Public Input No. 3728-NFPA 70-2020 [Global Input]

See Attached Word Document for Changes

Additional Proposed Changes

File Name	Description	Approved
240_and_490_Public_Input_-_Final0.docx	Global PI to Revise Articles 240, 242 and Chapter 4, Adding New Articles 245 and 495.	

Statement of Problem and Substantiation for Public Input

This Public Input is submitted on behalf of a Correlating Committee Long-Range Planning Task Group consisting of Robert Osborne (Chair), Paul Barnhart, Lou Grahor, David Temple, Donny Cook, Dean Hunter, Mike Querry, Roger McDaniel, Dave Burns, Rod Belisle, and Kevin Rogers. This Public Input, along with other companion Public Inputs, was developed with the goal of improving usability and providing a platform to increase the focus on requirements associated with Medium or High Voltage.

Installations, including campus-wide distribution systems, microgrids, alternative energy installations, etc., are covered by the Scope of the NEC®; however, requirements for conductors, equipment, and raceways used in applications operating in systems rated over 1000 volts are treated as an "after-thought" in how they are arranged in the document and covered by Technical Committees. In many cases, the "over 1000 volts" requirements exist in a dedicated "Part" within the Article – such is the case with existing Article 300. In other cases, similar products are handled in two separate Articles, such as with "switchgear", with equipment rated 1000 volts and below addressed in Article 408, and equipment rated over 1000 volts addressed in Article 490. In addition to these two approaches, there are Articles where the "over 1000 volts" is intermingled with the "under 1000 volt" requirements, such as the case with Article 225. In many of these cases, the information for over 1000 volts is very limited (for example, Article 240 has only 3 Sections in the Part dedicated to requirements for over 1000 volts).

This Task Group's initial task was to establish a demarcation for what can be referred to as Medium or High Voltage. The recommendation has been to establish this threshold as being equipment rated over 1000 Vac, 1500 Vdc. It is believed that levels below these voltages can be addressed with existing requirements for systems rated 1000 V ac max, and 1500 V dc, as this has been established as a upper limit for photovoltaic applications within Article 690, with requirements noting that those systems are not required to comply with Parts II and III of Article 490.

Using these limits, the Task Group then set out to identify a structure to better align requirements, improve consistency in approach, improve usability, and create the opportunity for Code Making Panels to have an increased focus on higher voltage applications.
All changes to Articles 240 and 242, along with Chapter 4, are being submitted as a Global Input, and below is a summary of those changes:

• Overcurrent Protection requirements in Part IX of Article 240 (Overcurrent Protection over 1000 Volts, Nominal), and Overvoltage Protection requirements in Part III of Article 242 (Surge Arresters, Over 1000 Volts) are relocated to a new Article 245, "Overcurrent and Overvoltage Protection for Systems Rated Over 1000 VAC, 1500 VDC. In addition, requirements from Article 490 that are specific to overcurrent protection are relocated to the new Article 245. A summary of the relocated Sections is noted below:
o Reconditioning requirements in Section 240.88 and 240.102 that are specific to overcurrent devices rated over 1000 volts are relocated to Section 245.15

o Section 490.21 is relocated to Section 245.21.
o Sections 240.100 and 240.101 are relocated to Sections 245.26 and 245.27, respectively.
o Sections 242.40 – 242-56 are relocated to Sections 245.42 – 245.56.
o Scope of 242 is revised to address only Overvoltage Protection rated not more than 1000 volts.
o Over 1000 Volt Equipment Articles (490 and 399) are relocated from Table 242.3 to new Table 245.40
o Article 242 is restructured to only have one Part to cover all Overvoltage Protection not more than 1000 volts.
• Article 490 has been renumbered to become Article 495 and remains “Equipment over 1000 Volts, Nominal”
• Article 495 now consists of 10 parts:
o Parts I –V are existing 490 text relocated and renumbered to “New” Article 495
o Part VI consists of relocated materials from Article 430 Part XI “Over 1000 Volts, Nominal,” with Sections 430.221 - 430.227 relocated to Sections 495.80 - 495.86
 The over 1000 Volts portions of tables 430.249 and 430.250, including notes, have also been relocated o Part VI.
o Part VII contains the requirements from Article 450 regarding Transformers, Over 1000 Volts, including requirements for liquid-filled transformers. While liquid-filled transformers (including “less-flammable,” “non-flammable,” “askarel-insulated”) may be used in any installation, they are more common in installations over 1000 volts. While these requirements are relocated to Article 495, a new section 450.23 notes that the requirements in Part VII of 495 apply.
o Part VIII contains requirements from Article 450 Part III, Transformer Vaults. While transformer vaults may be used in any installation, they are more common in installations over 1000 volts. While these requirements are relocated to Article 495, a new section 450.40 notes that the requirements in Part VIII of 495 apply.
o Part IX contains the Requirements from Article 460 Part II, Capacitors, Over 1000 volts, nominal, (previously numbered 460.24 - 460.28).
o Part X contains the requirements from Article 470 (Resistors and Reactors), Part II Over 1000 volts, Nominal (previously numbered 470.18 - 470.20).

Note: There are other Public Inputs being submitted that address restructuring, and these are identified as “Companion Public Inputs”. Other Article or Section references may be impacted due restructuring activities by those companion Public Inputs; however, changes to references outside of Articles 240, 242, and Chapter 4 are not shown in this Public Input.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3765-NFPA 70-2020 [New Section after 250.194(B)]	Companion Public Input (Article 255)
Public Input No. 3772-NFPA 70-2020 [New Section after 110.79]	Companion Public Input (Article 115)
Public Input No. 3815-NFPA 70-2020 [New Section after 200.11]	Companion Public Input (Article 205)
Public Input No. 3819-NFPA 70-2020 [Global Input]	Companion Public Input (Article 235)
Public Input No. 3827-NFPA 70-2020 [Global Input]	Companion Public Input (Article 305)
Public Input No. 3838-NFPA 70-2020 [Section No. 690.31(A)]	Companion Public Input (Section 690.31(A))
Public Input No. 3846-NFPA 70-2020 [Section No. 694.30(A)]	Companion Public Input (Section 694.30(A))
Public Input No. 3849-NFPA 70-2020 [New Part after IV.]	Companion Public Input (Section 706.30)

Submitter Information Verification

Submitter Full Name: Robert Osborne

Organization: UL LLC
Street Address:
City:
State:
Zip:
Submittal Date: Wed Sep 09 11:28:25 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7941-NFPA 70-2020

Statement: CMP-9 provides text for a revised Article 495 based on the actions and substantiation of the Medium Voltage Task Group.

The text of this FR is based on NEC 2020 text. CMP-9 acknowledges that changes made to Article 490 would need to be incorporated into Article 495. Article 495 as proposed would essentially replace Article 490.

Below is a summary of the changes that result in a new Article 495:

• Article 490 has been renumbered to become Article 495 and remains “Equipment over 1000 Volts, Nominal” Article 495 now includes flexible cords and flexible cables from Article 400 that are rated 2000 Volts and greater.

• Article 495 now consists of 10 parts:

• Parts I –V are existing 490 text relocated and renumbered to “New” Article 495

• Part VI consists of relocated materials from Article 430 Part XI “Over 1000 Volts, Nominal,” with Sections 430.221 - 430.227 relocated to Sections 495.80 - 495.86. The over 1000 Volts portions of tables 430.249 and 430.250, including notes, have also been relocated o Part VI.

• Part VII contains the requirements from Article 450 regarding Transformers, Over 1000 Volts, including requirements for liquid-filled transformers. While liquid-filled transformers (including “less flammable,” “non-flammable,” “askarel-insulated”) may be used in any installation, they are more common in installations over 1000 volts. While these requirements are relocated to Article 495, a new section 450.23 notes that the requirements in Part VII of 495 apply.

• Part VIII contains requirements from Article 450 Part III, Transformer Vaults. While transformer vaults may be used in any installation, they are more common in installations over 1000 volts. While these requirements are relocated to Article 495, a new section 450.40 notes that the requirements in Part VIII of 495 apply.

• Changes to Article 450 will be necessary when requirements are relocated. The attached document shows how these changes will impact Article 450 (based on the 2020 Code text).

• Part IX contains the Requirements from Article 460 Part II, Capacitors, Over 1000 volts, nominal, (previously numbered 460.24 - 460.28).

• Part X contains the requirements from Article 470 (Resistors and Reactors), Part II Over 1000 volts, Nominal (previously numbered 470.18 - 470.20).

Below is a summary of the revisions (unrelated to PI-3728) to Article 495 that must be considered in the PC Stage:

• Informational Notes - Revised to comply with Clause 3.1.3.1 of the NEC Style Manual.

• 490.2 - In accordance with 2.2.2 of the NEC Style Manual, the definition for “High Voltage” is relocated to Article 100.

• Table 495.24 (“Note”) and Section 495.48(A)(12) - Article 242 (new to the 2020 Code) covers “surge equipment”; however, the title of the Article is “Overvoltage Protection”, as that is a more generic term. This revision aligns this text with the title of Article 242, and also includes the term “surge” as this has historically been used to describe this equipment. The use of the generic term “overvoltage protection” allows for a broader application of products that provide this protection.

• 495.37 - Requirements in sections 490.36 and 490.37 address different equipment, but have the same requirement. Since “Equipment”, as defined in Article 100 is a generic term, it covers all items identified in both sections. Rather than repeat the same requirement twice, they are combined into a single section (now 495.37), and a reference to the section in Article 250 that covers equipment grounding is added.

• 495.49 - The Technical committee has eliminated the statement to remove previously installed labels, as this is a general requirement contained in Chapter 1. As stated in clause 4.1.2 of the NEC Style Manual, general requirements contained in Chapter 1 shall not be repeated in other Articles of the document.

• 495.51(B) - Section 4.1.4 of the 2020 NEC® Style Manual prohibits references to an entire articles, with the exception of Article 100. The intent here is to point to the bonding and grounding parts that would apply in Article 250, which is Part X since this is "high voltage equipment", and requirements for portable equipment appear in Part X.

• 495.56 - Section 4.1.4 of the 2020 NEC® Style Manual prohibits references to an entire articles, with the exception of Article 100. The intent here is to point to the bonding and grounding parts that would apply in Article 250, which are Parts V, VI, and X since this is "high voltage equipment". The structure of this section is reordered for consistency, with “Part” occurring prior to “Article”.

• Part V - The use of larger resistance type boilers is becoming more prevalent as users move to de-carbonization and away from fossil fuels for heating. Other standards are referencing the NEC for evaluation and resistance type boilers operating over 1000V are not addressed in Article 490. Part V already addresses “Electrode-Type Boilers”, and rather than create a new “Part VI” that has identical requirements, Part V is revised to refer to “Boilers” more generically. The existing requirements for “Electrode-Type Boilers” would apply equally to other types of Boilers, including “Resistance-Type Boilers”. Changes are made throughout Part V to refer generically to “Boilers”.

Substantiation:

This Public Input is submitted on behalf of a Correlating Committee Long-Range Planning Task Group consisting of Robert Osborne (Chair), Paul Barnhart, Lou Grahor, David Temple, Donny Cook, Dean Hunter, Mike Querry, Roger McDaniel, Dave Burns, Rod Belisle, and Kevin Rogers. This Public Input, along with other companion Public Inputs, was developed with the goal of improving usability and providing a platform to increase the focus on requirements associated with Medium or High Voltage.

Installations, including campus-wide distribution systems, microgrids, alternative energy installations, etc., are covered by the Scope of the NEC®; however, requirements for conductors, equipment, and raceways used in applications operating in systems rated over 1000 volts are treated as an "after-thought" in how they are arranged in the document and covered by Technical Committees. In many cases, the "over 1000 volts" requirements exist in a dedicated "Part" within the Article – such is the case with existing Article 300. In other cases, similar products are handled in two separate Articles, such as with "switchgear", with equipment rated 1000 volts and below addressed in Article 408, and equipment rated over 1000 volts addressed in Article 490. In addition to these two approaches, there are Articles where the "over 1000 volts" is intermingled with the "under 1000 volt" requirements, such as the case with Article 225. In many of these cases, the information for over 1000 volts is very limited (for example, Article 240 has only 3 Sections in the Part dedicated to requirements for over 1000 volts).

This Task Group's initial task was to establish a demarcation for what can be referred to as Medium or High Voltage. The recommendation has been to establish this threshold as being equipment rated over 1000 Vac, 1500 Vdc. It is believed that levels below these voltages can be addressed with existing requirements for systems rated 1000 V ac max, and 1500 V dc, as this has been established as a upper limit for photovoltaic applications within Article 690, with requirements noting that those systems are not required to comply with Parts II and III of Article 490.

Using these limits, the Task Group then set out to identify a structure to better align requirements, improve consistency in approach, improve usability, and create the opportunity for Code Making Panels to have an increased focus on higher voltage applications.

All changes to Articles 240 and 242, along with Chapter 4, are being submitted as a Global Input, and below is a summary of those changes:

- Overcurrent Protection requirements in Part IX of Article 240 (Overcurrent Protection over 1000 Volts, Nominal), and Overvoltage Protection requirements in Part III of Article 242 (Surge Arresters, Over 1000 Volts) are relocated to a new Article 245, "Overcurrent and Overvoltage Protection for Systems Rated Over 1000 VAC, 1500 VDC. In addition, requirements from Article 490 that are specific to overcurrent protection are relocated to the new Article 245. A summary of the relocated Sections is noted below:
    - Reconditioning requirements in Section 240.88 and 240.102 that are specific to overcurrent devices rated over 1000 volts are relocated to Section 245.15
    - Section 490.21 is relocated to Section 245.21.
    - Sections 240.100 and 240.101 are relocated to Sections 245.26 and 245.27, respectively.
    - Sections 242.40 – 242-56 are relocated to Sections 245.42 – 245.56.
    - Scope of 242 is revised to address only Overvoltage Protection rated not more than 1000 volts.
    - Over 1000 Volt Equipment Articles (490 and 399) are relocated from Table 242.3 to new Table 245.40
    - Article 242 is restructured to only have one Part to cover all Overvoltage Protection not more than 1000 volts.

- Article 490 has been renumbered to become Article 495 and remains "Equipment over 1000 Volts, Nominal"

- Article 495 now consists of 10 parts:

    - Parts I –V are existing 490 text relocated and renumbered to "New" Article 495

    - Part VI consists of relocated materials from Article 430 Part XI "Over 1000 Volts, Nominal," with Sections 430.221 - 430.227 relocated to Sections 495.80 - 495.86

        - The over 1000 Volts portions of tables 430.249 and 430.250, including notes, have also been relocated o Part VI.

    - Part VII contains the requirements from Article 450 regarding Transformers, Over 1000 Volts, including requirements for liquid-filled transformers. While liquid-filled transformers (including "less-flammable," "non-flammable," "askarel-insulated") may be used in any installation, they are more common in installations over 1000 volts. While these requirements are relocated to Article 495, a new section 450.23 notes that the requirements in Part VII of 495 apply.

- Part VIII contains requirements from Article 450 Part III, Transformer Vaults. While transformer vaults may be used in any installation, they are more common in installations over 1000 volts. While these requirements are relocated to Article 495, a new section 450.40 notes that the requirements in Part VIII of 495 apply.

- Part IX contains the Requirements from Article 460 Part II, Capacitors, Over 1000 volts, nominal,(previously numbered 460.24 - 460.28).

- Part X contains the requirements from Article 470 (Resistors and Reactors), Part II Over 1000 volts, Nominal (previously numbered 470.18 - 470.20).

Note: There are other Public Inputs being submitted that address restructuring, and these are identified as "Companion Public Inputs". Other Article or Section references may be impacted due restructuring activities by those companion Public Inputs; however, changes to references outside of Articles 240, 242, and Chapter 4 are not shown in this Public Input.

Revisions to Article 240:

240.88 Reconditioned Equipment.
Reconditioned equipment shall be listed as "reconditioned" and the original listing mark removed.

(A) Circuit Breakers.
The use of reconditioned circuit breakers shall comply with (1) ~~through~~ and (2~~3~~):

(1) Molded-case circuit breakers shall not be permitted to be reconditioned.

(2) Low-~~ and medium~~ voltage power circuit breakers shall be permitted to be reconditioned.

~~(3) High-voltage circuit breakers shall be permitted to be reconditioned.~~

(B) Components.
The use of reconditioned trip units, protective relays, and current transformers shall comply with (1) and (2):

(1) Low-voltage power circuit breaker electronic trip units shall not be permitted to be reconditioned.

(2) Electromechanical protective relays and current transformers shall be permitted to be reconditioned.

~~Part IX. Overcurrent Protection over 1000 Volts, Nominal~~

~~240.100 Feeders and Branch Circuits.~~

~~(A) Location and Type of Protection.~~
~~Feeder and branch-circuit conductors shall have overcurrent protection in each ungrounded conductor located at the point where the conductor receives its supply or at an alternative location in the circuit when designed under engineering supervision that includes but is not limited to considering the appropriate fault studies and time-current coordination analysis of the protective devices and the conductor damage curves. The overcurrent protection shall be permitted to be provided by either 240.100(A)(1) or (A)(2).~~

~~(1) Overcurrent Relays and Current Transformers.~~
~~Circuit breakers used for overcurrent protection of 3-phase circuits shall have a minimum of three overcurrent relay elements operated from three current transformers. The separate overcurrent relay elements (or protective functions) shall be permitted to be part of a single electronic protective relay unit.~~
~~On 3-phase, 3-wire circuits, an overcurrent relay element in the residual circuit of the current transformers shall be permitted to replace one of the phase relay elements.~~
~~An overcurrent relay element, operated from a current transformer that links all phases of a 3-phase, 3-wire circuit, shall be permitted to replace the residual relay element and one of the phase-conductor current transformers. Where the neutral conductor is not regrounded on the load side of the circuit as permitted in 250.184(B), the current transformer shall be permitted to link all 3-phase conductors and the grounded circuit conductor (neutral).~~

~~(2) Fuses.~~
~~A fuse shall be connected in series with each ungrounded conductor.~~

~~(B) Protective Devices.~~
~~The protective device(s) shall be capable of detecting and interrupting all values of current that can occur at their location in excess of their trip-setting or melting point.~~

~~(C) Conductor Protection.~~
~~The operating time of the protective device, the available short-circuit current, and the conductor used shall be coordinated to prevent damaging or dangerous temperatures in conductors or conductor insulation under short-circuit conditions.~~

~~240.101 Additional Requirements for Feeders.~~

~~(A) Rating or Setting of Overcurrent Protective Devices.~~

~~The continuous ampere rating of a fuse shall not exceed three times the ampacity of the conductors. The long-time trip element setting of a breaker or the minimum trip setting of an electronically actuated fuse shall not exceed six times the ampacity of the conductor. For fire pumps, conductors shall be permitted to be protected for overcurrent in accordance with 695.4(B)(2).~~

~~(B) Feeder Taps.~~
~~Conductors tapped to a feeder shall be permitted to be protected by the feeder overcurrent device where that overcurrent device also protects the tap conductor.~~

~~240.102 Reconditioned Equipment.~~
~~Medium-voltage fuseholders and medium-voltage nonrenewable fuses shall not be permitted to be reconditioned.~~

Revisions to Article 242:

ARTICLE 242 Overvoltage Protection

Part I. General

242.1 Scope. This article provides the general requirements, installation requirements, and connection requirements for overvoltage protection and overvoltage ~~protective devices. Part II covers~~ surge protective devices (SPDs) permanently installed on premises wiring systems of not more than 1000 volts, nominal~~, while Part III covers surge arresters permanently installed on premises wiring systems over 1000 volts, nominal~~.

Informational Note No. 1: Article 245~~2~~ covers surge arresters permanently installed on premises wiring systems over 1000 volts, nominal~~combines and replaces Articles 280 and 285 in *NFPA 70* 2017~~.

Informational Note No. 2: Surge arresters 1000 volts or less are also known as Type 1 surge protective devices (SPDs).

242.3 Other Articles. Equipment shall be protected against overvoltage in accordance with the article in this *Code* that covers the type of equipment or location specified in Table 242.3.

Table 242.3 Other Articles

Equipment	Article
Class I locations	501
Class II locations	502
Community antenna television and radio distribution systems	820
Critical operations power systems	708
Elevators, dumbwaiters, escalators, moving walks, platform lifts, and stairway chairlifts	620
Emergency systems	700
~~Equipment over 1000 volts, nominal~~	~~490~~
Fire pumps	695
Industrial machinery	670
Information technology equipment	645
Modular data centers	646
~~Outdoor overhead conductors over 1000 volts~~	~~399~~
Radio and television equipment	810
Receptacles, cord connectors, and attachment plugs (caps)	406
Wind electric systems	694

~~**Part II. Surge Protective Devices (SPDs), 1000 Volts or Less**~~

~~Informational Note: Surge arresters 1000 volts or less are also known as Type 1 SPDs.~~

242.6 Uses Not Permitted. An SPD device shall not be installed in the following:

(1) Circuits over 1000 volts

(2) On ungrounded systems, impedance grounded systems, or corner grounded delta systems unless listed specifically for use on these systems

(3) Where the rating of the SPD is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application

242.8 Listing. An SPD shall be a listed device.

242.10 Short-Circuit Current Rating. The SPD shall be marked with a short-circuit current rating and shall not be installed at a point on the system where the available fault current is in excess of that rating. This marking requirement shall not apply to receptacles.

242.12 Type 1 SPDs. Type 1 SPDs shall be installed in accordance with 242.12(A) and (B).

(A) Installation. Type 1 SPDs shall be permitted to be connected in accordance with one of the following:

(1) To the supply side of the service disconnect as permitted in 230.82(4)

(2) As specified in 242.14

(B) At the Service. When installed at services, Type 1 SPDs shall be connected to one of the following:

(1) Grounded service conductor

(2) Grounding electrode conductor

(3) Grounding electrode for the service

(4) Equipment grounding terminal in the service equipment

242.14 Type 2 SPDs. Type 2 SPDs shall be installed in accordance with 242.14(A) through (C).

(A) Service-Supplied Building or Structure. Type 2 SPDs shall be connected anywhere on the load side of a service disconnect overcurrent device required in 230.91 unless installed in accordance with 230.82(8).

(B) Feeder-Supplied Building or Structure.
Type 2 SPDs shall be connected at the building or structure anywhere on the load side of the first overcurrent device at the building or structure.

(C) Separately Derived System.
The SPD shall be connected on the load side of the first overcurrent device in a separately derived system.

242.16 Type 3 SPDs. Type 3 SPDs shall be permitted to be installed on the load side of branch-circuit overcurrent protection up to the equipment served. If included in the manufacturer's instructions, the Type 3 SPD connection shall be a minimum 10 m (30 ft) of conductor distance from the service or separately derived system disconnect.

242.18 Type 4 and Other Component Type SPDs. Type 4 component assemblies and other component type SPDs shall only be installed by the equipment manufacturer.

242.20 Number Required. Where used at a point on a circuit, the SPD shall be connected to each ungrounded conductor.

242.22 Location. SPDs shall be permitted to be located indoors or outdoors and shall be made inaccessible to unqualified persons unless listed for installation in accessible locations.

242.24 Routing of Connections. The conductors used to connect the SPD to the line or bus and to ground shall not be any longer than necessary and shall avoid unnecessary bends.

242.26 Connection. Where an SPD device is installed, it shall comply with 242.12, 242.14, 242.16, 242.28. and 242.30.

242.28 Conductor Size. Line and grounding conductors shall not be smaller than 14 AWG copper or 12 AWG aluminum.
242.30 Connection Between Conductors. An SPD shall be permitted to be connected between any two conductors — ungrounded conductor(s), grounded conductor, equipment grounding conductor, or grounding electrode conductor. The grounded conductor and the equipment grounding conductor shall be interconnected only by the normal operation of the SPD during a surge.

242.32 Grounding Electrode Conductor Connections and Enclosures. Except as indicated in this article, SPD grounding connections shall be made as specified in Article 250, Part III. Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).

~~**Part III. Surge Arresters, Over 1000 Volts**~~

~~**242.40 Uses Not Permitted.**~~
~~A surge arrester shall not be installed where the rating of the surge arrester is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application.~~

~~**242.42 Surge Arrester Selection.**~~
~~The surge arresters shall comply with 242.42(A) and (B).~~
~~**(A) Rating.**~~
~~The rating of a surge arrester shall be equal to or greater than the maximum continuous operating voltage available at the point of application.~~
~~**(1) Solidly Grounded Systems.**~~
~~The maximum continuous operating voltage shall be the phase-to-ground voltage of the system.~~
~~**(2) Impedance or Ungrounded System.**~~
~~The maximum continuous operating voltage shall be the phase-to-phase voltage of the system.~~
~~**(B) Silicon Carbide Types.**~~
~~The rating of a silicon carbide-type surge arrester shall be not less than 125 percent of the rating specified in 242.42(A).~~

~~Informational Note No. 1: For further information on surge arresters, see IEEE C62.11-2012, *Standard for Metal-Oxide Surge Arresters for Alternating-Current Power Circuits (>1 kV)*, and IEEE C62.22-2009, *Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems*.~~
~~Informational Note No. 2: The selection of a properly rated metal oxide arrester is based on considerations of maximum continuous operating voltage and the magnitude and duration of overvoltages at the arrester location as affected by phase-to-ground faults, system grounding techniques, switching surges, and other causes. See the manufacturer's application rules for selection of the specific arrester to be used at a particular location.~~
~~**242.44 Number Required.**~~
~~Where used at a point on a circuit, a surge arrester shall be connected to each ungrounded conductor. A single installation of such surge arresters shall be permitted to protect a number of interconnected circuits if no circuit is exposed to surges while disconnected from the surge arresters.~~

~~**242.46 Location.**~~
~~Surge arresters shall be permitted to be located indoors or outdoors. Surge arresters shall be made inaccessible to unqualified persons unless listed for installation in accessible locations.~~

~~**242.48 Routing of Surge Arrester Equipment Grounding Conductors.**~~
~~The conductor used to connect the surge arrester to line, bus, or equipment and to an equipment grounding conductor or grounding electrode connection point as provided in 242.50 shall not be any longer than necessary and shall avoid unnecessary bends.~~

~~**242.50 Connection.**~~
~~The arrester shall be connected to one of the following:~~

~~(1) Grounded service conductor~~

~~(2) Grounding electrode conductor~~

~~(3) Grounding electrode for the service~~

~~(4) Equipment grounding terminal in the service equipment~~

~~**242.52 Surge Arrester Conductors.**~~

~~The conductor between the surge arrester and the line, and the surge arrester and the grounding connection, shall not be smaller than 6 AWG copper or aluminum.~~

~~242.54 Interconnections.~~

~~The surge arrester protecting a transformer that supplies a secondary distribution system shall be interconnected as specified in 242.54(A), (B), or (C).~~

~~(A) Metal Interconnections.~~

~~A metal interconnection shall be made to the secondary grounded circuit conductor or the secondary circuit grounding electrode conductor, if, in addition to the direct grounding connection at the surge arrester, the connection complies with 242.54(A)(1) or (A)(2).~~

~~(1) Additional Grounding Connection.~~

~~The grounded conductor of the secondary has a grounding connection elsewhere to a continuous metal underground water piping system. In urban water-pipe areas where there are at least four water-pipe connections on the neutral conductor and not fewer than four such connections in each mile of neutral conductor, the metal interconnection shall be permitted to be made to the secondary neutral conductor with omission of the direct grounding connection at the surge arrester.~~

~~(2) Multigrounded Neutral System Connection.~~

~~The grounded conductor of the secondary system is part of a multigrounded neutral system or static wire of which the primary neutral conductor or static wire has at least four grounding connections in each 1.6 km (1 mile) of line in addition to a grounding connection at each service.~~

~~(B) Through Spark Gap or Device.~~

~~Where the surge arrester grounding electrode conductor is not connected as in 242.54(A), or where the secondary is not grounded as in 242.54(A) but is otherwise grounded as in 250.52, an interconnection shall be made through a spark gap or listed device as required by 242.54(B)(1) or (B)(2).~~

~~(1) Ungrounded or Unigrounded Primary System.~~

~~For ungrounded or unigrounded primary systems, the spark gap for a listed device shall have a 60-Hz breakdown voltage of at least twice the primary circuit voltage but not necessarily more than 10 kV, and there shall be at least one other ground on the grounded conductor of the secondary that is not less than 6.0 m (20 ft) distant from the surge-arrester grounding electrode.~~

~~(2) Multigrounded Neutral Primary System.~~

~~For multigrounded neutral primary systems, the spark gap or listed device shall have a 60-Hz breakdown of not more than 3 kV, and there shall be at least one other ground on the grounded conductor of the secondary that is not less than 6.0 m (20 ft) distant from the surge-arrester grounding electrode.~~

~~(C) By Special Permission.~~

~~An interconnection of the surge-arrester ground and the secondary neutral conductor, other than as provided in 242.54(A) or (B), shall be permitted to be made only by special permission.~~

~~242.56 Grounding Electrode Conductor Connections and Enclosures.~~

~~Except as indicated in this article, surge-arrester grounding electrode conductor connections shall be made as specified in Article 250, Parts III and X. Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).~~

Proposed new Article 245:

Article 245 Overcurrent and Overvoltage Protection for Systems Rated Over 1000 VAC, 1500 VDC

Part I. General and Scope

245.1 Scope.

This article covers requirements for the installation of overcurrent protection of circuits and related electrical equipment and over and overvoltage protection (surge arresters) permanently installed on premises wiring systems over 1000 VAC, 1500 VDC, nominal.

245.15 Reconditioned Equipment.

Reconditioned equipment shall be listed as "reconditioned" and the original listing mark removed.

(A) Medium and high-voltage circuit breakers shall be permitted to be reconditioned

(B) Electromechanical protective relays and current transformers shall be permitted to be reconditioned

(C) Medium-voltage fuseholders and medium-voltage nonrenewable fuses shall not be permitted to be reconditioned.

Part II. Overcurrent Protection

245.21 Circuit Interrupting Devices

(A) Circuit Breakers

(1) Location.

(a) Circuit breakers installed indoors shall be mounted either in metal-enclosed units or fire-resistant cell-mounted units, or they shall be permitted to be open-mounted in locations accessible to qualified persons only.

(b) Circuit breakers used to control oil-filled transformers in a vault shall either be located outside the transformer vault or be capable of operation from outside the vault.

(c) Oil circuit breakers shall be arranged or located so that adjacent readily combustible structures or materials are safeguarded in an approved manner

(2) Operating Characteristics. Circuit breakers shall have the following equipment or operating characteristics:

1. An accessible mechanical or other identified means for manual tripping, independent of control power
2. Be release free (trip free)
3. If capable of being opened or closed manually while energized, main contacts that operate independently of the speed of the manual operation
4. A mechanical position indicator at the circuit breaker to show the open or closed position of the main contacts

5. A means of indicating the open and closed position of the breaker at the point(s) from which they may be operated

(3) Nameplate. A circuit breaker shall have a permanent and legible nameplate showing manufacturer's name or trademark, manufacturer's type or identification number, continuous current rating, interrupting rating in megavolt-amperes (MVA) or amperes, and maximum voltage rating. Modification of a circuit breaker affecting its rating(s) shall be accompanied by an appropriate change of nameplate information.

(4) Rating. Circuit breakers shall have the following ratings:

1. The continuous current rating of a circuit breaker shall not be less than the maximum continuous current through the circuit breaker.

2. The interrupting rating of a circuit breaker shall not be less than the available fault current the circuit breaker will be required to interrupt, including contributions from all connected sources of energy.

3. The closing rating of a circuit breaker shall not be less than the maximum asymmetrical fault current into which the circuit breaker can be closed.

4. The momentary rating of a circuit breaker shall not be less than the maximum asymmetrical fault current at the point of installation.

5. The rated maximum voltage of a circuit breaker shall not be less than the maximum circuit voltage.

(5) Retrofit Trip Units. Retrofit trip units shall be listed for use with the specific circuit breaker with which it is installed

(B) Power Fuses and Fuseholders.

(1) Use. Where fuses are used to protect conductors and equipment, a fuse shall be placed in each ungrounded conductor. Two power fuses shall be permitted to be used in parallel to protect the same load if both fuses have identical ratings and both fuses are installed in an identified common mounting with electrical connections that divide the current equally. Power fuses of the vented type shall not be used indoors, underground, or in metal enclosures unless identified for the use.

(2) Interrupting Rating. The interrupting rating of power fuses shall not be less than the available fault current the fuse is required to interrupt, including contributions from all connected sources of energy.

(3) Voltage Rating. The maximum voltage rating of power fuses shall not be less than the maximum circuit voltage. Fuses having a minimum recommended operating voltage shall not be applied below this voltage.

(4) Identification of Fuse Mountings and Fuse Units. Fuse mountings and fuse units shall have permanent and legible nameplates showing the manufacturer's type or designation, continuous current rating, interrupting current rating, and maximum voltage rating.

(5) Fuses. Fuses that expel flame in opening the circuit shall be designed or arranged so that they function properly without hazard to persons or property.

(6) Fuseholders. Fuseholders shall be designed or installed so that they are de-energized while a fuse is being replaced. A field-applied permanent and legible sign, in accordance with 110.21(B), shall be installed immediately adjacent to the fuseholders and shall be worded as follows:

DANGER — DISCONNECT CIRCUIT BEFORE REPLACING FUSES.

Exception: Fuses and fuseholders designed to permit fuse replacement by qualified persons using identified equipment without de-energizing the fuseholder shall be permitted.

(7) High-Voltage Fuses. Switchgear and substations that utilize high-voltage fuses shall be provided with a gang-operated disconnecting switch. Isolation of the fuses from the circuit shall be provided by either connecting a switch between the source and the fuses or providing roll-out switch and fuse-type construction. The switch shall be of the load-interrupter type, unless mechanically or electrically interlocked with a load-interrupting device arranged to reduce the load to the interrupting capability of the switch.

Exception: More than one switch shall be permitted as the disconnecting means for one set of fuses where the switches are installed to provide connection to more than one set of supply conductors. The switches shall be mechanically or electrically interlocked to permit access to the fuses only when all switches are open. A conspicuous sign shall be placed at the fuses identifying the presence of more than one source.

(C) Distribution Cutouts and Fuse Links — Expulsion Type.

(1) Installation. Cutouts shall be located so that they may be readily and safely operated and re-fused, and so that the exhaust of the fuses does not endanger persons. Distribution cutouts shall not be used indoors, underground, or in metal enclosures.

(2) Operation. Where fused cutouts are not suitable to interrupt the circuit manually while carrying full load, an approved means shall be installed to interrupt the entire load. Unless the fused cutouts are interlocked with the switch to prevent opening of the cutouts under load, a conspicuous sign shall be placed at such cutouts identifying that they shall not be operated under load.

(3) Interrupting Rating. The interrupting rating of distribution cutouts shall not be less than the available fault current the cutout is required to interrupt, including contributions from all connected sources of energy.

(4) Voltage Rating. The maximum voltage rating of cutouts shall not be less than the maximum circuit voltage.

(5) Identification. Distribution cutouts shall have on their body, door, or fuse tube a permanent and legible nameplate or identification showing the manufacturer's type or designation, continuous current rating, maximum voltage rating, and interrupting rating.

(6) Fuse Links. Fuse links shall have a permanent and legible identification showing continuous current rating and type.

(7) Structure Mounted Outdoors. The height of cutouts mounted outdoors on structures shall provide safe clearance between lowest energized parts (open or closed position) and standing surfaces, in accordance with 110.34(E).

(D) Oil-Filled Cutouts.

(1) Continuous Current Rating. The continuous current rating of oil-filled cutouts shall not be less than the maximum continuous current through the cutout.

(2) Interrupting Rating. The interrupting rating of oil-filled cutouts shall not be less than the available fault current the oil-filled cutout is required to interrupt, including contributions from all connected sources of energy.

(3) Voltage Rating. The maximum voltage rating of oil-filled cutouts shall not be less than the maximum circuit voltage.

(4) Fault Closing Rating. Oil-filled cutouts shall have a fault closing rating not less than the maximum asymmetrical fault current that can occur at the cutout location, unless suitable interlocks or operating procedures preclude the possibility of closing into a fault.

(5) Identification. Oil-filled cutouts shall have a permanent and legible nameplate showing the rated continuous current, rated maximum voltage, and rated interrupting current.

(6) Fuse Links. Fuse links shall have a permanent and legible identification showing the rated continuous current.

(7) Location. Cutouts shall be located so that they are readily and safely accessible for re-fusing, with the top of the cutout not over 1.5 m (5 ft) above the floor or platform.

(8) Enclosure. Suitable barriers or enclosures shall be provided to prevent contact with nonshielded cables or energized parts of oil-filled cutouts.

(E) Load Interrupters. Load-interrupter switches shall be permitted if suitable fuses or circuit breakers are used in conjunction with these devices to interrupt available fault currents. Where these devices are used in combination, they shall be coordinated electrically so that they will safely withstand the effects of closing, carrying, or interrupting all possible currents up to the assigned maximum short-circuit rating.

Where more than one switch is installed with interconnected load terminals to provide for alternate connection to different supply conductors, each switch shall be provided with a warning sign identifying the presence of more than one source. Each warning sign or label shall comply with 110.21.

(1) Continuous Current Rating. The continuous current rating of interrupter switches shall equal or exceed the maximum continuous current at the point of installation.

(2) Voltage Rating. The maximum voltage rating of interrupter switches shall equal or exceed the maximum circuit voltage.

(3) Identification. Interrupter switches shall have a permanent and legible nameplate including the following information: manufacturer's type or designation, continuous current rating, interrupting current rating, fault closing rating, maximum voltage rating.

(4) Switching of Conductors. The switching mechanism shall be arranged to be operated from a location where the operator is not exposed to energized parts and shall be arranged to open all ungrounded conductors of the circuit simultaneously with one operation. Switches shall be arranged to be locked in the open position. Metal-enclosed switches shall be operable from outside the enclosure.

245.26 Feeders and Branch Circuits

(A) Location and Type of Protection. Feeder and branch-circuit conductors shall have overcurrent protection in each ungrounded conductor located at the point where the conductor receives its supply or at an alternative location in the circuit when designed under engineering supervision that includes but is not limited to considering the appropriate fault studies and time–current coordination analysis of the protective devices and the conductor damage curves. The overcurrent protection shall be permitted to be provided by either 245.26(A)(1) or (A)(2).

(1) Overcurrent Relays and Current Transformers. Circuit breakers used for overcurrent protection of 3-phase circuits shall have a minimum of three overcurrent relay elements operated from three current transformers. The separate overcurrent relay elements (or protective functions) shall be permitted to be part of a single electronic protective relay unit.

On 3-phase, 3-wire circuits, an overcurrent relay element in the residual circuit of the current transformers shall be permitted to replace one of the phase relay elements.

An overcurrent relay element, operated from a current transformer that links all phases of a 3-phase, 3-wire circuit, shall be permitted to replace the residual relay element and one of the phase-conductor current transformers. Where the neutral conductor is not regrounded on the load side of the circuit as permitted in 250.184(B), the current transformer shall be permitted to link all 3-phase conductors and the grounded circuit conductor (neutral).

(2) Fuses. A fuse shall be connected in series with each ungrounded conductor.

(B) Protective Devices. The protective device(s) shall be capable of detecting and interrupting all values of current that can occur at their location in excess of their trip-setting or melting point.

(C) Conductor Protection. The operating time of the protective device, the available short-circuit current, and the conductor used shall be coordinated to prevent damaging or dangerous temperatures in conductors or conductor insulation under short-circuit conditions.

245.27 Additional Requirements for Feeders.

(A) Rating or Setting of Overcurrent Protective Devices. The continuous ampere rating of a fuse shall not exceed three times the ampacity of the conductors. The long-time trip element setting of a breaker or the minimum trip setting of an electronically actuated fuse shall not exceed six times the ampacity of the conductor. For fire pumps, conductors shall be permitted to be protected for overcurrent in accordance with 695.4(B)(2).

(B) Feeder Taps. Conductors tapped to a feeder shall be permitted to be protected by the feeder overcurrent device where that overcurrent device also protects the tap conductor.

Part III. Overvoltage Protection

245.40 Other Articles. Equipment shall be protected against overvoltage in accordance with the article in this Code that covers the type of equipment or location specified in Table 245.40.

Table 245.40 Other Articles

Equipment	**Article**
Equipment over 1000 volts, nominal	495
Outdoor overhead conductors over 1000 volts	399

245.41 Uses Not Permitted. A surge arrester shall not be installed where the rating of the surge arrester is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application.

245.42 Surge Arrester Selection. The surge arresters shall comply with 245.42(A) and (B).

(A) Rating. The rating of a surge arrester shall be equal to or greater than the maximum continuous operating voltage available at the point of application.

(1) Solidly Grounded Systems. The maximum continuous operating voltage shall be the phase-to-ground voltage of the system.

(2) Impedance or Ungrounded System. The maximum continuous operating voltage shall be the phase-to-phase voltage of the system.

(B) Silicon Carbide Types. The rating of a silicon carbide-type surge arrester shall be not less than 125 percent of the rating specified in 245.42(A).

Informational Note No. 1: For further information on surge arresters, see IEEE C62.11-2012, *Standard for Metal-Oxide Surge Arresters for Alternating-Current Power Circuits (>1 kV)*, and IEEE C62.22-2009, *Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems*.

Informational Note No. 2: The selection of a properly rated metal oxide arrester is based on considerations of maximum continuous operating voltage and the magnitude and duration of overvoltages at the arrester location as affected by phase-to-ground faults, system grounding techniques, switching surges, and other causes. See the manufacturer's application rules for selection of the specific arrester to be used at a particular location.

245.44 Number Required. Where used at a point on a circuit, a surge arrester shall be connected to each ungrounded conductor. A single installation of such surge arresters shall be permitted to protect a number of interconnected circuits if no circuit is exposed to surges while disconnected from the surge arresters.

245.46 Location. Surge arresters shall be permitted to be located indoors or outdoors. Surge arresters shall be made inaccessible to unqualified persons unless listed for installation in accessible locations.

245.48 Routing of Surge Arrester Equipment Grounding Conductors. The conductor used to connect the surge arrester to line, bus, or equipment and to an equipment grounding conductor or grounding electrode connection point as provided in 245.50 shall not be any longer than necessary and shall avoid unnecessary bends.

245.50 Connection. The arrester shall be connected to one of the following:

1. Grounded service conductor
2. Grounding electrode conductor
3. Grounding electrode for the service
4. Equipment grounding terminal in the service equipment

245.52 Surge-Arrester Conductors. The conductor between the surge arrester and the line, and the surge arrester and the grounding connection, shall not be smaller than 6 AWG copper or aluminum.

245.54 Interconnections. The surge arrester protecting a transformer that supplies a secondary distribution system shall be interconnected as specified in 245.54(A), (B), or (C).

(A) Metal Interconnections. A metal interconnection shall be made to the secondary grounded circuit conductor or the secondary circuit grounding electrode conductor, if, in addition to the direct grounding connection at the surge arrester, the connection complies with 245.54(A)(1) or (A)(2).

(1) Additional Grounding Connection. The grounded conductor of the secondary has a grounding connection elsewhere to a continuous metal underground water piping system. In urban water-pipe areas where there are at least four water-pipe connections on the neutral conductor and not fewer than four such connections in each mile of neutral conductor, the metal interconnection shall be permitted to be made to the secondary neutral conductor with omission of the direct grounding connection at the surge arrester.

(2) Multigrounded Neutral System Connection. The grounded conductor of the secondary system is part of a multigrounded neutral system or static wire of which the primary neutral conductor or static wire has at least four grounding connections in each 1.6 km (1 mile) of line in addition to a grounding connection at each service.

(B) Through Spark Gap or Device. Where the surge arrester grounding electrode conductor is not connected as in 245.54(A), or where the secondary is not grounded as in 245.54(A) but is otherwise grounded as in 250.52, an interconnection shall be made through a spark gap or listed device as required by 245.54(B)(1) or (B)(2).

(1) Ungrounded or Unigrounded Primary System. For ungrounded or unigrounded primary systems, the spark gap for a listed device shall have a 60-Hz breakdown voltage of at least twice the primary circuit voltage but not necessarily more than 10 kV, and there shall be at least one other ground on the grounded conductor of the secondary that is not less than 6.0 m (20 ft) distant from the surge-arrester grounding electrode.

