information for identifying the system and its installation limitations to maintain a minimum fire-resistive rating.

(3) Electrical Circuit Protective System.

Protectants for cables specified in 760.176(C), (D), and (E) that are part of an electrical circuit protective system shall be identified with the protective system identifier and hourly rating marked on the protectant or the smallest unit container and installed in accordance with the listing of the protective system.

Informational Note: One method of defining an electrical circuit protective system is by establishing a rating when tested in accordance with UL 1724, *Fire Tests for Electrical Circuit Protective Systems*. UL guide information for electrical circuit integrity systems (FHIT) contains information for identifying the system and its installation limitations to maintain the fire-resistive rating.

(G) NPLFA Cable Markings.

Multiconductor non–power-limited fire alarm cables shall be marked in accordance with Table 760.176(G). Non–power-limited fire alarm circuit cables shall be permitted to be marked with a maximum usage voltage rating of 150 volts. Cables that are listed for circuit integrity shall be identified with the suffix "-CI" as defined in 760.176(F). The temperature rating shall be marked on the jacket of NPLFA cables that have a temperature rating exceeding 60°C (140°F). The jacket of NPLFA cables shall be marked with the conductor size.

Informational Note: Cable types are listed in descending order of fire performance.

Table 760.176(G) NPLFA Cable Markings

Cable Marking	Type	Reference
NPLFP	Non–power-limited fire alarm circuit cable for use in "other space used for environmental air"	760.176(C) and (G)
NPLFR	Non–power-limited fire alarm circuit riser cable	760.176(D) and (G)
NPLF	Non–power-limited fire alarm circuit cable	760.176(E) and (G)

Note: Cables identified in 760.176(C), (D), and (E) and meeting the requirements for circuit integrity shall have the additional classification using the suffix "-CI" (for example, NPLFP-CI, NPLFR-CI, and NPLF-CI).

Additional Proposed Changes

File Name	Description	Approved
3_CN_377_Detail.pdf	3 CN377	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 377 appeared in the First Draft Report on First Revision No. 9538.

The Correlating Committee directs the panel to review the need for the informational notes in 760.176 based on 90.7 and the reference to Informative Annex A.

Related Item

- First Revision No. 9538

Submitter Information Verification

Submitter Full Name:	CC on NEC-AAC
Organization:	NEC Correlating Committee
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 03 13:10:11 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	Section 90.7 and Annex A are for general information. The informational notes provide specific information relating to the appropriate standards that could be used to determine the acceptability of an installation.

Correlating Committee Note No. 377-NFPA 70-2021 [Detail]

Submitter Information Verification

Committee: NEC-P03
Submittal Date: Fri May 07 11:28:23 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs the panel to review the need for the informational notes in 760.176 based on 90.7 and the reference to Informative Annex A.

First Revision No. 9538-NFPA 70-2021 [Detail]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
0 Not Returned
11 Affirmative All
1 Affirmative with Comments
0 Negative with Comments
0 Abstention

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Holub, Richard A.
Hunter, Dean C.
Johnston, Michael J.
Kendall, David H.
Kovacik, John R.
Manche, Alan
McDaniel, Roger D.
Porter, Christine T.
Williams, David A.

Affirmative with Comment

Hickman, Palmer L.

The following committee statement should be revised to correctly add "Informative" to "Annex A:" The Correlating Committee directs the panel to review the need for the informational notes in 760.176 based on 90.7 and the reference to Annex A.

Public Comment No. 730-NFPA 70-2021 [Section No. 760.176]

760.176 Listing and Marking of NPLFA Cables.

Non-power-limited fire alarm cables installed as wiring within buildings shall be listed in accordance with 760.176(A) and (B) and as being resistant to the spread of fire in accordance with 760.176(C) through (F), and shall be marked in accordance with 760.176(G). Cable used in a wet location shall be listed for use in wet locations or have a moisture-impervious metal sheath. Non-power-limited fire alarm cables shall have a temperature rating of not less than 60°C (140°F). Non-power-limited fire alarm cables shall be permitted to contain optical fibers.