(2) Multigrounded Neutral Primary System. For multigrounded neutral primary systems, the spark gap or listed device shall have a 60-Hz breakdown of not more than 3 kV, and there shall be at least one other ground on the grounded conductor of the secondary that is not less than 6.0 m (20 ft) distant from the surge-arrester grounding electrode.

(C) By Special Permission. An interconnection of the surge-arrester ground and the secondary neutral conductor, other than as provided in 245.54(A) or (B), shall be permitted to be made only by special permission.

245.56 Grounding Electrode Conductor Connections and Enclosures. Except as indicated in this article, surge-arrester grounding electrode conductor connections shall be made as specified in Article 250, Parts III and X. Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).

Revisions to Chapter 4

ARTICLE 430 Motors, Motor Circuits, and Controllers

(Only deleted / relocated text of Article 430 shown) (-relocated to Article 495 Part VI)

~~**Part XI. Over 1000 Volts, Nominal**~~

~~**430.221 General.** Part XI recognizes the additional hazard due to the use of higher voltages. It adds to or amends the other provisions of this article.~~

~~**430.222 Marking on Controllers.** In addition to the marking required by 430.8, a controller shall be marked with the control voltage.~~

~~**430.223 Raceway Connection to Motors.** Flexible metal conduit or liquidtight flexible metal conduit not exceeding 1.8 m (6 ft) in length shall be permitted to be employed for raceway connection to a motor terminal enclosure.~~

~~**430.224 Size of Conductors.** Conductors supplying motors shall have an ampacity not less than the current at which the motor overload protective device(s) is selected to trip.~~

~~**430.225 Motor-Circuit Overcurrent Protection.**~~

~~**(A) General.** Each motor circuit shall include coordinated protection to automatically interrupt overload and fault currents in the motor, the motor-circuit conductors, and the motor control apparatus.~~
~~*Exception: Where a motor is critical to an operation and the motor should operate to failure if necessary to prevent a greater hazard to persons, the sensing device(s) shall be permitted to be connected to a supervised annunciator or alarm instead of interrupting the motor circuit.*~~

~~**(B) Overload Protection.**~~

~~**(1) Type of Overload Device.** Each motor shall be protected against dangerous heating due to motor overloads and failure to start by a thermal protector integral with the motor or external current-sensing devices, or both. Protective device settings for each motor circuit shall be determined under engineering supervision.~~

~~**(2) Wound-Rotor Alternating-Current Motors.** The secondary circuits of wound-rotor ac motors, including conductors, controllers, and resistors rated for the application, shall be considered as protected against overcurrent by the motor overload protection means.~~

~~**(3) Operation.** Operation of the overload interrupting device shall simultaneously disconnect all ungrounded conductors.~~

~~**(4) Automatic Reset.** Overload sensing devices shall not automatically reset after trip unless resetting of the overload sensing device does not cause automatic restarting of the motor or there is no hazard to persons created by automatic restarting of the motor and its connected machinery.~~

~~**(C) Fault-Current Protection.**~~

~~**(1) Type of Protection.** Fault-current protection shall be provided in each motor circuit as specified by either 430.225(C)(1)(a) or (C)(1)(b).~~

> ~~(a) A circuit breaker of suitable type and rating arranged so that it can be serviced without hazard. The circuit breaker shall simultaneously disconnect all ungrounded conductors. The circuit breaker shall be permitted to sense the fault current by means of integral or external sensing elements.~~

~~(b) Fuses of a suitable type and rating placed in each ungrounded conductor. Fuses shall be used with suitable disconnecting means, or they shall be of a type that can also serve as the disconnecting means. They shall be arranged so that they cannot be serviced while they are energized.~~

~~**(2) Reclosing.** Fault-current interrupting devices shall not automatically reclose the circuit.~~
~~*Exception: Automatic reclosing of a circuit shall be permitted where the circuit is exposed to transient faults and where such automatic reclosing does not create a hazard to persons.*~~

~~**(3) Combination Protection.** Overload protection and fault-current protection shall be permitted to be provided by the same device.~~

~~**430.226 Rating of Motor Control Apparatus.** The ultimate trip current of overcurrent (overload) relays or other motor-protective devices used shall not exceed 115 percent of the controller's continuous current rating. Where the motor branch-circuit disconnecting means is separate from the controller, the disconnecting means current rating shall not be less than the ultimate trip setting of the overcurrent relays in the circuit.~~

~~**430.227 Disconnecting Means.** The controller disconnecting means shall be lockable in accordance with 110.25.~~

Table 430.249 Full-Load Current, Two-Phase Alternating-Current Motors (4-Wire)
The following values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Current in the common conductor of a 2-phase, 3-wire system will be 1.41 times the value given. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

	Induction-Type Squirrel Cage and Wound Rotor (Amperes)				
Horsepower	**115 Volts**	**230 Volts**	**460 Volts**	**575 Volts**	~~**2300 Volts**~~
1⁄2	4.0	2.0	1.0	0.8	—
3⁄4	4.8	2.4	1.2	1.0	—
1	6.4	3.2	1.6	1.3	—
1 1⁄2	9.0	4.5	2.3	1.8	—
2	11.8	5.9	3.0	2.4	—
3	—	8.3	4.2	3.3	—
5	—	13.2	6.6	5.3	—
7 1⁄2	—	19	9.0	8.0	—

Table 430.249 Full-Load Current, Two-Phase Alternating-Current Motors (4-Wire)
The following values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Current in the common conductor of a 2-phase, 3-wire system will be 1.41 times the value given. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

	Induction-Type Squirrel Cage and Wound Rotor (Amperes)				
Horsepower	**115 Volts**	**230 Volts**	**460 Volts**	**575 Volts**	~~**2300 Volts**~~
10	—	24	12	10	—
15	—	36	18	14	—
20	—	47	23	19	—
25	—	59	29	24	—
30	—	69	35	28	—
40	—	90	45	36	—
50	—	113	56	45	—
60	—	133	67	53	~~14~~
75	—	166	83	66	~~18~~
100	—	218	109	87	~~23~~
125	—	270	135	108	~~28~~
150	—	312	156	125	~~32~~
200	—	416	208	167	~~43~~

Table 430.250 Full-Load Current, Three-Phase Alternating-Current Motors
The following values of full-load currents are typical for motors running at speeds usual for belted motors and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

	Induction-Type Squirrel Cage and Wound Rotor (Amperes)							Synchronous-Type Unity Power Factor* (Amperes)			
Horsepo wer	115 V olts	200 V olts	208 V olts	230 V olts	460 V olts	575 V olts	~~2300 V olts~~	230 V olts	460 V olts	575 V olts	~~2300 V olts~~
1/2	4.4	2.5	2.4	2.2	1.1	0.9	—	—	—	—	—
3/4	6.4	3.7	3.5	3.2	1.6	1.3	—	—	—	—	—
1	8.4	4.8	4.6	4.2	2.1	1.7	—	—	—	—	—
1 1/2	12.0	6.9	6.6	6.0	3.0	2.4	—	—	—	—	—
2	13.6	7.8	7.5	6.8	3.4	2.7	—	—	—	—	—
3	—	11.0	10.6	9.6	4.8	3.9	—	—	—	—	—
5	—	17.5	16.7	15.2	7.6	6.1	—	—	—	—	—
7 1/2	—	25.3	24.2	22	11	9	—	—	—	—	—
10	—	32.2	30.8	28	14	11	—	—	—	—	—
15	—	48.3	46.2	42	21	17	—	—	—	—	—
20	—	62.1	59.4	54	27	22	—	—	—	—	—
25	—	78.2	74.8	68	34	27	—	53	26	21	—
30	—	92	88	80	40	32	—	63	32	26	—
40	—	120	114	104	52	41	—	83	41	33	—
50	—	150	143	130	65	52	—	104	52	42	—

Table 430.250 Full-Load Current, Three-Phase Alternating-Current Motors
The following values of full-load currents are typical for motors running at speeds usual for belted motors and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

	Induction-Type Squirrel Cage and Wound Rotor (Amperes)							Synchronous-Type Unity Power Factor* (Amperes)			
Horsepo wer	115 V olts	200 V olts	208 V olts	230 V olts	460 V olts	575 V olts	~~2300 V olts~~	230 V olts	460 V olts	575 V olts	~~2300 V olts~~
60	—	177	169	154	77	62	16	123	61	49	~~12~~
75	—	221	211	192	96	77	20	155	78	62	~~15~~
100	—	285	273	248	124	99	26	202	101	81	~~20~~
125	—	359	343	312	156	125	31	253	126	101	~~25~~
150	—	414	396	360	180	144	37	302	151	121	~~30~~
200		552	528	480	240	192	49	400	201	161	~~40~~
250	—	—	—	—	302	242	60	—	—	—	—
300	—	—	—	—	361	289	72	—	—	—	—
350	—	—	—	—	414	336	83	—	—	—	—
400	—	—	—	—	477	382	95	—	—	—	—
450	—	—	—	—	515	412	103	—	—	—	—
500	—	—	—	—	590	472	118	—	—	—	—

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

ARTICLE 450 Transformers ~~and Transformer Vaults~~ (Including Secondary Ties)

(450 part III Vaults -deleted / relocated)(relocated to Article 495 Parts VII and VIII)(450.21(c) edit also)

Part I. General Provisions

450.1 Scope. This article covers the installation of all transformers.

> Informational Note: Article 495 includes additional requirements for transformers rated over 1000 volts ac, 1500 volts dc, nominal on either or both the primary or the secondary.

Exception No. 1: Current transformers.

Exception No. 2: Dry-type transformers that constitute a component part of other apparatus and comply with the requirements for such apparatus.

Exception No. 3: Transformers that are an integral part of an X-ray, high-frequency, or electrostatic-coating apparatus.

Exception No. 4: Transformers used with Class 2 and Class 3 circuits that comply with Article 725.

Exception No. 5: Transformers for sign and outline lighting that comply with Article 600.

Exception No. 6: Transformers for electric-discharge lighting that comply with Article 410.

Exception No. 7: Transformers used for power-limited fire alarm circuits that comply with Part III of Article 760.

Exception No. 8: Transformers used for research, development, or testing, where effective arrangements are provided to safeguard persons from contacting energized parts.

This article covers the installation of transformers dedicated to supplying power to a fire pump installation as modified by Article 695.

This article also covers the installation of transformers in hazardous (classified) locations as modified by Articles 501 through 504.

450.2 Definition.
The definitions in this section shall apply only within this article.

Transformer.
An individual transformer, single- or polyphase, identified by a single nameplate, unless otherwise indicated in this article.

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

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

Informational Note No. 2: Nonlinear loads can increase heat in a transformer without operating its overcurrent protective device.

(A) Transformers Over 1000 Volts, Nominal. Overcurrent protection shall be provided in accordance with Table 495.103.

(B) Transformers 1000 Volts, Nominal, or Less. Overcurrent protection shall be provided in accordance with Table 450.3(~~B)~~.

Exception: Where the transformer is installed as a motor control circuit transformer in accordance with 430.72(C)(1) through (C)(5).

~~Table 450.3(A) Maximum Rating or Setting of Overcurrent Protection for Transformers Over 1000 Volts (as a Percentage of Transformer-Rated Current)~~

		~~Primary Protection over 1000 Volts~~		~~Secondary Protection (See Note 2.)~~		
				~~Over 1000 Volts~~		~~1000 Volts or Less~~
~~Location Limitations~~	~~Transformer Rated Impedance~~	~~Circuit Breaker (See Note 4.)~~	~~Fuse Rating~~	~~Circuit Breaker (See Note 4.)~~	~~Fuse Rating~~	~~Circuit Breaker or Fuse Rating~~
~~Any location~~	~~Not more than 6%~~	~~600% (See Note 1.)~~	~~300% (See Note 1.)~~	~~300% (See Note 1.)~~	~~250% (See Note 1.)~~	~~125% (See Note 1.)~~
	~~More than 6% and not more than 10%~~	~~400% (See Note 1.)~~	~~300% (See Note 1.)~~	~~250% (See Note 1.)~~	~~225% (See Note 1.)~~	~~125% (See Note 1.)~~
~~Supervised locations only (See Note 3.)~~	~~Any~~	~~300% (See Note 1.)~~	~~250% (See Note 1.)~~	~~Not required~~	~~Not required~~	~~Not required~~
	~~Not more than 6%~~	~~600%~~	~~300%~~	~~300% (See Note 5.)~~	~~250% (See Note 5.)~~	~~250% (See Note 5.)~~
	~~More than 6% and not more than 10%~~	~~400%~~	~~300%~~	~~250% (See Note 5.)~~	~~225% (See Note 5.)~~	~~250% (See Note 5.)~~

~~Notes:~~

~~1. Where the required fuse rating or circuit breaker setting does not correspond to a standard rating or setting, a higher rating or setting that does not exceed the following shall be permitted:~~

~~a. The next higher standard rating or setting for fuses and circuit breakers 1000 volts and below, or~~

~~b. The next higher commercially available rating or setting for fuses and circuit breakers above 1000 volts.~~

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

~~3. A supervised location is a location where conditions of maintenance and supervision ensure that only qualified persons monitor and service the transformer installation.~~

~~4. Electronically actuated fuses that may be set to open at a specific current shall be set in accordance with settings for circuit breakers.~~

~~5. A transformer equipped with a coordinated thermal overload protection by the manufacturer shall be permitted to have separate secondary protection omitted.~~

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

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

Notes:

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

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

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

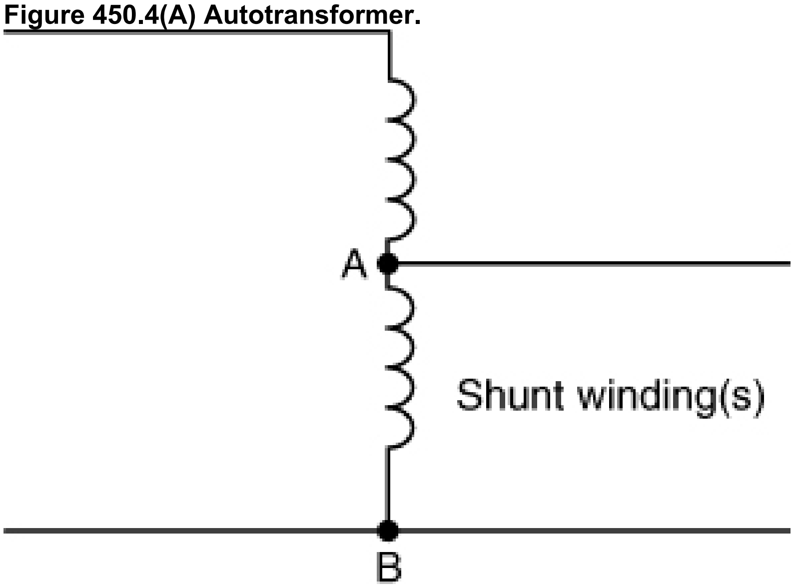
(C) Voltage (Potential) Transformers. Voltage (potential) transformers installed indoors or enclosed shall be protected with primary fuses.

Informational Note: For protection of instrument circuits including voltage transformers, see 408.52.

450.4 Autotransformers 1000 Volts, Nominal, or Less.

(A) Overcurrent Protection. Each autotransformer 1000 volts, nominal, or less shall be protected by an individual overcurrent device installed in series with each ungrounded input conductor. Such overcurrent device shall be rated or set at not more than 125 percent of the rated full-load input current of the autotransformer. Where this calculation does not correspond to a standard rating of a fuse or nonadjustable circuit breaker and the rated input current is 9 amperes or more, the next higher standard rating described in 240.6 shall be permitted. An overcurrent device shall not be installed in series with the shunt winding (the winding common to both the input and the output circuits) of the autotransformer between Points A and B as shown in Figure 450.4(A).

Figure 450.4(A) Autotransformer.



Exception: Where the rated input current of the autotransformer is less than 9 amperes, an overcurrent device rated or set at not more than 167 percent of the input current shall be permitted.

(B) Transformer Field-Connected as an Autotransformer. A transformer field-connected as an autotransformer shall be identified for use at elevated voltage.

Informational Note: For information on permitted uses of autotransformers, see 210.9 and 215.11.

450.5 Grounding Autotransformers. Grounding autotransformers covered in this section are zigzag or T-connected transformers connected to 3-phase, 3-wire ungrounded systems for the purpose of creating a 3-phase, 4-wire distribution system or providing a neutral point for grounding purposes. Such transformers shall have a continuous per-phase current rating and a continuous neutral current rating. Zigzag-connected transformers shall not

be installed on the load side of any system grounding connection, including those made in accordance with 250.24(B), 250.30(A)(1), or 250.32(B), Exception No. 1.
Informational Note: The phase current in a grounding autotransformer is one-third the neutral current.

(A) Three-Phase, 4-Wire System. A grounding autotransformer used to create a 3-phase, 4-wire distribution system from a 3-phase, 3-wire ungrounded system shall conform to 450.5(A)(1)through (A)(4).

(1) Connections. The transformer shall be directly connected to the ungrounded phase conductors and shall not be switched or provided with overcurrent protection that is independent of the main switch and common-trip overcurrent protection for the 3-phase, 4-wire system.

(2) Overcurrent Protection. An overcurrent sensing device shall be provided that will cause the main switch or common-trip overcurrent protection referred to in 450.5(A)(1) to open if the load on the autotransformer reaches or exceeds 125 percent of its continuous current per-phase or neutral rating. Delayed tripping for temporary overcurrents sensed at the autotransformer overcurrent device shall be permitted for the purpose of allowing proper operation of branch or feeder protective devices on the 4-wire system.

(3) Transformer Fault Sensing. A fault-sensing system that causes the opening of a main switch or common-trip overcurrent device for the 3-phase, 4-wire system shall be provided to guard against single-phasing or internal faults.

Informational Note: This can be accomplished by the use of two subtractive-connected donut-type current transformers installed to sense and signal when an unbalance occurs in the line current to the autotransformer of 50 percent or more of rated current.

(4) Rating. The autotransformer shall have a continuous neutral-current rating that is not less than the maximum possible neutral unbalanced load current of the 4-wire system.

(B) Ground Reference for Fault Protection Devices. A grounding autotransformer used to make available a specified magnitude of ground-fault current for operation of a ground-responsive protective device on a 3-phase, 3-wire ungrounded system shall conform to 450.5(B)(1) and (B)(2).

(1) Rating. The autotransformer shall have a continuous neutral-current rating not less than the specified ground-fault current.

(2) Overcurrent Protection. Overcurrent protection shall comply with 450.5(B)(2)(a) and (B)(2)(b).

(a) *Operation and Interrupting Rating.* An overcurrent protective device having an interrupting rating in compliance with 110.9 and that will open simultaneously all ungrounded conductors when it operates shall be applied in the grounding autotransformer branch circuit.

(b) *Ampere Rating.* The overcurrent protection shall be rated or set at a current not exceeding 125 percent of the autotransformer continuous per-phase current rating or 42 percent of the continuous-current rating of any series-connected devices in the autotransformer neutral connection. Delayed tripping for temporary overcurrents to permit the proper operation of ground-responsive tripping devices on the main system shall be permitted but shall not exceed values that would be more than the short-time current rating of the grounding autotransformer or any series connected devices in the neutral connection thereto.

Exception: For high-impedance grounded systems covered in 250.36, where the maximum ground-fault current is designed to be not more than 10 amperes, and where the grounding autotransformer and the grounding impedance are rated for continuous duty, an overcurrent device rated not more than 20 amperes that will simultaneously open all ungrounded conductors shall be permitted to be installed on the line side of the grounding autotransformer.

(C) Ground Reference for Damping Transitory Overvoltages. A grounding autotransformer used to limit transitory overvoltages shall be of suitable rating and connected in accordance with 450.5(A)(1).

450.6 Secondary Ties. As used in this article, a secondary tie is a circuit operating at 1000 volts, nominal, or less between phases that connects two power sources or power supply points, such as the secondaries of two transformers. The tie shall be permitted to consist of one or more conductors per phase or neutral. Conductors connecting the secondaries of transformers in accordance with 450.7 shall not be considered secondary ties. As used in this section, the word *transformer* means a transformer or a bank of transformers operating as a unit.

(A) Tie Circuits. Tie circuits shall be provided with overcurrent protection at each end as required in Parts I, II, and VIII of Article 240.

Under the conditions described in 450.6(A)(1) and 450.6(A)(2), the overcurrent protection shall be permitted to be in accordance with 450.6(A)(3).

(1) Loads at Transformer Supply Points Only. Where all loads are connected at the transformer supply points at each end of the tie and overcurrent protection is not provided in accordance with Parts I, II, and VIII of Article 240, the ampacity of the tie shall not be less than 67 percent of the rated secondary current of the highest rated transformer supplying the secondary tie system.

(2) Loads Connected Between Transformer Supply Points. Where load is connected to the tie at any point between transformer supply points and overcurrent protection is not provided in accordance with Parts I, II, and VIII of Article 240, the ampacity of the tie shall not be less than 100 percent of the rated secondary current of the highest rated transformer supplying the secondary tie system.

Exception: Tie circuits comprised of multiple conductors per phase shall be permitted to be sized and protected in accordance with 450.6(A)(4).

(3) Tie Circuit Protection. Under the conditions described in 450.6(A)(1) and (A)(2), both supply ends of each ungrounded tie conductor shall be equipped with a protective device that opens at a predetermined temperature of the tie conductor under short-circuit conditions. This protection shall consist of one of the following: (1) a fusible link cable connector, terminal, or lug, commonly known as a limiter, each being of a size corresponding with that of the conductor and of construction and characteristics according to the operating voltage and the type of insulation on the tie conductors or (2) automatic circuit breakers actuated by devices having comparable time–current characteristics.

(4) Interconnection of Phase Conductors Between Transformer Supply Points. Where the tie consists of more than one conductor per phase or neutral, the conductors of each phase or neutral shall comply with 450.6(A)(4)(a) or (A)(4)(b).

(a) *Interconnected.* The conductors shall be interconnected in order to establish a load supply point, and the protective device specified in 450.6(A)(3) shall be provided in each ungrounded tie conductor at this point on both sides of the interconnection. The means of interconnection shall have an ampacity not less than the load to be served.

(b) *Not Interconnected.* The loads shall be connected to one or more individual conductors of a paralleled conductor tie without interconnecting the conductors of each phase or neutral and without the protection specified in 450.6(A)(3) at load connection points. Where this is done, the tie conductors of each phase or neutral shall have a combined capacity ampacity of not less than 133 percent of the rated secondary current of the highest rated transformer supplying the secondary tie system, the total load of such taps shall not exceed the rated secondary current of the highest rated transformer, and the loads shall be equally divided on each phase and on the individual conductors of each phase as far as practicable.

(5) Tie Circuit Control. Where the operating voltage exceeds 150 volts to ground, secondary ties provided with limiters shall have a switch at each end that, when open, de-energizes the associated tie conductors and limiters. The current rating of the switch shall not be less than the rated current ampacity of the conductors connected to the switch. It shall be capable of interrupting its rated current, and it shall be constructed so that it will not open under the magnetic forces resulting from short-circuit current.

(B) Overcurrent Protection for Secondary Connections. Where secondary ties are used, an overcurrent device rated or set at not more than 250 percent of the rated secondary current of the transformers shall be provided in the secondary connections of each transformer supplying the tie system. In addition, an automatic circuit breaker actuated by a reverse-current relay set to open the circuit at not more than the rated secondary current of the transformer shall be provided in the secondary connection of each transformer.

(C) Grounding. Where the secondary tie system is grounded, each transformer secondary supplying the tie system shall be grounded in accordance with the requirements of 250.30 for separately derived systems.

450.7 Parallel Operation. Transformers shall be permitted to be operated in parallel and switched as a unit, provided the overcurrent protection for each transformer meets the requirements of 495.103~~450.3(A)~~ for primary and secondary protective devices over 1000 volts, or 450.3(B) for primary and secondary protective devices 1000 volts or less.

450.8 Guarding. Transformers shall be guarded as specified in 450.8(A) through (D).

(A) Mechanical Protection. Appropriate provisions shall be made to minimize the possibility of damage to transformers from external causes where the transformers are exposed to physical damage.

(B) Case or Enclosure. Dry-type transformers shall be provided with a noncombustible moisture-resistant case or enclosure that provides protection against the accidental insertion of foreign objects.

(C) Exposed Energized Parts. Switches or other equipment operating at 1000 volts, nominal, or less and serving only equipment within a transformer enclosure shall be permitted to be installed in the transformer enclosure if accessible to qualified persons only. All energized parts shall be guarded in accordance with 110.27. ~~and 110.34.~~

(D) Voltage Warning. The operating voltage of exposed live parts of transformer installations shall be indicated by signs or visible markings on the equipment or structures.

450.9 Ventilation. The ventilation shall dispose of the transformer full-load heat losses without creating a temperature rise that is in excess of the transformer rating.

Informational Note No. 1: See IEEE C57.12.00-2015, *General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers*, and IEEE C57.12.01-2015, *General Requirements for Dry-Type Distribution and Power Transformers*.

Informational Note No. 2: Additional losses occur in some transformers where nonsinusoidal currents are present, resulting in increased heat in the transformer above its rating. See IEEE C57.110-2008, *Recommended Practice for Establishing Liquid-Filled and Dry-Type Power and Distribution Transformer Capability When Supplying Nonsinusoidal Load Currents*, where transformers are utilized with nonlinear loads.

Transformers with ventilating openings shall be installed so that the ventilating openings are not blocked by walls or other obstructions. The required clearances shall be clearly marked on the transformer. Transformer top surfaces that are horizontal and readily accessible shall be marked to prohibit storage.

450.10 Grounding.

(A) Dry-Type Transformer Enclosures. Where separate equipment grounding conductors and supply-side bonding jumpers are installed, a terminal bar for all grounding and bonding conductor connections shall be secured inside the transformer enclosure. The terminal bar shall be bonded to the enclosure in accordance with 250.12 and shall not be installed on or over any vented portion of the enclosure.

Exception: Where a dry-type transformer is equipped with wire-type connections (leads), the grounding and bonding connections shall be permitted to be connected together using any of the methods in 250.8 and shall be bonded to the enclosure if of metal.

(B) Other Metal Parts. Exposed non–current-carrying metal parts of transformer installations, including fences, guards, and so forth, shall be grounded and bonded under the conditions and in the manner specified for electrical equipment and other exposed metal parts in Parts V, VI, and VII of Article 250.

450.11 Marking.

(A) General. Each transformer shall be provided with a nameplate giving the following information:

(1) Name of manufacturer

(2) Rated kilovolt-amperes

(3) Frequency

(4) Primary and secondary voltage

(5) Impedance of transformers 25 kVA and larger

(6) Required clearances for transformers with ventilating openings

(7) Amount and kind of insulating liquid where used

(8) For dry-type transformers, temperature class for the insulation system

(B) Source Marking. A transformer shall be permitted to be supplied at the marked secondary voltage, provided that the installation is in accordance with the manufacturer's instructions.

450.12 Terminal Wiring Space. The minimum wire-bending space at fixed, 1000-volt and below terminals of transformer line and load connections shall be as required in 312.6. Wiring space for pigtail connections shall conform to Table 314.16(B).

450.13 Accessibility. All transformers ~~and transformer vaults~~ shall be readily accessible to qualified personnel for inspection and maintenance or shall meet the requirements of 450.13(A) or 450.13(B).

(A) Open Installations. Dry-type transformers 1000 volts, nominal, or less, located in the open on walls, columns, or structures, shall not be required to be readily accessible.

(B) Hollow Space Installations. Dry-type transformers 1000 volts, nominal, or less and not exceeding 50 kVA shall be permitted in hollow spaces of buildings not permanently closed in by structure, provided they meet the ventilation requirements of 450.9 and separation from combustible materials requirements of 450.21(A). Transformers so installed shall not be required to be readily accessible.

450.14 Disconnecting Means. Transformers, other than Class 2 or Class 3 transformers, shall have a disconnecting means located either in sight of the transformer or in a remote location. Where located in a remote location, the disconnecting means shall be lockable open in accordance with 110.25, and its location shall be field marked on the transformer.

Part II. Specific Provisions Applicable to Different Types of Transformers

450.21 Dry-Type Transformers Installed Indoors.

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

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

(B) Over 112½ kVA. Individual dry-type transformers of more than 112½ kVA rating shall be installed in a transformer room of fire-resistant construction having a minimum fire rating of 1 hour.

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

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

Informational Note: See ASTM E119-18a, *Standard Test Methods for Fire Tests of Building Construction and Materials*.

(C) Over 35,000 Volts. Dry-type transformers rated over 35,000 volts shall be installed in a vault complying with Part VIII of ~~this~~ article 495.

450.22 Dry-Type Transformers Installed Outdoors. Dry-type transformers installed outdoors shall have a weatherproof enclosure.

Transformers exceeding 112½ kVA shall not be located within 300 mm (12 in.) of combustible materials of buildings unless the transformer has Class 155 insulation systems or higher and is completely enclosed except for ventilating openings.

450.23 ~~Less-Flammable~~ Liquid-Insulated Transformers. Liquid-insulated transformers shall comply with Part VII of article 495. ~~Transformers insulated with listed less-flammable liquids that have a fire point of not less than 300°C shall be permitted to be installed in accordance with 450.23(A) or 450.23(B).~~

450.40 Transformer Vaults. Transformer vaults shall comply with Part VIII of article 495.

~~**(A) Indoor Installations.** Indoor installations shall be permitted in accordance with one of the following:~~
~~(1) In Type I or Type II buildings, in areas where all of the following requirements are met:~~
~~a. The transformer is rated 35,000 volts or less.~~
~~b. No combustible materials are stored.~~
~~c. A liquid confinement area is provided.~~
~~d. The installation complies with all the restrictions provided for in the listing of the liquid.~~
~~Informational Note: Such restrictions can include, but are not limited to, maximum pressure of the tank, use of a pressure relief valve, appropriate fuse types, and proper sizing of overcurrent protection.~~
~~(2) If an automatic fire extinguishing system and a liquid confinement area is present, provided the transformer is rated 35,000 volts or less~~
~~(3) If the installation complies with 450.26~~
~~**(B) Outdoor Installations.** Less-flammable liquid-filled transformers shall be permitted to be installed outdoors, attached to, adjacent to, or on the roof of buildings, if installed in accordance with (1) or (2).~~
~~(1) For Type I and Type II buildings, the installation shall comply with all the restrictions provided for in the listing of the liquid.~~
~~Informational Note No. 1: Installations adjacent to combustible material, fire escapes, or door and window openings can require additional safeguards such as those listed in 450.27.~~
~~Informational Note No. 2: Such restrictions can include, but are not limited to: maximum pressure of the tank, use of a pressure relief valve, appropriate fuse types, and proper sizing of overcurrent protection.~~
~~(2) In accordance with 450.27.~~
~~Informational Note No. 1: As used in this section, *Type I and Type II buildings* refers to Type I and Type II building construction as defined in NFPA 220-2018, *Standard on Types of Building Construction. Combustible materials* refers to those materials not classified as noncombustible or limited-combustible as defined in NFPA 220-2018, *Standard on Types of Building Construction.*~~

~~Informational Note No. 2: See definition of *Listed* in Article 100.~~

~~**450.24 Nonflammable Fluid-Insulated Transformers.** Transformers insulated with a dielectric fluid identified as nonflammable shall be permitted to be installed indoors or outdoors. Such transformers installed indoors and rated over 35,000 volts shall be installed in a vault. Such transformers installed indoors shall be furnished with a liquid confinement area and a pressure-relief vent. The transformers shall be furnished with a means for absorbing any gases generated by arcing inside the tank, or the pressure-relief vent shall be connected to a chimney or flue that will carry such gases to an environmentally safe area.~~

~~Informational Note: Safety may be increased if fire hazard analyses are performed for such transformer installations.~~

~~For the purposes of this section, a nonflammable dielectric fluid is one that does not have a flash point or fire point and is not flammable in air.~~

~~**450.25 Askarel-Insulated Transformers Installed Indoors.**~~ ~~Askarel-insulated transformers installed indoors and rated over 25 kVA shall be furnished with a pressure-relief vent. Where installed in a poorly ventilated place, they shall be furnished with a means for absorbing any gases generated by arcing inside the case, or the pressure-relief vent shall be connected to a chimney or flue that carries such gases outside the building. Askarel-insulated transformers rated over 35,000 volts shall be installed in a vault.~~

~~**450.26 Oil-Insulated Transformers Installed Indoors.**~~ ~~Oil-insulated transformers installed indoors shall be installed in a vault constructed as specified in Part~~ VIII~~III of this article~~ 495~~.~~

~~*Exception No. 1: Where the total capacity does not exceed 112½ kVA, the vault specified in Part*~~ *VIII*~~*III of this articl*~~ *495*~~*e shall be permitted to be constructed of reinforced concrete that is not less than 100 mm (4 in.) thick.*~~

~~*Exception No. 2: Where the nominal voltage does not exceed 1000, a vault shall not be required if suitable arrangements are made to prevent a transformer oil fire from igniting other materials and the total capacity in one location does not exceed 10 kVA in a section of the building classified as combustible or 75 kVA where the surrounding structure is classified as fire-resistant construction.*~~

~~*Exception No. 3: Electric furnace transformers that have a total rating not exceeding 75 kVA shall be permitted to be installed without a vault in a building or room of fire-resistant construction, provided suitable arrangements are made to prevent a transformer oil fire from spreading to other combustible material.*~~

~~*Exception No. 4: A transformer that has a total rating not exceeding 75 kVA and a supply voltage of 1000 volts or less that is an integral part of charged-particle-accelerating equipment shall be permitted to be installed without a vault in a building or room of noncombustible or fire-resistant construction, provided suitable arrangements are made to prevent a transformer oil fire from spreading to other combustible material.*~~

~~*Exception No. 5: Transformers shall be permitted to be installed in a detached building that does not comply with Part III of this article if neither the building nor its contents present a fire hazard to any other building or property, and if the building is used only in supplying electric service and the interior is accessible only to qualified persons.*~~

~~*Exception No. 6: Oil-insulated transformers shall be permitted to be used without a vault in portable and mobile surface mining equipment (such as electric excavators) if each of the following conditions is met:*~~

~~*(1) Provision is made for draining leaking fluid to the ground.*~~

~~*(2) Safe egress is provided for personnel.*~~

~~*(3) A minimum 6-mm (¼-in.) steel barrier is provided for personnel protection.*~~

~~**450.27 Oil-Insulated Transformers Installed Outdoors.**~~ ~~Combustible material, combustible buildings, and parts of buildings, fire escapes, and door and window openings shall be safeguarded from fires originating in oil-insulated transformers installed on roofs, attached to or adjacent to a building or combustible material.~~
~~In cases where the transformer installation presents a fire hazard, one or more of the following safeguards shall be applied according to the degree of hazard involved:~~

~~(1) Space separations~~

~~(2) Fire-resistant barriers~~

~~(3) Automatic fire suppression systems~~

~~(4) Enclosures that confine the oil of a ruptured transformer tank~~

~~Oil enclosures shall be permitted to consist of fire-resistant dikes, curbed areas or basins, or trenches filled with coarse, crushed stone. Oil enclosures shall be provided with trapped drains where the exposure and the quantity of oil involved are such that removal of oil is important.~~

~~Informational Note: For additional information on transformers installed on poles or structures or under ground, see ANSI/IEEE C2-2017, *National Electrical Safety Code*.~~

~~**450.28 Modification of Transformers.** When modifications are made to a transformer in an existing installation that change the type of the transformer with respect to Part II of this article, such transformer shall be marked to show the type of insulating liquid installed, and the modified transformer installation shall comply with the applicable requirements for that type of transformer.~~

~~Part III. Transformer Vaults~~

~~**450.41 Location.** Vaults shall be located where they can be ventilated to the outside air without using flues or ducts wherever such an arrangement is practicable.~~

~~**450.42 Walls, Roofs, and Floors.** The walls and roofs of vaults shall be constructed of materials that have approved structural strength for the conditions with a minimum fire resistance of 3 hours. The floors of vaults in contact with the earth shall be of concrete that is not less than 100 mm (4 in.) thick, but, where the vault is constructed with a vacant space or other stories below it, the floor shall have approved structural strength for the load imposed thereon and a minimum fire resistance of 3 hours. For the purposes of this section, studs and wallboard construction shall not be permitted.~~

~~*Exception: Where transformers are protected with automatic sprinkler, water spray, carbon dioxide, or halon, construction of 1-hour rating shall be permitted.*~~

~~Informational Note No. 1: For additional information, see ASTM E119-18a, *Methods for Fire Tests of Building Construction and Materials*.~~

~~Informational Note No. 2: A typical 3-hour construction is 150 mm (6 in.) thick reinforced concrete.~~

~~**450.43 Doorways.** Vault doorways shall be protected in accordance with 450.43(A), (B), and (C).~~

~~**(A) Type of Door.** Each doorway leading into a vault from the building interior shall be provided with a tight-fitting door that has a minimum fire rating of 3 hours. The authority having jurisdiction shall be permitted to require such a door for an exterior wall opening where conditions warrant.~~

~~*Exception: Where transformers are protected with automatic sprinkler, water spray, carbon dioxide, or halon, construction of 1-hour rating shall be permitted.*~~

~~Informational Note: For additional information, see NFPA 80-2016, *Standard for Fire Doors and Other Opening Protectives*.~~

~~**(B) Sills.** A door sill or curb that is of an approved height that will confine the oil from the largest transformer within the vault shall be provided, and in no case shall the height be less than 100 mm (4 in.).~~

~~**(C) Locks.** Doors shall be equipped with locks, and doors shall be kept locked, with access being allowed only to qualified persons. Personnel doors shall open in the direction of egress and be equipped with listed fire exit hardware.~~

~~**450.45 Ventilation Openings.** Where required by 450.9, openings for ventilation shall be provided in accordance with 450.45(A) through (F).~~

~~**(A) Location.** Ventilation openings shall be located as far as possible from doors, windows, fire escapes, and combustible material.~~

~~**(B) Arrangement.** A vault ventilated by natural circulation of air shall be permitted to have roughly half of the total area of openings required for ventilation in one or more openings near the floor and the remainder in one or more openings in the roof or in the sidewalls near the roof, or all of the area required for ventilation shall be permitted in one or more openings in or near the roof.~~

~~**(C) Size.** For a vault ventilated by natural circulation of air to an outdoor area, the combined net area of all ventilating openings, after deducting the area occupied by screens, gratings, or louvers, shall not be less than 1900 mm² (3 in.²) per kVA of transformer capacity in service, and in no case shall the net area be less than 0.1 m² (1 ft²) for any capacity under 50 kVA.~~

~~**(D) Covering.** Ventilation openings shall be covered with durable gratings, screens, or louvers, according to the treatment required in order to avoid unsafe conditions.~~

~~**(E) Dampers.** All ventilation openings to the indoors shall be provided with automatic closing fire dampers that operate in response to a vault fire. Such dampers shall possess a standard fire rating of not less than 1½ hours.~~
~~Informational Note: See ANSI/UL 555-2016,~~ ~~*Standard for Fire Dampers*.~~

~~**(F) Ducts.** Ventilating ducts shall be constructed of fire-resistant material.~~

~~**450.46 Drainage.** Where practicable, vaults containing more than 100 kVA transformer capacity shall be provided with a drain or other means that will carry off any accumulation of oil or water in the vault unless local conditions make this impracticable. The floor shall be pitched to the drain where provided.~~

~~**450.47 Water Pipes and Accessories.** Any pipe or duct system foreign to the electrical installation shall not enter or pass through a transformer vault. Piping or other facilities provided for vault fire protection, or for transformer cooling, shall not be considered foreign to the electrical installation.~~

~~**450.48 Storage in Vaults.** Materials shall not be stored in transformer vaults.~~

ARTICLE 460 Capacitors

(Part II, Over 1000 Volts deleted / relocated to Article 495 Part IV. "Part I" is deleted as a Part in 460)

460.1 Scope. This article covers the installation of capacitors on electrical circuits operating at 1000 Volts ac, 1500 Volts dc, nominal or less.

Surge capacitors or capacitors included as a component part of other apparatus and conforming with the requirements of such apparatus are excluded from these requirements.

This article also covers the installation of capacitors in hazardous (classified) locations as modified by Articles 501 through 503.

> Informational Note: Article 495 includes requirements for capacitors rated over 1000 volts ac, 1500 volts dc, nominal.

~~**460.2 Definitions.** The definition in this section shall apply only within this article.~~

~~**Safe Zone.** Low probability of damage other than a slight swelling of the capacitor case, as identified by the case rupture curve of the capacitor.~~

460.3 Enclosing and Guarding.

(A) Containing More Than 11 L (3 gal) of Flammable Liquid. Capacitors containing more than 11 L (3 gal) of flammable liquid shall be enclosed in vaults or outdoor fenced enclosures complying with Article 110, Part III. This limit shall apply to any single unit in an installation of capacitors.

(B) Accidental Contact. Where capacitors are accessible to unauthorized and unqualified persons, they shall be enclosed, located, or guarded so that persons cannot come into accidental contact or bring conducting materials into accidental contact with exposed energized parts, terminals, or buses associated with them. However, no additional guarding is required for enclosures accessible only to authorized and qualified persons.

~~**Part I. 1000 Volts, Nominal, and Under**~~

460.6 Discharge of Stored Energy. Capacitors shall be provided with a means of discharging stored energy.

(A) Time of Discharge. The residual voltage of a capacitor shall be reduced to 50 volts, nominal, or less within 1 minute after the capacitor is disconnected from the source of supply.

(B) Means of Discharge. The discharge circuit shall be either permanently connected to the terminals of the capacitor or capacitor bank or provided with automatic means of connecting it to the terminals of the capacitor bank on removal of voltage from the line. Manual means of switching or connecting the discharge circuit shall not be used.

460.8 Conductors.

(A) Ampacity. The ampacity of capacitor circuit conductors shall not be less than 135 percent of the rated current of the capacitor. The ampacity of conductors that connect a capacitor to the terminals of a motor or to motor circuit conductors shall not be less than one-third the ampacity of the motor circuit conductors and in no case less than 135 percent of the rated current of the capacitor.

(B) Overcurrent Protection. An overcurrent device shall be provided in each ungrounded conductor for each capacitor bank. The rating or setting of the overcurrent device shall be as low as practicable.
Exception: A separate overcurrent device shall not be required for a capacitor connected on the load side of a motor overload protective device.

(C) Disconnecting Means. A disconnecting means shall be provided in each ungrounded conductor for each capacitor bank and shall meet the following requirements:

(1) The disconnecting means shall open all ungrounded conductors simultaneously.

(2) The disconnecting means shall be permitted to disconnect the capacitor from the line as a regular operating procedure.

(3) The rating of the disconnecting means shall not be less than 135 percent of the rated current of the capacitor.

Exception: A separate disconnecting means shall not be required where a capacitor is connected on the load side of a motor controller.

460.9 Rating or Setting of Motor Overload Device. Where a motor installation includes a capacitor connected on the load side of the motor overload device, the rating or setting of the motor overload device shall be based on the improved power factor of the motor circuit.

The effect of the capacitor shall be disregarded in determining the motor circuit conductor rating in accordance with 430.22.

460.10 Grounding. Capacitor cases shall be connected to the equipment grounding conductor.

Exception: Capacitor cases shall not be connected to the equipment grounding conductor where the capacitor units are supported on a structure designed to operate at other than ground potential.

460.12 Marking. Each capacitor shall be provided with a nameplate giving the name of the manufacturer, rated voltage, frequency, kilovar or amperes, number of phases, and, if filled with a combustible liquid, the volume of liquid. Where filled with a nonflammable liquid, the nameplate shall so state. The nameplate shall also indicate whether a capacitor has a discharge device inside the case.