Informational Note: See UL 1425, *Standard for Cables for Non-Power-Limited Fire-Alarm Circuits*, for information on non-power-limited fire alarm cables.

(A) NPLFA Conductor Materials.

Conductors shall be 18 AWG or larger solid or stranded copper.

(B) Insulated Conductors.

Insulation on conductors shall be rated for the system voltage and not less than 600 V. Insulated conductors 14 AWG and larger shall be one of the types listed in Table 310.4(1) or one that is identified for this use. Insulated conductors 18 AWG and 16 AWG shall be in accordance with 760.49.

(C) Type NPLFP.

Type NPLFP non-power-limited fire alarm cable for use in other space used for environmental air shall be listed as being suitable for use in other space used for environmental air as described in 300.22(C) and shall also be listed as having adequate fire-resistant and low smoke–producing characteristics.

Informational Note: One method of defining a cable that is low-smoke producing cable and fire-resistant cable is that the cable exhibits a maximum peak optical density of 0.50 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.52 m (5 ft) or less when tested in accordance with NFPA 262-2019, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*.

(D) Type NPLFR.

Type NPLFR non–power-limited fire alarm riser cable shall be listed as being suitable for use in a vertical run in a shaft or from floor to floor and shall also be listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor.

Informational Note: One method of defining fire-resistant characteristics capable of preventing the carrying of fire from floor to floor is that the cables pass ANSI/UL 1666-2012, *Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts*.

(E) Type NPLF.

Type NPLF non–power-limited fire alarm cable shall be listed as being suitable for general-purpose fire alarm use, with the exception of risers, ducts, plenums, and other space used for environmental air, and shall also be listed as being resistant to the spread of fire.

Informational Note: One method of defining *resistant to the spread of fire* is that the cables do not spread fire to the top of the tray in the “UL Flame Exposure, Vertical Tray Flame Test” in ANSI/UL 1685-2010, *Standard for Safety for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*. The smoke measurements in the test method are not applicable.

Another method of defining *resistant to the spread of fire* is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the CSA “Vertical Flame Test — Cables in Cable Trays,” as described in CSA C22.2 No. 0.3-M-2001, *Test Methods for Electrical Wires and Cables*.

(F) Fire Alarm Circuit Integrity (CI) Cable, Fire-Resistive Cable System, or Electrical Circuit Protective System.

Cables that are used for survivability of critical circuits under fire conditions shall be listed and meet the requirements of 760.176(F)(1), (F)(2), or (F)(3).

Informational Note: See 12.4.3 and 12.4.4 of *NFPA 72*-2019, *National Fire Alarm and Signaling Code*, for fire alarm circuit integrity (CI) cable, fire-resistive cable systems, or electrical circuit protective systems that might be used for fire alarm circuits to comply with the survivability requirements to maintain the circuit's electrical function during fire conditions for a defined period of time.

(1) Circuit Integrity (CI) Cables.

Circuit integrity (CI) cables specified in 760.176(C), (D), and (E) and used for survivability of critical circuits shall be marked for an additional classification using the suffix "-CI." In order to maintain its listed fire-resistive rating, CI cables shall only be installed in free air in accordance with 760.24(B). CI cables shall only be permitted to be installed in a raceway where specifically listed and marked as part of an electrical circuit protective fire-resistive cable system as covered in 760.176(F)(2). CI cables shall only be permitted to be installed in a raceway where specifically listed and marked as part of an electrical circuit protective system as covered in 760.176(F)(2).

Informational Note: One method of defining CI cable is by establishing a rating when tested in accordance with UL 2196, *Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables*, as specified in UL 1425, *Cables for Non-Power-Limited Fire-Alarm Circuits*. UL guide information for non-power-limited fire alarm circuits (HNHT) contains information for identifying the cable and its installation limitations to maintain the fire-resistive rating.