~~**Part II. Over 1000 Volts, Nominal**~~

~~**460.24 Switching.**~~

~~**(A) Load Current.** Group-operated switches shall be used for capacitor switching and shall be capable of the following:~~

~~(1) Carrying continuously not less than 135 percent of the rated current of the capacitor installation~~

~~(2) Interrupting the maximum continuous load current of each capacitor, capacitor bank, or capacitor installation that will be switched as a unit~~

~~(3) Withstanding the maximum inrush current, including contributions from adjacent capacitor installations~~

~~(4) Carrying currents due to faults on capacitor side of switch~~

~~**B) Isolation.**~~

~~**(1) General.** A means shall be installed to isolate from all sources of voltage each capacitor, capacitor bank, or capacitor installation that will be removed from service as a unit. The isolating means shall provide a visible gap in the electrical circuit adequate for the operating voltage.~~

~~**(2) Isolating or Disconnecting Switches with No Interrupting Rating.** Isolating or disconnecting switches (with no interrupting rating) shall be interlocked with the load-interrupting device or shall be provided with prominently displayed caution signs in accordance with 490.22 to prevent switching load current.~~

~~**(C) Additional Requirements for Series Capacitors.** The proper switching sequence shall be ensured by use of one of the following:~~

~~(1) Mechanically sequenced isolating and bypass switches~~

~~(2) Interlocks~~

~~(3) Switching procedure prominently displayed at the switching location~~

~~**460.25 Overcurrent Protection.**~~

~~**(A) Provided to Detect and Interrupt Fault Current.** A means shall be provided to detect and interrupt fault current likely to cause dangerous pressure within an individual capacitor.~~

~~**(B) Single Pole or Multipole Devices.** Single-pole or multipole devices shall be permitted for this purpose.~~

~~**(C) Protected Individually or in Groups.** Capacitors shall be permitted to be protected individually or in groups.~~

~~**(D) Protective Devices Rated or Adjusted.** Protective devices for capacitors or capacitor equipment shall be rated or adjusted to operate within the limits of the safe zone for individual capacitors.~~

~~**460.26 Identification.** Each capacitor shall be provided with a permanent nameplate giving the manufacturer's name, rated voltage, frequency, kilovar or amperes, number of phases, and the volume of liquid identified as flammable, if such is the case.~~

~~**460.27 Grounding.** Capacitor cases shall be connected to the equipment grounding conductor. If the capacitor neutral point is connected to a grounding electrode conductor, the connection shall be made in accordance with Part III of Article 250.~~

~~*Exception: Capacitor cases shall not be connected to the equipment grounding conductor where the capacitor units are supported on a structure designed to operate at other than ground potential.*~~

~~**460.28 Means for Discharge.**~~

~~**(A) Means to Reduce the Residual Voltage.** A means shall be provided to reduce the residual voltage of a capacitor to 50 volts or less within 5 minutes after the capacitor is disconnected from the source of supply.~~

~~**(B) Connection to Terminals.** A discharge circuit shall be either permanently connected to the terminals of the capacitor or provided with automatic means of connecting it to the terminals of the capacitor bank after disconnection of the capacitor from the source of supply. The windings of motors, transformers, or other equipment directly connected to capacitors without a switch or overcurrent device interposed shall meet the requirements of 460.28(A).~~

ARTICLE 470 Resistors and Reactors

(Part II, Over 1000 Volts deleted / relocate to Article 495 Part X. Part I is deleted as a part in Article 470)

~~**Part I. 1000 Volts, Nominal, and Under**~~

470.1 Scope. This article covers the installation of separate resistors and reactors on electrical circuits rated no more than 1000 volts ac, 1500 volts dc, nominal.

Exception: Resistors and reactors that are component parts of other apparatus.

This article also covers the installation of resistors and reactors in hazardous (classified) locations as modified by Articles 501 through 504.

> Informational Note: Article 495 includes requirements for resistors and reactors rated over 1000 volts ac, 1500 volts dc, nominal.

470.2 Location. Resistors and reactors shall not be placed where exposed to physical damage.

470.3 Space Separation. A thermal barrier shall be required if the space between the resistors and reactors and any combustible material is less than 305 mm (12 in.).

470.4 Conductor Insulation. Insulated conductors used for connections between resistance elements and controllers shall be suitable for an operating temperature of not less than 90°C (194°F).

Exception: Other conductor insulations shall be permitted for motor starting service.

~~**Part II. Over 1000 Volts, Nominal**~~

~~**470.18 General.**~~

~~**(A) Protected Against Physical Damage.** Resistors and reactors shall be protected against physical damage.~~

~~**(B) Isolated by Enclosure or Elevation.** Resistors and reactors shall be isolated by enclosure or elevation to protect personnel from accidental contact with energized parts.~~

~~**(C) Combustible Materials.** Resistors and reactors shall not be installed in close enough proximity to combustible materials to constitute a fire hazard and shall have a clearance of not less than 305 mm (12 in.) from combustible materials.~~

~~**(D) Clearances.** Clearances from resistors and reactors to grounded surfaces shall be adequate for the voltage involved.~~

~~**(E) Temperature Rise from Induced Circulating Currents.** Metallic enclosures of reactors and adjacent metal parts shall be installed so that the temperature rise from induced circulating currents is not hazardous to personnel or does not constitute a fire hazard.~~

~~**470.19 Grounding.** Resistor and reactor cases or enclosures shall be connected to the equipment grounding conductor.~~

~~*Exception: Resistor or reactor cases or enclosures supported on a structure designed to operate at other than ground potential shall not be connected to the equipment grounding conductor.*~~

~~**470.20 Oil-Filled Reactors.** Installation of oil-filled reactors, in addition to the above requirements, shall comply with applicable requirements of Article~~ 450~~.~~

ARTICLE 49~~5~~0 Equipment Over 1000 Volts AC, 1500 VDC, Nominal

(Article 490 is renumbered Article 495. Changes to 490 shown below, along with additions from other Chapter 4 Articles where MV requirements have been relocated to 495)

Part I. General

49~~5~~0.1 Scope. This article covers the general requirements for equipment operating at more than 1000 volts ac, 1500 volts dc, nominal.

Informational Note No. 1: See *NFPA 70E*-2018, *Standard for Electrical Safety in the Workplace*, for electrical safety requirements for employee workplaces.

Informational Note No. 2: For further information on hazard signs and labels, see ANSI Z535.4-2011, *Product Signs and Safety Labels*.

Informational Note No. 3: For information regarding power distribution apparatus, see IEEE 3001.5-2013, *Recommended Practice for the Application of Power Distribution Apparatus in Industrial and Commercial Power Systems*.

49~~5~~0.2 Definition. The definition in this section shall apply only within this article.

High Voltage. A potential difference of more than 1000 volts, nominal.

Safe Zone. Low probability of damage other than a slight swelling of the capacitor case, as identified by the case rupture curve of the capacitor.

Transformer.
An individual transformer, single- or polyphase, identified by a single nameplate, unless otherwise indicated in this article

49~~5~~0.3 Other Articles. Enclosures in damp or wet locations shall meet the requirements of 312.2.

~~**(A) Oil-Filled Equipment.** Installation of electrical equipment, other than transformers covered in Article 450, containing more than 38 L (10 gal) of flammable oil per unit shall meet the requirements of Parts II and III of Article 450.~~

~~**(AB) Enclosures in Damp or Wet Locations.** Enclosures in damp or wet locations shall meet the requirements of 312.2.~~

495.4 Flexible Cords and Flexible Cable Types.

Flexible cords and flexible cables over 1000 volts shall conform to the description in Table 49500.4. The use of flexible cords and flexible cables other than those in Table 49500.4shall require permission by the authority having jurisdiction.

Table 4~~0~~95~~0~~.4 Flexible Cords and Flexible Cables

Trade Name	Type Letter	Voltage	AWG or kcmil	Number of Conductors	Insulation	AWG or kcmil	Nominal Insulation Thickness		Braid on Each Conductor	Outer Covering	Use
							mm	mils			
Portable power cable	G	2000	12–500	2–6 plus equipment grounding conductor(s)	Thermoset	12–2 1–4/0 250–500	1.52 2.03 2.41	60 80 95		Oil-resistant thermoset	Portable and extra-hard usage
	G-GC[7]	2000	12–500	3–6 plus equipment grounding conductors and 1 ground check conductor	Thermoset	12–2 1–4/0 250–500	1.52 2.03 2.41	60 80 95		Oil-resistant thermoset	
Portable power cable	PPE[7]	2000	12–500	1–6 plus optional equipment grounding conductor(s)	Thermoplastic elastomer	12–2 1–4/0 250–500	1.52 2.03 2.41	60 80 95		Oil-resistant thermo-plastic elastomer	Portable, extra-hard usage
Portable power cable	W[7]	2000	12–500 501–1000	1–6 1	Thermoset	12–2 1–4/0 250–500 501–1000	1.52 2.03 2.41 2.80	60 80 95 110		Oil-resistant thermoset	Portable, extra-hard usage

Notes:
[7]Types G, G-GC, S, SC, SCE, SCT, SE, SEO, SEOO, SEW, SEOW, SEOOW, SO, SOO, SOW, SOOW, ST, STO, STOO, STW, STOW, STOOW, PPE, and W shall be permitted for use on theater stages, in garages, and elsewhere where flexible cords are permitted by this *Code*.

Part II. Equipment — Specific Provisions

~~490.21 Circuit-Interrupting Devices.~~
~~490.21(A) Circuit Breakers.~~
~~490.21(A)(1) Location.~~

~~(a) Circuit breakers installed indoors shall be mounted either in metal-enclosed units or fire-resistant cell-mounted units, or they shall be permitted to be open-mounted in locations accessible to qualified persons only.~~

~~(b) Circuit breakers used to control oil-filled transformers in a vault shall either be located outside the transformer vault or be capable of operation from outside the vault.~~

~~(c) Oil circuit breakers shall be arranged or located so that adjacent readily combustible structures or materials are safeguarded in an approved manner.~~

~~490.21(A)(2) Operating Characteristics.~~
~~Circuit breakers shall have the following equipment or operating characteristics:~~

~~(1 An accessible mechanical or other identified means for manual tripping, independent of control power~~

~~(2) Be release free (trip free)~~

~~(3) If capable of being opened or closed manually while energized, main contacts that operate independently of the speed of the manual operation~~

~~(4) A mechanical position indicator at the circuit breaker to show the open or closed position of the main contacts~~

~~(5) A means of indicating the open and closed position of the breaker at the point(s) from which they may be operated~~

~~490.21(A)(3) Nameplate.~~
~~A circuit breaker shall have a permanent and legible nameplate showing manufacturer's name or trademark, manufacturer's type or identification number, continuous current rating, interrupting rating in megavolt-amperes (MVA) or amperes, and maximum voltage rating. Modification of a circuit breaker affecting its rating(s) shall be accompanied by an appropriate change of nameplate information.~~

~~490.21(A)(4) Rating.~~
~~Circuit breakers shall have the following ratings:~~

~~(1)The continuous current rating of a circuit breaker shall not be less than the maximum continuous current through the circuit breaker.~~

~~(2) The interrupting rating of a circuit breaker shall not be less than the available fault current the circuit breaker will be required to interrupt, including contributions from all connected sources of energy.\~~

~~(3) The closing rating of a circuit breaker shall not be less than the maximum asymmetrical fault current into which the circuit breaker can be closed.~~

~~(4) The momentary rating of a circuit breaker shall not be less than the maximum asymmetrical fault current at the point of installation.~~

~~(5) The rated maximum voltage of a circuit breaker shall not be less than the maximum circuit voltage.~~

~~490.21(A)(5) Retrofit Trip Units.~~

~~Retrofit trip units shall be listed for use with the specific circuit breaker with which it is installed.~~

~~490.21(B) Power Fuses and Fuseholders.~~

~~490.21(B)(1) Use.~~

~~Where fuses are used to protect conductors and equipment, a fuse shall be placed in each ungrounded conductor. Two power fuses shall be permitted to be used in parallel to protect the same load if both fuses have identical ratings and both fuses are installed in an identified common mounting with electrical connections that divide the current equally. Power fuses of the vented type shall not be used indoors, underground, or in metal enclosures unless identified for the use.~~

~~490.21(B)(2) Interrupting Rating.~~

~~The interrupting rating of power fuses shall not be less than the available fault current the fuse is required to interrupt, including contributions from all connected sources of energy.~~

~~490.21(B)(3) Voltage Rating.~~

~~The maximum voltage rating of power fuses shall not be less than the maximum circuit voltage. Fuses having a minimum recommended operating voltage shall not be applied below this voltage.~~

~~490.21(B)(4) Identification of Fuse Mountings and Fuse Units.~~

~~Fuse mountings and fuse units shall have permanent and legible nameplates showing the manufacturer's type or designation, continuous current rating, interrupting current rating, and maximum voltage rating.~~

~~490.21(B)(5) Fuses.~~

~~Fuses that expel flame in opening the circuit shall be designed or arranged so that they function properly without hazard to persons or property.~~

~~490.21(B)(6) Fuseholders.~~

~~Fuseholders shall be designed or installed so that they are de-energized while a fuse is being replaced. A field-applied permanent and legible sign, in accordance with 110.21(B), shall be installed immediately adjacent to the fuseholders and shall be worded as follows:~~

~~DANGER — DISCONNECT CIRCUIT BEFORE REPLACING FUSES.~~

~~Exception: Fuses and fuseholders designed to permit fuse replacement by qualified persons using identified equipment without de-energizing the fuseholder shall be permitted.~~

~~490.21(B)(7) High-Voltage Fuses.~~

~~Switchgear and substations that utilize high-voltage fuses shall be provided with a gang-operated disconnecting switch. Isolation of the fuses from the circuit shall be provided by either connecting a switch between the source and the fuses or providing roll-out switch and fuse-type construction. The switch shall be of the load-interrupter type, unless mechanically or electrically interlocked with a load-interrupting device arranged to reduce the load to the interrupting capability of the switch.~~

~~Exception: More than one switch shall be permitted as the disconnecting means for one set of fuses where the switches are installed to provide connection to more than one set of supply conductors. The switches shall be mechanically or electrically interlocked to permit access to the fuses only when all switches are open. A conspicuous sign shall be placed at the fuses identifying the presence of more than one source.~~

~~490.21(C) Distribution Cutouts and Fuse Links — Expulsion Type.~~

~~490.21(C)(1) Installation.~~

~~Cutouts shall be located so that they may be readily and safely operated and re-fused, and so that the exhaust of the fuses does not endanger persons. Distribution cutouts shall not be used indoors, underground, or in metal enclosures.~~

~~490.21(C)(2) Operation.~~

~~Where fused cutouts are not suitable to interrupt the circuit manually while carrying full load, an approved means shall be installed to interrupt the entire load. Unless the fused cutouts are interlocked with the switch to prevent opening of the cutouts under load, a conspicuous sign shall be placed at such cutouts identifying that they shall not be operated under load.~~

~~490.21(C)(3) Interrupting Rating.~~

~~The interrupting rating of distribution cutouts shall not be less than the available fault current the cutout is required to interrupt, including contributions from all connected sources of energy.~~

~~490.21(C)(4) Voltage Rating.~~

~~The maximum voltage rating of cutouts shall not be less than the maximum circuit voltage.~~

~~490.21(C)(5) Identification.~~

~~Distribution cutouts shall have on their body, door, or fuse tube a permanent and legible nameplate or identification showing the manufacturer's type or designation, continuous current rating, maximum voltage rating, and interrupting rating.~~

~~490.21(C)(6) Fuse Links.~~

~~Fuse links shall have a permanent and legible identification showing continuous current rating and type.~~

~~490.21(C)(7) Structure Mounted Outdoors.~~

~~The height of cutouts mounted outdoors on structures shall provide safe clearance between lowest energized parts (open or closed position) and standing surfaces, in accordance with 110.34(E).~~

~~490.21(D) Oil-Filled Cutouts.~~

~~490.21(D)(1) Continuous Current Rating.~~

~~The continuous current rating of oil-filled cutouts shall not be less than the maximum continuous current through the cutout.~~

~~490.21(D)(2) Interrupting Rating.~~

~~The interrupting rating of oil-filled cutouts shall not be less than the available fault current the oil-filled cutout is required to interrupt, including contributions from all connected sources of energy.~~

~~490.21(D)(3) Voltage Rating.~~

~~The maximum voltage rating of oil-filled cutouts shall not be less than the maximum circuit voltage.~~

~~490.21(D)(4) Fault Closing Rating.~~

~~Oil-filled cutouts shall have a fault closing rating not less than the maximum asymmetrical fault current that can occur at the cutout location, unless suitable interlocks or operating procedures preclude the possibility of closing into a fault.~~

~~490.21(D)(5) Identification.~~

~~Oil-filled cutouts shall have a permanent and legible nameplate showing the rated continuous current, rated maximum voltage, and rated interrupting current.~~

~~490.21(D)(6) Fuse Links.~~

~~Fuse links shall have a permanent and legible identification showing the rated continuous current.~~

~~490.21(D)(7) Location.~~

~~Cutouts shall be located so that they are readily and safely accessible for re-fusing, with the top of the cutout not over 1.5 m (5 ft) above the floor or platform.~~

~~490.21(D)(8) Enclosure.~~

~~Suitable barriers or enclosures shall be provided to prevent contact with nonshielded cables or energized parts of oil-filled cutouts.~~

~~**490.21(E) Load Interrupters.**~~
~~Load-interrupter switches shall be permitted if suitable fuses or circuit breakers are used in conjunction with these devices to interrupt available fault currents. Where these devices are used in combination, they shall be coordinated electrically so that they will safely withstand the effects of closing, carrying, or interrupting all possible currents up to the assigned maximum short-circuit rating.~~

~~Where more than one switch is installed with interconnected load terminals to provide for alternate connection to different supply conductors, each switch shall be provided with a warning sign identifying the presence of more than one source. Each warning sign or label shall comply with 110.21.~~

~~**490.21(E)(1) Continuous Current Rating.**~~
~~The continuous current rating of interrupter switches shall equal or exceed the maximum continuous current at the point of installation.~~

~~**490.21(E)(2) Voltage Rating.**~~
~~The maximum voltage rating of interrupter switches shall equal or exceed the maximum circuit voltage.~~

~~**490.21(E)(3) Identification.**~~
~~Interrupter switches shall have a permanent and legible nameplate including the following information: manufacturer's type or designation, continuous current rating, interrupting current rating, fault closing rating, maximum voltage rating.~~

~~**490.21(E)(4) Switching of Conductors.**~~
~~The switching mechanism shall be arranged to be operated from a location where the operator is not exposed to energized parts and shall be arranged to open all ungrounded conductors of the circuit simultaneously with one operation. Switches shall be arranged to be locked in the open position. Metal-enclosed switches shall be operable from outside the enclosure.~~

~~**490.21(E)(5) Stored Energy for Opening.**~~
~~The stored-energy operator shall be permitted to be left in the uncharged position after the switch has been closed if a single movement of the operating handle charges the operator and opens the switch.~~

~~**490.21(E)(6) Supply Terminals.**~~
~~The supply terminals of fused interrupter switches shall be installed at the top of the switch enclosure, or, if the terminals are located elsewhere, the equipment shall have barriers installed so as to prevent persons from accidentally contacting energized parts or dropping tools or fuses into energized parts.~~

495~~0~~.22 Isolating Means. Means shall be provided to completely isolate an item of equipment from all ungrounded conductors. The use of isolating switches shall not be required where there are other ways of de-energizing the equipment for inspection and repairs, such as draw-out-type switchgear units and removable truck panels.

Isolating switches not interlocked with an approved circuit-interrupting device shall be provided with a sign warning against opening them under load. The warning sign(s) or label(s) shall comply with 110.21(B).

An identified fuseholder and fuse shall be permitted as an isolating switch.

495~~0~~.23 Voltage Regulators. Proper switching sequence for regulators shall be ensured by use of one of the following:

(1) Mechanically sequenced regulator bypass switch(es)

(2) Mechanical interlocks

(3) Switching procedure prominently displayed at the switching location

495~~0~~.24 Minimum Space Separation. In field-fabricated installations, the minimum air separation between bare live conductors and between such conductors and adjacent grounded surfaces shall not be less than the values given in Table 495~~0~~.24. These values shall not apply to interior portions or exterior terminals of equipment designed, manufactured, and tested in accordance with accepted national standards.

Table 495~~0~~.24 Minimum Clearance of Live Parts

Nominal Voltage Rating (kV)	Impulse Withstand, Basic Impulse Level B.I.L (kV)		Minimum Clearance of Live Parts							
			Phase-to-Phase				Phase-to-Ground			
			Indoors		Outdoors		Indoors		Outdoors	
	Indoors	Outdoors	mm	in.	mm	in.	mm	in.	Mm	in.
2.4–4.16	60	95	115	4.5	180	7	80	3.0	155	6
7.2	75	95	140	5.5	180	7	105	4.0	155	6
13.8	95	110	195	7.5	305	12	130	5.0	180	7
14.4	110	110	230	9.0	305	12	170	6.5	180	7
23	125	150	270	10.5	385	15	190	7.5	255	10
34.5	150	150	320	12.5	385	15	245	9.5	255	10
	200	200	460	18.0	460	18	335	13.0	335	13
46	—	200	—	—	460	18	—	—	335	13
	—	250	—	—	535	21	—	—	435	17
69	—	250	—	—	535	21	—	—	435	17
	—	350	—	—	790	31	—	—	635	25
115	—	550	—	—	1350	53	—	—	1070	42

Table 49~~0~~5.24 Minimum Clearance of Live Parts

Nominal Voltage Rating (kV)	Impulse Withstand, Basic Impulse Level B.I.L (kV)		Minimum Clearance of Live Parts							
			Phase-to-Phase				Phase-to-Ground			
			Indoors		Outdoors		Indoors		Outdoors	
	Indoors	Outdoors	mm	in.	mm	in.	mm	in.	Mm	in.
138	—	550	—	—	1350	53	—	—	1070	42
	—	650	—	—	1605	63	—	—	1270	50
161	—	650	—	—	1605	63	—	—	1270	50
	—	750	—	—	1830	72	—	—	1475	58
230	—	750	—	—	1830	72	—	—	1475	58
	—	900	—	—	2265	89	—	—	1805	71
	—	1050	—	—	2670	105	—	—	2110	83

Note: The values given are the minimum clearance for rigid parts and bare conductors under favorable service conditions. They shall be increased for conductor movement or under unfavorable service conditions or wherever space limitations permit. The selection of the associated impulse withstand voltage for a particular system voltage is determined by the characteristics of the surge protective equipment.

49~~0~~5.25 Backfeed. Installations where the possibility of backfeed exists shall comply with 49~~0~~5.25(A) and (B), which follow.

(A) Sign. A permanent sign in accordance with 110.21(B) shall be installed on the disconnecting means enclosure or immediately adjacent to open disconnecting means with the following words or equivalent: DANGER — CONTACTS ON EITHER SIDE OF THIS DEVICE MAY BE ENERGIZED BY BACKFEED.

(B) Diagram. A permanent and legible single-line diagram of the local switching arrangement, clearly identifying each point of connection to the high-voltage section, shall be provided within sight of each point of connection.

495.26 ~~(A)~~ Oil-Filled Equipment. Installation of electrical equipment, other than transformers covered in ~~Article~~ Part VII~~450~~, containing more than 38 L (10 gal) of flammable oil per unit shall meet the requirements of Parts VI~~I and III of Article 450~~.

Informational Note: The same requirements for oil used in oil-filled transformers are also applicable to other oil-filled equipment.

Part III. Equipment — Switchgear and Industrial Control Assemblies

495~~0~~.30 General. Part III covers assemblies of switchgear and industrial control equipment including, but not limited to, switches and interrupting devices and their control, metering, protection, and regulating equipment where they are an integral part of the assembly, with associated interconnections and supporting structures.

495~~0~~.31 Arrangement of Devices in Assemblies. Arrangement of devices in assemblies shall be such that individual components can safely perform their intended function without adversely affecting the safe operation of other components in the assembly.

495~~0~~.32 Guarding of High-Voltage Energized Parts Within a Compartment. Where access for other than visual inspection is required to a compartment that contains energized high-voltage parts, barriers shall be provided to prevent accidental contact by persons, tools, or other equipment with energized parts. Exposed live parts shall only be permitted in compartments accessible to qualified persons. Fuses and fuseholders designed to enable future replacement without de-energizing the fuseholder shall only be permitted for use by qualified persons.

495~~0~~.33 Guarding of Energized Parts Operating at 1000 Volts, Nominal, or Less Within Compartments. Energized bare parts mounted on doors shall be guarded where the door must be opened for maintenance of equipment or removal of draw-out equipment.

495~~0~~.34 Clearance for Cable Conductors Entering Enclosure. The unobstructed space opposite terminals or opposite raceways or cables entering a switchgear or control assembly shall be approved for the type of conductor and method of termination.

495~~0~~.35 Accessibility of Energized Parts.

(A) High-Voltage Equipment. Doors that would provide unqualified persons access to high-voltage energized parts shall be locked. Permanent signs in accordance with 110.21(B) shall be installed on panels or doors that provide access to live parts over 1000 volts and shall read DANGER — HIGH VOLTAGE — KEEP OUT.

(B) Control Equipment. Where operating at 1000 volts, nominal, or less, control equipment, relays, motors, and the like shall not be installed in compartments with high-voltage parts or high-voltage wiring, unless:

(1) The access means is interlocked with the high-voltage switch or disconnecting means to prevent the access means from being opened or removed when the high-voltage switch is in the closed position or a withdrawable disconnecting means is in the connected position, and

(2) All high-voltage parts or high-voltage wiring in the compartment that remain energized when a fixed mounted high-voltage switch is in the open position or a withdrawable disconnecting means is in the isolating (fully withdrawn) position are protected by insulating or grounded metal barriers to prevent accidental contact with energized high-voltage parts or wiring.

(C) High-Voltage Instruments or Control Transformers and Space Heaters. High-voltage instrument or control transformers and space heaters shall be permitted to be installed in the high-voltage compartment without access restrictions beyond those that apply to the high-voltage compartment generally.

495~~0~~.36 Grounding. Frames of switchgear and control assemblies shall be connected to an equipment grounding conductor or, where permitted, the grounded conductor.

495~~0~~.37 Grounding of Devices. The metal cases or frames, or both, such as those of instruments, relays, meters, and instrument and control transformers, located in or on switchgear or control assemblies, shall be connected to an equipment grounding conductor or, where permitted, the grounded conductor.

495~~0~~.38 Door Stops and Cover Plates. External hinged doors or covers shall be provided with stops to hold them in the open position. Cover plates intended to be removed for inspection of energized parts or wiring shall be equipped with lifting handles and shall not exceed 1.1 m^2 (12 ft^2) in area or 27 kg (60 lb) in weight, unless they are hinged and bolted or locked.

495~~0~~.39 Gas Discharge from Interrupting Devices. Gas discharged during operating of interrupting devices shall be directed so as not to endanger personnel.

495~~0~~.40 Visual Inspection Windows. Windows intended for visual inspection of disconnecting switches or other devices shall be of suitable transparent material.

495~~0~~.41 Location of Industrial Control Equipment. Routinely operated industrial control equipment shall meet the requirements of 495~~0~~.41(A) unless infrequently operated, as covered in 495~~0~~.41(B).

(A) Control and Instrument Transfer Switch Handles or Push Buttons. Control and instrument transfer switch handles or push buttons shall be in a readily accessible location at an elevation of not over 2.0 m (6 ft 7 in.).

Exception: Operating handles requiring more than 23 kg (50 lb) of force shall be located no higher than 1.7 m (66 in.) in either the open or closed position.

(B) Infrequently Operated Devices. Where operating handles for such devices as draw-out fuses, fused potential or control transformers and their primary disconnects, and bus transfer and isolating switches are only operated infrequently, the handles shall be permitted to be located where they are safely operable and serviceable from a portable platform.

495~~0~~.42 Interlocks — Interrupter Switches. Interrupter switches equipped with stored energy mechanisms shall have mechanical interlocks to prevent access to the switch compartment unless the stored energy mechanism is in the discharged or blocked position.

495~~0~~.43 Stored Energy for Opening. The stored energy operator shall be permitted to be left in the uncharged position after the switch has been closed if a single movement of the operating handle charges the operator and opens the switch.

495~~0~~.44 Fused Interrupter Switches.

(A) Supply Terminals. The supply terminals of fused interrupter switches shall be installed at the top of the switch enclosure or, if the terminals are located elsewhere, the equipment shall have barriers installed so as to prevent persons from accidentally contacting energized parts or dropping tools or fuses into energized parts.

(B) Backfeed. Where fuses can be energized by backfeed, a sign shall be placed on the enclosure door identifying this hazard.

(C) Switching Mechanism. The switching mechanism shall be arranged to be operated from a location outside the enclosure where the operator is not exposed to energized parts and shall be arranged to open all ungrounded conductors of the circuit simultaneously with one operation. Switches shall be lockable open in accordance with 110.25.

495~~0~~.45 Circuit Breakers — Interlocks.

(A) Circuit Breakers. Circuit breakers equipped with stored energy mechanisms shall be designed to prevent the release of the stored energy unless the mechanism has been fully charged.

(B) Mechanical Interlocks. Mechanical interlocks shall be provided in the housing to prevent the complete withdrawal of the circuit breaker from the housing when the stored energy mechanism is in the fully charged position, unless a suitable device is provided to block the closing function of the circuit breaker before complete withdrawal.

495~~0~~.46 Circuit Breaker Locking. Circuit breakers shall be capable of being locked in the open position or, if they are installed in a drawout mechanism, that mechanism shall be capable of being locked in such a position that the mechanism cannot be moved into the connected position. In either case, the provision for locking shall be lockable open in accordance with 110.25.

495~~0~~.47 Switchgear Used as Service Equipment. Switchgear installed as high-voltage service equipment shall include a ground bus for the connection of service cable shields and to facilitate the attachment of safety grounds for personnel protection. This bus shall be extended into the compartment where the service conductors are terminated. Where the compartment door or panel provides access to parts that can only be de-energized and visibly isolated by the serving utility, the warning sign required by 495~~0~~.35(A) shall include a notice that access is limited to the serving utility or is permitted only following an authorization of the serving utility.

495~~0~~.48 Substation Design, Documentation, and Required Diagram.
(A) Design and Documentation. Substations shall be designed by a qualified licensed professional engineer. Where components or the entirety of the substation are listed by a qualified electrical testing laboratory, documentation of internal design features subject to the listing investigation shall not be required. The design shall address but not be limited to the following topics, and the documentation of this design shall be made available to the authority having jurisdiction:

(1) Clearances and exits

(2) Electrical enclosures

(3) Securing and support of electrical equipment

(4) Fire protection

(5) Safety ground connection provisions

(6) Guarding live parts

(7) Transformers and voltage regulation equipment

(8) Conductor insulation, electrical and mechanical protection, isolation, and terminations

(9) Application, arrangement, and disconnection of circuit breakers, switches, and fuses

(10) Provisions for oil filled equipment

(11) Switchgear

(12) Surge arresters

495~~0~~.48(B) Diagram. A permanent, single-line diagram of the switchgear shall be provided in a readily visible location within the same room or enclosed area with the switchgear, and this diagram shall clearly identify interlocks, isolation means, and all possible sources of voltage to the installation under normal or emergency conditions, and the marking on the switchgear shall cross-reference the diagram.

Exception: Where the equipment consists solely of a single cubicle or metal-enclosed substation containing only one high-voltage switching device, diagrams shall not be required.

495~~0~~.49 Reconditioned Switchgear. Switchgear, or sections of switchgear, within the scope of this article shall be permitted to be reconditioned. The reconditioning process shall use design qualified parts verified under applicable standards and be performed in accordance with any instructions provided by the manufacturer. Reconditioned switchgear shall be listed or field labeled as *reconditioned*, and previously applied listing marks, if any, within the portions reconditioned shall be removed. If equipment has been damaged by fire, products of combustion, or water, it shall be specifically evaluated by its manufacturer or a qualified testing laboratory prior to being returned to service.

Part IV. Mobile and Portable Equipment

495~~0~~.51 General.

(A) Covered. The provisions of this part shall apply to installations and use of high-voltage power distribution and utilization equipment that is portable, mobile, or both, such as substations and switch houses mounted on skids, trailers, or cars; mobile shovels; draglines; cranes; hoists; drills; dredges; compressors; pumps; conveyors; underground excavators; and the like.

(B) Other Requirements. The requirements of this part shall be additional to, or amendatory of, those prescribed in Articles 100 through 725 of this *Code*. Special attention shall be paid to Article 250.

(C) Protection. Approved enclosures or guarding, or both, shall be provided to protect portable and mobile equipment from physical damage.

(D) Disconnecting Means. Disconnecting means shall be installed for mobile and portable high-voltage equipment according to the requirements of Part VIII of Article 230 and shall disconnect all ungrounded conductors.

495~~0~~.52 Overcurrent Protection. Motors driving single or multiple dc generators supplying a system operating on a cyclic load basis do not require overload protection, provided that the thermal rating of the ac drive motor cannot be exceeded under any operating condition. The branch-circuit protective device(s) shall provide short-circuit and locked-rotor protection and shall be permitted to be external to the equipment.

495~~0~~.53 Enclosures. All energized switching and control parts shall be enclosed in grounded metal cabinets or enclosures. These cabinets or enclosures shall be marked DANGER — HIGH VOLTAGE — KEEP OUT and shall be locked so that only authorized and qualified persons can enter. The danger marking(s) or label(s) shall comply with 110.21(B). Circuit breakers and protective equipment shall have the operating means projecting through the metal cabinet or enclosure so these units can be reset without opening locked doors. With doors closed, safe access for normal operation of these units shall be provided.

495~~0~~.54 Collector Rings. The collector ring assemblies on revolving-type machines (shovels, draglines, etc.) shall be guarded to prevent accidental contact with energized parts by personnel on or off the machine.

495~~0~~.55 Power Cable Connections to Mobile Machines. A metallic enclosure shall be provided on the mobile machine for enclosing the terminals of the power cable. The enclosure shall include terminal connections to the machine frame for the equipment grounding conductor. Ungrounded conductors shall be attached to insulators or be terminated in approved high-voltage cable couplers (which include equipment grounding conductor connectors) of proper voltage and ampere rating. The method of cable termination used shall prevent any strain or pull on the cable from stressing the electrical connections. The enclosure shall have provision for locking so that only authorized and qualified persons may open it and shall be marked as follows:

DANGER — HIGH VOLTAGE — KEEP OUT.

The danger marking(s) or label(s) shall comply with 110.21(B).

495~~0~~.56 High-Voltage Portable Cable for Main Power Supply. Flexible high-voltage cable supplying power to portable or mobile equipment shall comply with Article 250 and Article 400, Part III.

Part V. Electrode-Type Boilers

495~~0~~.70 General. The provisions of Part V shall apply to boilers operating over 1000 volts, nominal, in which heat is generated by the passage of current between electrodes through the liquid being heated.

495~~0~~.71 Electrical Supply System. Electrode-type boilers shall be supplied only from a 3-phase, 4-wire solidly grounded wye system, or from isolating transformers arranged to provide such a system. Control circuit voltages shall not exceed 150 volts, shall be supplied from a grounded system, and shall have the controls in the ungrounded conductor.

495~~0~~.72 Branch-Circuit Requirements.

(A) Rating. Each boiler shall be supplied from an individual branch circuit rated not less than 100 percent of the total load.

(B) Common-Trip Fault-Interrupting Device. The circuit shall be protected by a 3-phase, common-trip fault-interrupting device, which shall be permitted to automatically reclose the circuit upon removal of an overload condition but shall not reclose after a fault condition.

(C) Phase-Fault Protection. Phase-fault protection shall be provided in each phase, consisting of a separate phase-overcurrent relay connected to a separate current transformer in the phase.

(D) Ground Current Detection. Means shall be provided for detection of the sum of the neutral conductor and equipment grounding conductor currents and shall trip the circuit-interrupting device if the sum of those currents exceeds the greater of 5 amperes or 7½ percent of the boiler full-load current for 10 seconds or exceeds an instantaneous value of 25 percent of the boiler full-load current.

(E) Grounded Neutral Conductor. The grounded neutral conductor shall be as follows:

(1) Connected to the pressure vessel containing the electrodes

(2) Insulated for not less than 1000 volts

(3) Have not less than the ampacity of the largest ungrounded branch-circuit conductor

(4) Installed with the ungrounded conductors in the same raceway, cable, or cable tray, or, where installed as open conductors, in close proximity to the ungrounded conductors

(5) Not used for any other circuit

495~~0~~.73 Pressure and Temperature Limit Control. Each boiler shall be equipped with a means to limit the maximum temperature, pressure, or both, by directly or indirectly interrupting all current flow through the electrodes. Such means shall be in addition to the temperature, pressure, or both, regulating systems and pressure relief or safety valves.

495~~0~~.74 Bonding. All exposed non–current-carrying metal parts of the boiler and associated exposed metal structures or equipment shall be bonded to the pressure vessel or to the neutral conductor to which the vessel is connected in accordance with 250.102, except the ampacity of the bonding jumper shall not be less than the ampacity of the neutral conductor.

Part VI. Motors, Motor Circuits and Controllers

495.80 ~~430.221~~ General. Part ~~XI~~ VI recognizes the additional hazard due to the use of higher voltages. It adds to or amends the other provisions of ~~this~~ article 430.

~~430.222~~495.81 Marking on Controllers. In addition to the marking required by 430.8, a controller shall be marked with the control voltage.

~~430.223~~495.82 Raceway Connection to Motors. Flexible metal conduit or liquidtight flexible metal conduit not exceeding 1.8 m (6 ft) in length shall be permitted to be employed for raceway connection to a motor terminal enclosure.

~~430.224~~495.83 Size of Conductors. Conductors supplying motors shall have an ampacity not less than the current at which the motor overload protective device(s) is selected to trip.

~~430.225~~495.84 Motor-Circuit Overcurrent Protection.

(A) General. Each motor circuit shall include coordinated protection to automatically interrupt overload and fault currents in the motor, the motor-circuit conductors, and the motor control apparatus.

Exception: Where a motor is critical to an operation and the motor should operate to failure if necessary to prevent a greater hazard to persons, the sensing device(s) shall be permitted to be connected to a supervised annunciator or alarm instead of interrupting the motor circuit.

(B) Overload Protection.

(1) Type of Overload Device. Each motor shall be protected against dangerous heating due to motor overloads and failure to start by a thermal protector integral with the motor or external current-sensing devices, or both. Protective device settings for each motor circuit shall be determined under engineering supervision.

(2) Wound-Rotor Alternating-Current Motors. The secondary circuits of wound-rotor ac motors, including conductors, controllers, and resistors rated for the application, shall be considered as protected against overcurrent by the motor overload protection means.

(3) Operation. Operation of the overload interrupting device shall simultaneously disconnect all ungrounded conductors.

(4) Automatic Reset. Overload sensing devices shall not automatically reset after trip unless resetting of the overload sensing device does not cause automatic restarting of the motor or there is no hazard to persons created by automatic restarting of the motor and its connected machinery.

(C) Fault-Current Protection.

(1) Type of Protection. Fault-current protection shall be provided in each motor circuit as specified by either ~~430.225(C)(1)~~495.84(C)(1)(a) or (C)(1)(b).

(a) A circuit breaker of suitable type and rating arranged so that it can be serviced without hazard. The circuit breaker shall simultaneously disconnect all ungrounded conductors. The circuit breaker shall be permitted to sense the fault current by means of integral or external sensing elements.

(b) Fuses of a suitable type and rating placed in each ungrounded conductor. Fuses shall be used with suitable disconnecting means, or they shall be of a type that can also serve as the disconnecting means. They shall be arranged so that they cannot be serviced while they are energized.

(2) Reclosing. Fault-current interrupting devices shall not automatically reclose the circuit.

Exception: Automatic reclosing of a circuit shall be permitted where the circuit is exposed to transient faults and where such automatic reclosing does not create a hazard to persons.

(3) Combination Protection. Overload protection and fault-current protection shall be permitted to be provided by the same device.

~~430.226~~495.85 Rating of Motor Control Apparatus. The ultimate trip current of overcurrent (overload) relays or other motor-protective devices used shall not exceed 115 percent of the controller's continuous current rating. Where the motor branch-circuit disconnecting means is separate from the controller, the disconnecting means current rating shall not be less than the ultimate trip setting of the overcurrent relays in the circuit.

~~430.227~~495.86 Disconnecting Means. The controller disconnecting means shall be lockable in accordance with 110.25.

Part ~~XI~~IV~~V~~. Tables

Table 495.87 Full-Load Current, Two-Phase Alternating-Current Motors (4-Wire)

The following values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Current in the common conductor of a 2-phase, 3-wire system will be 1.41 times the value given. The voltages listed are rated motor voltages. ~~The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.~~ The currents listed shall be permitted for system voltage ranges of 2300 to 2400 volts.

Horsepower	Induction-Type Squirrel Cage and Wound Rotor (Amperes)				
	~~115 Volts~~	~~230 Volts~~	~~460 Volts~~	~~575 Volts~~	2300 Volts
60	—	~~133~~	~~67~~	~~53~~	14
75	—	~~166~~	~~83~~	~~66~~	18
100	—	~~218~~	~~109~~	~~87~~	23
125	—	~~270~~	~~135~~	~~108~~	28
150	—	~~312~~	~~156~~	~~125~~	32
200	—	~~416~~	~~208~~	~~167~~	43

Table 495.88 Full-Load Current, Three-Phase Alternating-Current Motors

The following values of full-load currents are typical for motors running at speeds usual for belted motors and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of ~~110 to 120, 220 to 240, 440 to 480, and 550 to 600~~2300 to 2400 volts.

Horsepower	Induction-Type Squirrel Cage and Wound Rotor (Amperes)							-	Synchronous-Type Unity Power Factor* (Amperes)			
	~~115 Volts~~	~~200 Volts~~	~~208 Volts~~	~~230 Volts~~	~~460 Volts~~	~~575 Volts~~	2300 Volts	-	~~230 Volts~~	~~460 Volts~~	~~575 Volts~~	2300 Volts
60	—	~~177~~	~~169~~	~~154~~	~~77~~	~~62~~	16	_	~~123~~	~~61~~	~~49~~	12
100	—	~~285~~	~~273~~	~~248~~	~~124~~	~~99~~	26	_	~~202~~	~~101~~	~~81~~	20
125	—	~~359~~	~~343~~	~~312~~	~~156~~	~~125~~	31	_	~~253~~	~~126~~	~~101~~	25
150	—	~~414~~	~~396~~	~~360~~	~~180~~	~~144~~	37	_	~~302~~	~~151~~	~~121~~	30
200	_	~~552~~	~~528~~	~~480~~	~~240~~	~~192~~	49	_	~~400~~	~~201~~	~~161~~	40

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

Part VII. Transformers

~~**ARTICLE 450 Transformers and Transformer Vaults (Including Secondary Ties)**~~
~~**Part I. General Provisions**~~

~~450.1~~495.100 ~~Scope~~General Provisions. This ~~article~~ Part~~section~~ covers the installation of all transformers over 1000 volts on either the Primary or Secondary. Part VII supplements or amends the other provisions of article 450.

Exception No. 1: Current transformers.

Exception No. 2: Dry-type transformers that constitute a component part of other apparatus and comply with the requirements for such apparatus.

Exception No. 3: Transformers that are an integral part of an X-ray, high-frequency, or electrostatic-coating apparatus.

~~*Exception No. 4: Transformers used with Class 2 and Class 3 circuits that comply with Article 725.*~~

Exception No. 4~~5~~: Transformers for sign and outline lighting that comply with Article 600.

Exception No. 5~~6~~: Transformers for electric-discharge lighting that comply with Article 410.

~~*Exception No. 7: Transformers used for power-limited fire alarm circuits that comply with Part III of Article 760.*~~

Exception No. 6~~8~~: Transformers used for research, development, or testing, where effective arrangements are provided to safeguard persons from contacting energized parts.

This article covers the installation of transformers dedicated to supplying power to a fire pump installation as modified by Article 695.

This article also covers the installation of transformers in hazardous (classified) locations as modified by Articles 501 through 504.

x~~450.2~~495.102 ~~Definition.~~ ~~The definitions in this section shall apply only within this article.~~

~~**Transformer.** An individual transformer, single- or polyphase, identified by a single nameplate, unless otherwise indicated in this article.~~

495.102 Exposed Energized Parts. Switches or other equipment operating at 1000 volts, nominal, or less and serving only equipment within a transformer enclosure shall be permitted to be installed in the transformer enclosure if accessible to qualified persons only. All energized parts shall be guarded in accordance with 110.27 and 110.34.

~~450.3~~495.103 Overcurrent Protection. Overcurrent protection of transformers shall comply with ~~, (B), or (C).~~495.103 As used in this section, the word *transformer* shall mean a transformer or polyphase bank of two or more single-phase transformers operating as a unit.

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

Informational Note No. 2: Nonlinear loads can increase heat in a transformer without operating its overcurrent protective device.

~~**450.3(A) Transformers Over 1000 Volts, Nominal.**~~
~~Overcurrent protection shall be provided in accordance with Table 450.3(A).~~

Table ~~450.3~~495.103 ~~(A)~~ Maximum Rating or Setting of Overcurrent Protection for Transformers Over 1000 Volts (as a Percentage of Transformer-Rated Current)

				Secondary Protection (See Note 2.)		
		Primary Protection over 1000 Volts		Over 1000 Volts		1000 Volts or Less
Location Limitations	**Transformer Rated Impedance**	**Circuit Breaker (See Note 4.)**	**Fuse Rating**	**Circuit Breaker (See Note 4.)**	**Fuse Rating**	**Circuit Breaker or Fuse Rating**
Any location	Not more than 6%	600% (See Note 1.)	300% (See Note 1.)	300% (See Note 1.)	250% (See Note 1.)	125% (See Note 1.)
	More than 6% and not more than 10%	400% (See Note 1.)	300% (See Note 1.)	250% (See Note 1.)	225% (See Note 1.)	125% (See Note 1.)
Supervised locations only (See Note 3.)	Any	300% (See Note 1.)	250% (See Note 1.)	Not required	Not required	Not required
	Not more than 6%	600%	300%	300% (See Note 5.)	250% (See Note 5.)	250% (See Note 5.)
	More than 6% and not more than 10%	400%	300%	250% (See Note 5.)	225% (See Note 5.)	250% (See Note 5.)

Notes:

1. Where the required fuse rating or circuit breaker setting does not correspond to a standard rating or setting, a higher rating or setting that does not exceed the following shall be permitted:

a. The next higher standard rating or setting for fuses and circuit breakers 1000 volts and below, or

b. The next higher commercially available rating or setting for fuses and circuit breakers above 1000 volts.

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

3. A supervised location is a location where conditions of maintenance and supervision ensure that only qualified persons monitor and service the transformer installation.

4. Electronically actuated fuses that may be set to open at a specific current shall be set in accordance with settings for circuit breakers.

5. A transformer equipped with a coordinated thermal overload protection by the manufacturer shall be permitted to have separate secondary protection omitted.

~~450.21~~495.104 Dry-Type Transformers Installed Indoors.

(A) Not Over 112⁄ 2 kVA. Dry-type transformers installed indoors and rated 112⁄ 2 kVA or less shall have a separation of at least 300 mm (12 in.) from combustible material unless separated from the combustible material by a fire-resistant, heat-insulated barrier.

(B) Over 112⁄ 2 kVA. Individual dry-type transformers of more than 112⁄ 2 kVA rating shall be installed in a transformer room of fire-resistant construction having a minimum fire rating of 1 hour.

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

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

Informational Note: See ASTM E119-18a, *Standard Test Methods for Fire Tests of Building Construction and Materials*.

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

~~450.22~~495.105 Dry-Type Transformers Installed Outdoors. Dry-type transformers installed outdoors shall have a weatherproof enclosure.

Transformers exceeding 112⁄ 2 kVA shall not be located within 300 mm (12 in.) of combustible materials of buildings unless the transformer has Class 155 insulation systems or higher and is completely enclosed except for ventilating openings.

~~450.23~~495.106 Less-Flammable Liquid-Insulated Transformers. Transformers insulated with listed less-flammable liquids that have a fire point of not less than 300°C shall be permitted to be installed in accordance with 495.106~~450.23~~(A) or 495.106~~450.23~~(B).

~~450.23~~495.106(A) Indoor Installations. Indoor installations shall be permitted in accordance with one of the following:

(1) In Type I or Type II buildings, in areas where all of the following requirements are met:

a. The transformer is rated 35,000 volts or less.

b. No combustible materials are stored.

c. A liquid confinement area is provided.

d. The installation complies with all the restrictions provided for in the listing of the liquid.

Informational Note: Such restrictions can include, but are not limited to, maximum pressure of the tank, use of a pressure relief valve, appropriate fuse types, and proper sizing of overcurrent protection.

(2) If an automatic fire extinguishing system and a liquid confinement area is present, provided the transformer is rated 35,000 volts or less

(3) If the installation complies with 495.109 ~~450.26~~

(B) Outdoor Installations.
Less-flammable liquid-filled transformers shall be permitted to be installed outdoors, attached to, adjacent to, or on the roof of buildings, if installed in accordance with (1) or (2).

(1) For Type I and Type II buildings, the installation shall comply with all the restrictions provided for in the listing of the liquid.

Informational Note No. 1: Installations adjacent to combustible material, fire escapes, or door and window openings can require additional safeguards such as those listed in 495.110 ~~450.27~~.
Informational Note No. 2: Such restrictions can include, but are not limited to: maximum pressure of the tank, use of a pressure relief valve, appropriate fuse types, and proper sizing of overcurrent protection.

(2) In accordance with ~~450.27~~495.110.

Informational Note No. 1: As used in this section, *Type I and Type II buildings* refers to Type I and Type II building construction as defined in NFPA 220-2018, *Standard on Types of Building Construction*. *Combustible materials* refers to those materials not classified as noncombustible or limited-combustible as defined in NFPA 220-2018, *Standard on Types of Building Construction*.
Informational Note No. 2: See definition of *Listed* in Article 100.

~~450.24~~495.107 Nonflammable Fluid-Insulated Transformers. Transformers insulated with a dielectric fluid identified as nonflammable shall be permitted to be installed indoors or outdoors. Such transformers installed indoors and rated over 35,000 volts shall be installed in a vault. Such transformers installed indoors shall be furnished with a liquid confinement area and a pressure-relief vent. The transformers shall be furnished with a means for absorbing any gases generated by arcing inside the tank, or the pressure-relief vent shall be connected to a chimney or flue that will carry such gases to an environmentally safe area.

Informational Note: Safety may be increased if fire hazard analyses are performed for such transformer installations.

For the purposes of this section, a nonflammable dielectric fluid is one that does not have a flash point or fire point and is not flammable in air.

~~450.25~~495.108 Askarel-Insulated Transformers Installed Indoors. Askarel-insulated transformers installed indoors and rated over 25 kVA shall be furnished with a pressure-relief vent. Where installed in a poorly ventilated place, they shall be furnished with a means for absorbing any gases generated by arcing inside the case, or the pressure-relief vent shall be connected to a chimney or flue that carries such gases outside the building. Askarel-insulated transformers rated over 35,000 volts shall be installed in a vault.

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

Exception No. 1: Where the total capacity does not exceed 112½ kVA, the vault specified in Part III of this article shall be permitted to be constructed of reinforced concrete that is not less than 100 mm (4 in.) thick.

Exception No. 2: Where the nominal voltage does not exceed 1000, a vault shall not be required if suitable arrangements are made to prevent a transformer oil fire from igniting other materials and the total capacity in one location does not exceed 10 kVA in a section of the building classified as combustible or 75 kVA where the surrounding structure is classified as fire-resistant construction.

Exception No. 3: Electric furnace transformers that have a total rating not exceeding 75 kVA shall be permitted to be installed without a vault in a building or room of fire-resistant construction, provided suitable arrangements are made to prevent a transformer oil fire from spreading to other combustible material.

Exception No. 4: A transformer that has a total rating not exceeding 75 kVA and a supply voltage of 1000 volts or less that is an integral part of charged-particle-accelerating equipment shall be permitted to be installed without a vault in a building or room of noncombustible or fire-resistant construction, provided suitable arrangements are made to prevent a transformer oil fire from spreading to other combustible material.

Exception No. 5: Transformers shall be permitted to be installed in a detached building that does not comply with Part III of this article if neither the building nor its contents present a fire hazard to any other building or property, and if the building is used only in supplying electric service and the interior is accessible only to qualified persons.

Exception No. 6: Oil-insulated transformers shall be permitted to be used without a vault in portable and mobile surface mining equipment (such as electric excavators) if each of the following conditions is met:

(1) Provision is made for draining leaking fluid to the ground.

(2) Safe egress is provided for personnel.

(3) A minimum 6-mm (¼-in.) steel barrier is provided for personnel protection.

495.110 Oil-Insulated Transformers Installed Outdoors.
Combustible material, combustible buildings, and parts of buildings, fire escapes, and door and window openings shall be safeguarded from fires originating in oil-insulated transformers installed on roofs, attached to or adjacent to a building or combustible material.

In cases where the transformer installation presents a fire hazard, one or more of the following safeguards shall be applied according to the degree of hazard involved:

(1) Space separations

(2) Fire-resistant barriers

(3) Automatic fire suppression systems

(4) Enclosures that confine the oil of a ruptured transformer tank

Oil enclosures shall be permitted to consist of fire-resistant dikes, curbed areas or basins, or trenches filled with coarse, crushed stone. Oil enclosures shall be provided with trapped drains where the exposure and the quantity of oil involved are such that removal of oil is important.

Informational Note: For additional information on transformers installed on poles or structures or under ground, see ANSI/IEEE C2-2017, *National Electrical Safety Code.*

495.111 Modification of Transformers.
When modifications are made to a transformer in an existing installation that change the type of the transformer with respect to Part VII of this article, such transformer shall be marked to show the type of insulating liquid installed, and the modified transformer installation shall comply with the applicable requirements for that type of transformer.

Part ~~III~~VIII. Transformer Vaults

~~450.41~~495.112 Location. Vaults shall be located where they can be ventilated to the outside air without using flues or ducts wherever such an arrangement is practicable.

495.113 Accessibility. All transformer vaults shall be readily accessible to qualified personnel for inspection and maintenance or shall meet the requirements of 450.13(A) or 450.13(B).

~~450.42~~495.114~~3~~ Walls, Roofs, and Floors. The walls and roofs of vaults shall be constructed of materials that have approved structural strength for the conditions with a minimum fire resistance of 3 hours. The floors of vaults in contact with the earth shall be of concrete that is not less than 100 mm (4 in.) thick, but, where the vault is constructed with a vacant space or other stories below it, the floor shall have approved structural strength for the load imposed thereon and a minimum fire resistance of 3 hours. For the purposes of this section, studs and wallboard construction shall not be permitted.

Exception: Where transformers are protected with automatic sprinkler, water spray, carbon dioxide, or halon, construction of 1-hour rating shall be permitted.

Informational Note No. 1: For additional information, see ASTM E119-18a, *Methods for Fire Tests of Building Construction and Materials*.

Informational Note No. 2: A typical 3-hour construction is 150 mm (6 in.) thick reinforced concrete.

~~450.43~~495.115~~4~~ Doorways. Vault doorways shall be protected in accordance with 495.115~~4450.43~~(A), (B), and (C).

(A) Type of Door. Each doorway leading into a vault from the building interior shall be provided with a tight-fitting door that has a minimum fire rating of 3 hours. The authority having jurisdiction shall be permitted to require such a door for an exterior wall opening where conditions warrant.

Exception: Where transformers are protected with automatic sprinkler, water spray, carbon dioxide, or halon, construction of 1-hour rating shall be permitted.

Informational Note: For additional information, see NFPA 80-2016, *Standard for Fire Doors and Other Opening Protectives*.

(B) Sills. A door sill or curb that is of an approved height that will confine the oil from the largest transformer within the vault shall be provided, and in no case shall the height be less than 100 mm (4 in.).

(C) Locks. Doors shall be equipped with locks, and doors shall be kept locked, with access being allowed only to qualified persons. Personnel doors shall open in the direction of egress and be equipped with listed fire exit hardware.

~~450.45~~495.116~~5~~ Ventilation Openings. Where required by 450.9, openings for ventilation shall be provided in accordance with 495.116~~5450.45~~(A) through (F).

(A) Location. Ventilation openings shall be located as far as possible from doors, windows, fire escapes, and combustible material.

(B) Arrangement. A vault ventilated by natural circulation of air shall be permitted to have roughly half of the total area of openings required for ventilation in one or more openings near the floor and the remainder in one or more openings in the roof or in the sidewalls near the roof, or all of the area required for ventilation shall be permitted in one or more openings in or near the roof.

(C) Size. For a vault ventilated by natural circulation of air to an outdoor area, the combined net area of all ventilating openings, after deducting the area occupied by screens, gratings, or louvers, shall not be less than 1900 mm^2 (3 $in.^2$) per kVA of transformer capacity in service, and in no case shall the net area be less than 0.1 m^2 (1 ft^2) for any capacity under 50 kVA.

(D) Covering. Ventilation openings shall be covered with durable gratings, screens, or louvers, according to the treatment required in order to avoid unsafe conditions.

(E) Dampers. All ventilation openings to the indoors shall be provided with automatic closing fire dampers that operate in response to a vault fire. Such dampers shall possess a standard fire rating of not less than 1½ hours.
Informational Note: See ANSI/UL 555-2016, *Standard for Fire Dampers*.

(F) Ducts. Ventilating ducts shall be constructed of fire-resistant material.

495.117~~6~~ ~~450.46~~ Drainage. Where practicable, vaults containing more than 100 kVA transformer capacity shall be provided with a drain or other means that will carry off any accumulation of oil or water in the vault unless local conditions make this impracticable. The floor shall be pitched to the drain where provided.

495.118~~7~~ ~~450.47~~ Water Pipes and Accessories. Any pipe or duct system foreign to the electrical installation shall not enter or pass through a transformer vault. Piping or other facilities provided for vault fire protection, or for transformer cooling, shall not be considered foreign to the electrical installation.

495.119~~8~~ ~~450.48~~ Storage in Vaults. Materials shall not be stored in transformer vaults.

Part IX. Capacitors

495.120~~119~~ Enclosing and Guarding.

(A) Containing More Than 11 L (3 gal) of Flammable Liquid. Capacitors containing more than 11 L (3 gal) of flammable liquid shall be enclosed in vaults or outdoor fenced enclosures complying with Article 110, Part III. This limit shall apply to any single unit in an installation of capacitors.

(B) Accidental Contact. Where capacitors are accessible to unauthorized and unqualified persons, they shall be enclosed, located, or guarded so that persons cannot come into accidental contact or bring conducting materials into accidental contact with exposed energized parts, terminals, or buses associated with them. However, no additional guarding is required for enclosures accessible only to authorized and qualified persons

495.121~~0~~ Not Covered.

Surge capacitors or capacitors included as a component part of other apparatus and conforming with the requirements of such apparatus are excluded from these requirements.

This Part also covers the installation of capacitors in hazardous (classified) locations as modified by Articles 501 through 503.

495.122~~1~~ Switching.

(A) Load Current. Group-operated switches shall be used for capacitor switching and shall be capable of the following:

(1) Carrying continuously not less than 135 percent of the rated current of the capacitor installation

(2) Interrupting the maximum continuous load current of each capacitor, capacitor bank, or capacitor installation that will be switched as a unit

(3) Withstanding the maximum inrush current, including contributions from adjacent capacitor installations

(4) Carrying currents due to faults on capacitor side of switch

(B) Isolation.

(1) General. A means shall be installed to isolate from all sources of voltage each capacitor, capacitor bank, or capacitor installation that will be removed from service as a unit. The isolating means shall provide a visible gap in the electrical circuit adequate for the operating voltage.

(2) Isolating or Disconnecting Switches with No Interrupting Rating. Isolating or disconnecting switches (with no interrupting rating) shall be interlocked with the load-interrupting device or shall be provided with prominently displayed caution signs in accordance with 495~~0~~.22 to prevent switching load current.

(C) Additional Requirements for Series Capacitors. The proper switching sequence shall be ensured by use of one of the following:

(1) Mechanically sequenced isolating and bypass switches

(2) Interlocks

(3) Switching procedure prominently displayed at the switching location

495.123~~2~~ Overcurrent Protection.

(A) Provided to Detect and Interrupt Fault Current. A means shall be provided to detect and interrupt fault current likely to cause dangerous pressure within an individual capacitor.

(B) Single Pole or Multipole Devices. Single-pole or multipole devices shall be permitted for this purpose.

(C) Protected Individually or in Groups. Capacitors shall be permitted to be protected individually or in groups.

(D) Protective Devices Rated or Adjusted. Protective devices for capacitors or capacitor equipment shall be rated or adjusted to operate within the limits of the safe zone for individual capacitors.

495.124~~3~~ ~~460.26~~ Identification. Each capacitor shall be provided with a permanent nameplate giving the manufacturer's name, rated voltage, frequency, kilovar or amperes, number of phases, and the volume of liquid identified as flammable, if such is the case.

495.125~~4~~ ~~460.27~~ Grounding. Capacitor cases shall be connected to the equipment grounding conductor. If the capacitor neutral point is connected to a grounding electrode conductor, the connection shall be made in accordance with Part III of Article 250.

Exception: Capacitor cases shall not be connected to the equipment grounding conductor where the capacitor units are supported on a structure designed to operate at other than ground potential.

495.126~~5~~ ~~460.28~~ Means for Discharge.

(A) Means to Reduce the Residual Voltage. A means shall be provided to reduce the residual voltage of a capacitor to 50 volts or less within 5 minutes after the capacitor is disconnected from the source of supply.

(B) Connection to Terminals. A discharge circuit shall be either permanently connected to the terminals of the capacitor or provided with automatic means of connecting it to the terminals of the capacitor bank after disconnection of the capacitor from the source of supply. The windings of motors, transformers, or other equipment directly connected to capacitors without a switch or overcurrent device interposed shall meet the requirements of 495.126~~60.28~~(A).

Part X. Resistors and Reactors

~~470.18~~495.130 General.

(A) Protected Against Physical Damage.

Resistors and reactors shall be protected against physical damage.

(B) Isolated by Enclosure or Elevation. Resistors and reactors shall be isolated by enclosure or elevation to protect personnel from accidental contact with energized parts.

(C) Combustible Materials. Resistors and reactors shall not be installed in close enough proximity to combustible materials to constitute a fire hazard and shall have a clearance of not less than 305 mm (12 in.) from combustible materials.

(D) Clearances. Clearances from resistors and reactors to grounded surfaces shall be adequate for the voltage involved.

(E) Temperature Rise from Induced Circulating Currents. Metallic enclosures of reactors and adjacent metal parts shall be installed so that the temperature rise from induced circulating currents is not hazardous to personnel or does not constitute a fire hazard.

495.131 ~~470.19~~ Grounding. Resistor and reactor cases or enclosures shall be connected to the equipment grounding conductor.

Exception: Resistor or reactor cases or enclosures supported on a structure designed to operate at other than ground potential shall not be connected to the equipment grounding conductor.

495.132 ~~470.20~~ Oil-Filled Reactors. Installation of oil-filled reactors, in addition to the above requirements, shall comply with applicable requirements of Article 495, Part VII~~450~~.

Public Input No. 3567-NFPA 70-2020 [New Article after 100]

TITLE OF NEW CONTENT

Type your content here ... Feeder Panel Board: Create a definition fo term

Statement of Problem and Substantiation for Public Input

This would create a definition for the general term sub panel.

Submitter Information Verification

Submitter Full Name:	Brian Cornell
Organization:	Brian Cornell
Affiliation:	Contractor
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Sep 09 08:01:53 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: Panelboards may be referred to in many ways depending on the application such as feeder panelboard, sub panelboard, feed thru panelboard and so on but they are all panelboards. The existing text is clear.

Public Input No. 1731-NFPA 70-2020 [Definition: Panelboard.]

Panelboard.

A single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet, enclosure, or cutout box placed in or against a wall, partition, or other support; and accessible only from the front or, where placed within a floor-mounted commercial appliance outlet center, from the top . (CMP-9)

Additional Proposed Changes

File Name	Description	Approved
Public_Input_No._1731-NFPA_70-2020_Definition_Panelboard_.docx	Clean MSWord DOCX copy of this Public Input No. 1731 WITHOUT TerraView alteration of the Submitter's intent	

Statement of Problem and Substantiation for Public Input

See the uploaded attachment of a manual entry of this Public Input with text content that hasn't been Terrarized and is consequently readable.

.

New 2020 NEC® Section 408.43, in conjunction with this definition as worded ("accessible only from the front"), has had in some jurisdictions the consequence of potentially disallowing a long-existing, listed product type: in-floor-mounted commercial appliance outlet centers, composed of factory- or field-installed panelboards and commercial appliance outlet center enclosures. Because of the generalizations of this new 2020 NEC® Section 408.43, it is essential to recognize explicitly these in-floor-mounted commercial appliance outlet centers having face-up panelboards accessed from the top.

.

For hotels, warehouses, convention centers, exhibition halls, casinos, gaming facilities, et alibi, commercial appliance outlet centers are listed to receive factory- or field-installed panelboards and are listed for in-floor mounting in large facilities and venues (not all assembly occupancies), to supply electrical power and other services. Such listed commercial appliance outlet centers and listed commercial appliance outlet center enclosures that provide for diversion and routing of water spillage away from face-up panelboards installed flat or slightly angled within and for adequate drainage, and can be found in UL Product Category AUUZ.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 1705-NFPA 70-2020 [Section No. 408.43]	correlated clarifications
Public Input No. 1761-NFPA 70-2020 [Section No. 518.5]	correlated clarifications
Public Input No. 1705-NFPA 70-2020 [Section No. 408.43]	
Public Input No. 1761-NFPA 70-2020 [Section No. 518.5]	

Submitter Information Verification

Submitter Full Name: Brian Rock

Organization: Hubbell Incorporated

Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 25 16:27:12 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7946-NFPA 70-2020

Statement: Panelboards are commonly installed in cabinets and cutout boxes but may be installed in many types of equipment so this addition would cover other applications with the term identified equipment.

Public Input No. 892-NFPA 70-2020 [Definition: Panelboard.]

Panelboard.

A single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be ~~placed~~ installed in equipment such as a switchboard, industrial control panel, explosionproof panelboard enclosure or a cabinet or cutout box placed in or against a wall, partition, or other support; and accessible only from the front. (CMP-9)

Statement of Problem and Substantiation for Public Input

The proposed revision provides additional examples of equipment that could contain a panelboard such as in a switchboard, explosionproof enclosure or other enclosure.

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz
Organization: NECA
Street Address:
City:
State:
Zip:
Submittal Date: Tue Apr 21 12:48:35 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7946-NFPA 70-2020

Statement: Panelboards are commonly installed in cabinets and cutout boxes but may be installed in many types of equipment so this addition would cover other applications with the term identified equipment.

Public Input No. 1096-NFPA 70-2020 [Section No. 312.2]

312.2 Damp and Wet Locations.

In damp or wet locations, surface-type enclosures within the scope of this article shall be placed or equipped so as to prevent moisture or water from entering and accumulating within the cabinet or cutout box, and shall be mounted so there is at least 6-mm (¼-in.) airspace between the enclosure and the wall or other supporting surface. Enclosures installed in wet locations shall be weatherproof. For enclosures in wet locations, raceways or cables entering <u>at or</u> above the level of uninsulated live parts shall use <u>threaded hub</u> fittings listed for wet locations.

<u>Enclosures designed to be surface mounted shall be surface mounted when installed in a wet or damp location or if raceways served route through a wet or damp location at or above the enclosure mounted height. Weep holes of enclosures designed for wet or damp locations shall not be blocked by structure or building finishes.</u>

Exception: Nonmetallic enclosures shall be permitted to be installed without the airspace on a concrete, masonry, tile, or similar surface.

Informational Note: For protection against corrosion, see 300.6.

Statement of Problem and Substantiation for Public Input

Four items to address:

1. Entering an enclosure that has live parts, with raceways or cables, I propose, will become more stringent by including the level of uninsulated live parts not just 'above the level of live parts'. Driving or sideways rains, sprinkler system water, or similar can enter an enclosure and wash live parts by existing standards. By adding 'at or' would include the lowest height of busbars or uninsulated live parts.

2. Wet location fittings by themselves are insufficient when connected directly to an enclosure without the aid of a threaded hub. Raintight EMT connectors, PVC male adapters, and the like do allow water to get around the fitting and into the enclosure. The raintight portion of the fitting appears to cover the raceway side of the fitting, not the flat surface enclosure side of the fitting. The locknut or locknut/gasket combination does not adequately keep water and moisture out. Corrosion and faulted circuits can occur if rains and moisture can't be kept out of the enclosures listed in 312.1 and the enclosures of 408 included to 312 by 408.2.

3. Raintight EMT fittings, PVC male adapters, and the like suffice when installed below busbar or uninsulated live parts level.

4. Dimples out the back of some enclosures are designed to step the enclosure off the surface. These dimples become non-functional when this type of enclosure is embedded (within stucco for example). Enclosures mounted this way may never experience a problem. Problems can arise if water or moisture were able to enter the enclosure and become trapped. Premature failure or worse, of the enclosure or components within the enclosure will occur if water or moisture is trapped. Water may also enter from a conduit entering the enclosure.

Existing installations across the country that have already been inspected and approved appear to violate the already written first part of 312.2 by trapping enclosures and weep holes due to structure. The structure can be stucco finish or finished carpentry in an attempt to hide an 'unsightly' electrical enclosure. 110.26 clearances may also come into play and referenced.

I'd say please disregard the latter part of my public input on blocking weep holes if this is already adequately written in the NEC (possibly not adequately enforced in the field).

Do consider though, the first part of the public input on threaded hub fittings at or above uninsulated live parts or busbars. I believe this is overdue.

Submitter Information Verification

Submitter Full Name:	Norman Feck
Organization:	State of Colorado
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sat May 16 11:16:39 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: CMP-9 concludes the section is correctly written. The enclosures within the scope of Art. 312 and placed in wet or damp locations will be rated NEMA 3R at minimum, and as such the enclosures will have been evaluated for corrosion resistance, as also required by 312.10(A). In addition, the current wording requires placement or being equipped to prevent water accumulation. In the event the enclosure does not have them, a weep hole can easily be added; if the weep hole was improperly located so as to be blocked by structure, the installation no longer accords with the requirements.A driving rain does not counteract the effects of gravity within an enclosure; the broadening of these requirements to levels below uninsulated live parts is not justified and does not conflict with 110.3(B) which, in the event that such coverage is mandated by a listing instruction, will continue to apply. This section provides minimum requirements; an installation instruction providing more robust connection provisions will apply in addition to NEC minimums. A rear entry to an enclosure must be judged by the AHJ in accordance with these provisions.

Public Input No. 2713-NFPA 70-2020 [Section No. 312.2]

312.2 Damp and Wet Locations.

In damp or wet locations, surface-type enclosures within the scope of this article shall be placed or equipped so as to prevent moisture or water from entering and accumulating within the cabinet or cutout box, and shall be mounted so there is at least 6-mm (¼-in.) airspace between the enclosure and the wall or other supporting surface. Enclosures installed in wet locations shall be weatherproof. For enclosures in wet locations, raceways or ~~cables entering above the level of uninsulated live parts shall~~ cables shall use fittings listed for wet locations.

Exception: Nonmetallic enclosures shall be permitted to be installed without the airspace on a concrete, masonry, tile, or similar surface.

Informational Note: For protection against corrosion, see 300.6.

Statement of Problem and Substantiation for Public Input

Raceways or cables entering on the side or top of a wet locations enclosure can allow water to accumulate, and can corrode enclosure regardless of the location of live parts. The enclosure is vital to prevent contact with live parts.

Submitter Information Verification

Submitter Full Name: Greg Chontow
Organization: Town of Dover
Street Address:
City:
State:
Zip:
Submittal Date: Sat Aug 29 09:11:00 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: CMP-9 concludes the section is correctly written. The enclosures within the scope of Art. 312 and placed in wet or damp locations will be rated NEMA 3R at minimum, and as such the enclosures will have been evaluated for corrosion resistance, as also required by 312.10(A). In addition, the current wording requires placement or being equipped to prevent water accumulation. In the event the enclosure does not have them, a weep hole can easily be added; if the weep hole was improperly located so as to be blocked by structure, the installation no longer accords with the requirements. A driving rain does not counteract the effects of gravity within an enclosure; the broadening of these requirements to levels below uninsulated live parts is not justified and does not conflict with 110.3(B) which, in the event that such coverage is mandated by a listing instruction, will continue to apply. This section provides minimum requirements; an installation instruction providing more robust connection provisions will apply in addition to NEC minimums. A rear entry to an enclosure must be judged by the AHJ in accordance with these provisions.

Public Input No. 3449-NFPA 70-2020 [Section No. 312.2]

312.2 Damp and Wet Locations.

In damp or wet locations, surface-type enclosures within the scope of this article shall be placed or equipped so as to prevent moisture or water from entering and accumulating within the cabinet or cutout box, and shall be mounted so there is at least 6-mm (¼-in.) airspace between the enclosure and the wall or other supporting surface. Enclosures installed in wet locations shall be weatherproof. For enclosures in wet locations, raceways or ~~cables entering above the level of uninsulated live parts shall~~ cables shall use fittings listed for wet locations.

Exception: Nonmetallic enclosures shall be permitted to be installed without the airspace on a concrete, masonry, tile, or similar surface.

Informational Note: For protection against corrosion, see 300.6.

Statement of Problem and Substantiation for Public Input

Raceways or cables and their fittings entering enclosures in a wet locations can allow water to accumulate, and can corrode enclosure regardless of the location of live parts. The enclosure is vital to prevent contact with live parts. Raceways or cable fittings in wet locations should be listed for a wet location regardless of where it enters the enclosure (in a wet location).

Submitter Information Verification

Submitter Full Name: Rudolph Garza
Organization: IAEI
Affiliation: IAEI
Street Address:
City:
State:
Zip:

Submittal Date: Tue Sep 08 15:17:42 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: CMP-9 concludes the section is correctly written. The enclosures within the scope of Art. 312 and placed in wet or damp locations will be rated NEMA 3R at minimum, and as such the enclosures will have been evaluated for corrosion resistance, as also required by 312.10(A). In addition, the current wording requires placement or being equipped to prevent water accumulation. In the event the enclosure does not have them, a weep hole can easily be added; if the weep hole was improperly located so as to be blocked by structure, the installation no longer accords with the requirements. A driving rain does not counteract the effects of gravity within an enclosure; the broadening of these requirements to levels below uninsulated live parts is not justified and does not conflict with 110.3(B) which, in the event that such coverage is mandated by a listing instruction, will continue to apply. This section provides minimum requirements; an installation instruction providing more robust connection provisions will apply in addition to NEC minimums. A rear entry to an enclosure must be judged by the AHJ in accordance with these provisions.

Public Input No. 351-NFPA 70-2020 [Section No. 312.2]

312.2 Damp and Wet Locations.

In damp or wet locations, surface-type enclosures within the scope of this article shall be placed or equipped so as to prevent moisture or water from entering and accumulating within the cabinet or cutout box, and shall be mounted so there is at least 6-mm (¼-in.) airspace between the enclosure and the wall or other supporting surface. Enclosures installed in wet locations shall be weatherproof. For enclosures in wet locations, raceways or cables entering ~~above the level of uninsulated live parts shall use fittings listed for wet locations~~ from a non exposed side shall be permitted to be of the dry type when provided with a sealant above the connector .

Exception: Nonmetallic enclosures shall be permitted to be installed without the airspace on a concrete, masonry, tile, or similar surface.

Informational Note: For protection against corrosion, see 300.6.

Statement of Problem and Substantiation for Public Input

The problem here is this section allow non- wet location rated connections below uninsulated live parts however this would be in direct conflict with 110.3 (B). This old mentality of drip proof is inconsistent with the product listing when exposed to a wet condition and this practice should no longer be allowed however if the enclosure is installed against a wall and a sealant above the connect is provided then a dry type connector should be allowed. this is actually current practice example: an outdoor bell box housing a receptacle NM cable is connected with a dry type connector with duct seal to divert any moist or water around the connection the same for a Meter socket with SER

Submitter Information Verification

Submitter Full Name: Alfio Torrisi
Organization: Master Electrician
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jan 23 09:55:11 EST 2020
Committee: NEC-P09

Committee Statement

Resolution: CMP-9 concludes the section is correctly written. The enclosures within the scope of Art. 312 and placed in wet or damp locations will be rated NEMA 3R at minimum, and as such the enclosures will have been evaluated for corrosion resistance, as also required by 312.10(A). In addition, the current wording requires placement or being equipped to prevent water accumulation. In the event the enclosure does not have them, a weep hole can easily be added; if the weep hole was improperly located so as to be blocked by structure, the installation no longer accords with the requirements. A driving rain does not counteract the effects of gravity within an enclosure; the broadening of these requirements to levels below uninsulated live parts is not justified and does not conflict with 110.3(B) which, in the event that such coverage is mandated by a listing instruction, will continue to apply. This section provides minimum requirements; an installation instruction providing more robust connection provisions will apply in addition to NEC minimums. A rear entry to an enclosure must be judged by the AHJ in accordance with these provisions.

Public Input No. 457-NFPA 70-2020 [Section No. 312.2]

312.2 Damp ~~and~~ or Wet Locations.

In damp or wet locations, surface-type enclosures within the scope of this article shall be placed or equipped so as to prevent moisture or water from entering and accumulating within the cabinet or cutout box, and shall be mounted so there is at least 6-mm (¼-in.) airspace between the enclosure and the wall or other supporting surface. Enclosures installed in wet locations shall be weatherproof. For enclosures in wet locations, raceways or cables entering above the level of uninsulated live parts shall use fittings listed for wet locations.

Exception: Nonmetallic enclosures shall be permitted to be installed without the airspace on a concrete, masonry, tile, or similar surface.

Informational Note: For protection against corrosion, see 300.6.

Statement of Problem and Substantiation for Public Input

a location cannot be both damp and wet. The beginning of the parent text of this section has the correct verbiage that should be in the title of this section. This change doesn't seek to change the intent of this section but simply make the title match the requirement.

Submitter Information Verification

Submitter Full Name: Thomas Domitrovich
Organization: Eaton Corporation
Street Address:
City:
State:
Zip:
Submittal Date: Tue Feb 11 07:43:27 EST 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7702-NFPA 70-2020

Statement: CMP-9 is revising the section title to agree with the text. A given location cannot be both damp and wet.

CMP-9 is placing the reference at the beginning of the Informational Note, to comply with the new NEC Style Manual at 3.1.3.1

Public Input No. 1736-NFPA 70-2020 [Section No. 312.5]

312.5 Cabinets, Cutout Boxes, and Meter Socket Enclosures.

(A) Conductors. Conductors entering enclosures within the scope of this article shall be protected from abrasion ~~and shall comply with 312~~ . ~~5(A) through (C).~~

(

~~A) Openings to Be Closed.~~

~~Openings through which conductors enter shall be closed in an approved manner.~~

~~(~~

~~B)~~

~~Metal~~

~~Cabinets, Cutout Boxes, and Meter Socket~~

~~Enclosures.~~

~~Where metal enclosures within the scope of this article are installed with messenger-supported wiring, open wiring on insulators, or concealed knob-and-tube wiring, conductors shall enter through insulating bushings or, in dry locations, through flexible tubing extending from the last insulating support and firmly secured to the enclosure.~~

(C) Cables.

~~Where cable is used~~

Where cables enter enclosures withing the scope of this article , each cable shall be secured to the cabinet, cutout box, or meter socket enclosure. Openings through which cables enter shall be closed in an approved manner.

Exception No. 1: Cables with entirely nonmetallic sheaths shall be permitted to enter the top of ~~a surface-mounted~~ an enclosure through one or more nonflexible raceways not less than 450 mm (18 in.) and not more than 3.0 m (10 ft) in length, provided all of the following conditions are met:

(1) Each cable is fastened within 300 mm (12 in.), measured along the sheath, of the outer end of the raceway.

(2) The raceway extends to an accessible area directly above the enclosure and does not penetrate a structural ceiling.

(3) A fitting is provided on ~~each end of~~ the raceway to protect the cable(s) from abrasion ~~and the fittings remain accessible after installation~~ .

(4) The raceway is sealed or plugged at the outer end using approved means so as to prevent access to the enclosure through the raceway.

(5) The cable sheath is continuous through the raceway and extends into the enclosure beyond the fitting not less than 6 mm (¼ in.).

(6) The raceway is fastened at its outer end and at other points in accordance with the applicable article.

(7) Where installed as conduit or tubing, the cable fill does not exceed the amount that would be permitted for complete conduit or tubing systems by Table 1 of Chapter 9 of this Code and all applicable notes thereto. Note 2 to the tables in Chapter 9 does not apply to this condition.

Informational Note: See Table 1 in Chapter 9, including Note 9, for allowable cable fill in circular raceways. See 310.15(C)(1) for required ampacity reductions for multiple cables installed in a common raceway.

Exception No. 2: ~~Single~~ For cable tray installations, s ingle conductors and multiconductor cables shall be permitted to enter enclosures in accordance with 392.46(A) or (B).

Statement of Problem and Substantiation for Public Input

Organize the rule into a list format and allow the exception to apply to both concealed and exposed installations.

Submitter Information Verification

Submitter Full Name:	Mike Holt
Organization:	Mike Holt Enterprises Inc
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Jun 25 17:10:43 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: CMP-9 is resolving all five of these PIs because they expand the application of the exception in ways that are inconsistent with the safety objectives of the requirements. CMP-9 notes that the fundamental rule is for each cable (or cable pair as recognized in some connector designs) to enter the enclosure through a connector designed for that purpose, and therefore capable of confining an arcing event to the enclosure. The exception trades off that ideal, to a carefully crafted extent, in favor of a substantial improvement in workmanship, as frequently applied in light commercial work involving suspended ceilings and related applications. PI-4423 would create an additional exception for outdoor applications extended from the sides, back or bottom of the enclosure in wet locations, greatly exceeding the intended use of the existing exception. PI-1736 would extend the reach of the exception to concealed applications. This is an entirely unnecessary expansion of usage because the cabinets to which it applies are equipped with numerous cable knockouts, or can be punched accordingly, and the concealed use entirely avoids the workmanship issues that motivated the insertion of the exception in the 1999 NEC. PI-2025 is resolved because there is no need to extend the requirement to raceways given the requirement in 300.12. In addition, CMP-9 is uncertain as to the exact intent of the first “sentence” in (C) as proposed because as written the words do not form a sentence in the English language. CMP-9 acknowledges that there is no ¼-in. sheath extension requirement at this location, but concludes that the rule would be excessive in cabinets with their far greater volumes that allow for better entrainment of such conductors. PI-1215 is resolved because there is no substantiation that supports the dramatic decrease in containment that would occur in such replacement panelboards. PI-538 is resolved because any extension of the exception as described would dramatically decrease the containment function of the cabinet due to the effective elimination of any significant raceway length. In addition, CMP-9 is reluctant to apply this concept to the back of a cabinet. Such locations are inherently much closer to the energized busbars. Contrary to the assertion made in the substantiation, these pre-punched knockout positions are related to potential supply or related uses such as a feed-through application, and with the bending space calculated in accordance with 408.55(C).

Public Input No. 2025-NFPA 70-2020 [Section No. 312.5]

312.5 Cabinets, Cutout Boxes, and Meter Socket Enclosures.

Conductors entering enclosures within the scope of this article shall be protected from abrasion and shall comply with 312.5(A) through (C).

(A) Openings to Be Closed.

Openings through which conductors enter shall be closed in an approved manner.

(B) Metal Cabinets, Cutout Boxes, and Meter Socket Enclosures.

Where metal enclosures within the scope of this article are installed with messenger-supported wiring, open wiring on insulators, or concealed knob-and-tube wiring, conductors shall enter through insulating bushings or, in dry locations, through flexible tubing extending from the last insulating support and firmly secured to the enclosure.

(C) ~~–~~ **Raceways and** Cables.

Where raceways or cables shall be secured to the cabinet, cutout box, or meter socket enclosure. Where nonmetallic-sheathed cable, multiconductor Type UF, or multiconductor Type SE cable is used, ~~each cable shall be secured to~~ the sheath shall extend not less than 6 mm (1⁄4 in.) inside the cabinet, cutout box, or meter socket enclosure and beyond any cable clamp .

Exception No. 1: Cables with entirely nonmetallic sheaths shall be permitted to enter the top of a surface-mounted enclosure through one or more nonflexible raceways not less than 450 mm (18 in.) and not more than 3.0 m (10 ft) in length, provided all of the following conditions are met:

(1) Each cable is fastened within 300 mm (12 in.), measured along the sheath, of the outer end of the raceway.

(2) The raceway extends directly above the enclosure and does not penetrate a structural ceiling.

(3) A fitting is provided on each end of the raceway to protect the cable(s) from abrasion and the fittings remain accessible after installation.

(4) The raceway is sealed or plugged at the outer end using approved means so as to prevent access to the enclosure through the raceway.

(5) The cable sheath is continuous through the raceway and extends into the enclosure beyond the fitting not less than 6 mm (¼ in.).

(6) The raceway is fastened at its outer end and at other points in accordance with the applicable article.

(7) Where installed as conduit or tubing, the cable fill does not exceed the amount that would be permitted for complete conduit or tubing systems by Table 1 of Chapter 9 of this Code and all applicable notes thereto. Note 2 to the tables in Chapter 9 does not apply to this condition.

Informational Note: See Table 1 in Chapter 9, including Note 9, for allowable cable fill in circular raceways. See 310.15(C)(1) for required ampacity reductions for multiple cables installed in a common raceway.

Exception No. 2: Single conductors and multiconductor cables shall be permitted to enter enclosures in accordance with 392.46(A) or (B).

Statement of Problem and Substantiation for Public Input

I added raceways to the rule so that it's clear that raceways are also required to be secured. The additional text "Where nonmetallic-sheathed cable or
multiconductor Type UF cable is used, the sheath shall extend not less than 6 mm (1⁄4 in.) inside the box and beyond any cable clamp." was extracted from 314.17(B). Currently there is no rule on the minimum length of the sheath.

Submitter Information Verification

Submitter Full Name:	Mike Holt
Organization:	Mike Holt Enterprises Inc
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sun Jul 26 09:58:02 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: CMP-9 is resolving all five of these PIs because they expand the application of the exception in ways that are inconsistent with the safety objectives of the requirements. CMP-9 notes that the fundamental rule is for each cable (or cable pair as recognized in some connector designs) to enter the enclosure through a connector designed for that purpose, and therefore capable of confining an arcing event to the enclosure. The exception trades off that ideal, to a carefully crafted extent, in favor of a substantial improvement in workmanship, as frequently applied in light commercial work involving suspended ceilings and related applications. PI-4423 would create an additional exception for outdoor applications extended from the sides, back or bottom of the enclosure in wet locations, greatly exceeding the intended use of the existing exception. PI-1736 would extend the reach of the exception to concealed applications. This is an entirely unnecessary expansion of usage because the cabinets to which it applies are equipped with numerous cable knockouts, or can be punched accordingly, and the concealed use entirely avoids the workmanship issues that motivated the insertion of the exception in the 1999 NEC. PI-2025 is resolved because there is no need to extend the requirement to raceways given the requirement in 300.12. In addition, CMP-9 is uncertain as to the exact intent of the first “sentence” in (C) as proposed because as written the words do not form a sentence in the English language. CMP-9 acknowledges that there is no ¼-in. sheath extension requirement at this location, but concludes that the rule would be excessive in cabinets with their far greater volumes that allow for better entrainment of such conductors. PI-1215 is resolved because there is no substantiation that supports the dramatic decrease in containment that would occur in such replacement panelboards. PI-538 is resolved because any extension of the exception as described would dramatically decrease the containment function of the cabinet due to the effective elimination of any significant raceway length. In addition, CMP-9 is reluctant to apply this concept to the back of a cabinet. Such locations are inherently much closer to the energized busbars. Contrary to the assertion made in the substantiation, these pre-punched knockout positions are related to potential supply or related uses such as a feed-through application, and with the bending space calculated in accordance with 408.55(C).

Public Input No. 352-NFPA 70-2020 [Section No. 312.5(A)]

(A) ~~Openings to Be Closed~~ Conductors .

~~Openings through which conductors enter~~ Single conductors entering an enclosure shall be ~~closed~~ protected in an approved manner.

Statement of Problem and Substantiation for Public Input

This issue is addressed in section 110.12 (A) and is not needed to be repeated here. However single conductors such as grounding electrode conductors or equipment grounding conductors allowed in 250.130 (C) entering an enclosures are not addressed this new language would allow the use of manufacture holes in equipment, or chase nipples and NM cables with bushings to be acceptable if approved

Submitter Information Verification

Submitter Full Name: Alfio Torrisi

Organization: Master electrician

Street Address:

City:

State:

Zip:

Submittal Date: Thu Jan 23 10:32:01 EST 2020

Committee: NEC-P09

Committee Statement

Resolution: CMP-9 disagrees with the assertion that 110.12(A), which covers “unused openings,” applies to “openings through which conductors enter” and therefore, the substantiation is not persuasive. In addition, CMP-9 does not want to write a rule that could be interpreted as infringing on the jurisdiction of CMP-5 relative to how grounding electrode conductors are permitted to enter enclosures.