(2) Fire-Resistive Cable Systems.

Cables specified in 760.176(C), (D), (E), and (F)(1) that are part of a fire-resistive cable system shall be identified with the system identifier and hourly rating marked on the protectant or the smallest unit container and installed in accordance with the listing of the system.

Informational Note: One method of defining a fire-resistive cable system is by establishing a rating when tested in accordance with UL 2196, *Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables*. UL guide information for electrical circuit integrity systems (FHIT) contains information for identifying the system and its installation limitations to maintain a minimum fire-resistive rating.

(3) Electrical Circuit Protective System.

Protectants for cables specified in 760.176(C), (D), and (E) that are part of an electrical circuit protective system shall be identified with the protective system identifier and hourly rating marked on the protectant or the smallest unit container and installed in accordance with the listing of the protective system.

Informational Note: One method of defining an electrical circuit protective system is by establishing a rating when tested in accordance with UL 1724, *Fire Tests for Electrical Circuit Protective Systems*. UL guide information for electrical circuit integrity systems (FHIT) contains information for identifying the system and its installation limitations to maintain the fire-resistive rating.

(G) NPLFA Cable Markings.

Multiconductor non–power-limited fire alarm cables shall be marked in accordance with Table 760.176(G). Non–power-limited fire alarm circuit cables shall be permitted to be marked with a maximum usage voltage rating of 150 volts. Cables that are listed for circuit integrity shall be identified with the suffix "-CI" as defined in 760.176(F). The temperature rating shall be marked on the jacket of NPLFA cables that have a temperature rating exceeding 60°C (140°F). The jacket of NPLFA cables shall be marked with the conductor size.

Informational Note: Cable types are listed in descending order of fire performance.

Table 760.176(G) NPLFA Cable Markings

Cable Marking	Type	Reference
NPLFP	Non–power-limited fire alarm circuit cable for use in "other space used for environmental air"	760.176(C) and (G)
NPLFR	Non–power-limited fire alarm circuit riser cable	760.176(D) and (G)
NPLF	Non–power-limited fire alarm circuit cable	760.176(E) and (G)

Note: Cables identified in 760.176(C), (D), and (E) and meeting the requirements for circuit integrity shall have the additional classification using the suffix "-CI" (for example, NPLFP-CI, NPLFR-CI, and NPLF-CI).

Additional Proposed Changes

File Name	Description	Approved
3_CN_380.pdf	3 CN380	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 370 appeared in the First Draft Report on First Revision No. 9536.

The Correlating Committee directs the panel to review the need for the informational note in 760.176 based on 90. 7 and the reference to Informative Annex A.

Related Item

• First Revision No. 9536

Submitter Information Verification

Submitter Full Name:	CC on NEC-AAC
Organization:	NEC Correlating Committee
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 03 14:18:18 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	Section 90.7 and Annex A are for general information. The informational notes provide specific information relating to the appropriate standards that could be used to determine the acceptability of an installation.

Correlating Committee Note No. 380-NFPA 70-2021 [Section No. 760.176 [Excluding any Sub-Sections]]

Submitter Information Verification

Committee: NEC-P03
Submittal Date: Fri May 07 11:53:09 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs the panel to review the need for the informational note in 760.176 based on 90.7 and the reference to Informative Annex A.

First Revision No. 9536-NFPA 70-2021 [Section No. 760.176 [Excluding any Sub-Sections]]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
0 Not Returned
11 Affirmative All
1 Affirmative with Comments
0 Negative with Comments
0 Abstention

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Holub, Richard A.
Hunter, Dean C.
Johnston, Michael J.
Kendall, David H.
Kovacik, John R.
Manche, Alan
McDaniel, Roger D.
Porter, Christine T.
Williams, David A.

Affirmative with Comment

Hickman, Palmer L.