Public Input No. 2134-NFPA 70-2020 [Section No. 312.5(B)]

(B) Metal Cabinets, Cutout Boxes, and Meter Socket Enclosures.

Where metal enclosures within the scope of this article are installed with messenger-supported wiring, open wiring on insulators, or concealed knob-and-tube wiring, conductors shall enter through insulating bushings or, in dry locations, through flexible tubing extending from the last insulating support and firmly secured to the enclosure or within 300 mm (12 in .) of the enclosure .

Statement of Problem and Substantiation for Public Input

Section 300.15 requires that fittings and connectors must only be used with the specific wiring methods for which they are designed and listed. As best I have been able to determine, fittings listed for securing loom to enclosures--as well as concealable fittings for transitioning from loom to other wiring methods--are no longer manufactured. In fact, the product standard, 514(B) contains a test, in 8.20, suitable for securing modern loom but not necessarily older, larger loom. Therefore, where it is necessary to enclose knob-and-tube wiring in loom, it will be useful to have an alternative means of securing it. For example, where an installer is replacing a panelboard, to avoid having to cut slots in the enclosure between knockouts, the conductors need to be run closer to each other than is permitted by 394.19(A). The proposed permission, parallel to that in 312.5(C), will formalize a practice that many AHJs may informally allow at present.

Submitter Information Verification

Submitter Full Name: David Shapiro

Organization: Safety First Electrical

Street Address:

City:

State:

Zip:

Submittal Date: Sun Aug 02 15:11:15 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: CMP-9 resolves this PI because the stated dimension is not substantiated. The rule in 394.19(A) (3 in. separation, 1 in. over structure) is not relevant to the objective of regulating entry into enclosures, and for that purpose the stated dimension of 12 in. is excessive. CMP-9 concludes that the existing requirement for firm securement to the enclosure is sufficient. There are many methods to accomplish this, and the AHJ will be the judge as to suitability.

Public Input No. 4423-NFPA 70-2020 [New Section after 312.5(C)]

Exception No. 3:

Exception 3: Cables with entirely nonmetallic sheaths shall be permitted to enter the sides, back, or bottom of an exterior surface-mounted enclosure through one or more nonmetallic flexible raceway types listed for use in a wet location, provided all of the following conditions are met:

(1) *Each cable is secured within 300 mm (12 in.), measured along the sheath, of the outer end of the raceway.*

(2) *The raceway extends inside the interior of the building stud cavity for a minimum of 300 mm (12 in.) from the end of the uppermost bend in the raceway and does not penetrate the top plate.*

(3) *A wet location connector listed for use with the raceway is utilized for entrance to the enclosure.*

(4) *The raceway is sealed or plugged at the outer end using approved means so as to prevent access to the enclosure through the raceway.*

(5) *The cable sheath is continuous through the raceway and extends into the enclosure beyond the fitting not less than 6 mm (¼ in.).*

(6) *The raceway is fastened at its outer end and at other points in accordance with the applicable article.*

(7) *Where no more than four cables are installed in a flexible raceway, Table 1 of Chapter 9 shall apply. Where installed as conduit or tubing, the cable fill does not exceed the amount that would be permitted for complete conduit or tubing systems by table 1 of Chapter 9 of this code and all applicable notes thereto. Note 2 to the tables in Chapter 9 does not apply to this condition.*

Exception to (7): Note 2 to the tables shall be permitted to apply to this condition where only a single multi-conductor cable is installed.

(1) *Type NM or NMC cable shall be permitted to be installed in a raceway which conforms to this section to exterior mounted panelboards that comply with 312.2 if not more than 450 mm (18 in.) is exposed to a damp or wet location as defined in 300.9.*

Informational Note: See Table 1 in Chapter 9, Including Note 9, for allowable cable fill in circular raceways. See 310.15 (C)(1) for required ampacity reductions for multiple cables installed in a common raceway. See 300.9 for permissible conductor and cable types installed in raceways in wet locations abovegrade.

Additional Proposed Changes

File Name	Description	Approved
I_4423-NFPA_70-2020_CHRIS_VALTIERRA.pdf	P I 4423-NFPA 70-2020_CHRIS_VALTIERRA	

Statement of Problem and Substantiation for Public Input

Current Code text creates the unintended consequence of NM and SE cables entering an exterior surface mounted enclosure in a wet location through the building envelope.

These changes will permit codification of three issues which exist or will exist after the adoption of the 2020 NEC because of sections 230.71(B) & 230.85.

1. SE Cable Style R is the most common cable installed in the North Texas area as well as other parts of the United States for Single Family, (33,000 new permits annually) Two Family, and Multi-Family Dwelling Unit feeders. Currently there is not a listed, raintight connector for SE-R cable. When terminated into NEMA-3R Service Disconnects or Meter Packs containing service disconnects located in a wet location on the exterior, there is not a Code compliant solution for the cable entrance into the equipment.

2. Type NM cable entrances into exterior panelboards and exterior device boxes. Currently the Standard Trade Practice for the North Texas Region and other parts of the United States, is to enter in the back of a NEMA-3R cabinet via a PVC male adaptor. This practice is not codified, is a violation of the listing of the PVC male adaptor and can permit insects, vermin and the like to enter the enclosure through the PVC male adaptor as well as permit the uncooled products of combustion to escape into the building.

3. Additionally, in structures of Type III, IV, and V construction, Type NM and NMC cable is typically installed to exterior device boxes in damp and wet locations via LFNC raceway.

The modification of this section of the NEC (as well as a modification of section 334.10) would provide a codified path for the installation of branch circuit and feeder cables to meter packs, panelboards and exterior device locations while limiting the exposure of cables which are not listed for wet locations to a minimum length and providing a raintight raceway entrance into wet location enclosures. Regarding the NM and NMC cable located in the wet location area of the masonry and voids behind the equipment, I do not know of any cable failures in this area where the cables have been employed in this manner.

By limiting the number of cables to two, this avoids the requirements of the allowable cable fill does not exceed that permitted for complete conduit or tubing systems by Table 1 of Chapter 9 of the Code, and all applicable notes thereto.

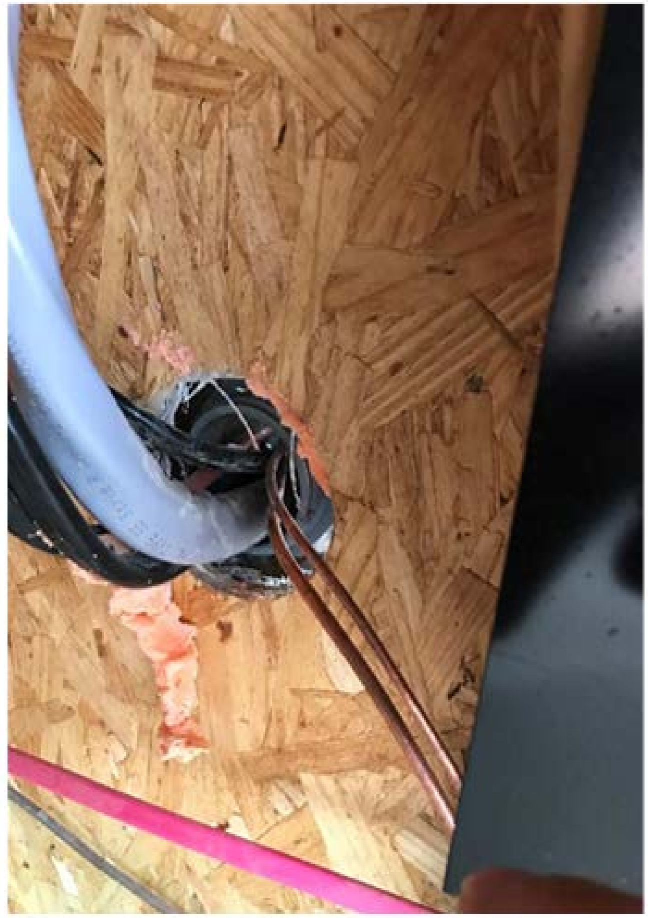
Submitter Information Verification

Submitter Full Name:	Chris Valtierra
Organization:	City of Waco TX
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Sep 10 12:50:40 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: CMP-9 is resolving all five of these PIs because they expand the application of the exception in ways that are inconsistent with the safety objectives of the requirements. CMP-9 notes that the fundamental rule is for each cable (or cable pair as recognized in some connector designs) to enter the enclosure through a connector designed for that purpose, and therefore capable of confining an arcing event to the enclosure. The exception trades off that ideal, to a carefully crafted extent, in favor of a substantial improvement in workmanship, as frequently applied in light commercial work involving suspended ceilings and related applications. PI-4423 would create an additional exception for outdoor applications extended from the sides, back or bottom of the enclosure in wet locations, greatly exceeding the intended use of the existing exception. PI-1736 would extend the reach of the exception to concealed applications. This is an entirely unnecessary expansion of usage because the cabinets to which it applies are equipped with numerous cable knockouts, or can be punched accordingly, and the concealed use entirely avoids the workmanship issues that motivated the insertion of the exception in the 1999 NEC. PI-2025 is resolved because there is no need to extend the requirement to raceways given the requirement in 300.12. In addition, CMP-9 is uncertain as to the exact intent of the first “sentence” in (C) as proposed because as written the words do not form a sentence in the English language. CMP-9 acknowledges that there is no ¼-in. sheath extension requirement at this location, but concludes that the rule would be excessive in cabinets with their far greater volumes that allow for better entrainment of such conductors. PI-1215 is resolved because there is no substantiation that supports the dramatic decrease in containment that would occur in such replacement panelboards. PI-538 is resolved because any extension of the exception as described would dramatically decrease the containment function of the cabinet due to the effective elimination of any significant raceway length. In addition, CMP-9 is reluctant to apply this concept to the back of a cabinet. Such locations are inherently much closer to the energized busbars. Contrary to the assertion made in the substantiation, these pre-punched knockout positions are related to potential supply or related uses such as a feed-through application, and with the bending space calculated in accordance with 408.55(C).

PI 4423-NFPA 70-2020 Chris Valtierra


SUPPLY®

Public Input No. 1215-NFPA 70-2020 [Section No. 312.5(C)]

(C) Cables.

Where cable is used, each cable shall be secured to the cabinet, cutout box, or meter socket enclosure.

Exception No. 1: Cables with entirely nonmetallic sheaths shall be permitted to enter the top of a surface-mounted enclosure through one or more nonflexible raceways not less than 450 mm (18 in.) and not more than 3.0 m (10 ft) in length, provided all of the following conditions are met:

(1) Each cable is fastened within 300 mm (12 in.), measured along the sheath, of the outer end of the raceway.

(2) The raceway extends directly above the enclosure and does not penetrate a structural ceiling.

(3) A fitting is provided on each end of the raceway to protect the cable(s) from abrasion and the fittings remain accessible after installation.

(4) The raceway is sealed or plugged at the outer end using approved means so as to prevent access to the enclosure through the raceway.

(5) The cable sheath is continuous through the raceway and extends into the enclosure beyond the fitting not less than 6 mm (¼ in.).

(6) The raceway is fastened at its outer end and at other points in accordance with the applicable article.

(7) Where installed as conduit or tubing, the cable fill does not exceed the amount that would be permitted for complete conduit or tubing systems by Table 1 of Chapter 9 of this Code and all applicable notes thereto. Note 2 to the tables in Chapter 9 does not apply to this condition.

Informational Note: See Table 1 in Chapter 9, including Note 9, for allowable cable fill in circular raceways. See 310.15(C)(1) for required ampacity reductions for multiple cables installed in a common raceway.

~~Exception No~~ Exception No . 2: To facilitate the change out of existing panelboards (primary residential) where single or multiple nonmetallic sheathed cables enter the cabinet from the back or any of the sides through a bushing or nipple additional cable securement is not required.

Exception No. 3: Single conductors and multiconductor cables shall be permitted to enter enclosures in accordance with 392.46(A) or (B).

Statement of Problem and Substantiation for Public Input

To facilitate the change out of existing panelboards (primary residential) where single or multiple nonmetallic sheathed cables enter the cabinet from the back or any of the sides through a bushing or nipple additional cable securement is not required.

For many decades multiple (usually all of the cables) nonmetallic sheathed cables entered a panelboard cabinet through a single opening in the cabinet; typically, the backside of the cabinet. When changing out an existing panelboard it is typically not practical to secure each of the existing nonmetallic sheathed cables to the cabinet.

A new or an expanded exception to 312.5 (C) Cables will provide needed clarity to inspectors, installers, etc.

Submitter Information Verification

Submitter Full Name: Gary Hein
Organization: Submission is independent of employer.
Street Address:
City:
State:
Zip:
Submittal Date: Sat May 23 08:56:54 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: CMP-9 is resolving all five of these PIs because they expand the application of the exception in ways that are inconsistent with the safety objectives of the requirements. CMP-9 notes that the fundamental rule is for each cable (or cable pair as recognized in some connector designs) to enter the enclosure through a connector designed for that purpose, and therefore capable of confining an arcing event to the enclosure. The exception trades off that ideal, to a carefully crafted extent, in favor of a substantial improvement in workmanship, as frequently applied in light commercial work involving suspended ceilings and related applications. PI-4423 would create an additional exception for outdoor applications extended from the sides, back or bottom of the enclosure in wet locations, greatly exceeding the intended use of the existing exception. PI-1736 would extend the reach of the exception to concealed applications. This is an entirely unnecessary expansion of usage because the cabinets to which it applies are equipped with numerous cable knockouts, or can be punched accordingly, and the concealed use entirely avoids the workmanship issues that motivated the insertion of the exception in the 1999 NEC. PI-2025 is resolved because there is no need to extend the requirement to raceways given the requirement in 300.12. In addition, CMP-9 is uncertain as to the exact intent of the first “sentence” in (C) as proposed because as written the words do not form a sentence in the English language. CMP-9 acknowledges that there is no ¼-in. sheath extension requirement at this location, but concludes that the rule would be excessive in cabinets with their far greater volumes that allow for better entrainment of such conductors. PI-1215 is resolved because there is no substantiation that supports the dramatic decrease in containment that would occur in such replacement panelboards. PI-538 is resolved because any extension of the exception as described would dramatically decrease the containment function of the cabinet due to the effective elimination of any significant raceway length. In addition, CMP-9 is reluctant to apply this concept to the back of a cabinet. Such locations are inherently much closer to the energized busbars. Contrary to the assertion made in the substantiation, these pre-punched knockout positions are related to potential supply or related uses such as a feed-through application, and with the bending space calculated in accordance with 408.55(C).

Public Input No. 538-NFPA 70-2020 [Section No. 312.5(C)]

(C) Cables.

Where cable is used, each cable shall be secured to the cabinet, cutout box, or meter socket enclosure.

Exception No. 1: Cables with entirely nonmetallic sheaths shall be permitted to enter the top or back of a surface-mounted enclosure through one or more nonflexible raceways not less than 450 mm (~~18 in~~ 2 in .) and not more than 3.0 m (10 ft) in length, provided all of the following conditions are met:

(1) Each cable is fastened within 300 mm (12 in.), measured along the sheath, of the outer end of the raceway.

(2) The raceway extends directly above the enclosure and does not penetrate a structural ceiling.

(3) A fitting is provided on each end of the raceway to protect the cable(s) from abrasion and the fittings remain accessible after installation.

(4) The raceway is sealed or plugged at the outer end using approved means so as to prevent access to the enclosure through the raceway.

(5) The cable sheath is continuous through the raceway and extends into the enclosure beyond the fitting not less than 6 mm (¼ in.).

(6) The raceway is fastened at its outer end and at other points in accordance with the applicable article.

(7) Where installed as conduit or tubing, the cable fill does not exceed the amount that would be permitted for complete conduit or tubing systems by Table 1 of Chapter 9 of this Code and all applicable notes thereto. Note 2 to the tables in Chapter 9 does not apply to this condition.

Informational Note: See Table 1 in Chapter 9, including Note 9, for allowable cable fill in circular raceways. See 310.15(C)(1) for required ampacity reductions for multiple cables installed in a common raceway.

Exception No. 2: Single conductors and multiconductor cables shall be permitted to enter enclosures in accordance with 392.46(A) or (B).

Statement of Problem and Substantiation for Public Input

Where installing an outdoor cabinet or cut out for a panel or load center on a dwelling there is not enough room to accommodate individual cables. This is using the same exception as before but allowing it to be used coming in the back of the box not just the top. This also makes the wall where it is mounted to be better sealed because it will not take as much surface area . Load centers and panels come with pre-made large holes at the bottom in the back that are designed for this common practice. Many jurisdictions will not allow one or two large nipples in the back and refer to this section as the reason to reject the installation.

Submitter Information Verification

Submitter Full Name: David Hittinger
Organization: IEC
Street Address:

City:

State:

Zip:

Submittal Date: Wed Feb 26 15:23:18 EST 2020

Committee: NEC-P09

Committee Statement

Resolution: CMP-9 is resolving all five of these PIs because they expand the application of the exception in ways that are inconsistent with the safety objectives of the requirements. CMP-9 notes that the fundamental rule is for each cable (or cable pair as recognized in some connector designs) to enter the enclosure through a connector designed for that purpose, and therefore capable of confining an arcing event to the enclosure. The exception trades off that ideal, to a carefully crafted extent, in favor of a substantial improvement in workmanship, as frequently applied in light commercial work involving suspended ceilings and related applications. PI-4423 would create an additional exception for outdoor applications extended from the sides, back or bottom of the enclosure in wet locations, greatly exceeding the intended use of the existing exception. PI-1736 would extend the reach of the exception to concealed applications. This is an entirely unnecessary expansion of usage because the cabinets to which it applies are equipped with numerous cable knockouts, or can be punched accordingly, and the concealed use entirely avoids the workmanship issues that motivated the insertion of the exception in the 1999 NEC. PI-2025 is resolved because there is no need to extend the requirement to raceways given the requirement in 300.12. In addition, CMP-9 is uncertain as to the exact intent of the first “sentence” in (C) as proposed because as written the words do not form a sentence in the English language. CMP-9 acknowledges that there is no ¼-in. sheath extension requirement at this location, but concludes that the rule would be excessive in cabinets with their far greater volumes that allow for better entrainment of such conductors. PI-1215 is resolved because there is no substantiation that supports the dramatic decrease in containment that would occur in such replacement panelboards. PI-538 is resolved because any extension of the exception as described would dramatically decrease the containment function of the cabinet due to the effective elimination of any significant raceway length. In addition, CMP-9 is reluctant to apply this concept to the back of a cabinet. Such locations are inherently much closer to the energized busbars. Contrary to the assertion made in the substantiation, these pre-punched knockout positions are related to potential supply or related uses such as a feed-through application, and with the bending space calculated in accordance with 408.55(C).

Public Input No. 353-NFPA 70-2020 [Section No. 312.5 [Excluding any Sub-Sections]]

~~Conductors~~ Insulated or covered conductors entering enclosures within the scope of this article shall be protected from abrasion and shall comply with 312.5(A) through (C).

Statement of Problem and Substantiation for Public Input

what is the point if they are not insulated or covered

Submitter Information Verification

Submitter Full Name: Alfio Torrisi
Organization: master electrician
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jan 23 10:52:28 EST 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7704-NFPA 70-2020
Statement: Cmp-9 is correcting the parent language to accurately cover the intended coverage of this section.

Public Input No. 3562-NFPA 70-2020 [Section No. 312.6]

312.6 Deflection of Conductors.

Conductors at terminals or conductors entering or leaving cabinets, cutout boxes, and meter socket enclosures shall comply with 312.6(A) through (C).

Exception: Wire-bending space in enclosures for motor controllers with provisions for one or two wires per terminal shall comply with 430.10(B).

(A) Width of Wiring Gutters.

Conductors shall not be deflected within a cabinet or cutout box unless a gutter having a width in accordance with Table 312.6(A) is provided. Conductors in parallel in accordance with 310.10(G) shall be judged on the basis of the number of conductors in parallel.

Table 312.6(A) Minimum Wire-Bending Space at Terminals and Minimum Width of Wiring Gutters

Wire Size (AWG or kcmil)		Wires per Terminal									
All Other Conductors	Compact Stranded AA-8000 Aluminum Alloy Conductors (see Note 2)	1		2		3		4		5	
		mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
14–10	12–8	Not specified		—	—	—	—	—	—	—	—
8–6	6–4	38.1	1½	—	—	—	—	—	—	—	—
4–3	2–1	50.8	2	—	—	—	—	—	—	—	—
2	1/0	63.5	2½	—	—	—	—	—	—	—	—
1	2/0	76.2	3	—	—	—	—	—	—	—	—
1/0–2/0	3/0–4/0	88.9	3½	127	5	178	7	—	—	—	—
3/0–4/0	250–300	102	4	152	6	203	8	—	—	—	—
250	350	114	4½	152	6	203	8	254	10	—	—
300–350	400–500	127	5	203	8	254	10	305	12	—	—
400–500	600–750	152	6	203	8	254	10	305	12	356	14
600–700	800–1000	203	8	254	10	305	12	356	14	406	16
750–900	—	203	8	305	12	356	14	406	16	457	18
1000–1250	—	254	10	—	—	—	—	—	—	—	—
1500–2000	—	305	12	—	—	—	—	—	—	—	—

Notes:

1. Bending space at terminals shall be measured in a straight line from the end of the lug or wire connector (in the direction that the wire leaves the terminal) to the wall, barrier, or obstruction.

2. This column shall be permitted to be used to determine the minimum wire-bending space for compact stranded aluminum conductors in sizes up to 1000 kcmil and manufactured using AA-8000 series electrical grade aluminum alloy conductor material in accordance with 310.3(B). The minimum width of the wire gutter space shall be determined using the all other conductors value in this table.

(B) Wire-Bending Space at Terminals.

Wire-bending space at each terminal shall be provided in accordance with 312.6(B)(1) or (B)(2).

(1) Conductors Not Entering or Leaving Opposite Wall.

Table 312.6(A) shall apply where the conductor does not enter or leave the enclosure through the wall opposite its terminal.

(2) Conductors Entering or Leaving Opposite Wall.

Table 312.6(B) shall apply where the conductor does enter or leave the enclosure through the wall opposite its terminal.

Exception No. 1: Where the distance between the wall and its terminal is in accordance with Table 312.6(A), a conductor shall be permitted to enter or leave an enclosure through the wall opposite its terminal, provided the conductor enters or leaves the enclosure where the gutter joins an adjacent gutter that has a width that conforms to Table 312.6(B) for the conductor.

Exception No. 2: A conductor not larger than 350 kcmil shall be permitted to enter or leave an enclosure containing only a meter socket(s) through the wall opposite its terminal, provided the distance between the terminal and the opposite wall is not less than that specified in Table 312.6(A) and the terminal is a lay-in type or removable lug with integral mounting tang, where the terminal is either of the following:

(1) Directed toward the opening in the enclosure and within a 45-degree angle of directly facing the enclosure wall

(2) Directly facing the enclosure wall and offset not greater than 50 percent of the bending space specified in Table 312.6(A)

Informational Note: *Offset* is the distance measured along the enclosure wall from the axis of the centerline of the terminal to a line passing through the center of the opening in the enclosure.

Table 312.6(B) Minimum Wire-Bending Space at Terminals

Wire Size (AWG or kcmil)		**Wires per Terminal**							
		1		**2**		**3**		**4 or More**	
All Other Conductors	**Compact Stranded AA-8000 Aluminum Alloy Conductors (See Note 3.)**	**mm**	**in.**	**mm**	**in.**	**mm**	**in.**	**mm**	**in.**
14–10	12–8	Not specified		—	—	—		—	—
8	6	38.1	1½	—	—	—		—	—
6	4	50.8	2	—	—	—		—	—
4	2	76.2	3	—	—	—		—	—
3	1	76.2	3	—	—	—		—	—
2	1/0	88.9	3½	—	—	—		—	—
1	2/0	114	4½	—	—	—		—	—
1/0	3/0	140	5½	140	5½	178	7	—	—
2/0	4/0	152	6	152	6	190	7½	—	—
3/0	250	165[a]	6½[a]	165[a]	6½[a]	203	8	—	—
4/0	300	178[b]	7[b]	190[c]	7½[c]	216[a]	8½[a]	—	—
250	350	216[d]	8½[d]	216[d]	8½[d]	229[b]	9[b]	254	10
300	400	254[e]	10[e]	254[d]	10[d]	279[b]	11[b]	305	12
350	500	305[e]	12[e]	305[e]	12[e]	330[e]	13[e]	356[d]	14[d]
400	600	330[e]	13[e]	330[e]	13[e]	356[e]	14[e]	381[e]	15[e]
500	700–750	356[e]	14[e]	356[e]	14[e]	381[e]	15[e]	406[e]	16[e]
600	800–900	381[e]	15[e]	406[e]	16[e]	457[e]	18[e]	483[e]	19[e]

Wire Size (AWG or kcmil)		Wires per Terminal							
		1		2		3		4 or More	
All Other Conductors	Compact Stranded AA-8000 Aluminum Alloy Conductors (See Note 3.)	mm	in.	mm	in.	mm	in.	mm	in.
700	1000	406[e]	16[e]	457[e]	18[e]	508[e]	20[e]	559[e]	22[e]
750	—	432[e]	17[e]	483[e]	19[e]	559[e]	22[e]	610[e]	24[e]
800	—	457	18	508	20	559	22	610	24
900	—	483	19	559	22	610	24	610	24
1000	—	508	20	—	—	—		—	
1250	—	559	22	—	—	—		—	
1500	—	610	24	—	—	—		—	
1750	—	610	24	—	—	—		—	
2000	—	610	24	—	—	—		—	

Notes:

1. Bending space at terminals shall be measured in a straight line from the end of the lug or wire connector in a direction perpendicular to the enclosure wall.

2. For removable and lay-in wire terminals intended for only one wire, bending space shall be permitted to be reduced by the following number of millimeters (inches):

[a]12.7 mm (½ in.)

[b]25.4 mm (1 in.)

[c]38.1 mm (1½ in.)

[d]50.8 mm (2 in.)

[e]76.2 mm (3 in.)

3. This column shall be permitted to determine the required wire-bending space for compact stranded aluminum conductors in sizes up to 1000 kcmil and manufactured using AA-8000 series electrical grade aluminum alloy conductor material in accordance with 310.3(B).

(C) Conductors 4 AWG or Larger.

Installation shall comply with 300.4(G).

Additional Proposed Changes

File Name	Description	Approved
NEC_2023_Proposed_Change_To_Section_312_6.docx	Proposal to move information contained in 312.6 to Article 110	

Statement of Problem and Substantiation for Public Input

This proposal is to relocate all the information contained in Section 312.6 to Article 110. Minimum wire bending space issues are extremely common in electrical installations. Tables 312.6(A) and (B) are referenced in several articles (312, 314, 366, 376, 378, 380, 404, 450). Moving the information contained in 312.6 to Article 110 would promote consistency and commonality in locating this information.

Submitter Information Verification

Submitter Full Name: Mark Mathews
Organization: Not affiliated with a company or business
Affiliation: Not affiliated with a client or organization
Street Address:
City:
State:
Zip:
Submittal Date: Tue Sep 08 22:56:24 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: CMP-9 is resolving this PI because the bending space required at terminations is logically related to the enclosures within the scope of the article. This subject has been included here since the emergence of cabinets and cutout boxes as a separate article (then Art. 373) in the 1947 edition, and users are justifiably accustomed to finding it in this location. In addition, with the exception of Art. 100, responsibility for coverage of technical content has been made on an article by article basis by the Correlating Committee. The technical expertise for the evaluation of these requirements plainly belongs to CMP-9, and this would be lost if the material were relocated into Art. 110.

This proposal is to relocate the information contained in Section 312.6, *Deflection of Conductors*, to Article 110.

This proposal does not include technical changes to 312.6.

Public Input No. 409-NFPA 70-2020 [Section No. 312.8(A)]

(A) Splices, Taps, and Feed-Through Conductors.

The wiring space of enclosures for switches or overcurrent devices shall be permitted for conductors feeding through, spliced, or tapping off to other enclosures, switches, or overcurrent devices where all of the following conditions are met:

(1) **Comply with 314.28(A)(2)**

(1) The total of all conductors installed at any cross section of the wiring space does not exceed 40 percent of the cross-sectional area of that space.

(2) The total area of all conductors, splices, and taps installed at any cross section of the wiring space does not exceed 75 percent of the cross-sectional area of that space.

(3) A warning label complying with 110.21(B) is applied to the enclosure that identifies the closest disconnecting means for any feed-through conductors.

Statement of Problem and Substantiation for Public Input

In 312.8(A) it doesn't mention anything about calculations regarding the conductor bends. If conductors are passing through a panel the cabinet could be too small for the conductor bend radius. It also don't make any reference to 314.16 and 314.28(A) and the installer could be in violation by not taking it into account. If splices are made and the cabinet that encloses the overcurrent protection is being used as a pull box then please reference it in in 312.8(A).

Please clarify.

Submitter Information Verification

Submitter Full Name: Jose Franco

Organization: [Not Specified]

Street Address:

City:

State:

Zip:

Submittal Date: Mon Feb 03 16:42:01 EST 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7708-NFPA 70-2020

Statement: If large conductors (4 AWG and up) are installed in these wiring spaces, the dimensions in 314.28(A)(2) should be applied. These enclosures do not differ in terms of minimum bending space concerns from comparable enclosures in Art. 314.

Public Input No. 2295-NFPA 70-2020 [Section No. 312.8(B)(1)]

(1) Identification.

~~The power monitoring or energy~~ Power monitoring equipment and energy management equipment shall either be identified as a field installable accessory as part of the listed equipment, or ~~is~~ shall be a listed kit evaluated for field installation in switch or overcurrent device enclosures.

Statement of Problem and Substantiation for Public Input

1) The logic operator 'or' does not apply between the two categories of power monitoring equipment and energy management equipment. If both types were present, than this language would infer only one need comply rather than both. So the logic operator 'and' is required.
2) the syntax for the two compliance options infer that "or is a listed kit" should be written as "or as a listed kit".

Submitter Information Verification

Submitter Full Name: John Blissett
Organization: Bernhard TME
Street Address:
City:
State:
Zip:

Submittal Date: Thu Aug 13 17:51:35 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7709-NFPA 70-2020

Statement: CMP-9 is editorially correcting the syntax of the existing text to clarify that the equipment in any given enclosure may be either an accessory or a kit, with differing standards of product acceptance as applicable.

Public Input No. 1214-NFPA 70-2020 [New Section after 312.10(C)]

Machine Screws

Include language requiring machine screws to attach covers similar in intent to 404.10 (B) and 406.5 to prevent the use of screws such as wood or drywall screws.

Statement of Problem and Substantiation for Public Input

Add language perhaps to 312.10 Construction Specifications to specifically require screws used to attach covers and similar that enter cabinets, cutout boxes, or meter socket enclosures to be of a design that lessens the possibility of damage to conductors.

Include language requiring machine screws to attach covers similar in intent to 404.10 (B) and 406.5 to prevent the use of screws such as wood or drywall screws.

Submitter Information Verification

Submitter Full Name: Gary Hein

Organization: Submission is independent of employer.

Street Address:

City:

State:

Zip:

Submittal Date: Sat May 23 08:50:11 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7820-NFPA 70-2020

Statement: CMP-9 is addressing the hazards involved in the insertion, blind or otherwise, of screws into enclosures within the scope of Art. 312. Any screw sanctioned by the equipment manufacturer will be automatically acceptable. Other screws, such as those used to attach identifying medallions must have machine threads and have blunt ends. This eliminates sharp points and coarse threads with the attendant sharp-edged thread exposures of typical sheet metal screws. The length of penetration is also limited in areas of an enclosure that form a boundary of a wiring gutter or other wiring space. For such exposures, the penetration is limited to ¼ inch. However, if the penetration in such cases is near (within 3/8 inch) an adjacent wall, the length increases to allow a ½ inch screw (expressed in terms of the amount of actual penetration, or 7/16ths inch). This reflects the successful use of screws to attach covers on boxes and wireways.

Public Input No. 2901-NFPA 70-2020 [New Section after 312.11]

314.25 Covers and Canopies.

In completed installations, each cabinets, cutout boxes, and meter socket enclosures shall have a cover.

Statement of Problem and Substantiation for Public Input

This is an important requirement that is missing from Article 312.

Submitter Information Verification

Submitter Full Name:	Mike Holt
Organization:	Mike Holt Enterprises Inc
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Sep 03 09:04:01 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: FR-7711-NFPA 70-2020

Statement: CMP-9 is inserting a rule that will assure that covers are provided. Unlike the comparable requirement for boxes in 314.25, this rule is being inserted in Part II of the article that addresses product standards. The covers for these enclosures are highly specialized and therefore should be created by the equipment manufacturers involved and included in the product acceptance evaluation. Although this action does fill a gap in the Code, CMP-9 concludes such covers are routinely being manufactured and shipped with equipment now being installed in the field.

Public Input No. 661-NFPA 70-2020 [New Section after 312.11]

312.14 Dissimilar Metals.

Where practicable, dissimilar metals in contact anywhere in the system shall be avoided to eliminate

the possibility of galvanic action. Aluminum cabinets,cutout boxes and enclosures shall be permitted to be used with galvanized steel fittings,

and galvanized steel cabintes, cutout boxes and enclosures shall be permitted to be used with aluminum fittings where not subject to severe

corrosive influences. Stainless steel cabintes, cutout boxes and encloures shall only be used with stainless steel fittings and approved accessories, and raceways

Statement of Problem and Substantiation for Public Input

currently there is no requirement to use cabinets with compatible raceways and fitting or to avoid general galvanic action

Submitter Information Verification

Submitter Full Name: Alfio Torrisi
Organization: master electrician
Street Address:
City:
State:
Zip:
Submittal Date: Mon Mar 16 10:55:51 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: CMP-9 concludes that the issues of contact between dissimilar metals are adequately addressed in the various metal raceway articles, generally at Sections 14. CMP-9 also concludes that an action on its part in this article would create the ongoing possibility of conflicts with those raceway sections, and therefore represent poor code administration.

Public Input No. 1097-NFPA 70-2020 [New Section after 312.11(D)]

TITLE OF NEW CONTENT 312.26 Coarse Thread Screws.

Type your content here ...

Coarse thread screw(s) shall not enter electrical enclosures.

Statement of Problem and Substantiation for Public Input

Whether coarse thread screws are added before conductors or electrical components are installed or added to an existing installation; they are a recipe for disaster. Coarse thread self-tapper screws are very convenient and used this way and should be a code violation. The closest the NEC comes to addressing it is 314.23B1 but it isn't the same message as this new public input.

The way the new entry is worded allows coarse thread screws to exit enclosures. For instance, an electrical component could be mounted in an electrical enclosure with coarse thread self-tapper screws zipped from the inside to the outside of the enclosure.

It isn't necessary to write this public input again in Article 408. Already, 408.2 includes Article 408 by mentioning Article 312.

An inspector friend of mine told me of the time he removed a meter enclosure cover and it blew up in his face and hands. A brass address tag was zipped to the meter enclosure cover with a framing screw. Evidently, the screw entered the ungrounded conductor insulation and was just shy of the conductor itself. Removing the cover created the faulted circuit. Don't ask about tamper tags and energized circuits. That's all I know!

This isn't the only reason. I believe field installed sharp points and edges do not belong. Often, they are installed blind to what is enclosed. They can also inhibit the removal of covers by dragging on conductors or deadfronts.

Submitter Information Verification

Submitter Full Name: Norman Feck

Organization: State of Colorado

Street Address:

City:

State:

Zip:

Submittal Date: Sat May 16 12:17:33 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7820-NFPA 70-2020

Statement: CMP-9 is addressing the hazards involved in the insertion, blind or otherwise, of screws into enclosures within the scope of Art. 312. Any screw sanctioned by the equipment manufacturer will be automatically acceptable. Other screws, such as those used to attach identifying medallions must have machine threads and have blunt ends. This eliminates sharp points and coarse threads with the attendant sharp-edged thread exposures of typical sheet metal screws. The length of penetration is also limited in areas of an enclosure that form a boundary of a wiring gutter or other wiring space. For such exposures, the penetration is limited to ¼ inch. However, if the penetration in such cases is near (within 3/8 inch) an adjacent wall, the length increases to allow a ½ inch screw (expressed in terms of the amount of actual penetration, or 7/16ths inch). This reflects the successful use of screws to attach covers on boxes and wireways.

Public Input No. 1291-NFPA 70-2020 [Section No. 314.16]

314.16 Number of Conductors in Outlet, Device, and Junction Boxes, and Conduit Bodies.

Boxes and conduit bodies shall be of an approved size to provide free space for all enclosed conductors. In no case shall the volume of the box, as calculated in 314.16(A), be less than the fill calculation as calculated in 314.16(B). The minimum volume for conduit bodies shall be as calculated in 314.16(C).

The provisions of this section shall not apply to terminal housings supplied with motors or generators.

Informational Note: For volume requirements of motor or generator terminal housings, see 430.12.

Boxes and conduit bodies enclosing conductors 4 AWG or larger shall also comply with the provisions of 314.28. Outlet and device boxes shall also comply with 314.24.

(A) Box Volume Calculations.

The volume of a wiring enclosure (box) shall be the total volume of the assembled sections and, where used, the space provided by plaster rings, domed covers, extension rings, and so forth, that are marked with their volume or are made from boxes the dimensions of which are listed in Table 314.16(A). Where a box is provided with one or more securely installed barriers, the volume shall be apportioned to each of the resulting spaces. Each barrier, if not marked with its volume, shall be considered to take up 8.2 cm^3 (½ $in.^3$) if metal, and 16.4 cm^3 (1.0 $in.^3$) if nonmetallic.

(1) Standard Boxes.

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

(2) Other Boxes.

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

Table 314.16(A) Metal Boxes

Box Trade Size			Minimum Volume		Maximum Number of Conductors* (arranged by AWG size)						
mm	in.	-	cm3	in.3	18	16	14	12	10	8	6
100 × 32	(4 × 1¼)	round/octagonal	205	12.5	8	7	6	5	5	5	2
100 × 38	(4 × 1½)	round/octagonal	254	15.5	10	8	7	6	6	5	3
100 × 54	(4 × 2⅛)	round/octagonal	353	21.5	14	12	10	9	8	7	4
100 × 32	(4× 1¼)	square	295	18.0	12	10	9	8	7	6	3
100 × 38	(4 × 1½)	square	344	21.0	14	12	10	9	8	7	4
100 × 54	(4 × 2⅛)	square	497	30.3	20	17	15	13	12	10	6
120 × 32	(4¹¹⁄₁₆ × 1¼)	square	418	25.5	17	14	12	11	10	8	5
120 × 38	(4¹¹⁄₁₆ × 1½)	square	484	29.5	19	16	14	13	11	9	5
120 × 54	(4¹¹⁄₁₆ × 2⅛)	square	689	42.0	28	24	21	18	16	14	8
75 × 50 × 38	(3 × 2 × 1½)	device	123	7.5	5	4	3	3	3	2	1
75 × 50 × 50	(3 × 2 × 2)	device	164	10.0	6	5	5	4	4	3	2
75× 50 × 57	(3× 2 × 2¼)	device	172	10.5	7	6	5	4	4	3	2
75 × 50 × 65	(3 × 2 × 2½)	device	205	12.5	8	7	6	5	5	4	2
75 × 50 × 70	(3 × 2 × 2¾)	device	230	14.0	9	8	7	6	5	4	2
75 × 50 × 90	(3 × 2 × 3½)	device	295	18.0	12	10	9	8	7	6	3
100 × 54 × 38	(4 × 2⅛ × 1½)	device	169	10.3	6	5	5	4	4	3	2
100 × 54 × 48	(4 × 2⅛ × 1⅞)	device	213	13.0	8	7	6	5	5	4	2
100 × 54 × 54	(4 × 2⅛ × 2⅛)	device	238	14.5	9	8	7	6	5	4	2
95 × 50 × 65	(3¾ × 2 × 2½)	masonry box/gang	230	14.0	9	8	7	6	5	4	2
95 × 50 × 90	(3¾ × 2 × 3½)	masonry box/gang	344	21.0	14	12	10	9	8	7	4
min. 44.5 depth	FS — single cover/gang (1¾)		221	13.5	9	7	6	6	5	4	2

Box Trade Size			Minimum Volume		Maximum Number of Conductors* (arranged by AWG size)						
mm	in.	-	cm3	in.3	18	16	14	12	10	8	6
min. 60.3 depth	FD — single cover/gang (2⅜)	295	18.0	12	10	9	8	7	6	3	
min. 44.5 depth	FS — multiple cover/gang (1¾)	295	18.0	12	10	9	8	7	6	3	
min. 60.3 depth	FD — multiple cover/gang (2⅜)	395	24.0	16	13	12	10	9	8	4	

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

(B) Box Fill Calculations.

The volumes in paragraphs 314.16(B)(1) through (B)(5), as applicable, shall be added together. No allowance shall be required for small fittings such as locknuts and bushings. Each space within a box installed with a barrier shall be calculated separately.

(1) Conductor Fill.

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

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

(2) Clamp Fill.

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

A clamp assembly that incorporates a cable termination for the cable conductors shall be listed and marked for use with specific nonmetallic boxes. Conductors that originate within the clamp assembly shall be included in conductor fill calculations covered in 314.16(B)(1) as though they entered from outside the box. The clamp assembly shall not require a fill allowance, but the volume of the portion of the assembly that remains within the box after installation shall be excluded from the box volume as marked in 314.16(A)(2).

(3) Support Fittings Fill.

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

(4) Device or Equipment Fill.

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

Table 314.16(B) Volume Allowance Required per Conductor

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

(5) Equipment Grounding Conductor Fill.

Where up to four equipment grounding conductors or equipment bonding jumpers enter a box, a single volume allowance in accordance with Table 314.16(B) shall be made based on the largest equipment grounding conductor or equipment bonding jumper entering the box. A ¼ volume allowance shall be made for each additional equipment grounding conductor or equipment bonding jumper that enters the box, based on the largest equipment grounding conductor or equipment bonding ~~conductor~~ jumper .

(C) Conduit Bodies.

(1) General.

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

(2) With Splices, Taps, or Devices.

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

(3) Short Radius Conduit Bodies.

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

Statement of Problem and Substantiation for Public Input

The word "conductor" was revised and replaced with 'jumper" to be consistent with language used in this section. The Equipment Bonding Jumper is a defined term per Article 100.

Submitter Information Verification

Submitter Full Name:	Megan Hayes
Organization:	Nema
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu May 28 11:29:24 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: FR-7734-NFPA 70-2020

Statement: CMP-9 has decided to revisit the action taken in the comment period of the 1996 cycle, when the reference to equipment bonding jumpers was initially added (Comment 9-5). It was substantiated on the basis that these components can run within raceways. CMP-9 now concludes that any such application, if even possible, would constitute an extension of an equipment grounding conductor, and would be addressable as such. In general, such jumpers begin and end within the box. As such, counting them would conflict with the general principle of not counting such wires, as stated in the final sentence of 314.16(B)(1). Removal of this phrasing simplifies the wording of the paragraph, and increases usability.

CMP-9 is also clarifying how the ¼ volume allowance is applied when different sizes of equipment grounding conductors enter the box. The current wording bases the basic fill allowance on the largest EGC entering the box; the revised wording makes clear the logical extension of that concept when the ¼ volume adder applies. For example, the EGC allowance for eight 12 AWG EGCs is (1+4×¼)2¼ = 4½ in3. If even one of those EGCs is a 10 AWG, then the allowance increases to (1+4×¼)2½ = 5 in3.

Public Input No. 1954-NFPA 70-2020 [Section No. 314.16(A)(2)]

(2) Other Boxes.

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

Table 314.16(A) Metal Boxes

Box Trade Size			**Minimum Volume**		**Maximum Number of Conductors*** (arranged by AWG size)							
mm	**in.**			**cm^3**	**in.^{3}**	**18**	**16**	**14**	**12**	**10**	**8**	**6**
100 × 32	(4 × 1¼)	round/octagonal	205	12.5	8	7	6	5	5~~5~~	4	2	
100 × 38	(4 × 1½)	round/octagonal	254	15.5	10	8	7	6	6~~5~~	4	3	
100 × 54	(4 × 2⅛)	round/octagonal	353	21.5	14	12	10	9	8	7	4	
100 × 32	(4× 1¼)	square	295	18.0	12	10	9	8	7	6	3	
100 × 38	(4 × 1½)	square	344	21.0	14	12	10	9	8	7	4	
100 × 54	(4 × 2⅛)	square	497	30.3	20	17	15	13	12	10	6	
120 × 32	(4¹¹⁄₁₆ × 1¼)	square	418	25.5	17	14	12	11	10	8	5	
120 × 38	(4¹¹⁄₁₆ × 1½)	square	484	29.5	19	16	14	13	11	9	5	
120 × 54	(4¹¹⁄₁₆ × 2⅛)	square	689	42.0	28	24	21	18	16	14	8	
75 × 50 × 38	(3 × 2 × 1½)	device	123	7.5	5	4	3	3	3	2	1	
75 × 50 × 50	(3 × 2 × 2)	device	164	10.0	6	5	5	4	4	3	2	
75× 50 × 57	(3× 2 × 2¼)	device	172	10.5	7	6	5	4	4	3	2	
75 × 50 × 65	(3 × 2 × 2½)	device	205	12.5	8	7	6	5	5	4	2	
75 × 50 × 70	(3 × 2 × 2¾)	device	230	14.0	9	8	7	6	5	4	2	
75 × 50 × 90	(3 × 2 × 3½)	device	295	18.0	12	10	9	8	7	6	3	
100 × 54 × 38	(4 × 2⅛ × 1½)	device	169	10.3	6	5	5	4	4	3	2	
100 × 54 × 48	(4 × 2⅛ × 1⅞)	device	213	13.0	8	7	6	5	5	4	2	
100 × 54 × 54	(4 × 2⅛ × 2⅛)	device	238	14.5	9	8	7	6	5	4	2	
95 × 50 × 65	(3¾ × 2 × 2½)	masonry box/gang	230	14.0	9	8	7	6	5	4	2	
95 × 50 × 90	(3¾ × 2 × 3½)	masonry box/gang	344	21.0	14	12	10	9	8	7	4	
min. 44.5 depth	FS — single cover/gang (1¾)		221	13.5	9	7	6	6	5	4	2	

Box Trade Size			Minimum Volume		Maximum Number of Conductors* (arranged by AWG size)						
mm	in.		cm3	in.3	18	16	14	12	10	8	6
min. 60.3 depth	FD — single cover/gang (2⅜)	295	18.0	12	10	9	8	7	6	3	
min. 44.5 depth	FS — multiple cover/gang (1¾)	295	18.0	12	10	9	8	7	6	3	
min. 60.3 depth	FD — multiple cover/gang (2⅜)	395	24.0	16	13	12	10	9	8	4	

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

Statement of Problem and Substantiation for Public Input

According to Table 314.16(B), an 8 AWG is 3.00 cubic inches. This means a 12.5 cubic inch box should only be capable of holding four of them, not five. Please note that Terra has decided to a bit of uninvited editing. My intention is to change the top two rows, 8 AWG column, to "4" conductors.

Submitter Information Verification

Submitter Full Name: Ryan Jackson

Organization: Ryan Jackson

Street Address:

City:

State:

Zip:

Submittal Date: Mon Jul 20 20:45:51 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7727-NFPA 70-2020

Statement: CMP-9 is correcting an error in the top row only of Table 314.16(A), in the 8 AWG column, by reducing it from 5 conductors to 4 conductors. This reflects the division of the rated volume (12.5 in3) by the required volume allowance for 8 AWG of 3 in3. This column was correct until the metrication task group made comprehensive changes throughout the 2002 NEC to shift from soft conversions to hard conversions as the default method. CMP-9 was presented with a new table (Proposal 9-14) set up with hard conversions. Every one of these values needed to be changed to soft conversions in one column, and dimensionless trade sizes in another column, all as allowed in 90.9. Had this work not been done, the NEC would have conflicted with established product standards and created chaos. During the process of making all the recalculations and related edits, the error in the 8 AWG column in the Table as submitted, which read 5 and not 4, was overlooked and it has continued until this cycle.

Public Input No. 2296-NFPA 70-2020 [Section No. 314.16(A)(2)]

(2) Other Boxes.

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

Table 314.16(A) Metal Boxes

Box Trade Size			**Minimum Volume**		**Maximum Number of Conductors*** (arranged by AWG size)							
mm	**in.**	-		**cm^3**	**$in.^3$**	**18**	**16**	**14**	**12**	**10**	**8**	**6**
100 × 32	(4 × 1¼)	round/octagonal	205	12.5	8	7	6	5	5	5	2	
100 × 38	(4 × 1½)	round/octagonal	254	15.5	10	8	7	6	6	5	3	
100 × 54	(4 × 2⅛)	round/octagonal	353	21.5	14	12	10	9	8	7	4	
100 × 32	(4× 1¼)	square	295	18.0	12	10	9	8	7	6	3	
100 × 38	(4 × 1½)	square	344	21.0	14	12	10	9	8	7	4	
100 × 54	(4 × 2⅛)	square	497	30.3	20	17	15	13	12	10	6	
120 × 32	(4¹¹⁄₁₆ × 1¼)	square	418	25.5	17	14	12	11	10	8	5	
120 × 38	(4¹¹⁄₁₆ × 1½)	square	484	29.5	19	16	14	13	11	9	5	
120 × 54	(4¹¹⁄₁₆ × 2⅛)	square	689	42.0	28	24	21	18	16	14	8	
75 × 50 × 38	(3 × 2 × 1½)	device	123	7.5	5	4	3	3	3	2	1	
75 × 50 × 50	(3 × 2 × 2)	device	164	10.0	6	5	5	4	4	3	2	
75× 50 × 57	(3× 2 × 2¼)	device	172	10.5	7	6	5	4	4	3	2	
75 × 50 × 65	(3 × 2 × 2½)	device	205	12.5	8	7	6	5	5	4	2	
75 × 50 × 70	(3 × 2 × 2¾)	device	230	14.0	9	8	7	6	5	4	2	
75 × 50 × 90	(3 × 2 × 3½)	device	295	18.0	12	10	9	8	7	6	3	
100 × 54 × 38	(4 × 2⅛ × 1½)	device	169	10.3	6	5	5	4	4	3	2	
100 × 54 × 48	(4 × 2⅛ × 1⅞)	device	213	13.0	8	7	6	5	5	4	2	
100 × 54 × 54	(4 × 2⅛ × 2⅛)	device	238	14.5	9	8	7	6	5	4	2	
95 × 50 × 65	(3¾ × 2 × 2½)	masonry box/gang	230	14.0	9	8	7	6	5	4	2	
95 × 50 × 90	(3¾ × 2 × 3½)	masonry box/gang	344	21.0	14	12	10	9	8	7	4	
min. 44.5 depth	FS — single cover/gang (1¾)		221	13.5	9	7	6	6	5	4	2	

Box Trade Size			Minimum Volume		Maximum Number of Conductors* (arranged by AWG size)						
mm	in.		cm3	in.3	18	16	14	12	10	8	6
min. 60.3 depth	FD — single cover/gang (2⅜)	295	18.0	12	10	9	8	7	6	3	
min. 44.5 depth	FS — multiple cover/gang (1¾)	295	18.0	12	10	9	8	7	6	3	
min. 60.3 depth	FD — multiple cover/gang (2⅜)	395	24.0	16	13	12	10	9	8	4	

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

Statement of Problem and Substantiation for Public Input

The statement; "shall be permitted to have their volume marked as required..." is nonsensical. If it's required, then that it is also permitted is irrelevant.

Submitter Information Verification

Submitter Full Name: John Blissett
Organization: Bernhard TME
Street Address:
City:
State:
Zip:
Submittal Date: Thu Aug 13 18:01:23 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: CMP-9 concludes that the requirement is correctly worded. A manufacturer who produces a box that is one of those described in the table, but that has a larger capacity than the table default, is permitted but not required to so mark the actual volume on the box. If, and only if, the box is so marked, then that revised volume is what is used to calculate the overall enclosure volume.

Public Input No. 2297-NFPA 70-2020 [Section No. 314.16(B)(2)]

(2) Clamp Fill.

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

A clamp assembly that incorporates a cable termination for the cable conductors shall be listed and marked for use with specific nonmetallic boxes. Conductors that originate within the clamp assembly shall be included in conductor fill calculations covered in 314.16(B)(1) as though they entered from outside the box. The ~~clamp assembly shall not require a fill allowance, but the volume of the~~ portion of the ~~assembly that remains within~~ clamp inside the box ~~after installation shall be excluded from the box volume as marked in 314.16(A)(2)~~ . shall count against the fill allowance .

Statement of Problem and Substantiation for Public Input

The following wording can be stated much simpler;
"The clamp assembly shall not require a fill allowance, but the volume of the portion of the assembly that remains within the box after installation shall be excluded from the box volume as marked in 314.16(A)(2)."
The same intent can be accomplished with this text;
"The volume portion of the clamp assembly that resides inside the box shall count against the box fill allowance."

Submitter Information Verification

Submitter Full Name: John Blissett
Organization: Bernhard TME
Street Address:
City:
State:
Zip:
Submittal Date: Thu Aug 13 18:06:56 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7731-NFPA 70-2020

Statement: CMP-9 is deleting the second paragraph of 314.16(B)(2) because the product line it was intended to cover is not being produced for market. It was incorporated in the 2014 NEC (Proposal 9-37) for this purpose, and the inclusion was made contingent on CMP 7 (now CMP-6) accepting correlating language in Art. 334. The panel statement supporting this action concluded by saying "CMP-9 believes the principal responsibility for determining the technical merit of this new approach should rest with CMP-7."

CMP-7 (now CMP-6) rejected that language in the 2014 cycle, with a statement to the effect that the code at that time in 334.30 did not disallow it. However, both the 2017 and the 2020 NEC refer (in 334.30) to "every cable entry into enclosures", and this method does not comply because it terminates NM cable on the outside of a box. To accomplish this, in the case of three-conductor applications, a special configuration of NM cable was developed. No challenges have been registered to this disqualifying wording (in Art. 334) to date.

CMP-9 will revisit this action during the comment period in the event there is credible reason to believe the method will actually come to market.

Public Input No. 4258-NFPA 70-2020 [Section No. 314.16(B)(4)]

(4) Device or Equipment Fill.

For each yoke or strap containing one or more Tier 1* devices or equipment, a double

~~volume~~
value allowance in accordance with Table 314.16(B) shall be made for each yoke or strap based on the largest conductor connected

~~to~~
to9 a device(s) or equipment supported by that yoke or strap. For each yoke or strap containing one or more Tier 2** devices or equipment, a value of four (4) times the allowance in accordance with Table 314.16(B) shall be made for each yoke or strap based on the largest conductor connected to9 a device(s) or equipment supported by that yoke or strap. A device or utilization equipment wider than a single

~~50 mm~~
50mm (

~~2 in~~
2 in .) device box as described in

~~Table 314~~
414 .16(A) shall have double

~~volume~~
allowances

~~provided~~
for each gang required for mounting. The minimum box depth for a Tier 2** device shall be 2 inches.

* Tier 1 devices shall be any device or equipment on a single yoke whose volume is less than 4000 cm cubed, or 1575 cube inches, and less than 50mm in width.

** Tier 2 devices shall be any device or equipment on a single yoke whose volume is more than 4000 cm cubed, or 1575 cube inches, and less than 50mm in width.

Table 314.16(B) Volume Allowance Required per Conductor

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

Statement of Problem and Substantiation for Public Input

I feel these changes are necessary due to the volume size of newer devices such as AFCI/GFCI receptacles, and the many new styles of electronic controls being utilized in Smart homes. These changes would allow the devices to be installed without fear of damage to the conductors serving the device.

Submitter Information Verification

Submitter Full Name: Doug Linger

Organization: Ben Franklin Career Center

Street Address:

City:

State:

Zip:

Submittal Date: Thu Sep 10 08:43:14 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: The NEC already responds to the technical concerns raised in the substantiation. Similar suggestions have been made repeatedly, in every case due to a lack of understanding by the submitters as to why the NEC is worded as it is. The NEC successfully used a single allowance for any included device from the 1947 edition until the 1990 edition. GFCIs first appeared in the 1971 NEC (effective as of 1973), thus preceding the two-conductor allowance by 17 years. The double allowance was suggested in the 1987 NEC (Proposal 9-17), but limited to GFCIs, timers, and dimmers. This drew ten negative comments, and resulted in the issue being held and a task group created for the 1990 cycle. One of the critical objections (Comment 9-12) noted that an increased allowance conditioned on particular devices would be incapable of inspection during a rough inspection, because the configuration and device selections would be unknowable to an inspector at that time. In the 1990 cycle, the double allowance for devices entered the NEC (Proposal 9-24). The panel statement read as follows, and clearly informs the present language: “The panel believes it would be impractical to make one or two conductor deductions based on the size or type of device. Furthermore, marking devices with the volume they occupy would not be a practical solution either because boxes are generally selected and installed before the devices are selected. The panel believes a two (2) conductor deduction for all devices will ensure adequate capacity for all devices currently used in the industry.” Over the intervening 30 years, many proposals and now public inputs have been received to increase the allowances for various types and configurations of devices. Every single one has been rejected because the substantiation consistently fails to address the reasons for the current language. In fact, inputs like PI 4258 substantiate a reduction in allowances for most devices, with the retention of the double allowance only for large devices. CMP- 9, for the reasons described in this statement, has consistently refused to take such a step, and continues this approach for the 2023 cycle.

Public Input No. 2343-NFPA 70-2020 [Section No. 314.16(B)(5)]

(5) Equipment Grounding Conductor Fill.

Where up to four equipment grounding conductors or equipment bonding jumpers enter a box, a single volume allowance in accordance with Table 314.16(B) shall be made based on the largest equipment grounding conductor or equipment bonding jumper entering the box. A ¼ volume allowance shall be made for each additional equipment grounding conductor or equipment bonding jumper that enters the box, based on the largest equipment grounding conductor or equipment bonding conductor in the box .

Statement of Problem and Substantiation for Public Input

Adding the text "in the box" at the end of the second sentence will clarify the additional ¼ volume allowance must also be based on the largest equipment grounding conductor in the box. For example; if four 12/2 NM cables were brought into a box and then one or more14/2 NM cables, the first allowance (up to four) would be based on the 12/2 NM cables as it is clear that deduction must be based on the largest equipment grounding conductor entering the box. By adding the additional proposed text, it will be clear the additional ¼ volume allowance must also be based on the largest conductor in the box (the12 AWG in this example).

Submitter Information Verification

Submitter Full Name: Mark Hilbert
Organization: MR Hilbert Electrical Inspections and Training
Street Address:
City:
State:
Zip:

Submittal Date: Mon Aug 17 11:33:09 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7734-NFPA 70-2020

Statement: CMP-9 has decided to revisit the action taken in the comment period of the 1996 cycle, when the reference to equipment bonding jumpers was initially added (Comment 9-5). It was substantiated on the basis that these components can run within raceways. CMP-9 now concludes that any such application, if even possible, would constitute an extension of an equipment grounding conductor, and would be addressable as such. In general, such jumpers begin and end within the box. As such, counting them would conflict with the general principle of not counting such wires, as stated in the final sentence of 314.16(B)(1). Removal of this phrasing simplifies the wording of the paragraph, and increases usability.

CMP-9 is also clarifying how the ¼ volume allowance is applied when different sizes of equipment grounding conductors enter the box. The current wording bases the basic fill allowance on the largest EGC entering the box; the revised wording makes clear the logical extension of that concept when the ¼ volume adder applies. For example, the EGC allowance for eight 12 AWG EGCs is (1+4×¼)2¼ = 4½ in3. If even one of those EGCs is a 10 AWG, then the allowance increases to (1+4×¼)2½ = 5 in3.

Public Input No. 412-NFPA 70-2020 [Section No. 314.16(B) [Excluding any Sub-Sections]]

The volumes in paragraphs 314.16(B)(1) through (B)(5), as applicable, shall be added together. No allowance shall be required for small fittings such as locknuts and bushings. Each space within a box installed with a barrier shall be calculated separately.

B.

6. Terminal blocks are to be counted as 2 conductor of the largest awg size.

Additional Proposed Changes

File Name	Description	Approved
CAB69DCE-DACD-4516-A530-C71196561900.jpeg	Conduit body with terminal block	

Statement of Problem and Substantiation for Public Input

The terminal block takes a lot of space in a GUA or conduit body more than a strap but it is not counted. The terminal block is bigger than small wirenuts, straps and is almost the same size as a device. This cause for overfilling the conduit bodies. There is no rule for this and is it as safety issue because the wire can be pinched and arc.

Submitter Information Verification

Submitter Full Name: Jose Franco
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Feb 03 17:17:44 EST 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7977-NFPA 70-2020

Statement: CMP-9 is addressing the use of terminal blocks in outlet and device boxes. These are not commonly installed, but where provided, they take up enough volume to merit a conductor allowance. One example of this usage occurs in 680.23(F)(2)(b). CMP-9 concludes the double fill suggested in PI 412 is excessive, and is reducing it to a single allowance. In addition, CMP-9 is basing the allowance on the size of conductors actually landed in the terminal block; the size of an unterminated conductor should not be a factor in this calculation.

CMP 9 notes that the reference to “a GUA or conduit body” may indicate a lack of understanding on the part of the submitter as to the distinction between boxes and conduit bodies, particularly in the realm of hazardous location enclosures. Terminal blocks are not located in conduit bodies, and the fact that GUA boxes have threaded hubs does not make them conduit bodies. In addition, if such terminal blocks are attached by screws to a GUA box by drilling and tapping in the field, the continued suitability for use in hazardous locations would need to be reevaluated.

Public Input No. 4131-NFPA 70-2020 [Section No. 314.16 [Excluding any Sub-Sections]]

Boxes and conduit bodies shall be of an approved size to provide free space for all enclosed conductors. In no case shall the volume of the box, as calculated in 314.16(A), be less than the fill calculation as calculated in 314.16(B). The minimum volume for conduit bodies shall be as calculated in 314.16(C).

~~The provisions of~~ this section shall not apply to terminal housings supplied with motors or generators.

> Informational Note: For volume requirements of motor or generator terminal housings, see 430.12.

Boxes and conduit bodies enclosing conductors 4 AWG or larger shall also comply ~~with the provisions of~~ with 314.28. Outlet and device boxes shall also comply with 314.24.

Statement of Problem and Substantiation for Public Input

Deleting the words "the provisions of" does not change the meaning of the section. Two Locations

Submitter Information Verification

Submitter Full Name: David Williams
Organization: Delta Charter Township
Street Address:
City:
State:
Zip:
Submittal Date: Wed Sep 09 21:40:57 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7726-NFPA 70-2020

Statement: CMP-9 is removing two superfluous references to “the provisions of” that do not add substance to the Code. Although the PI only refers to 314.16, CMP-9 is reviewing all such usage within Art. 312 and 314.

CMP-9 is also correcting the structure of the Informational Note to comply with the Style Manual.

Public Input No. 1293-NFPA 70-2020 [Section No. 314.17]

314.17 Conductors and Cables Entering Boxes, Conduit Bodies, or Fittings.

Conductors entering boxes, conduit bodies, or fittings shall be protected from abrasion. Conductors and cables shall comply with 314.17(A) through (~~D~~ C).

(A) Openings to Be Closed.

Openings through which conductors enter shall be closed in ~~a manner identified for the application~~ an approved manner .

(B) Boxes and Conduit Bodies.

The installation of the conductors and cables in boxes and conduit bodies shall comply with 314.17(B)(1) through (B)(4).

(1) Conductors Entering Through Individual Holes or Through Flexible Tubing.

For messenger-supported wiring, open wiring on insulators, or concealed knob-and-tube wiring, the conductors shall enter the box through individual holes. In installations where metal boxes or conduit bodies are used with conductors unprotected by flexible tubing, the individual openings shall be provided with insulating bushings. Where flexible tubing is used to enclose the conductors, the tubing shall extend from the last insulating support to not less than 6 mm (¼ in.) inside the box or conduit body and beyond any cable clamp. The wiring method shall be secured to the box or conduit body.

(2) ~~Conductors~~ Cables Entering Through Cable Clamps.

Where cable assemblies with nonmetallic sheathes are used, the sheath shall extend not less than 6 mm (¼ in.) inside the box and beyond any cable clamp. Except as ~~provided~~ specified in 300.15(C), the wiring method shall be secured to the box or conduit body.

Exception: Where nonmetallic-sheathed cable is used with single gang nonmetallic boxes not larger than a nominal size 57 mm × 100 mm (2¼ in. × 4 in.) mounted in walls or ceilings, and where the cable is fastened within 200 mm (8 in.) of the box measured along the sheath and where the sheath extends through a cable knockout not less than 6 mm (¼ in.), securing the cable to the box shall not be required. Multiple cable entries shall be permitted in a single cable knockout opening.

(3) ~~Conductors~~ Conductors and Cables Entering Through Raceways.

Where the raceway is complete between boxes, conduit bodies, or both and encloses individual conductors or nonmetallic cable assemblies or both, the conductors or cable assemblies shall not be required to be additionally secured. Where raceways enclose cable assemblies ~~as provided~~ as specified in 300.15(C), the cable assembly shall not be required to be additionally secured within the box or conduit body.

(4) Temperature Limitation.

Nonmetallic boxes and conduit bodies shall be suitable for the lowest temperature-rated conductor entering the box or conduit body.

(C) Conductors 4 AWG or Larger.

Installation shall comply with 300.4(G).

Informational Note: See 110.12(A) for requirements on closing unused cable and raceway knockout openings.

Statement of Problem and Substantiation for Public Input

The words “and cables” are being added to the charging paragraph and throughout 314.17 were appropriate. This change will provide clarification to users that the rule applies to single conductors and cable assemblies.

The reference to 314.17(A) through (D) was changed to 314.17(A) through (C) for editorial correlation.

314.17 (A) has been revised to correlate it with 312.5 (A) and 110.12(A).

In accordance with Public Input No. 3453-NFPA 70-2017 [Global Input] to the 2020 NEC®, in two places overlooked in that Code cycle, “as provided in 300.15(C)” is replaced by “as specified in 300.15(C)”. Nothing is being furnished (provided).

Spelling of “sheathes” is corrected to “sheaths”, in accordance with 3.2.1.2 of Manual of Style for NFPA Technical Committee Documents.

Submitter Information Verification

Submitter Full Name: Megan Hayes

Organization: Nema

Street Address:

City:

State:

Zip:

Submittal Date: Thu May 28 11:40:26 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7738-NFPA 70-2020

Statement: CMP-9 is making editorial corrections and improvements to this section. Specifically, the title and parent language now specifically include the usual application to cables, and the application is corrected to (A) through (C). The current reference to (D) is a typo left over from the 2020 NEC reorganization of this section. The standard of product acceptance is revised to “approved” allowing some flexibility on the part of an AHJ. The spelling error on the plural form of the word “sheath” is corrected to “sheaths”. The reference in (B)(3) to “as provided” is changed to “as covered” which is more correct.

CMP-9 is also adjusting the wording regarding the length of cable sheaths to clarify that the ¼-inch dimension is taken from the point where the cable emerges from the clamping mechanism and not from the point where it enters the box.

Public Input No. 372-NFPA 70-2020 [Section No. 314.17]

314.17 Conductors Entering Boxes, Conduit Bodies, or Fittings.

Conductors entering boxes, conduit bodies, or fittings shall be protected from abrasion and shall comply with 314.17(A) through (~~D~~ C).

(A) Openings to Be Closed.

Openings through which conductors enter shall be closed in a manner identified for the application.

(B) Boxes and Conduit Bodies.

The installation of the conductors in boxes and conduit bodies shall comply with 314.17(B)(1) through (B)(4).

(1) Conductors Entering Through Individual Holes or Through Flexible Tubing.

For messenger-supported wiring, open wiring on insulators, or concealed knob-and-tube wiring, the conductors shall enter the box through individual holes. In installations where metal boxes or conduit bodies are used with conductors unprotected by flexible tubing, the individual openings shall be provided with insulating bushings. Where flexible tubing is used to enclose the conductors, the tubing shall extend from the last insulating support to not less than 6 mm (¼ in.) inside the box or conduit body and beyond any cable clamp. The wiring method shall be secured to the box or conduit body.

(2) Conductors Entering Through Cable Clamps.

Where cable assemblies with nonmetallic sheathes are used, the sheath shall extend not less than 6 mm (¼ in.) inside the box and beyond any cable clamp. Except as provided in 300.15(C), the wiring method shall be secured to the box or conduit body.

Exception: Where nonmetallic-sheathed cable is used with single gang nonmetallic boxes not larger than a nominal size 57 mm × 100 mm (2¼ in. × 4 in.) mounted in walls or ceilings, and where the cable is fastened within 200 mm (8 in.) of the box measured along the sheath and where the sheath extends through a cable knockout not less than 6 mm (¼ in.), securing the cable to the box shall not be required. Multiple cable entries shall be permitted in a single cable knockout opening.

(3) Conductors Entering Through Raceways.

Where the raceway is complete between boxes, conduit bodies, or both and encloses individual conductors or nonmetallic cable assemblies or both, the conductors or cable assemblies shall not be required to be additionally secured. Where raceways enclose cable assemblies as provided in 300.15(C), the cable assembly shall not be required to be additionally secured within the box or conduit body.

(4) Temperature Limitation.

Nonmetallic boxes and conduit bodies shall be suitable for the lowest temperature-rated conductor entering the box or conduit body.

(C) Conductors 4 AWG or Larger.

Installation shall comply with 300.4(G).

Informational Note: See 110.12(A) for requirements on closing unused cable and raceway knockout openings.

Statement of Problem and Substantiation for Public Input

There is no (D).

Submitter Information Verification

Submitter Full Name:	Scott Cameron
Organization:	True Electric LLC
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon Jan 27 03:05:10 EST 2020
Committee:	NEC-P09

Committee Statement

Resolution: FR-7738-NFPA 70-2020

Statement: CMP-9 is making editorial corrections and improvements to this section. Specifically, the title and parent language now specifically include the usual application to cables, and the application is corrected to (A) through (C). The current reference to (D) is a typo left over from the 2020 NEC reorganization of this section. The standard of product acceptance is revised to “approved” allowing some flexibility on the part of an AHJ. The spelling error on the plural form of the word “sheath” is corrected to “sheaths”. The reference in (B)(3) to “as provided” is changed to “as covered” which is more correct.

CMP-9 is also adjusting the wording regarding the length of cable sheaths to clarify that the ¼-inch dimension is taken from the point where the cable emerges from the clamping mechanism and not from the point where it enters the box.

Public Input No. 1945-NFPA 70-2020 [Section No. 314.17(A)]

(A) Openings to Be Closed.

Openings <u>not against a noncombustible surface</u> through which conductors enter shall be closed in a manner identified for the application.

Statement of Problem and Substantiation for Public Input

The code makes it sound like the holes on the back of a surface mounted box need to be filled, even if the surface is noncombustible.

Submitter Information Verification

Submitter Full Name: Jon Mitchell

Organization: Garriott Electric

Affiliation: Employee

Street Address:

City:

State:

Zip:

Submittal Date: Mon Jul 20 12:15:33 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: CMP-9 disagrees that a mounting hole is included within the openings described in this section. The scope of the section is clearly limited to cable entries, or conductor entries in the case of single-conductor wiring methods. See the editorial changes in this section that provide additional clarification.

Public Input No. 1099-NFPA 70-2020 [Section No. 314.17(B)(2)]

(2) Conductors Entering Through Cable Clamps.

Where cable assemblies with nonmetallic sheathes are used, the sheath shall extend not less than 6 mm (¼ in.) inside the box and beyond any cable clamp. Except as provided in 300.15(C), the wiring method shall be secured to the box or conduit body.

Exception: Where nonmetallic-sheathed cable is used with single gang nonmetallic boxes not larger than a nominal size 57 mm × 100 mm (2¼ in. × 4 in.) mounted in walls or ceilings, and where the cable is fastened within 200 mm (8 in.) of the box measured along the sheath and where the sheath extends through a cable knockout not less than 6 mm (¼ in.), securing the cable to the box shall not be required. Multiple cable entries shall be permitted in a single cable knockout opening.

The exhibit picture of the NEC Handbook for the exception should be replaced. Exhibit 314.5 for 314.17(B)(2) Exception. This was formerly 314.17C Exception. It violates 300.4D.

Statement of Problem and Substantiation for Public Input

The 12-2 NM stapled parallel and side by side along a standard 2" x 4" must be butted tightly together or it violates 300.4D. For example: 12-2 NM-B is 7/16" wide and shall be stapled flat. A standard 2" x 4" wood member is 3 1/2" wide. A typical staple prong is 1/8" wide.

3 1/2" - (1 1/4" + 1 1/4" for both sides of the wood member) = 1" left to work with
1" - (7/16" + 7/16" + 1/8") = 0"

Note: 1" would also be the maximum size hole permitted to be bored but wouldn't recommend it because it would have to be precise which isn't likely as field work as opposed to operating a drill press in a shop condition.

As an inspector, I don't allow this 'railroad tracking' of NM on 2" x 4"s unless the cables are tight. If the staples didn't stagger each other it would be a violation by 1/8". Usually though they are never maintained as required. It isn't just the points of securing but must be maintained, as well.

Submitter Information Verification

Submitter Full Name: Norman Feck
Organization: State of Colorado
Street Address:
City:
State:
Zip:
Submittal Date: Sat May 16 12:52:15 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: This PI does not state revised NEC language and therefore does not comply with the REGULATIONS GOVERNING THE DEVELOPMENT OF NFPA STANDARDS.

Public Input No. 3737-NFPA 70-2020 [Section No. 314.17(B)(2)]

(2) Conductors Entering Through Cable Clamps.

Where cable assemblies with nonmetallic sheathes are used, the sheath shall extend inside the box not less than 6 mm (¼ in.) ~~inside the box and beyond~~ beyond the end of any cable clamp. Except as provided in 300.15(C), the wiring method shall be secured to the box or conduit body.

Exception: Where nonmetallic-sheathed cable is used with single gang nonmetallic boxes not larger than a nominal size 57 mm × 100 mm (2¼ in. × 4 in.) mounted in walls or ceilings, and where the cable is fastened within 200 mm (8 in.) of the box measured along the sheath and where the sheath extends through a cable knockout not less than 6 mm (¼ in.), securing the cable to the box shall not be required. Multiple cable entries shall be permitted in a single cable knockout opening.

Statement of Problem and Substantiation for Public Input

The present wording could imply that the 1/4" measurement is taken from the back of the box and not from the projection of the cable clamp which extends inside the box.

Submitter Information Verification

Submitter Full Name: Thomas Milbury
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Sep 09 11:35:22 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7738-NFPA 70-2020

Statement: CMP-9 is making editorial corrections and improvements to this section. Specifically, the title and parent language now specifically include the usual application to cables, and the application is corrected to (A) through (C). The current reference to (D) is a typo left over from the 2020 NEC reorganization of this section. The standard of product acceptance is revised to "approved" allowing some flexibility on the part of an AHJ. The spelling error on the plural form of the word "sheath" is corrected to "sheaths". The reference in (B)(3) to "as provided" is changed to "as covered" which is more correct.

CMP-9 is also adjusting the wording regarding the length of cable sheaths to clarify that the ¼-inch dimension is taken from the point where the cable emerges from the clamping mechanism and not from the point where it enters the box.

Public Input No. 2447-NFPA 70-2020 [Section No. 314.20]

314.20 Flush-Mounted Installations.

Installations within or behind a surface of concrete, tile, gypsum, plaster, or other noncombustible material, including boxes employing a flush-type cover or faceplate, shall be made so that the front edge of the box, plaster ring, extension ring, or listed extender will not be set back of the finished surface more than 6 mm (¼ in.).

Installations within a surface of wood or other combustible surface material, boxes, plaster rings, extension rings, or listed extenders shall extend to the finished surface or project therefrom. A minimum of 6 mm (1/4 in) clearance shall be maintained between a listed slide-in extender and any point where a free conductor enters the enclosure.

Additional Proposed Changes

File Name	Description	Approved
Shapiro_IAEI_Public_Input-314.20.docx	PI with relevant field images added	

Statement of Problem and Substantiation for Public Input

Depending on how far forward raceways or cables are attached to enclosures, slide-in box extenders can put them at risk. The cable shown is entering through knockouts that were part of the box design. I believe that we should not have to rely on 110.12 to forbid this use, most especially with slide-in extender, which could be metal or nonmetallic. If an inspector wants to accept the use of such an extender, trimmed away from where it would hit the conductors where it runs too deep, that's their call. But let's make sure the extenders don't bite into wiring.

Submitter Information Verification

Submitter Full Name: David Shapiro

Organization: Safety First Electrical

Street Address:

City:

State:

Zip:

Submittal Date: Sat Aug 22 16:04:38 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: CMP-9 observes that such extenders necessarily hug the sides of boxes out of the necessity to avoid interference with the device, and rarely confront wiring entries because such entries would likely prevent the insertion of the device. For the freakishly rare instances where a side entry was so perfectly located as to create an issue, CMP-9 suggests the application of 110.7. Any attempt to prescriptively address this in Art. 314 is likely to primarily result in unintended consequences. In addition, such a requirement would be very difficult to pick up on an inspection. See also the CMP-9 actions in this cycle on 314.24, which will tend to move such side entries rearward of any box extenders.

Public Input No. 1147-NFPA 70-2020 [New Section after 314.23(D)(2)]

TITLE OF NEW CONTENT

Exception Junction boxes for listed floor boxes shall not be required to be supported independently

Statement of Problem and Substantiation for Public Input

Furniture feeds often come as a assembly with a rectangle junction box that hangs below the floor with a EMT conduit & fitting supporting it. It is manufactured as an assembly and in my experience never required additional supports. We have had some inspectors that have been requiring the additional supports per 314.23. Personally I have never enforced additional supports but have not seen this specific item addressed. This exception would indeed address this installation one way or anothe

Submitter Information Verification

Submitter Full Name: James Dorsey
Organization: Douglas County Electrical Insp
Street Address:
City:
State:
Zip:
Submittal Date: Mon May 18 19:01:40 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: CMP-9 is resolving PI-1147. CMP-9 understands, after some discussion with a manufacturer and testing laboratory personnel, that the PI refers to the point of supply connection to a Fire-Rated Poke Through (FRPT) installation that utilizes a factory-equipped short vertical run of EMT that drops through a fire-rated concrete floor through a cored or cast hole into a suspended ceiling cavity on the floor below. That is the explanation for the PI pointing to suspended ceiling support wires on which the supply wiring may run, but that has no relevance to the rules for supporting a box that is made up on the end of the EMT. The relevant requirement is 314.23(E), and EMT joined to a box with a conventional EMT connector and a locknut does not comply with that rule. EMT cannot be threaded, and therefore cannot be threaded into a box, even if the box were supplied with hubs. CMP-9 does not now and has never permitted a box, in effect, to be supported by locknuts regardless of the number of entries so connected. UL 514A is silent on requirements for independent support of FRPT assembly boxes. The result is that a field connection to a listed FRPT assembly must comply with 314.23(E). This rule does make an exception for non-threaded conduit bodies for obvious reasons. This has been suggested as an avenue for making connections. However, the usage of any such enclosures to support splices to conductors supplied with the FRPT must comply with the volume requirements in 314.16(C)(2). As a practical matter, presently available conduit bodies would generally fail that rule. However, in the event that the FRPT design allowed for field wiring to terminate directly on the FRPT device, then a conduit body supported in accordance with 314.23(E) Exception would be permitted.

Public Input No. 3852-NFPA 70-2020 [Section No. 314.23(D)(2)]

(2) Support Wires.

The installation shall comply with 300.11(~~A~~ B). The enclosure shall be secured, using identified methods, to ceiling support wire(s), including any additional support wire(s) installed for ceiling support. Support wire(s) used for enclosure support shall be fastened at each end so as to be taut within the ceiling cavity.

Statement of Problem and Substantiation for Public Input

The change is designed to resolve an issue with what is pointed to. 300.11(A) contains the requirement pipes, boxes, and the like be secured. 300.11(B) contains the requirements regarding support wires. It is likely that the 2014 NEC may have been used as the reference for writing this originally (prior to the old A being split into A and B respectively). As this is a requirement for support wires, it is clear that the current 300.11(B) should be the citation listed here.

Submitter Information Verification

Submitter Full Name: Brandon Nelson

Organization: Minnesota Statewide LEA JATC

Street Address:

City:

State:

Zip:

Submittal Date: Wed Sep 09 14:00:21 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7742-NFPA 70-2020

Statement: CMP-9 is correcting the reference in Art. 300 from 300.11(A) to 300.11(B). Sec. 300.11 was reorganized in the 2017 cycle and this reference was not correlated at that time.

Public Input No. 187-NFPA 70-2019 [Section No. 314.23(E)]

(E) Raceway-Supported Enclosure and Conduit Bodies , Without Devices, Luminaires, or Lampholders.

(1) Enclosure,

An enclosure that does not contain a device(s), other than splicing devices, or supports a luminaire(s), a lampholder, or other equipment and is supported by entering ridged metalic raceways shall not exceed 1650 cm ^{3} (100 in. ^{3}) in size. It shall have threaded entries or identified hubs. It shall be supported by two or more ridged conduits threaded wrenchtight into the enclosure or hubs. Each ridged conduit shall be secured within 900 mm (3 ft) of the enclosure, or within 450 mm (18 in.) of the enclosure if all conduit entries are on the same side.

~~Exception:~~
(2) Conduit body

The following wiring methods shall be permitted to support a conduit body of any size, including a conduit body constructed with only one conduit entry, provided that the trade size of the conduit body is not larger than the largest trade size of the conduit or tubing:

(1) Intermediate metal conduit, Type IMC

(2) Rigid metal conduit, Type RMC

(3) Rigid polyvinyl chloride conduit, Type PVC

(4) Reinforced thermosetting resin conduit, Type RTRC

(5) Electrical metallic tubing, Type EMT

Statement of Problem and Substantiation for Public Input

this enclosure section is confusing, why there is an exception to an enclosure being supported by a raceway that does not address an enclosure. A conduit body and an Enclosure have two different definitions.. the current exception in this section is better suited as a general rule within this section. also the way it is written this section includes all raceway conduits including Non-metallic and metallic flexible conduit. I do not think this is the intent of this section. the change would make it clear only metal ridged raceways are allowed to support an enclosure

Submitter Information Verification

Submitter Full Name: Alfio Torrisi

Organization: Master Electrician

Street Address:

City:

State:

Zip:

Submittal Date: Tue Dec 17 15:52:32 EST 2019

Committee: NEC-P09

Committee Statement

Resolution: The Code is correctly written for enclosures without devices, luminaires or lampholders.

The first sentence limits the default reach of conduit support to 100 in3 enclosures. The requirements include wrenchtight threaded conduit entries (including entries into Myers hubs or equal), and limits on support distances and direction from the enclosure. Because large conduit bodies exceed the volume limit, and conduit bodies of all sizes are in general use on non-threaded raceways including PVC and EMT, the exception following allows them provided they do not exceed the size of the larger raceway entry.

Public Input No. 1100-NFPA 70-2020 [Section No. 314.23(H)(1)]

(1) Flexible Cord.

A box shall be supported from a multiconductor cord or cable in an approved manner that protects the conductors against strain ~~, such as a strain-relief connector threaded~~ <u>with a listed stain relief fitting threaded</u> into a box with a hub. <u>These strain relief fitings are required at the suspended box and at the box above the suspended box. Where there is no strain on the fitting of the upper box or enclosure, the strain relief fitting on the upper box or enclosure may be omitted.</u>

Statement of Problem and Substantiation for Public Input

Present wording of this code article leaves too much room for the inspector in the field to employ discretion. Also, both the upper and lower ends of the cable should be addressed. The upper end may be routed or knotted on significant structure where no strain would be placed on the upper end box or enclosure.

Submitter Information Verification

Submitter Full Name: Norman Feck

Organization: State of Colorado

Street Address:

City:

State:

Zip:

Submittal Date: Sat May 16 13:23:48 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7749-NFPA 70-2020

Statement: CMP-9 is revising the language of this paragraph to correctly integrate the provisions of the applicable UL guide card requirements that apply to fittings that connect flexible cord to enclosures equipped with hubs. Such applications require the use of tapered NPT threads.

CMP-9 is resolving the part of this PI that addresses supply connections because this section does not apply to the provisions regarding the securement of flexible cord from a ceiling box or comparable exit point. See 400.14 for coverage of this topic, a location within the jurisdiction of CMP-6.

Public Input No. 3711-NFPA 70-2020 [Section No. 314.24(B)(4)]

(4) Conductors 12 or 10 AWG.

Boxes that enclose devices or utilization equipment supplied by 12 or 10 AWG conductors shall have an internal depth that is not less than 30.2 mm (1$\frac{3}{16}$ in.). **The internal depth shall be measured from the mounting plane to the back wall of a box, or to the most forward edge of an integral hub, or a bushing, an adaptor, or a cable clamp projecting from the back wall of a box, whichever is le ss .** Where the equipment projects rearward from the mounting plane of the box by more than 25 mm (1 in.), the box shall have a depth not less than that of the equipment plus ~~6 mm~~ 12 mm ($\frac{1}{4}$ 2 in.).

Additional Proposed Changes

File Name	Description	Approved
Neutral_Deterioration.jpg	Blackening and compression of the neutral conductor can be seen.	

Statement of Problem and Substantiation for Public Input

This public input, along with the others I am providing, is a direct consequence of my investigation of a fire in a GFCI receptacle mounted on the outside of my house which could have been catastrophic, but thankfully wasn't. I am a licensed engineer. A detailed report was prepared.

The back wall of a box may not be in one plane and therefore the internal depth can vary across that back wall, as is the case with a weather resistant box that has an integral threaded hub. In addition, a fitting is typically used with a box and in the case of a standard box whose back wall is substantially planar, the internal depth at that fitting is reduced. With a standard receptacle that measures approximately 0.85 in. in depth, the required internal box depth of 1 5/16 in. provides a clearance measured from the back of the receptacle of about 0.46 in. This clearance is adequate for conductors to enter from the back of the box through a fitting, terminate on the receptacle and then fold back into the box, keeping in mind that 314.17(B)(2) requires a 1/4" sheath extension, and 300.14 requires the conductor length to extend 3" beyond the front of the box for ease of wire termination.

The outlet on the back wall of a weatherproof box for a GFCI is typically centered. In the case of a GFCI receptacle, the depth of the receptacle is likely more than 1 in. and therefore with the present wording of 314.24(B)(4) the internal depth of the box is allowed to be 1/4" more than the depth of the receptacle. This additional 1/4" is insufficient when compared to the approximately 0.46 in. clearance required for standard receptacles.

This insufficient clearance can result in the GFCI bottoming on the conductors with the mounting tabs of the receptacle gapping above the mounting plane of the box at the strap. Screwing the tabs to the strap then requires bending of the tabs to mount them securely, exerting a compression force on the body of the receptacle. This force can damage the internal electronic components of the ground fault circuitry. In addition, a compression force is applied to the relatively short and stiff portion of the conductors bending to reach the termination screws, even if the conductors are carefully routed around the side of the receptacle. The compression force on the wires will tend to loosen the wire terminations as well as compress the wire insulation. The internal electronic components of devices can generate heat with further deterioration of conditions in the box. The photo below was taken from the second, and only other, GFCI on the outside of my house. This GFCI did not burn, or fail, but the neutral conductor shows blackening which is likely the result of a localized heat concentration. There is also evidence of a softening and deformation of the white PVC insulation between blackened areas with a possible imprint from embossed lettering on the back of the GFCI. These indications are clear evidence of the need for more space in the box.

In addition, in the case of an outdoor weather resistant GFCI with a cover, any distortion of the front mounting plane of the GFCI will be a problem for proper installation of the gasketed cover. If the mounting plane isn't flat the gasket will not uniformly compress around the perimeter of the box for a weather resistant seal. Therefore, to alleviate the crowding, compression forces, and gasketing concerns that are introduced because of the greater depth of a GFCI, it is necessary to increase the clearance from the back of the GFCI receptacle, and other receptacles having a depth greater than 1 inch, to 1/2" and not just 1/4". This requirement can easily be met by using a deep box where necessary.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3690-NFPA 70-2020 [Section No. 314.24 [Excluding any Sub-Sections]]	

Submitter Information Verification

Submitter Full Name: Thomas Milbury
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Sep 09 11:14:14 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7869-NFPA 70-2020

Statement: CMP-9 is adjusting the language by broadening the reach of this section to address side entries. CMP-9 is aware of actual damage to conductors from installed devices or other equipment of sufficient size to create a conflict with entering conductors. The prevailing product standards create an acceptable size envelope for devices (or other equipment) mounted within boxes using yokes secured to customary gang points. This envelope is 1 3/4 in. wide by 2 13/16 in. high, with rounded corners having a radius of 7/16 in., and a plethora of devices take full advantage of this allotted profile. The same standards place no limitations on equipment depth. CMP 9 has informally surveyed available designs and found enormous depth variations in the market, very much complicating the creation of this requirement.