The Correlating Committee statement needs to be revised to be technically correct and so that the Code Panel can comply with the direction the Correlating Committee is providing. "Informative" needs to be added before "Annex" in the following Correlating Committee committee statement: "The Correlating Committee directs the panel to review the need for the informational note in 760.176 based on 90.7 and the reference to Annex A."

Public Comment No. 703-NFPA 70-2021 [Section No. 760.176(F)]

(F) Fire Alarm Circuit Integrity (CI) Cable, Fire-Resistive Cable System, or Electrical Circuit Protective System.

Cables that are used for survivability of critical circuits under fire conditions shall be listed and meet the requirements of 760.176(F)(1), (F)(2), or (F)(3).

Informational Note: See 12.4.3 and 12.4.4 of *NFPA 72*-2019, *National Fire Alarm and Signaling Code*, for fire alarm circuit integrity (CI) cable, fire-resistive cable systems, or electrical circuit protective systems that might be used for fire alarm circuits to comply with the survivability requirements to maintain the circuit's electrical function during fire conditions for a defined period of time.

(1) Circuit Integrity (CI) Cables.

Circuit integrity (CI) cables specified in 760.176(C), (D), and (E) and used for survivability of critical circuits shall be marked for an additional classification using the suffix "-CI." In order to maintain its listed fire-resistive rating, CI cables shall only be installed in free air in accordance with 760.24(B). CI cables shall only be permitted to be installed in a raceway where specifically listed and marked as part of an electrical circuit protective fire-resistive cable system as covered in 760.176(F)(2). CI cables shall only be permitted to be installed in a raceway where specifically listed and marked as part of an electrical circuit protective system as covered in 760.176(F)(2).

Informational Note: One method of defining CI cable is by establishing a rating when tested in accordance with UL 2196, *Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables*, as specified in UL 1425, *Cables for Non-Power-Limited Fire-Alarm Circuits*. UL guide information for non-power-limited fire alarm circuits (HNHT) contains information for identifying the cable and its installation limitations to maintain the fire-resistive rating.

(2) Fire-Resistive Cable Systems.

Cables specified in 760.176(C), (D), (E), and (F)(1) that are part of a fire-resistive cable system shall be identified with the system identifier and hourly rating marked on the protectant or the smallest unit container and installed in accordance with the listing of the system.

Informational Note: One method of defining a fire-resistive cable system is by establishing a rating when tested in accordance with UL 2196, *Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables*. UL guide information for electrical circuit integrity systems (FHIT) contains information for identifying the system and its installation limitations to maintain a minimum fire-resistive rating.

(3) Electrical Circuit Protective System.

Protectants for cables specified in 760.176(C), (D), and (E) that are part of an electrical circuit protective system shall be identified with the protective system identifier and hourly rating marked on the protectant or the smallest unit container and installed in accordance with the listing of the protective system.

Informational Note: One method of defining an electrical circuit protective system is by establishing a rating when tested in accordance with UL 1724, *Fire Tests for Electrical Circuit Protective Systems*. UL guide information for electrical circuit integrity systems (FHIT) contains information for identifying the system and its installation limitations to maintain the fire-resistive rating.

Additional Proposed Changes

File Name	Description	Approved
3_CN_371.pdf	3 CN371	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 371 appeared in the First Draft Report on First Revision No. 9553.

The Correlating Committee requests the panel to review the informational note for appropriate guidance to the user in accordance with section 3.1.3 of the NEC Style Manual. The panel may consider revising with the following revised language to " ... electrical circuit protective systems for additional information on fire alarm circuits to comply with ... "

Related Item

- First Revision No. 9553

Submitter Information Verification

Submitter Full Name:	CC on NEC-AAC
Organization:	NEC Correlating Committee
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 03 12:51:16 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR
Resolution:	SR-8608-NFPA 70-2021
Statement:	The informational notes have been revised to comply with 3.1.3 of the NEC Style Manual. In (E) the standard reference was updated. A “Note 2” was added to the table for cables that incorporated optical fibers.