For nominal 3 by 2 device boxes, any side entrance at the level of the device is a non-starter and will fail the new rule. For a 4-in. square box with two device yokes, either on internal gang mounts or the more usual case of a plaster ring (or raised cover), the rule gets interesting. The box interior will exceed the maximum device length by about 1 1/8 in, and therefore accommodate a top or bottom entry (considered in this statement as being in line with the yoke) at either end.

However, an entry at right angles to the yoke orientation (the standard gang spacing is 1 13/16 in.) would enter less than ¼-in. of available space to accommodate both a cable or raceway connection as well as wire manipulation. Attempts to force large devices into such spaces are what caused the loss experience cited in the substantiation for PI-2448. The NEC has not previously addressed this; the new rule will now prohibit such attempts.

CMP-9 does recognize that there are legitimate applications for which an entry, particularly in the case of rigid raceway methods, is preferred in this orientation. One solution is to use a larger (presumably a 4 11/16 in. square) box. Another solution is to lower the entry point by using a deeper box. The rule compares the depth of the equipment under its mounting yoke to the centerline of the wiring entry. If that line is equal to or below the equipment limit, then the entry can be used.

This may seem odd, but it is based on a careful geometric analysis that positioned the NEC limit of 9 No. 12 THHN conductors in a cross-section of ½ trade size EMT, and they all fit below the horizontal diameter of the EMT. In fact, as long as half the connector opening is unobstructed, in practice the entire wire fill can be routed to safely enter the enclosure. There are listed raceway connectors that have a minimal (less than ¼ in. and no threads) extension inside a box and that make this approach practical.

CMP-9 is adjusting the wording to assure that the depth of boxes accommodates wiring method entries where those entry points line up with the backs of installed devices or equipment.


MOUNTING K.O.
MADE IN U.S.A.
SUITABLE
FOR WET
LOCATIONS
LISTED
OUTLET BOX
MULBERRY

Public Input No. 2448-NFPA 70-2020 [Section No. 314.24(B) [Excluding any Sub-Sections]]

Outlet and device boxes that enclose devices or utilization equipment shall have a minimum internal depth and side clearance that accommodates the rearward projection of the equipment and the size of the conductors that supply the equipment. The internal depth shall include, where used, that of any extension boxes, plaster rings, or raised covers. A minimum of 6 mm (1/4 in) clearance shall be maintained between the device and any point where a free conductor enters the enclosure. The internal depth shall comply with all applicable provisions of 314.24(B)(1) through (B)(5).

Statement of Problem and Substantiation for Public Input

The present wording," Outlet and device boxes shall have an approved depth to allow equipment installed within them to be mounted properly and without likelihood of damage to conductors within the box,"

goes on in (B) to require 6 mm /1/4 in behind a device in an enclosure. However, even the title and the parent language speak only of approved depth, not width. Where a deep device is installed in a snug box, even one with sufficient depth to satisfy the volume requirements of Section 314.16, that 6 mm/ 1/4 in. can be rearward of a side knockout where the conductors enter. This means shoving the device past them can push the wires to the point of insulation damage where they emerge from sheath, locknut or bushing. What if a box is not snug? Suppose side knockouts are used in a square box, and devices are installed using mud rings? This type of installation will not be affected by the proposed change, because there should be enough side clearance between the inner edge of the device ring and the side of the box.

Here's the problem in numbers:

NEMA WD6-2016 gives standard dimensions for receptacles. For a couple of types it gives maximum width as 1.625 in, but on P. 15 it gives maximum envelope width as 1.75 in.

UL 514A, Metal boxes, Clause 7.5.3.1, says standard flush device boxes have a minimum width of 1.75 in.

Let's say we have a 2 in wide box with minimum-legal-thickness walls, and a device whose body is only the 1.625 in wide. This still gives less than 1/4 in. on each side of the device, if it's reasonably centered. With 6 mm/1/4 in. of sheath entering from a side knockout, the device leaves no room for the free conductors entering that knockout to make a turn–unless by grace of the installer mounting the device as far off-center as possible.

I see nothing in NEMA WD6 limiting device depth, and I see no reason for limiting device depth, so long as the box is not overfilled and the conductors are not otherwise put at risk.

UL 498, Standard for Attachment Plugs and Receptacles, Clause 29.2.1, says Flush Receptacles' dead-metal parts shall not have sharp edges or points that may be forced against the wiring during installation. It says nothing about sharp parts of nonmetallic parts. These can be hard enough to scrape insulation off conductors–I've seen this more than once.

That's why we need to specify minimum clearance in every direction from knockouts that bring wires in and out.

Submitter Information Verification

Submitter Full Name: David Shapiro
Organization: Safety First Electrical
Street Address:
City:
State:
Zip:
Submittal Date: Sat Aug 22 16:19:56 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7869-NFPA 70-2020

Statement: CMP-9 is adjusting the language by broadening the reach of this section to address side entries. CMP-9 is aware of actual damage to conductors from installed devices or other equipment of sufficient size to create a conflict with entering conductors. The prevailing product standards create an acceptable size envelope for devices (or other equipment) mounted within boxes using yokes secured to customary gang points. This envelope is 1 3/4 in. wide by 2 13/16 in. high, with rounded corners having a radius of 7/16 in., and a plethora of devices take full advantage of this allotted profile. The same standards place no limitations on equipment depth. CMP 9 has informally surveyed available designs and found enormous depth variations in the market, very much complicating the creation of this requirement.

For nominal 3 by 2 device boxes, any side entrance at the level of the device is a non-starter and will fail the new rule. For a 4-in. square box with two device yokes, either on internal gang mounts or the more usual case of a plaster ring (or raised cover), the rule gets interesting. The box interior will exceed the maximum device length by about 1 1/8 in, and therefore accommodate a top or bottom entry (considered in this statement as being in line with the yoke) at either end.

However, an entry at right angles to the yoke orientation (the standard gang spacing is 1 13/16 in.) would enter less than ¼-in. of available space to accommodate both a cable or raceway connection as well as wire manipulation. Attempts to force large devices into such spaces are what caused the loss experience cited in the substantiation for PI-2448. The NEC has not previously addressed this; the new rule will now prohibit such attempts.

CMP-9 does recognize that there are legitimate applications for which an entry, particularly in the case of rigid raceway methods, is preferred in this orientation. One solution is to use a larger (presumably a 4 11/16 in. square) box. Another solution is to lower the entry point by using a deeper box. The rule compares the depth of the equipment under its mounting yoke to the centerline of the wiring entry. If that line is equal to or below the equipment limit, then the entry can be used.

This may seem odd, but it is based on a careful geometric analysis that positioned the NEC limit of 9 No. 12 THHN conductors in a cross-section of ½ trade size EMT, and they all fit below the horizontal diameter of the EMT. In fact, as long as half the connector opening is unobstructed, in practice the entire wire fill can be routed to safely enter the enclosure. There are listed raceway connectors that have a minimal (less than ¼ in. and no threads) extension inside a box and that make this approach practical.

CMP-9 is adjusting the wording to assure that the depth of boxes accommodates wiring method entries where those entry points line up with the backs of installed devices or equipment.

Public Input No. 3690-NFPA 70-2020 [Section No. 314.24 [Excluding any Sub-Sections]]

Outlet and device boxes shall have an approved depth to allow equipment installed within them to be mounted properly and without likelihood of damage to conductors within the box or to the equipment itself .

Statement of Problem and Substantiation for Public Input

This public input, along with the others I am providing, is a direct consequence of my investigation of a fire in a GFCI receptacle mounted on the outside of my house which could have been catastrophic, but thankfully wasn't. I am a licensed engineer. A detailed report was prepared.

Although it is generally considered that conductors are at risk of physical damage within a box that is too small, there is also a possibility of damage to equipment that arises with devices having electronic components, such as GFCI receptacles, AFCI receptacles, and receptacles with USB chargers, surge suppression, or electromagnetic filters.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3711-NFPA 70-2020 [Section No. 314.24(B)(4)]	

Submitter Information Verification

Submitter Full Name: Thomas Milbury
Organization: [Not Specified]
Street Address:
City:
State:
Zip:

Submittal Date: Wed Sep 09 10:54:08 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7869-NFPA 70-2020

Statement: CMP-9 is adjusting the language by broadening the reach of this section to address side entries. CMP-9 is aware of actual damage to conductors from installed devices or other equipment of sufficient size to create a conflict with entering conductors. The prevailing product standards create an acceptable size envelope for devices (or other equipment) mounted within boxes using yokes secured to customary gang points. This envelope is 1 3/4 in. wide by 2 13/16 in. high, with rounded corners having a radius of 7/16 in., and a plethora of devices take full advantage of this allotted profile. The same standards place no limitations on equipment depth. CMP 9 has informally surveyed available designs and found enormous depth variations in the market, very much complicating the creation of this requirement.

For nominal 3 by 2 device boxes, any side entrance at the level of the device is a non-starter and will fail the new rule. For a 4-in. square box with two device yokes, either on internal gang mounts or the more usual case of a plaster ring (or raised cover), the rule gets interesting. The box interior will exceed the maximum device length by about 1 1/8 in, and therefore accommodate a top or bottom entry (considered in this statement as being in line with the yoke) at either end.

However, an entry at right angles to the yoke orientation (the standard gang spacing is 1 13/16 in.) would enter less than ¼-in. of available space to accommodate both a cable or raceway connection as well as wire manipulation. Attempts to force large devices into such spaces are what caused the loss experience cited in the substantiation for PI-2448. The NEC has not previously addressed this; the new rule will now prohibit such attempts.

CMP-9 does recognize that there are legitimate applications for which an entry, particularly in the case of rigid raceway methods, is preferred in this orientation. One solution is to use a larger (presumably a 4 11/16 in. square) box. Another solution is to lower the entry point by using a deeper box. The rule compares the depth of the equipment under its mounting yoke to the centerline of the wiring entry. If that line is equal to or below the equipment limit, then the entry can be used.

This may seem odd, but it is based on a careful geometric analysis that positioned the NEC limit of 9 No. 12 THHN conductors in a cross-section of ½ trade size EMT, and they all fit below the horizontal diameter of the EMT. In fact, as long as half the connector opening is unobstructed, in practice the entire wire fill can be routed to safely enter the enclosure. There are listed raceway connectors that have a minimal (less than ¼ in. and no threads) extension inside a box and that make this approach practical.

CMP-9 is adjusting the wording to assure that the depth of boxes accommodates wiring method entries where those entry points line up with the backs of installed devices or equipment.

Public Input No. 1737-NFPA 70-2020 [Section No. 314.25]

314.25 Covers and Canopies.

In completed installations, each box shall have a cover, faceplate, lampholder, or luminaire canopy, except where the installation complies with 410.24(B). Screws used for the purpose of attaching covers, or other equipment, to the box shall be either machine screws matching the thread gauge and size that is integral to the box or shall be in accordance with the manufacturer's instructions.

(A) Nonmetallic or Metal Covers and Plates.

Nonmetallic or metal covers and plates shall be permitted. Where metal covers or plates are used, they shall ~~comply with the grounding requirements of~~ be connected to the circuit equipment grounding conductor in accordance with 250.110.

Informational Note: For additional equipment grounding ~~requirements~~ conductor connections , see 410.42 for metal luminaire canopies, and 404.12 and 406.6(B) for metal faceplates.

(B) Exposed Combustible Wall or Ceiling Finish.

Where a luminaire canopy or pan is used, any combustible wall or ceiling finish exposed between the edge of the canopy or pan and the outlet box shall be covered with noncombustible material if required by 410.23.

(C) Flexible Cord Pendants.

Covers of outlet boxes and conduit bodies having holes through which flexible cord pendants pass shall be provided with identified bushings or shall have smooth, well-rounded surfaces on which the cords may bear. So-called hard rubber or composition bushings shall not be used.

Statement of Problem and Substantiation for Public Input

250.110, 410.42, 404.12, and 406.6(B) address the connection to the equipment grounding conductor. Grounding (earth as defined by the NEC) is not the proper term to be used.

Submitter Information Verification

Submitter Full Name:	Mike Holt
Organization:	Mike Holt Enterprises Inc
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Jun 25 17:33:19 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: FR-7752-NFPA 70-2020

Statement: CMP-9 is removing overly simplistic references to grounding in favor of references to equipment grounding connections. CMP-9 is making comparable corrections in the informational note. However, CMP-9 is not reordering the note to place the references first, as preferred in the Style Manual at Sec. 3.1.3.1, because the compound nature of this note is more clearly expressed, and with greater economy of wording, by having the common topic first, followed by the two references expressed sequentially. CMP-9 is also correcting the Art. 404 reference in the note.

Public Input No. 1514-NFPA 70-2020 [New Section after 314.25(A)]

TITLE OF NEW CONTENT

Type your content here ...314.25(A)(1)

In other than dwelling units. The covers for junction boxes shall be labeled with the circuit numbers that are in or passing through the junction box

Statement of Problem and Substantiation for Public Input

What a pleasure when you look up in a ceiling and find a Junction box labeled with the circuit numbers. This is common practice for some but certainly not all. Often when inspecting emergency lights, in existing areas the only way to locate the lighting circuit is to hope that the boxes are labelled. This would be a strong code change in keeping the companies at the same playing field while it is not really at a cost impact

Submitter Information Verification

Submitter Full Name: James Dorsey

Organization: Douglas County Electrical Insp

Street Address:

City:

State:

Zip:

Submittal Date: Sun Jun 14 18:24:25 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: The objective of the PI is to require “junction” box covers “in other than dwelling units” to have labels applied to their covers that specify the “circuit numbers” within them. CMP-9 concludes this may be a desirable design feature but does not address any minimum safety concern. In many cases it would be excessive, and is clearly beyond the scope of the Code as expressed in 90.1(B).

Public Input No. 1101-NFPA 70-2020 [New Section after 314.25(C)]

TITLE OF NEW CONTENT 314.26 Coarse Thread Scews.

Type your content here ...

Coarse thread screw(s) shall not enter a box or enclosure.

Statement of Problem and Substantiation for Public Input

Whether coarse thread screws are added before conductors or electrical components are installed or added to an existing installation; they are a recipe for disaster. Coarse thread self-tapper screws are very convenient and are used this way and should be a violation. The closest The NEC comes to addressing it is 314.23B1 and doesn't provide the same message as this new public input.

The way the new entry is worded allows coarse thread screws to exit enclosures. For instance, an electrical component could be mounted in an electrical enclosure with coarse thread self-tapper screws zipped from the inside to the outside of the enclosure.

Submitter Information Verification

Submitter Full Name: Norman Feck

Organization: State of Colorado

Street Address:

City:

State:

Zip:

Submittal Date: Sat May 16 13:34:26 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7821-NFPA 70-2020

Statement: CMP-9 is inserting language to protect against damage to conductors resulting from sharp projections from exposed threads of screws run through covers or sides of boxes. The location in Part I will make the requirement apply throughout the entire article. For correlation, CMP-9 is also inserting references to this rule throughout 314.70(A).

In all instances, the only permitted style of screw will be one with machine threads and a blunt end. This eliminates sharp points and coarse threads with the attendant sharp-edged thread exposures of typical sheet metal screws. The penetrating length varies depending on the application and location. First, a cover screw is the customary ½ inch screw provided with boxes, expressed as the penetrating amount, or 7/16 inch. They penetrate adjacent to a box wall at or near a corner, which tends to offer additional protection to an enclosed conductor. Other screws penetrating the cover are limited to 5/16-inch penetration, which allows the customary 3/8-inch faceplate screws used to attach devices to raised covers. It is understood that work directly with a cover inherently affords greater control over wire positioning than elsewhere in the box.

Large boxes, generally those covered in Sec. 314.28, have covers supplied with ½-in. long screws that enter close to an enclosure wall, and that therefore allow for a 7/16ths inch penetration. Outlet and device boxes (usually not over 100 in3) are more difficult because they are often more tightly packed and with severe visual obstruction of how wires are arranging themselves against a wall of the box. For that reason, screws added to a wall of such boxes are prohibited from any extension beyond the interior wall surface. There is correlating language with 314.23(B)(1) that allows for protected screws to run through the rearward portion of such boxes for mounting purposes.

A similar limitation is imposed on screws applied to conduit bodies. A screw entering any part of a conduit bodies is likely to create damage during any stage of the process of pulling wires, and in such cases the objection stands even with a cap nut on a projecting screw end.

The second exception addresses the short gang screws that are shipped with most steel device boxes holding the sides in place; when such boxes are ganged the same screws hold the ganged boxes together. These screws are made long enough to hold the sides in place, and extend into the box by about 3/32 in. when securing adjacent gangs. They are supplied by the box manufacturers and cannot be easily shortened to the point of being flush. CMP-9 is excusing them as well.

Public Input No. 458-NFPA 70-2020 [Section No. 314.25 [Excluding any Sub-Sections]]

In completed installations, each box ~~shall~~ and conduit body shall have a cover, faceplate, lampholder, or luminaire canopy, except where the installation complies with 410.24(B). Screws used for the purpose of attaching covers, or other equipment, to the box shall be either machine screws matching the thread gauge and size that is integral to the box or shall be in accordance with the manufacturer's instructions.

Statement of Problem and Substantiation for Public Input

Conduit bodies can contain splices, devices and terminations the same way a box can. Why are the present rules different for conduit bodies? There seems to be no logical reason to permit conduit bodies to remain uncovered, while boxes must be covered. Conduit bodies need to be covered too, in order keep any arcs and sparks contained within the enclosure, and to keep terminations protected.

Submitter Information Verification

Submitter Full Name: Russ Leblanc
Organization: Leblanc Consulting Services
Street Address:
City:
State:
Zip:
Submittal Date: Tue Feb 11 10:56:45 EST 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7751-NFPA 70-2020

Statement: CMP-9 is inserting a requirement that conduit bodies must be covered after installation, and the covering options differ from those for boxes generally, as expressed in an added sentence on the topic.

Public Input No. 1216-NFPA 70-2020 [Section No. 314.27(C)]

(C) Boxes at Ceiling-Suspended (Paddle) Fan Outlets.

Outlet boxes or outlet box systems used as the sole support of a ceiling-suspended (paddle) fan shall be listed, shall be marked on the interior of the box by their manufacturer as suitable for this purpose, and shall not support ceiling-suspended (paddle) fans that weigh more than 32 kg (70 lb). For outlet boxes or outlet box systems designed to support ceiling-suspended (paddle) fans that weigh more than 16 kg (35 lb), the required marking shall include the maximum weight to be supported.

Outlet boxes mounted in the ceilings of habitable rooms of dwelling occupancies in a location acceptable for the installation of a ceiling-suspended (paddle) fan shall comply with one of the following:

(1) Listed for the sole support of ceiling-suspended (paddle) fans

(2) An outlet box complying with the applicable requirements of 314.27 and providing access to structural framing capable of supporting of a ceiling-suspended (paddle) fan bracket or equivalent

Statement of Problem and Substantiation for Public Input

This change is consistent other NEC required manufacturer marking requirements such as 314.27(A)(1) and 314.27(A)(2).

Submitter Information Verification

Submitter Full Name: Gary Hein
Organization: Submission is independent of employer.
Street Address:
City:
State:
Zip:
Submittal Date: Sat May 23 09:10:39 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7760-NFPA 70-2020

Statement: CMP-9 is inserting a marking requirement on fan boxes on their interior so the suitability is evident during a rough inspection. This is consistent with the approach taken in 314.27(A)(1) and (A)(2). CMP-9 is also clarifying the wording of (2) to the effect that the access to framing is to be directly through the box, and not dependent of the box being removed for this purpose.

Public Input No. 1292-NFPA 70-2020 [Section No. 314.27(C)]

(C) Boxes at Ceiling-Suspended (Paddle) Fan Outlets.

Outlet boxes or outlet box systems used as the sole support of a ceiling-suspended (paddle) fan shall be listed, shall be marked by their manufacturer as suitable for this purpose, and shall not support ceiling-suspended (paddle) fans that weigh more than 32 kg (70 lb). For outlet boxes or outlet box systems designed to support ceiling-suspended (paddle) fans that weigh more than 16 kg (35 lb), the required marking shall include the maximum weight to be supported.

Outlet boxes mounted in the ceilings of habitable rooms of dwelling occupancies in a location acceptable for the installation of a ceiling-suspended (paddle) fan shall comply with one of the following:

(1) Listed for the sole support of ceiling-suspended (paddle) fans

(2) ~~An outlet box complying with the applicable requirements of~~ 314.27 ~~and providing access to structural framing capable of supporting of~~ Be installed so as to allow direct access through the box to the structural framing without removing the box. The structural framing shall be capable of supporting a ceiling-suspended (paddle) fan ~~bracket or equivalent~~ .

Statement of Problem and Substantiation for Public Input

The intent of this public input is strictly for clarity and usability. It is intended to maintain the original technical requirement without change.

Submitter Information Verification

Submitter Full Name: Megan Hayes
Organization: Nema
Street Address:
City:
State:
Zip:
Submittal Date: Thu May 28 11:33:04 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7760-NFPA 70-2020

Statement: CMP-9 is inserting a marking requirement on fan boxes on their interior so the suitability is evident during a rough inspection. This is consistent with the approach taken in 314.27(A)(1) and (A)(2). CMP-9 is also clarifying the wording of (2) to the effect that the access to framing is to be directly through the box, and not dependent of the box being removed for this purpose.

Public Input No. 1595-NFPA 70-2020 [Section No. 314.27(C)]

(C) Boxes at Ceiling-Suspended (Paddle) Fan Outlets.

Outlet boxes or outlet box systems used as the sole support of a ceiling-suspended (paddle) fan shall be listed, shall be marked by their manufacturer as suitable for this purpose, and shall not support ceiling-suspended (paddle) fans that weigh more than 32 kg (70 lb). For outlet boxes or outlet box systems designed to support ceiling-suspended (paddle) fans that weigh more than 16 kg (35 lb), the required marking shall include the maximum weight to be supported.

Outlet boxes mounted in the ceilings of habitable rooms of dwelling occupancies in a location acceptable for the installation of a ceiling-suspended (paddle) fan shall comply with ~~one of~~ the following:

(1) Listed for the sole support of ceiling-suspended (paddle) fans

(2) ~~An outlet box complying with the applicable requirements of~~ ~~314.27~~ ~~and providing access to~~ Supported by listed fan bracket identified for this purpose or structural framing capable of supporting of a ceiling-suspended (paddle) fan ~~bracket or equivalent~~

Statement of Problem and Substantiation for Public Input

The panel has a duty of reasonable care to the public:
90.1(A) Practical Safeguarding.
The purpose of this Code is the practical safeguarding of persons and property from hazards arising from the use of electricity.

Homeowners are for the most part, untrained persons, and the current language makes the presumption that they will know enough to remove the box that isn't capable of ceiling fan support, and replace it with one that is. Current NEC language makes this presumption. This is HIGHLY UNLIKELY that this is going to happen.

Hundreds of thousands of homeowners (if not millions) will go to the local home center, buy the ceiling fan, and then try to install it themselves. This is common. This is everyday. They are going to talk to the guy in the electrical aisle, and then go home and attempt to hang the ceiling fan. Sally is more concerned about picking up the kids from soccer practice and Fred just wants some appreciation from Sally for installing the new ceiling fan. The person installing the fan probably will not even read the manufacturers' instructions, and the NEC is the farthest thing from their mind. This is human nature.

In real life, it works like this:
Electrical fans have their own unique symbol on the approved electrical plan.
If the symbol for fan is shown, then the box that goes there should be a box that is listed for ceiling fan support.
If the symbol for a light is shown, then the box that goes there can be a standard box for a light.
If someone wants to put a regular light box there, then they can revise the approved plans to show that a standard box for a light goes there.
Plan revisions are common and there is nothing prohibiting the builder from doing this. The process is simple, and easy-peasy.

This change in the 2020 wasn't a good change, IMHO. To reiterate, the panel has a duty of reasonable care to the public.
The 2020 language is somewhat disingenuous because it relies on a future action that hasn't yet happened to qualify that the installation is a code-compliant installation.
The language "expects" the right thing to happen. In reality there is no guarantee this will happen. To quote Jim Pauley,

"We're inspectors - not expectors" NEC language should also reflect this train of thought, IMHO.

I don't think we should write code pertaining to a fan box, and say that a regular box can be used in that location.
There is a right way and a wrong way to wire a home and despite what the home builder associations may want from the electrical panels, we need to remain neutral on this issue.
Builders have the right to revise plans in order to show the correct type of box for the installation.
Inspectors inspect according to the approved plan set.
The proposed language codifies the box that is required to hang a fan.

Submitter Information Verification

Submitter Full Name:	Nick Sasso
Organization:	Clark County Building and Fire
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon Jun 22 18:53:10 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: CMP-9 is not backing away from its consistent position that it is not necessary to supply a paddle fan from a listed fan box, as long as that box is not actually being used to provide fan support. That was the case when fan boxes came into the Code in the 1987 cycle, and that remains the case presently. In fact, CMP-9 unanimously reiterated this policy in the 2020 cycle,With exceptions that are vanishingly rare, the NEC is not, must not, and indeed cannot be written to regulate unqualified and uninspected practice. For these reasons, CMP-9 resolves PI-1595 and PI-172. CMP-9 resolves PI-1910 because there is no certainty that the specific outlet box chosen for fan support will be the suitable one. However, the installer may be able to make a case with the AHJ for an application of 90.4 equivalency in such cases. CMP-9 also resolves PI-830. The suggested informational note pointing to four sections in Art. 422 is not helpful, because the sections so identified only reiterate generally understood requirements.

Public Input No. 172-NFPA 70-2019 [Section No. 314.27(C)]

(C) Boxes at Ceiling-Suspended (Paddle) Fan Outlets.

Outlet boxes mounted in the ceilings of habitable rooms of dwelling occupancies in a location acceptable for the installation of a ceiling-suspended (paddle) fan shall comply with the following:

Outlet boxes or outlet box systems used as the sole support of a ceiling-suspended (paddle) fan shall be listed, shall be marked by their manufacturer as suitable for this purpose, and shall not support ceiling-suspended (paddle) fans that weigh more than 32 kg (70 lb). For outlet boxes or outlet box systems designed to support ceiling-suspended (paddle) fans that weigh more than 16 kg (35 lb), the required marking shall include the maximum weight to be supported.~~Outlet boxes mounted in the ceilings of habitable rooms of dwelling occupancies in a location acceptable for the installation of a ceiling-suspended (paddle) fan shall comply with one of the following:~~

- ~~Listed for the sole support of ceiling-suspended (paddle) fans~~

~~An outlet box complying with the applicable requirements of 314.27 and providing access to structural framing capable of supporting of a ceiling-suspended (paddle) fan bracket or equivalent~~

A fan shall be permitted to be supported directly from structure if required by the fan manufacturer but the outlet box shall be listed and identified for fan support, to allow for future box supported fan installations.

Statement of Problem and Substantiation for Public Input

Current verbiage seems to allow a standard outlet box that is not allowed to support a fan to be installed in a dwelling where a fan may someday be installed, provided a hole is left to attach an anchor to building structure.
This method may have been acceptable for old style Hunter fans but I'm not aware of any modern fans that aren't designed to fasten directly to an outlet box. This creates a dangerous situation where a homeowner removes an old style anchor style fan and replaces it with a modern box mounted one using the existing box that is not approved or designed to support a fan.
By requiring a fan rated box at all of these locations you minimize incorrect and possibly hazardous installations.
The added sentence allows someone to install a larger or non-standard fan directly to building structure but still leaves a fan rated box for future replacements

Submitter Information Verification

Submitter Full Name: Ralph Baldwin
Organization: Legrand
Street Address:
City:
State:
Zip:

Submittal Date: Fri Dec 06 09:07:49 EST 2019
Committee: NEC-P09

Committee Statement

Resolution: CMP-9 is not backing away from its consistent position that it is not necessary to supply a paddle fan from a listed fan box, as long as that box is not actually being used to provide fan support. That was the case when fan boxes came into the Code in the 1987 cycle, and that remains the case presently. In fact, CMP-9 unanimously reiterated this policy in the 2020 cycle,With exceptions that are vanishingly rare, the NEC is not, must not, and indeed cannot be written to regulate unqualified and uninspected practice. For these reasons, CMP-9 resolves PI-1595 and PI-172. CMP-9 resolves PI-1910 because there is no certainty that the specific outlet box chosen for fan support will be the suitable one. However, the installer may be able to make a case with the AHJ for an application of 90.4 equivalency in such cases. CMP-9 also resolves PI-830. The suggested informational note pointing to four sections in Art. 422 is not helpful, because the sections so identified only reiterate generally understood requirements.

Public Input No. 1910-NFPA 70-2020 [Section No. 314.27(C)]

(C) Boxes at Ceiling-Suspended (Paddle) Fan Outlets.

Outlet boxes or outlet box systems used as the sole support of a ceiling-suspended (paddle) fan shall be listed, shall be marked by their manufacturer as suitable for this purpose, and shall not support ceiling-suspended (paddle) fans that weigh more than 32 kg (70 lb). For outlet boxes or outlet box systems designed to support ceiling-suspended (paddle) fans that weigh more than 16 kg (35 lb), the required marking shall include the maximum weight to be supported.

Outlet boxes mounted in the ceilings of habitable rooms of dwelling occupancies in a location acceptable for the installation of a ceiling-suspended (paddle) fan shall comply with one of the following:

(1) Listed for the sole support of ceiling-suspended (paddle) fans

(2) An outlet box complying with the applicable requirements of 314.27 and providing access to structural framing capable of supporting of a ceiling-suspended (paddle) fan bracket or equivalent

(3) <u>Exception 1: if a fan rated box is installed in the center of an area only the center box is required to be fan rated provided the remainder of ceiling boxes are clearly identified " not fan rated"</u>

Additional Proposed Changes

File Name	Description	Approved
1DAC115B-8D50-4FC0-8A91-86340663C66B.jpeg		
1DAC115B-8D50-4FC0-8A91-86340663C66B.jpeg		
1DAC115B-8D50-4FC0-8A91-86340663C66B.jpeg		

Statement of Problem and Substantiation for Public Input

With the use of led fixtures that mount directly to ceiling boxes some of the construction projects use in excess of 20 or more ceiling boxes just for led fixtures.
Some better direction, if applicable , such as measurements and/or an exception if a fan rated box is installed in the center of an area or room would helpful.

Submitter Information Verification

Submitter Full Name: Jason Sieracki
Organization: Harford County Govt
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jul 15 11:31:12 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: CMP-9 is not backing away from its consistent position that it is not necessary to supply a paddle fan from a listed fan box, as long as that box is not actually being used to provide fan support. That was the case when fan boxes came into the Code in the 1987 cycle, and that remains the case presently. In fact, CMP-9 unanimously reiterated this policy in the 2020 cycle,With exceptions that are vanishingly rare, the NEC is not, must not, and indeed cannot be written to regulate unqualified and uninspected practice. For these reasons, CMP-9 resolves PI-1595 and PI-172. CMP-9 resolves PI-1910 because there is no certainty that the specific outlet box chosen for fan support will be the suitable one. However, the installer may be able to make a case with the AHJ for an application of 90.4 equivalency in such cases. CMP-9 also resolves PI-830. The suggested informational note pointing to four sections in Art. 422 is not helpful, because the sections so identified only reiterate generally understood requirements.


Pendants
C:1J:351 BCK_2nd Flr
C:1J:351 BCK_2nd Flr

Public Input No. 830-NFPA 70-2020 [Section No. 314.27(C)]

(C) Boxes at Ceiling-Suspended (Paddle) Fan Outlets.

Outlet boxes or outlet box systems used as the sole support of a ceiling-suspended (paddle) fan shall be listed, shall be marked by their manufacturer as suitable for this purpose, and shall not support ceiling-suspended (paddle) fans that weigh more than 32 kg (70 lb). For outlet boxes or outlet box systems designed to support ceiling-suspended (paddle) fans that weigh more than 16 kg (35 lb), the required marking shall include the maximum weight to be supported.

Outlet boxes mounted in the ceilings of habitable rooms of dwelling occupancies in a location acceptable for the installation of a ceiling-suspended (paddle) fan shall comply with one of the following:

(1) Listed for the sole support of ceiling-suspended (paddle) fans

(2) An outlet box complying with the applicable requirements of 314.27 and providing access to structural framing capable of supporting of a ceiling-suspended (paddle) fan bracket or equivalent

Informational Note: For additional installation requirements for Ceiling-Suspended (Paddle) Fans, see 422.18, 422.19, 422.20 and 422.21

Statement of Problem and Substantiation for Public Input

The Informational note will assist the user with additional code articles specific to the installation of Ceiling-Suspended (Paddle) Fans.

Submitter Information Verification

Submitter Full Name: David Hittinger
Organization: IEC
Street Address:
City:
State:
Zip:
Submittal Date: Fri Apr 03 09:46:18 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: CMP-9 is not backing away from its consistent position that it is not necessary to supply a paddle fan from a listed fan box, as long as that box is not actually being used to provide fan support. That was the case when fan boxes came into the Code in the 1987 cycle, and that remains the case presently. In fact, CMP-9 unanimously reiterated this policy in the 2020 cycle,With exceptions that are vanishingly rare, the NEC is not, must not, and indeed cannot be written to regulate unqualified and uninspected practice. For these reasons, CMP-9 resolves PI-1595 and PI-172. CMP-9 resolves PI-1910 because there is no certainty that the specific outlet box chosen for fan support will be the suitable one.

However, the installer may be able to make a case with the AHJ for an application of 90.4 equivalency in such cases. CMP-9 also resolves PI-830. The suggested informational note pointing to four sections in Art. 422 is not helpful, because the sections so identified only reiterate generally understood requirements.

Public Input No. 3592-NFPA 70-2020 [Section No. 314.27(E)]

(E) ~~Separable Attachment Fittings~~ Locking Support Mounting Receptacle [Weight Supporting Ceiling Receptacle (WSCR)].

In habitable rooms, hallways, and foyers of one- and two-family dwellings, ceiling outlet boxes installed for sole support of luminaires and paddle fans shall a listed WSCR installed. Where the WSCR is installed within a box, it shall be included in the fill calculation covered in 314.16(B)(4).

Exception No. 1: A WSCR shall not be required in ceiling outlet boxes for electric-discharge, LED tube-type luminaires or track lighting.

Exception No. 2: A WSCR shall not be required in ceiling outlet boxes for recessed luminaires.

Exception No. 3: A WSCR shall not be required in ceiling outlet boxes for use with cove lighting.

(F) Weight Supporting Attachment Fittings (WSAF) .

Outlet boxes required in 314.27 shall be permitted to support listed ~~locking support and mounting receptacles~~ (WSCR) used in combination with compatible ~~attachment fittings~~ WSAF . The combination shall be identified for the support of equipment within the weight and mounting orientation limits of the listing. ~~Where the supporting receptacle is installed within a box, it shall be included in the fill calculation covered in 314.16(B)(4) .~~

Additional Proposed Changes

File Name	Description	Approved
SupportingMaterialFinal2.pdf	Supporting material with data from CPSC, NIOSH, CDC, OSHA, and the U.S. Census Bureau	

Statement of Problem and Substantiation for Public Input

WHY SHOULD A NEW (E) BE INSERTED? The "plug and play" receptacle (WSCR) increases safety by simplifying installation and most importantly, reducing the need to touch exposed conductors while installing luminaires. A new Section 314.27(E) on locking support mounting receptacles is being proposed for insertion to increase safety for the initial installation and for future exchanges of luminaires and paddle fans in one- and two-family dwellings. Three exceptions are proposed where the WSCR is not presently practical or not necessary due to configuration issues. While the requirement is for ceiling outlet boxes, the WSCR would be permitted for installation of luminaires mounted on wall (vertical) surfaces. The WSCR has been determined to be compatible with all known ceiling outlet boxes.

The existing 314.27(E) was modified to be new 314.27 (F) and to incorporate the new term (WSAF), as well as move the box fill reference to the receptacle section [new (E)] where it is better suited.

PLACEMENT. The proposed text is recommended for placement in Article 314 because it relates to support required of outlet boxes that then support luminaires or paddle fans. It also is related to the attachment fitting requirements found in the 2020 NEC® text under 314.27(E) [this would be renumbered to 310.27(F) with this revision]and provides convenience to users to have these requirements in the same area of the Code. Once installed, the WSCR will provide shock protection by reducing the need to work inside outlet boxes where there are energized conductors. It will provide fall protection by limiting both falls from unbalance and from the shock hazards that can result in falls and by reducing the time spent on ladders.

NAME CHANGE. The name of the "locking support mounting receptacle" is proposed to be simplified due to feedback from users and enforcers. It is proposed to be identified as "weight supporting ceiling receptacle (WSCR)", which better describes its function and features. Similarly, the attachment fitting is redesignated as "weight supporting attachment fitting (WSAF)", which also better describes its function and features and precludes confusion with unrelated fittings that attach, used elsewhere in the Code. See PIs 2690 and 2691 where the definitions are proposed.

DATA TO SUBSTANTIATE – SUMMARY OF SUPPORTING MATERIAL. A significant amount of information was collected and analyzed for this public input, including information from the U.S. Census Bureau, OSHA, NIOSH, CPSC, and CDC. It is included in the attached supporting material.

DIYers AND NON-ELECTRICIANS. A fundamental premise is that much of the home improvement work today is done by the do-it-yourselfer. The information on renovations is from the American Housing Survey, which is a report generated every two years by the U.S. Census Bureau. This report accumulates information on all aspects of housing. We have highlighted information that contrasts professional installations and do-it-yourself projects. It should be noted that licensing requirements vary among jurisdictions. A professional installer may not necessarily be licensed as an electrician. Information of the number of home improvement centers and hardware stores is provided to present a perspective on the size of the support network for home improvement. Home improvement stores are now a major factor in the US economy.

RENOVATION DATA. This report includes all of the residential renovations for each reporting period. Some of the larger renovation projects reported would have included electrical work, which was not separately categorized. Summary charts are provided on all renovations along with a single chart that reports on projects that were only classified as electrical.

DEATHS AND INJURIES REPORTED. Information from OSHA, NIOSH, CPSC, and CDC is based on reported accidents. OSHA and NIOSH data is reported in accordance with workplace accident reporting regulations. CPSC data is based on incidents that come to the attention of CPSC. Persons who are injured are not required to report their injuries to CPSC, so the information may be incomplete. The data on falls is based on reports from hospitals and clinics, which is contained in the WISQARS database. Two separate reports are presented, one for fatalities and one for non-fatal injuries.

<SEE ATTACHMENT FOR SUPPORTING DATA>

THAT NEXT HOME IMPROVEMENT – IS IT SAFE? People are always dreaming of that next home improvement or update. One of the most desirable ways to do that is by changing luminaires and adding or updating ceiling paddle fans.

As more DIYers are doing this improvement work, safety concerns grow exponentially. Some of the biggest safety issues are falls from ladders, electric shocks and electrocutions. A solution exists that you can employ in your products that mitigates all these very real hazards.

So, shouldn't the desires of the DIYers be accommodated safely? Benefits to you could be increased sales of luminaires or paddle fans – if we could just make it easier and safer.

…BECAUSE IT WAS ALWAYS DONE THAT WAY…? When overhead general lighting is going to be installed, why does the initial luminaire installation or future luminaire changes have to be hard-wired? Now technology exists to mitigate the hazards, as discussed here and should become mandatory for safety.

Safety in the NEC is a continuing evolution. When the screw shell lampholder design was standardized, why wasn't a weight supporting quick-connect option for luminaires and ceiling fans also included? Simply put, because the technology didn't exist. When looking around the home, most electrical equipment is plug and play, except ceiling luminaires and paddle fans. Furthermore, experience demonstrates that occupants would like to be able to change both luminaires and paddle fans.

One example of code and technology evolution is the use of a 2-wire lighting socket screw-shell adapter to power appliances. Evolution brought 2-wire receptacles for this purpose and these evolved to 3-wire grounded receptacles, some of which became GFCI-type receptacles. Advancements in technology coupled with the need to improve safety is the fundamental principle of the NEC.

DANGERS OF DOING IT THE “OLD” WAY. From your own experience, you understand the dangers of working on a ladder (with or without the luminaire or paddle fan) while wiring. Do you realize that, excluding motor vehicle accidents, falls are the #1 cause of injuries in construction (US Census Bureau BLS, 2019), which includes electricians? The data in the attached report validates your own experiences of strains and falls. Shouldn’t the wiring be done once, similar to any other receptacle, and the luminaire or paddle fan simply plugged in afterwards?

IT IS TIME TO TAKE ANOTHER STEP IN THE EVOLUTION TO FURTHER IMPROVE SAFETY.

DIYs ARE A LARGE SEGMENT OF RESIDENTIAL REMODELING
-- DIYers do between 36 - 38% of all home improvement projects (US Census Bureau, 2017)
-- DIYers do between 35.2 - 35.9% of all electrical home improvement projects (US Census Bureau, 2017).
-- Luminaires and paddle fans are two of the most popular electrical improvements.
-- HGTV, DIY Network, YouTube encourage DIY projects.
    -- House flipping is popular among DIYers, encouraged by HGTV programming.
-- There are several thousand home improvement stores nationwide to support DIY projects

HAZARDS FROM THE DIY INSTALLATION
-- Incorrect installations go undetected
    -- Incorrect wiring causing shorts and shocks
    -- Incorrect support causing luminaires/paddle fans to fall or damage wires
    -- Loss of grounding/bonding connection
-- Falls from ladders during installation from:
    -- Shocks
    -- Unsteadiness and losing balance
    -- Awkwardness of handling luminaires/paddle fans while connecting wires
-- Shocks during installation of replacement luminaires/paddle fans due to exposure of live wires

The extent of the DIY problem installations is not really known. There is rarely an electrical inspection initially, and subsequent real estate home inspectors often have a low level of electrical training. Also, there is no one or entity that is keeping statistics.

SIMPLER MAINTENANCE
-- Easy removal for cleaning luminaires/paddle fans and bulb replacement
-- Easy removal and reinstallation for painting the ceiling
-- Quick install/removal of luminaires/paddle fans

IF THE WORK IS DONE BY PROFESSIONALS, WHO ARE “PROFESSIONALS” INSTALLING LIGHTING/CEILING FANS? How many of the professional home improvement projects include an electrical professional on the team? Is the electrical work being performed by painters? Carpenters? Drywallers? Home handymen?
-- The CPSC estimates there are 4 electrocution deaths per year associated with lighting products (Hnatov, 2009) that they have been able to identify. One death is one too many.
    -- CPSC data from the National Electronic Injury Surveillance System (NEISS) database (CPSC, 2019) from 2009 to 2013 revealed 38 incidents resulting in hospital emergency room visits involving the
    installation of luminaires; 32 of those incidents involved falls and at least four of those incidents involved the victims being shocked.

CEILING FAN RECALLS
The CPSC website lists a number of ceiling fan and luminaire recalls (CPSC, 2018). If the new technology receptacle had been installed, the luminaire could be easily replaced by the homeowner, minimizing shock and fall hazards.

THE SOLUTION
The proposed solution is an innovative advance that makes the installation of luminaires/paddle fans safer not just for the current installation, but for future replacements. With this new technology installed during initial construction by electrical professionals there is:

-- a quick connect/disconnect capability (similar to a standard receptacle)
-- support of the weight of the luminaire/paddle fan
-- no supporting the weight or bulk of the luminaire/paddle fan during the receptacle installation
-- no additional rewiring necessary to install the new luminaire/paddle fan
-- no shock hazard during the quick connect of the luminaire/paddle fan

The WSCR is an advance that makes the installation of luminaires and paddle fans safer not just for the current installation, but for future replacements. For the initial installation, the only "weight" the installer has to deal with is the WSCR which is ounces not pounds.