Correlating Committee Note No. 371-NFPA 70-2021 [Section No. 760.176(F)]

Submitter Information Verification

Committee: NEC-P03

Submittal Date: Fri May 07 11:02:00 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee requests the panel to review the informational note for appropriate guidance to the user in accordance with section 3.1.3 of the NEC Style Manual. The panel may consider revising with the following revised language to "...electrical circuit protective systems for additional information on fire alarm circuits to comply with …"

First Revision No. 9553-NFPA 70-2021 [Section No. 760.176(F)]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
0 Not Returned
12 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Johnston, Michael J.
Kendall, David H.
Kovacik, John R.
Manche, Alan
McDaniel, Roger D.
Porter, Christine T.
Williams, David A.

Public Comment No. 731-NFPA 70-2021 [Section No. 760.179]

760.179 Listing and Marking of PLFA Cables and Insulated Continuous Line-Type Fire Detectors.

PLFA cables installed as wiring within buildings shall be listed as being resistant to the spread of fire and other criteria in accordance with 760.179(A) through (I) and shall be marked in accordance with 760.179(J). Insulated continuous line-type fire detectors shall be listed in accordance with 760.179(K). Cable used in a wet location shall be listed for use in wet locations or have a moisture-impervious metal sheath.

Informational Note: See UL 1424, *Cables for Power-Limited Fire-Alarm Circuits*, for applicable requirements for listing of power-limited fire alarm cable.

(A) Conductor Materials.

Conductors shall be solid or stranded copper.

(B) Conductor Size.

The size of conductors in a multiconductor cable shall not be smaller than 26 AWG. Single conductors shall not be smaller than 18 AWG.

(C) Voltage and Temperature Ratings.

The cable shall have a voltage rating of not less than 300 volts. The cable shall have a temperature rating of not less than 60°C (140°F).

(D) Type FPLP.

Type FPLP power-limited fire alarm plenum cable shall be listed as being suitable for use in ducts, plenums, and other space used for environmental air and shall also be listed as having adequate fire-resistant and low smoke-producing characteristics.

Informational Note: One method of defining a cable that is low-smoke producing cable and fire-resistant cable is that the cable exhibits a maximum peak optical density of 0.50 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.52 m (5 ft) or less when tested in accordance with NFPA 262-2019, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*.

(E) Type FPLR.

Type FPLR power-limited fire alarm riser cable shall be listed as being suitable for use in a vertical run in a shaft or from floor to floor and shall also be listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor.

Informational Note: One method of defining fire-resistant characteristics capable of preventing the carrying of fire from floor to floor is that the cables pass the requirements of ANSI/UL 1666-2012, *Standard Test for Flame Propagation Height of Electrical and Optical-Fiber Cable Installed Vertically in Shafts*.

(F) Type FPL.

Type FPL power-limited fire alarm cable shall be listed as being suitable for general-purpose fire alarm use, with the exception of risers, ducts, plenums, and other spaces used for environmental air, and shall also be listed as being resistant to the spread of fire.

Informational Note: One method of defining *resistant to the spread of fire* is that the cables do not spread fire to the top of the tray in the “UL Flame Exposure, Vertical Tray Flame Test” in ANSI/UL 1685-2012, *Standard for Safety for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*. The smoke measurements in the test method are not applicable.

Another method of defining *resistant to the spread of fire* is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the CSA “Vertical Flame Test — Cables in Cable Trays,” as described in CSA C22.2 No. 0.3-M-2001, *Test Methods for Electrical Wires and Cables*.

(G) Fire Alarm Circuit Integrity (CI) Cable, Fire-Resistive Cable System, or Electrical Circuit Protective System.

Cables that are used for survivability of critical circuits under fire conditions shall be listed and meet the requirements of 760.179(G)(1), (G)(2), or (G)(3).

Informational Note: See 12.4.3 and 12.4.4 of *NFPA 72*-2019, *National Fire Alarm and Signaling Code*, for fire alarm circuit integrity (CI) cable, fire-resistive cable systems, or electrical circuit protective systems that might be used for fire alarm circuits to comply with the survivability requirements to maintain the circuit's electrical function during fire conditions for a defined period of time.

(1) Circuit Integrity (CI) Cables.

Circuit integrity (CI) cables specified in 760.179(D), (E), (F), and (H) and used for survivability of critical circuits shall have an additional classification using the suffix "-CI." CI cables shall only be permitted to be installed in a raceway where specifically listed and marked as part of a fire-resistive system as covered in 760.179(G)(2).

(2) Electrical Circuit Protective System.

Cables specified in 760.179(D), (E), (F), (H), and (G)(1) that are part of an electrical circuit protective system shall be identified with the protective system number and hourly rating printed on the outer jacket of the cable and installed in accordance with the listing of the protective system.

(H) Coaxial Cables.

Coaxial cables shall be permitted to use 30 percent conductivity copper-covered steel center conductor wire and shall be listed as Type FPLP, FPLR, or FPL cable.

(I) Cables Containing Optical Fibers.

Composite optical fiber cables shall be listed as electrical cables based on the type of electrical conductors.

(J) Cable Marking.

The cable shall be marked in accordance with Table 760.179(J). The voltage rating shall not be marked on the cable. Cables that are listed for circuit integrity shall be identified with the suffix "-CI" as defined in 760.179(G). The temperature rating shall be marked on the jacket of PLFA cables that have a temperature rating exceeding 60°C (140°F). The jacket of PLFA cables shall be marked with the conductor size.

Informational Note No. 1: Voltage ratings on cables might be misinterpreted to suggest that the cables might be suitable for Class 1, electric light, and power applications.

Exception: Voltage markings shall be permitted where the cable has multiple listings and voltage marking is required for one or more of the listings.

Table 760.179(J) Cable Markings

Cable Marking	Type
FPLP	Power-limited fire alarm plenum cable
FPLR	Power-limited fire alarm riser cable
FPL	Power-limited fire alarm cable

Notes:

1. Cables identified in 760.179(D), (E), and (F) as meeting the requirements for circuit integrity shall have the additional classification using the suffix "-CI" (for example, FPLP-CI, FPLR-CI, and FPL-CI).

2. Cables containing optical fibers shall be provided with the suffix "-OF".

Informational Note No. 2: Cable types are listed in descending order of fire performance.

(K) Insulated Continuous Line-Type Fire Detectors.

Insulated continuous line-type fire detectors shall be rated in accordance with 760.179(C), listed as being resistant to the spread of fire in accordance with 760.179(D) through (F), and marked in accordance with 760.179(J), and the jacket compound shall have a high degree of abrasion resistance.

Additional Proposed Changes

File Name	Description	Approved
3_CN_381.pdf	3 CN381	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 381 appeared in the First Draft Report on First Revision No. 9541.

The Correlating Committee directs the panel to review the need for the informational note in 760.179 based on 90. 7 and the reference to Informative Annex A.

Related Item

• First Revision No. 9541

Submitter Information Verification

Submitter Full Name:	CC on NEC-AAC
Organization:	NEC Correlating Committee
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 03 14:20:35 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected
Resolution:	Section 90.7 and Annex A are for general information. The informational notes provide specific information relating to the appropriate standards that could be used to determine the acceptability of an installation.

Correlating Committee Note No. 381-NFPA 70-2021 [Section No. 760.179 [Excluding any Sub-Sections]]

Submitter Information Verification

Committee: NEC-P03

Submittal Date: Fri May 07 11:54:15 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs the panel to review the need for the informational note in 760.179 based on 90.7 and the reference to Informative Annex A.

First Revision No. 9541-NFPA 70-2021 [Section No. 760.179 [Excluding any Sub-Sections]]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
0 Not Returned
12 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Johnston, Michael J.
Kendall, David H.
Kovacik, John R.
Manche, Alan
McDaniel, Roger D.
Porter, Christine T.
Williams, David A.

Public Comment No. 704-NFPA 70-2021 [Section No. 760.179(G)]

(G) Fire Alarm Circuit Integrity (CI) Cable, Fire-Resistive Cable System, or Electrical Circuit Protective System.

Cables that are used for survivability of critical circuits under fire conditions shall be listed and meet the requirements of 760.179(G)(1), (G)(2), or (G)(3).

Informational Note: See 12.4.3 and 12.4.4 of *NFPA 72*-2019, *National Fire Alarm and Signaling Code*, for fire alarm circuit integrity (CI) cable, fire-resistive cable systems, or electrical circuit protective systems that might be used for fire alarm circuits to comply with the survivability requirements to maintain the circuit's electrical function during fire conditions for a defined period of time.

(1) Circuit Integrity (CI) Cables.

Circuit integrity (CI) cables specified in 760.179(D), (E), (F), and (H) and used for survivability of critical circuits shall have an additional classification using the suffix "-CI." CI cables shall only be permitted to be installed in a raceway where specifically listed and marked as part of a fire-resistive system as covered in 760.179(G)(2).

(2) Electrical Circuit Protective System.

Cables specified in 760.179(D), (E), (F), (H), and (G)(1) that are part of an electrical circuit protective system shall be identified with the protective system number and hourly rating printed on the outer jacket of the cable and installed in accordance with the listing of the protective system.

Additional Proposed Changes

File Name	Description	Approved
3_CN_372.pdf	3 CN372	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 372 appeared in the First Draft Report on First Revision No. 9585.

The Correlating Committee requests the panel to review the informational note for appropriate guidance to the user in accordance with section 3.1.3 of the NEC Style Manual. The panel may consider revising with the following language to " ... electrical circuit protective systems for additional information on fire alarm circuits to comply with ... "

Related Item

• First Revision No. 9585

Submitter Information Verification

Submitter Full Name:	CC on NEC-AAC
Organization:	NEC Correlating Committee
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 03 12:55:07 EDT 2021
Committee:	NEC-P03

Committee Statement

Committee Action:	Rejected but see related SR

Resolution: SR-8613-NFPA 70-2021

Statement: PC 704 was originally directed at 760.179(G). This section was removed from 760 and moved into 722.179(A)(7). The revisions were made to 722.179(A)(7).

The informational notes were revised to comply with section 3.1.3 of the NEC Style Manual.

Correlating Committee Note No. 372-NFPA 70-2021 [Section No. 760.179(G)]

Submitter Information Verification

Committee: NEC-P03

Submittal Date: Fri May 07 11:06:05 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee requests the panel to review the informational note for appropriate guidance to the user in accordance with section 3.1.3 of the NEC Style Manual. The panel may consider revising with the following language to "...electrical circuit protective systems for additional information on fire alarm circuits to comply with …"

First Revision No. 9585-NFPA 70-2021 [Section No. 760.179(G)]

Ballot Results

This item has passed ballot

12 Eligible Voters
0 Not Returned
12 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Johnston, Michael J.

Kendall, David H.

Kovacik, John R.

Manche, Alan

McDaniel, Roger D.

Porter, Christine T.

Williams, David A.

Public Comment No. 1610-NFPA 70-2021 [Part IV.]

Part IV. Installation

Statement of Problem and Substantiation for Public Comment

Please consider renumbering sections 335 through 379 as 235 through 279. I wasn't sure how to do this in Terra without adding a lot of extra work to everybody's already busy schedule, so I hope this works. The substantiation is consistency with other Code articles.

Related Item

- FR 9606

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Ryan Jackson
Street Address:
City:
State:
Zip:

Submittal Date: Mon Aug 16 16:35:13 EDT 2021
Committee: NEC-P03

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8301-NFPA 70-2021

Statement: The information in 726.336(H) is a duplication of what is covered in Article 722. The moving of 726.336 to 726.136 is done to be consistent with the numbering of other Articles. Re-alphabetize subsequent sections.