Without the weight/bulk, the falls may not have occurred. With the new technology WSCR in place, the initial installation of the luminaire and any replacement is a quick connect and no shock would have occurred.

If the WSCR and WSAF are required, homeowners and other installers would be protected from shock and fall accidents. They would also be more able to change luminaires/paddle fans at will, which would significantly increase the market.

The solution makes the initial installation safer and provides that future lighting replacements do not require the homeowner to come in contact with potentially live wiring. The WSCR and WSAF configurations protect homeowners and other DIY installers and make lighting replacements simple.

PUBLIC SAFETY.
The WSCR and WSAF would increase overall public safety; a previously installed WSCR (female portion in the ceiling) will:
-- REDUCE installation time and time on ladders (due to ease of installation)
-- REDUCE time standing on something substituting for a ladder (chair, table, sofa, etc.)
-- ELIMINATE homeowners splicing of wiring especially while on ladders
-- REDUCE incorrect installations that could lead to fires or shock hazards
-- REDUCE injuries and deaths from
    -- shock and electrocution
    -- falls
-- PROMOTES robust and safe first-time installation by professionals
-- ALLOWS quick connect for initial and future installations
-- ELIMINATE straining of conductors and connectors holding the weight of luminaire during installation
-- ELIMINATE the need to support the weight of the luminaire or ceiling paddle fan during wiring; the WSCR weighs ounces.
-- FACILITATES safety when the inspector verifies polarity of the wiring to the WSCR via a circuit tester (versus no polarity verification of luminaires/paddle fans currently).

ADDITIONAL BENEFITS TO MANUFACTURERS WHO LICENSE TECHNOLOGY. This submission complies with the ANSI/NFPA Essential Patent Policy, and the necessary documentation has been provided to NFPA. The WSCR and WSAF would benefit manufacturers as follows:
-- REDUCE liability exposure
-- INCREASE purchasing of luminaires/paddle fans due to
    -- reduced installation costs
    -- ease of installation
-- INCREASE purchasing of different types or themed luminaires/paddle fans could be easily quick connected/disconnected based on events/holidays/formality
-- DECREASE time get a certificate of occupancy once WSCR is installed in ceiling
-- INCREASE purchasing of WSCR by homebuilders who wish to maximize spec homes (easy switch out of luminaires/paddle fans based on customer preference)
-- REDUCE procrastination of remodeling (entire construction industry benefits)
-- INCREASE interchangeability by promoting standardization
-- INCREASED business - interchangeability that anyone's luminaire/paddle fan can be replaced with yours
-- DECREASE costs since multiple designs of connectors are not necessary
-- INCREASE product lines containing the "quick connect/disconnect" feature

CROSS REFERENCE. Cross-reference PIs 2690 and 2691, definitions for "Weight Supporting Ceiling Receptacle" and "Weight Supporting Attachment Fittings", respectively.

REFERENCES
American Housing Survey, (2011, 2013, 2015, 2017) https://www.census.gov/programs-surveys/ahs/data/interactive/ahstablecreator.html?s_areas=00000&s_year=2017&s_tablename=TABLE1&s_bygroup1=1&s_bygroup2=1&s_filtergroup1=1&s_filtergroup2=1

Fan Recalls U.S. Consumer Products Safety Commission. (2018, September 6). Retrieved May 19, 2020, from https://www.cpsc.gov/search?site=cpsc_site&output=xml_no_dtd&getfields=*&tlen=120&client=ek_drupal_01&proxystylesheet=ek_drupal_01&filter=p&query=fans

Hnatov, Matthew V. 2004 Electrocutions Associated with Consumer Products, Hazard Analysis Division, Directorate for Epidemiology, Consumer Products Safety Commission. April (2009, April)

National Census of Fatal Occupational Injuries in 2018 (17 Dec. 2019) https://www.bls.gov/news.release/pdf/cfoi.pdf. Accessed 20 May 2020.

National Electronic Injury Surveillance System On-Line Query System U.S. Consumer Products Safety Commission. (2019, July 08). Retrieved July 09, 2020, from https://www.cpsc.gov/cgibin/NEISSQuery/home.aspx

Submitter Information Verification

Submitter Full Name:	Amy Cronin
Organization:	Strategic Code Solutions LLC
Affiliation:	Sky Technologies (formerly Safety Quick Lighting and Fans)
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Sep 09 08:28:25 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: FR-7761-NFPA 70-2020

Statement: CMP-9 is updating the names for the existing terminology “locking support and mounting receptacles” and “attachment fitting” to correlate with newly defined terminology in Article 100, terminology that will include associated acronyms. Although optional, CMP-9 is electing to repeat the full names of the terms [“Weight Supporting Ceiling Receptacle (WSCR) and “Weight Supporting Attachment Fittings (WSAF)] in this section, their first such use in Article 314, in order to support usability.

CMP-9 is resolving all other portions of PI- 3592. The mandatory requirement for these receptacles cannot move forward here until luminaires that incorporate the attachment fittings are mandated in Art. 410. CMP-9 understands that CMP--18 is resolving PI 3423 that would accomplish this, due in part to a lack of industry standards. Optional usage of this equipment will remain acceptable under the new text.

September 2020

PROBLEMS AND SOLUTIONS SUMMARY

Problem: Traditional wiring

Existing practices allow wiring of luminaires and paddle fans that can result in faulty installations or hazards that can include:

- **Shocks, electrocutions, injuries & death**
- **Fires & shorts**
- **Exposure & contacting energized conductors**
- **Incorrect & sloppy wiring**
- **Splicing wires while on a ladder**
- **Straining of conductors & connectors holding the weight of luminaire during installation**
- **Incorrect installations go undetected**
  - Loss of grounding/bonding connections
- **Incorrect support causing luminaires/paddle fans to fall or damage wires**
- **Falls from ladders during installation from:**
  - Shocks
  - Unsteadiness and losing balance
  - Awkwardness - handling while connecting wires

Solution: Weight Supporting Ceiling Receptacle (WSCR)

Plugging-in luminaires & paddle fans using the WSCR & Weight Supporting Attachment Fitting (WSAF) will eliminate and/or reduce risk of faulty wire installations and can:

- **Reduce shocks, electrocutions, injuries & deaths**
- **Eliminate the need to touch wires; no exposed wires**
- **Prevent fires due to incorrect or sloppy wiring**
- **Provide a means to check polarity**
- **Eliminate straining of conductors & connectors holding the weight of luminaire during installation**
- **Eliminate splicing wires while on a ladder**
- **Reduce majority of time on ladders (unsteadiness & losing balance**
- **Reduce awkwardness of handling luminaires/paddle fans while connecting wires**

September 2020

Supporting Data for Public Input

REQUIREMENTS FOR WEIGHT SUPPORTING CEILING RECEPTACLE (WSCR) AND WEIGHT SUPPORTING ATTACHMENT FITTING (WSAF)

formerly Locking Support and Mounting Receptacle and Attachment Fitting

Table of Contents

MANY DIY'ERS MAKE THIS TECHNOLOGY CRUCIAL FOR SAFETY

Large Support Network for Do It Yourselfers

There is a significant market for do-it-yourself home improvement. Big-box retailers have sprung up across North America that supply products directly to the consumer. There are 2,286 North American Home Depot stores, 2155 Lowe's Stores, 5000 Ace Hardware stores, 3800 True Value stores, 4500 Do it Best stores, 1000 Harbor Freight stores and others that supply inexpensive tools to many of the DIYers. The DIY market is also supported by all sorts of You Tube videos, some of which is vendor supported, but much of which is generated by someone who may not be an expert. In addition, the Home and Garden TV Network (HGTV) has convinced many that they can make large profits by buying distressed existing home and flipping them. This has also encouraged homeowners to improve their own homes.

The big box stores are known for having large lighting departments that have extensive displays of fixtures. Many can arrange for a local contractor to do the installation. However, many consumers are taking on the project themselves or having some unlicensed handyman do the installation work.

The public inputs will propose to require that lighting outlets utilize listed WSCR and WSAF (locking support-type receptacles to connect to compatible attachment fittings) on luminaires and paddle fans. The use of the WSCR and WSAF simplify the replacement of luminaires and paddle fans. The use of the WSCR and WSAF limits the exposure to energized parts for future fixture replacements. Falls from ladders are a safety problem for professionals in the workplace. They are also a safety problem in the home. Simplifying the replacement process limits the time spent on ladders, and reduces the extended reach from higher ladder steps, minimizing the number of falls.

Fixtures have varying degrees of installation complexity and a variety of fastening means. There is also a lot of variety of degrees of assembly that is required. Some of assembly might take place on the ladder. With WSCR and WSAF, all of the assembly can take place off the ladder and the completed assembly can simply be raised into position and plugged in.

Renovation Statistics

The American Housing Survey, produced by the Census Bureau is generated every two years[1]. One of the many factors analyzed is home renovations. The survey analyzes professional and DIY renovations. The statistics appear to show a level percentage of DIY renovations out of the total number of renovations for each reporting period. Some renovations can easily be

[1] *U. S. Census Bureau, American Housing Survey*. (n.d.). Retrieved July 20, 2020, from https://www.census.gov/programs-surveys/ahs/data/interactive/ahstablecreator.html?s_areas=00000&s_year=2011&s_tablename=TABLE16&s_bygroup1=24&s_bygroup2=1&s_filtergroup1=1&s_filtergroup2=1.

performed by the homeowner. Surprisingly, the statistics also show a fairly consistent percentage of electrical renovations that are DIY. Permits are rarely taken out for DIY equipment replacements or renovations. That is sometimes the case with flipped homes. As a result, DIY work is rarely inspected by jurisdictional electrical inspectors. Even when permits are taken out, there is no guarantee that the work will be performed by professionals or that it will be inspected. Many jurisdictions will only spot check the work of homeowners because inspections cost money and if there is no inspection, the jurisdiction can just collect the permit fee. For those who are classified as professional, how many of the practitioners are electricians? How many are just handymen? Figures 1 through 4 illustrate the percentages of home improvement projects for a two-year period ending in 2017, 2015, 2013, and 2011. Figure 5 illustrates all of the electrical home improvement projects reported by the survey from 2010 through 2017. The background data is in Annex A.

FIGURES 1-4: LARGE PERCENTAGE OF HOME IMPROVEMENTS DONE BY DIY'ers; "PROFESSIONALS" CAN INCLUDE PAINTERS AND HANDYMEN, NOT ALWAYS ELECTRICIANS.

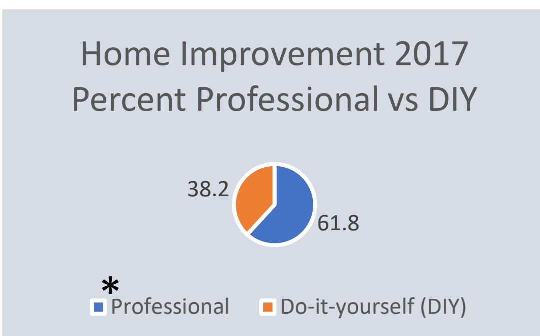


Figure 1.

* Professionals include handyman/painters/electricians

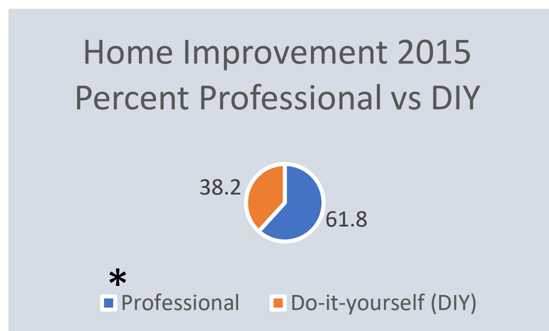


Figure 2.

* Professionals include handyman/painters/electricians

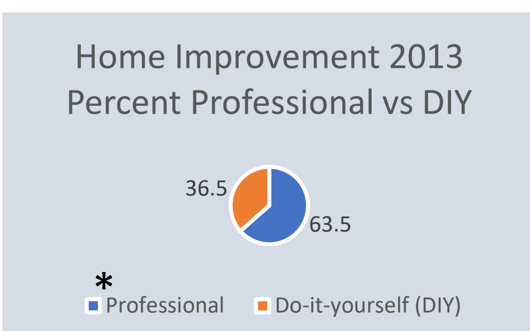


Figure 3.

* Professionals include handyman/painters/electricians

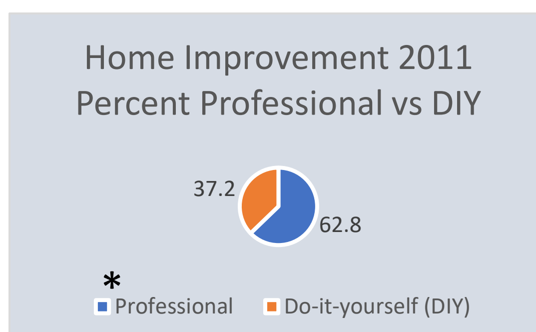
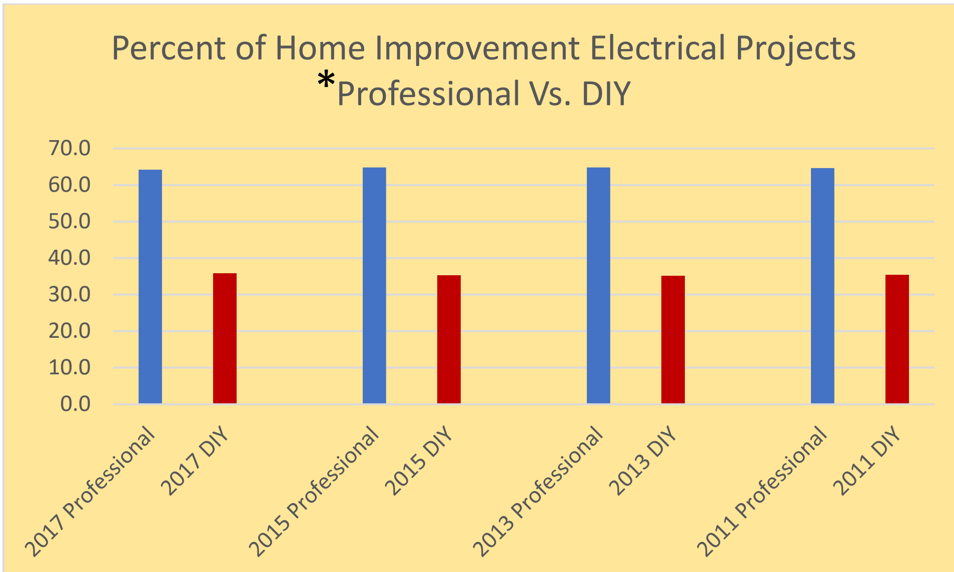


Figure 4.

* Professionals include handyman/painters/electricians

Electrical Home Improvement Projects

The number of people who are willing to do electrical work themselves has been a similar percentage to that of all DIY projects. It has also remained steady over the study periods of the survey. The raw statistics are included to provide a clearer picture of the types of home improvement projects undertaken. Many of the interior renovations likely include some electrical work, which may or may not be included separately as electrical work.



*Professionals include handyman/painters/electricians

Figure 5.

NFPA Residential Fire Statistics

NFPA estimates that 17,600 home fires in the US that are caused by faulty wiring connected with ceiling fans and lights (https://www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics-and-reports/Building-and-life-safety/oshomes.pdf) The report notes "Electrical distribution or lighting equipment was the leading cause of home fire property damage. An average of 35,000 such fires caused 500 deaths; 1,130 injuries; and $1.4 billion in direct property damage per year. Wiring and related equipment accounted for 7 percent of all home fires and 10 percent of all home fire deaths. Cords or plugs were involved in only 1 percent of the fires but 6 percent of the deaths. Extension cords dominated the cord or plug category. More information is available in the NFPA report, *Electrical Fires*[2]."

---

[2] Campbell, R. (2019, March). *Electrical Fires* (Tech.). Retrieved July 20, 2020, from National Fire Protection Association website: https://www.nfpa.org/News-and-Research/Data-research-and-tools/Electrical/Electrical

The following table notes fire statistics for lighting and distribution equipment. This is a rather broad category. There is a separate category for ceiling fans. It appears that fans category includes bathroom vent fans. It may also include kitchen exhaust fans.

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%)

Later on, NFPA's *Electrical Fires* report contains the following table, which, for the same time period has different and larger numbers:

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%)

Injury Reports

OSHA Reports. Falls from ladders are a frequent hazard. They happen in commercial and industrial settings as well as in residential situations. For example: in the OSHA electrocution training materials, an OSHA Fatal Fact is presented[3] that details a union electrician's death by electrocution during trouble shooting with lamps. The shock caused the electrician to fall off the ladder (OSHA Incident Report #0418800).[4]

Another example: in 2011, an electrician was electrocuted when the wires of a light fixture he was attempting to hang became stripped energizing the light fixture. As he grabbed one of the attached steel hanging cables, he received a fatal shock (OSHA Incident Report #0317700).[5] It is reasonable to conclude that this incident could have been avoided if the new technology receptacle/attachment fitting technology had been used because the fixture could not have become energized, as there would be no access to electricity through the disconnected fixture.

NIOSH Reports. The National Institute for Occupational Safety and Health (NIOSH) conducts the Fatal Accident Circumstances and Epidemiology (FACE) Project. Data are collected from a sample of fatal accidents, including electrical-related fatalities.

For example: NIOSH FACE Report 87-55[6] summarized a 1987 electrocution of a North Carolina electrician. While repairing a fluorescent light fixture over a kitchen sink in a single-family residence, a 33-year-old journeyman electrician was electrocuted when he contacted an energized wire on the load side of the ballast (400 volts). The ballast had been replaced. However, he could not get the light to operate properly. The electrician was sitting on the sink when he apparently contacted an energized wire on the load side of the ballast. The circuit had not been de-energized at the panel box or at the single-pole switch on the wall beside the sink.

It is reasonable to conclude that this incident might have been avoided if the WSCR/WSAF technology had been used. The receptacle would've already been installed, and the fixture could've been taken down through a simple quick disconnect for examination. If the fixture was determined to be in working order, additional work could be completed with the fixture

---

[3] Construction Focus Four: Electrocution Hazards, Instructor Guide. OSHA Training Institute, OSHA Directorate of Training and Education, April 2011. Document can be found online at https://www.osha.gov/dte/outreach/construction/focus_four/electrocution/electr_ig.pdf

[4] OSHA Report ID: 0418800 can be found at https://www.osha.gov/pls/imis/establishment.inspection_detail?id=18396960

[5] OSHA Report ID: 0317700 can be found at https://www.osha.gov/pls/imis/establishment.inspection_detail?id=314163627[6] NIOSH Face Reports 1982 to 2005 including 87-55 can be found at http://wwwn.cdc.gov/NIOSH-FACE/Default.cshtml?state=ALL&Incident_Year=ALL&Category2=0006&Submit=Submit#.VFjs8y7-DK0.email. This particular report can be located directly at http://www.cdc.gov/niosh/face/In-house/full8755.html

[6] NIOSH Face Reports 1982 to 2005 including 87-55 can be found at http://wwwn.cdc.gov/NIOSH-FACE/Default.cshtml?state=ALL&Incident_Year=ALL&Category2=0006&Submit=Submit#.VFjs8y7-DK0.email. This particular report can be located directly at http://www.cdc.gov/niosh/face/In-house/full8755.html

[7] 2004 Electrocutions Associated with Consumer Products, By Matthew V. Hnatov. Hazard Analysis Division, Directorate for Epidemiology, Consumer Products Safety Commission. April 2009

quickly disconnected and out of the vicinity so full attention could be given to the wiring. If the new technology had been used, the electrocution might have been avoided.

CPSC Data. It is important to note that CPSC data includes only the data the CPSC becomes aware of, and it is understood that there are many other incidents that are not reported or do not come to their attention. Consumers are not obligated to report incidents to the CPSC. The research from the National Electronic Injury Surveillance System (NEISS) database from 2009 to 2013 included the following:

- CPSC estimates 4 electrocution deaths per year associated with lighting products.[7]
- There were 38 incidents involving the installation of light fixtures that resulted in hospital emergency room visits;
- 32 of those incidents involved falls and at least four of those incidents involved the victims being shocked.

With the new technology, after the receptacle is installed in the ceiling, there is no additional wiring necessary, no weight or bulk of the fixture during the initial receptacle installation, certainty of connection of the fixture to the equipment grounding conductor, and no shock hazard during the quick connect of the fixture. Without the weight/bulk, the falls may not have occurred. With the new technology receptacle in place, installation of the luminaire is a quick connect and no shock would have occurred.

- There were 418 incidents involving changing light bulbs that resulted in hospital emergency room visits;
- 390 involved falls and at least six of those incidents involved the victims being shocked.
- There were 9 additional incidents associated with cleaning the light fixture that resulted in hospital emergency room visits; 8 of those involved falls.

Many of these incidents could have been avoided or minimized if the new technology receptacle/attachment fitting technology had been used. The fixture is simply disconnected and any bulb or fixture maintenance or cleaning can be done on a table, not at an elevation, thereby reducing the time at an elevated level, thereby reducing the hazard.

- There were 55 incidents involving a luminaire falling from the ceiling onto the victim that resulted in hospital emergency room visits.

If the receptacle/attachment fitting (WSCR/WSAF) technology had been used, many of these incidents could have been avoided or minimized. The new technology must pass weight support requirements in the UL product safety standards well beyond what the NEC permits.

---

[7] 2004 Electrocutions Associated with Consumer Products, By Matthew V. Hnatov. Hazard Analysis Division, Directorate for Epidemiology, Consumer Products Safety Commission. April 2009

The NEC does not permit the assembly to support a luminaire weighing more than 50 lbs or a ceiling fan weighing more than 70 lbs, therefore the fixtures would not fall.

CDC Data. According to the Centers for Disease Control and Prevention (CDC), falls are the number one cause of injury. From 2001-2017, there were 144,895,242 falls reported to CDC. During the same period, there were 443,576 deaths from falls. It is not unreasonable to assume that many of these falls involved working on a luminaire. Ladder related accidents are common. In addition, some will resort to stools, chairs, and chairs with boxes or books on them to get to the right height. Detailed information can be found in Annex B. There is little information on what the victims were doing when they fell.

In 1997, Industrial Safety and Hygiene News (ISHN) noted "According the American Academy of Orthopedic Surgeons, every year 500,000 people are treated for ladder-related injuries and approximately 300 of these incidents prove to be fatal. The Liberty Mutual Research Institute for Safety found that in 2007 alone, more than 400 people died as a result of falls on or from ladders or scaffolding[8].

Summary

When viewing data contained in the Annexes, it is important to note that there is no way to know the exact number of improper installations. For example, if there were one million annual installations of luminaires (it could be argued that there are significantly *more* annual installations per Annex A) and just 2% of them were improperly installed by an untrained do-it-yourselfers, that would result in 20,000 improperly installed luminaires.

[8] 500,000 Falls from Ladders Annually; 97 Percent Occur at Home or on Farms. (July 6, 2017). *Industrial Safety and Hygiene News*. Retrieved July 20, 2020, from https://www.ishn.com/articles/106830-000-falls-from-ladders-annually-97-percent-occur-at-home-or-on-farms

Annex A. Home Renovations Reported in the American Housing Survey

Survey Notes: Estimates and Margins of Error in thousands of housing units, except as indicated. Medians are rounded to four significant digits as part of disclosure avoidance protocol. Margin of Error is calculated at the 90% confidence interval. Weighting consistent with Census 2010. Blank cells represent zero; Z rounds to zero; '.' Represents not applicable or no cases in sample; S represents estimates that did not meet publication standards or withheld to avoid disclosure.

Characteristics	Professional/Do-It-Yourself Total Estimate	Professional Estimate	Do-It-Yourself Estimate
HOME IMPROVEMENT ACTIVITY IN LAST TWO YEARS (2017)			
Total			
Number of projects (1,000)	113,155	69,975	43,181
Median expenditures ($)	1,364	2,408	600
Total expenditures (1,000)	450,089,818	368,366,827	81,722,991
Disaster Repairs[1]			
Earthquake			
Number of projects (1,000)	S	S	S
Median expenditures ($)	S	S	300
Total expenditures (1,000)	S	S	S
Tornado/hurricane			
Number of projects (1,000)	418	303	115
Median expenditures ($)	7,000	7,000	S
Total expenditures (1,000)	4,490,105	3,276,862	S
Landslide			
Number of projects (1,000)	S	S	.
Median expenditures ($)	6,020	6,020	.
Total expenditures (1,000)	S	S	.
Fire			

Number of projects (1,000)	113	85	S
Median expenditures ($)	10,000	10,000	S
Total expenditures (1,000)	S	S	S
Flood			
Number of projects (1,000)	197	121	76
Median expenditures ($)	S	13,500	S
Total expenditures (1,000)	5,283,698	S	S
Other			
Number of projects (1,000)	867	734	133
Median expenditures ($)	9,500	10,500	3,800
Total expenditures (1,000)	10,898,601	10,190,039	708,562
Room Additions and Renovations[1]			
Bedroom			
Number of projects (1,000)	419	184	235
Median expenditures ($)	7,000	23,000	2,000
Total expenditures (1,000)	7,289,971	6,000,692	1,289,280
Bath			
Number of projects (1,000)	274	162	112
Median expenditures ($)	6,400	10,000	4,000
Total expenditures (1,000)	3,258,882	2,493,137	765,746
Recreation Room			
Number of projects (1,000)	196	105	91
Median expenditures ($)	S	24,000	3,750
Total expenditures (1,000)	4,880,565	3,875,457	S
Kitchen			
Number of projects (1,000)	159	94	65
Median expenditures ($)	S	30,000	S
Total expenditures (1,000)	4,559,506	3,686,182	S
Other			

Number of projects (1,000)	827	444	383
Median expenditures ($)	6,500	12,500	S
Total expenditures (1,000)	13,508,584	11,125,843	2,382,741
Remodeling[1]			
Bath			
Number of projects (1,000)	5,739	3,001	2,738
Median expenditures ($)	3,000	5,250	1,500
Total expenditures (1,000)	35,305,520	26,856,855	8,448,665
Kitchen			
Number of projects (1,000)	4,184	2,358	1,826
Median expenditures ($)	6,000	10,000	3,000
Total expenditures (1,000)	49,553,906	37,772,420	11,781,486
Exterior Additions and Replacements[1]			
Attached garage/carport			
Number of projects (1,000)	736	389	347
Median expenditures ($)	2,800	4,500	2,200
Total expenditures (1,000)	6,120,015	4,365,016	1,754,999
Porch/deck/patio/terrace			
Number of projects (1,000)	3,331	1,798	1,533
Median expenditures ($)	2,500	4,400	1,000
Total expenditures (1,000)	18,805,519	14,757,663	4,047,856
Roofing			
Number of projects (1,000)	6,766	5,656	1,110
Median expenditures ($)	6,000	6,800	2,200
Total expenditures (1,000)	50,222,041	45,937,650	4,284,391
Siding			
Number of projects (1,000)	1,937	1,264	672
Median expenditures ($)	3,000	4,800	920

Total expenditures (1,000)	9,468,686	8,030,873	1,437,813
Windows/doors			
Number of projects (1,000)	7,443	4,799	2,644
Median expenditures ($)	1,400	2,300	500
Total expenditures (1,000)	24,777,309	21,119,910	3,657,399
Chimney/stairs/other exterior additions			
Number of projects (1,000)	1,531	1,087	444
Median expenditures ($)	1,072	1,440	480
Total expenditures (1,000)	3,856,308	3,133,861	722,448
Interior Additions and Replacements[1]			
Insulation			
Number of projects (1,000)	2,712	1,451	1,261
Median expenditures ($)	750	1,250	400
Total expenditures (1,000)	3,886,216	2,948,857	937,359
Water pipes			
Number of projects (1,000)	3,014	1,792	1,221
Median expenditures ($)	550	1,000	200
Total expenditures (1,000)	4,549,002	3,972,440	576,562
Plumbing fixtures			
Number of projects (1,000)	8,192	3,924	4,268
Median expenditures ($)	400	700	250
Total expenditures (1,000)	10,766,188	8,227,445	2,538,743
Electrical wiring/fuse boxes/breaker switches			
Number of projects (1,000)	4,487	2,879	1,609
Median expenditures ($)	600	1,000	300
Total expenditures (1,000)	6,388,526	5,088,660	1,299,866
Security system			
Number of projects (1,000)	4,286	2,933	1,353

Median expenditures ($)	400	400	400
Total expenditures (1,000)	2,605,279	1,732,909	872,370
Flooring/carpeting/paneling/ceiling tiles			
Number of projects (1,000)	10,438	6,364	4,074
Median expenditures ($)	2,000	2,875	920
Total expenditures (1,000)	33,135,645	26,515,795	6,619,850
HVAC			
Number of projects (1,000)	9,930	8,571	1,359
Median expenditures ($)	3,600	4,000	2,000
Total expenditures (1,000)	43,413,330	39,616,745	3,796,585
Septic tank			
Number of projects (1,000)	355	300	55
Median expenditures ($)	3,000	3,000	S
Total expenditures (1,000)	1,474,779	1,387,439	S
Water heater/dishwasher/garbage disposal			
Number of projects (1,000)	14,569	8,457	6,113
Median expenditures ($)	500	700	400
Total expenditures (1,000)	10,813,487	7,882,752	2,930,735
Other interior			
Number of projects (1,000)	1,901	1,250	651
Median expenditures ($)	1,700	2,143	1,000
Total expenditures (1,000)	S	S	1,348,948
Lot or Yard Additions & Replacements[1]			
Driveways/walkways			
Number of projects (1,000)	3,858	2,627	1,231
Median expenditures ($)	1,800	2,640	550
Total expenditures (1,000)	12,015,598	10,545,199	1,470,399
Fencing/walls			

Number of projects (1,000)	4,449	2,303	2,146
Median expenditures ($)	1,300	2,600	601
Total expenditures (1,000)	10,140,802	7,603,533	2,537,269
Swimming pool/tennis court/recreational structures			
Number of projects (1,000)	967	537	431
Median expenditures ($)	3,500	7,500	748
Total expenditures (1,000)	11,131,910	10,170,999	960,911
Shed/detached garage/other building			
Number of projects (1,000)	2,337	1,095	1,243
Median expenditures ($)	2,000	3,100	1,000
Total expenditures (1,000)	11,680,657	7,570,385	4,110,272
Landscaping/sprinkler system			
Number of projects (1,000)	5,541	2,279	3,262
Median expenditures ($)	900	2,000	500
Total expenditures (1,000)	13,390,741	9,353,303	4,037,438
Other			
Number of projects (1,000)	964	612	352
Median expenditures ($)	2,000	3,000	500
Total expenditures (1,000)	4,583,936	4,169,719	414,217

Characteristics	Professional/Do-It-Yourself Total Estimate	Professional Estimate	Do-It-Yourself Estimate
HOME IMPROVEMENT ACTIVITY IN LAST TWO YEARS (2015)			
Total			
Number of projects (1,000)	123,481	76,277	47,204
Median expenditures ($)	1,200	2,000	600
Total expenditures (1,000)	431,497,494	347,110,853	84,386,641
Disaster Repairs[1]			
Earthquake			
Number of projects (1,000)	23	13	S
Median expenditures ($)	S	S	S
Total expenditures (1,000)	194,698	172,620	S
Tornado/hurricane			
Number of projects (1,000)	339	263	76
Median expenditures ($)	6,000	7,000	S
Total expenditures (1,000)	3,171,864	2,692,720	S
Lightning/fire			
Number of projects (1,000)	142	92	50
Median expenditures ($)	S	S	S
Total expenditures (1,000)	5,161,751	S	S
Flood			
Number of projects (1,000)	211	139	72
Median expenditures ($)	8,150	8,685	S
Total expenditures (1,000)	2,999,016	S	S
Other			
Number of projects (1,000)	823	708	115

Median expenditures ($)	8,550	9,000	3,000
Total expenditures (1,000)	10,029,780	9,309,961	S
Room Additions and Renovations[1]			
Bedroom			
Number of projects (1,000)	516	259	257
Median expenditures ($)	5,000	17,000	2,000
Total expenditures (1,000)	10,997,017	8,903,760	2,093,257
Bath			
Number of projects (1,000)	303	162	141
Median expenditures ($)	S	10,000	2,500
Total expenditures (1,000)	3,463,143	2,847,832	615,311
Recreation Room			
Number of projects (1,000)	253	124	130
Median expenditures ($)	S	15,000	2,800
Total expenditures (1,000)	3,036,052	2,510,855	525,197
Kitchen			
Number of projects (1,000)	198	133	65
Median expenditures ($)	12,110	15,000	5,000
Total expenditures (1,000)	4,355,845	3,925,883	S
Other			
Number of projects (1,000)	861	453	408
Median expenditures ($)	5,000	8,000	2,000
Total expenditures (1,000)	9,920,768	7,905,575	2,015,193
Remodeling[1]			
Bath			
Number of projects (1,000)	6,547	3,406	3,141
Median expenditures ($)	3,000	5,000	1,500
Total expenditures (1,000)	37,537,408	28,304,879	9,232,529

Kitchen			
Number of projects (1,000)	4,740	2,595	2,145
Median expenditures ($)	5,000	7,000	3,000
Total expenditures (1,000)	47,380,831	34,471,023	12,909,808
Exterior Additions and Replacements[1]			
Attached garage/carport			
Number of projects (1,000)	717	403	314
Median expenditures ($)	4,000	5,000	2,500
Total expenditures (1,000)	5,304,691	3,745,563	1,559,127
Porch/deck/patio/terrace			
Number of projects (1,000)	3,616	1,953	1,663
Median expenditures ($)	2,500	4,000	1,200
Total expenditures (1,000)	18,899,196	14,824,455	4,074,741
Roofing			
Number of projects (1,000)	8,035	6,543	1,492
Median expenditures ($)	5,500	6,000	2,500
Total expenditures (1,000)	52,948,893	47,088,310	5,860,584
Siding			
Number of projects (1,000)	2,275	1,607	667
Median expenditures ($)	3,000	4,000	1,000
Total expenditures (1,000)	12,524,667	10,787,609	1,737,057
Windows/doors			
Number of projects (1,000)	8,693	5,580	3,114
Median expenditures ($)	1,500	2,000	600
Total expenditures (1,000)	27,257,002	22,199,593	5,057,410
Chimney/stairs/other exterior additions			
Number of projects (1,000)	1,479	983	496
Median expenditures ($)	1,050	1,500	450
Total expenditures (1,000)	3,427,485	2,944,792	482,694

Interior Additions and Replacements[1]			
Insulation			
Number of projects (1,000)	3,531	1,862	1,669
Median expenditures ($)	750	1,200	400
Total expenditures (1,000)	4,991,329	3,779,128	1,212,201
Water pipes			
Number of projects (1,000)	3,540	2,080	1,461
Median expenditures ($)	500	900	200
Total expenditures (1,000)	5,259,795	4,233,234	1,026,561
Plumbing fixtures			
Number of projects (1,000)	9,116	4,313	4,804
Median expenditures ($)	400	550	250
Total expenditures (1,000)	9,667,129	6,882,298	2,784,831
Electrical wiring/fuse boxes/breaker switches			
Number of projects (1,000)	5,018	3,249	1,769
Median expenditures ($)	600	916	240
Total expenditures (1,000)	7,302,161	6,141,821	1,160,340
Security system			
Number of projects (1,000)	3,707	2,943	764
Median expenditures ($)	350	300	400
Total expenditures (1,000)	2,194,706	1,705,733	488,973
Flooring/carpeting/paneling/ceiling tiles			
Number of projects (1,000)	12,051	7,224	4,827
Median expenditures ($)	1,674	2,300	800
Total expenditures (1,000)	32,026,087	24,970,431	7,055,656
HVAC			
Number of projects (1,000)	10,301	8,915	1,387
Median expenditures ($)	3,150	3,429	1,800
Total expenditures (1,000)	40,379,006	36,507,489	3,871,517

Septic tank			
Number of projects (1,000)	387	319	68
Median expenditures ($)	3,000	3,000	900
Total expenditures (1,000)	1,584,211	1,255,016	S
Water heater/dishwasher/garbage disposal			
Number of projects (1,000)	15,838	9,316	6,522
Median expenditures ($)	500	700	400
Total expenditures (1,000)	11,087,649	7,899,118	3,188,531
Other interior			
Number of projects (1,000)	1,661	1,192	469
Median expenditures ($)	1,200	1,500	754
Total expenditures (1,000)	4,660,744	3,947,101	713,642
Lot or Yard Additions and Replacements[1]			
Driveways/walkways			
Number of projects (1,000)	4,099	2,712	1,387
Median expenditures ($)	1,500	2,000	500
Total expenditures (1,000)	10,744,436	9,123,787	1,620,649
Fencing/walls			
Number of projects (1,000)	4,369	2,289	2,080
Median expenditures ($)	1,000	2,000	600
Total expenditures (1,000)	9,239,951	6,722,489	2,517,462
Swimming pool/tennis court/recreational structures			
Number of projects (1,000)	806	445	361
Median expenditures ($)	4,000	7,000	800
Total expenditures (1,000)	8,864,172	7,345,981	1,518,191
Shed/detached garage/other building			
Number of projects (1,000)	2,359	1,023	1,337
Median expenditures ($)	1,500	2,500	1,000

Total expenditures (1,000)	9,333,571	5,637,621	3,695,950
Landscaping/sprinkler system			
Number of projects (1,000)	6,096	2,467	3,630
Median expenditures ($)	800	2,000	500
Total expenditures (1,000)	12,123,260	8,640,867	3,482,393
Other			
Number of projects (1,000)	829	514	315
Median expenditures ($)	1,500	2,250	S
Total expenditures (1,000)	3,429,179	2,945,964	483,215

Characteristics	Professional/Do-It-Yourself Total Estimate	Professional Estimate	Do-It-Yourself Estimate
HOME IMPROVEMENT ACTIVITY IN LAST TWO YEARS (2013)			
Total			
Number of projects (1,000)	93,558	59,411	34,147
Median expenditures ($)	1,000	2,000	500
Total expenditures (1,000)	300,831,306	246,338,538	54,492,768
Remodeling[1]			
Kitchen			
Number of projects (1,000)	2,954	1,700	1,253
Median expenditures ($)	5,000	6,200	3,000
Total expenditures (1,000)	26,626,680	18,827,473	7,799,207
Bath			
Number of projects (1,000)	4,064	2,168	1,896
Median expenditures ($)	2,500	4,000	1,500
Total expenditures (1,000)	18,685,777	13,962,662	4,723,115
Room Additions and Renovations[1]			
Kitchen			
Number of projects (1,000)	45	34	11
Median expenditures ($)	35,000	35,821	15,000
Total expenditures (1,000)	1,584,009	1,441,692	142,317
Bath			
Number of projects (1,000)	546	293	253
Median expenditures ($)	5,000	8,221	3,000
Total expenditures (1,000)	4,600,965	3,556,359	1,044,605

Bedroom			
Number of projects (1,000)	907	451	456
Median expenditures ($)	3,343	8,500	1,600
Total expenditures (1,000)	12,578,231	10,045,582	2,532,649
Recreation Room			
Number of projects (1,000)	320	136	184
Median expenditures ($)	5,000	6,627	3,700
Total expenditures (1,000)	2,899,929	1,581,672	1,318,257
Other			
Number of projects (1,000)	1,624	798	826
Median expenditures ($)	3,500	6,866	1,848
Total expenditures (1,000)	14,945,765	11,958,530	2,987,235
Systems and Equipment			
Plumbing/pipes			
Number of projects (1,000)	2,767	1,716	1,051
Median expenditures ($)	500	800	200
Total expenditures (1,000)	3,604,401	3,009,925	594,475
Electrical system			
Number of projects (1,000)	3,716	2,409	1,307
Median expenditures ($)	500	800	200
Total expenditures (1,000)	4,269,937	3,549,517	720,420
Plumbing fixtures			
Number of projects (1,000)	6,881	3,437	3,444
Median expenditures ($)	331	500	200
Total expenditures (1,000)	5,957,561	4,210,317	1,747,244
HVAC			
Number of projects (1,000)	7,250	6,340	910
Median expenditures ($)	3,000	3,200	1,500
Total expenditures (1,000)	26,516,143	24,496,257	2,019,885

Appliances/major equipment			
Number of projects (1,000)	14,838	9,177	5,661
Median expenditures ($)	400	500	334
Total expenditures (1,000)	8,617,672	6,333,578	2,284,094
Exterior Additions and Replacements[1]			
Roofing			
Number of projects (1,000)	5,851	4,876	975
Median expenditures ($)	5,000	5,500	1,800
Total expenditures (1,000)	36,079,462	33,223,391	2,856,071
Siding			
Number of projects (1,000)	1,677	1,219	458
Median expenditures ($)	3,000	4,200	500
Total expenditures (1,000)	7,437,346	6,749,185	688,161
Windows/doors			
Number of projects (1,000)	6,491	4,108	2,383
Median expenditures ($)	1,100	1,800	500
Total expenditures (1,000)	16,670,157	13,622,788	3,047,369
Interior Additions and Replacements[1]			
Insulation			
Number of projects (1,000)	2,681	1,617	1,065
Median expenditures ($)	573	955	300
Total expenditures (1,000)	3,060,617	2,498,934	561,683
Flooring/paneling/ceiling			
Number of projects (1,000)	14,241	8,534	5,706
Median expenditures ($)	1,000	1,647	500
Total expenditures (1,000)	27,522,730	21,585,632	5,937,098
Other interior			
Number of projects (1,000)	1,761	1,236	524

Median expenditures ($)	1,200	1,500	800
Total expenditures (1,000)	5,620,345	4,070,664	1,549,681
Other Additions and Replacements[1]			
Deck/porch			
Number of projects (1,000)	489	282	207
Median expenditures ($)	3,000	5,373	1,200
Total expenditures (1,000)	2,625,615	2,236,047	389,568
Patio/terrace/detached deck			
Number of projects (1,000)	2,737	1,534	1,203
Median expenditures ($)	2,000	3,500	1,000
Total expenditures (1,000)	11,324,775	9,034,084	2,290,691
Garage			
Number of projects (1,000)	94	73	21
Median expenditures ($)	18,000	24,000	500
Total expenditures (1,000)	2,206,566	2,140,830	65,736
Carport			
Number of projects (1,000)	94	58	37
Median expenditures ($)	1,400	2,269	500
Total expenditures (1,000)	440,123	381,558	58,565
Shed			
Number of projects (1,000)	1,547	746	801
Median expenditures ($)	1,400	2,500	800
Total expenditures (1,000)	8,344,883	6,885,567	1,459,315
Swimming pool/tennis court/recreational structures			
Number of projects (1,000)	628	359	269
Median expenditures ($)	3,000	5,075	600
Total expenditures (1,000)	4,951,069	4,436,168	514,901
Other exterior			
Number of projects (1,000)	7,548	4,620	2,928

Median expenditures ($)	1,500	2,000	500
Total expenditures (1,000)	19,708,734	16,325,326	3,383,408
Disaster Repairs			
Number of projects (1,000)	1,807	1,490	316
Median expenditures ($)	7,000	7,600	2,000
Total expenditures (1,000)	23,951,815	20,174,799	3,777,017
Other interior			
Number of projects (1,000)	1,661	1,192	469
Median expenditures ($)	1,200	1,500	754
Total expenditures (1,000)	4,660,744	3,947,101	713,642
Lot or Yard Additions and Replacements[1]			
Driveways/walkways			
Number of projects (1,000)	4,099	2,712	1,387
Median expenditures ($)	1,500	2,000	500
Total expenditures (1,000)	10,744,436	9,123,787	1,620,649
Fencing/walls			
Number of projects (1,000)	4,369	2,289	2,080
Median expenditures ($)	1,000	2,000	600
Total expenditures (1,000)	9,239,951	6,722,489	2,517,462
Swimming pool/tennis court/recreational structures			
Number of projects (1,000)	806	445	361
Median expenditures ($)	4,000	7,000	800
Total expenditures (1,000)	8,864,172	7,345,981	1,518,191
Shed/detached garage/other building			
Number of projects (1,000)	2,359	1,023	1,337
Median expenditures ($)	1,500	2,500	1,000
Total expenditures (1,000)	9,333,571	5,637,621	3,695,950

Landscaping/sprinkler system			
Number of projects (1,000)	6,096	2,467	3,630
Median expenditures ($)	800	2,000	500
Total expenditures (1,000)	12,123,260	8,640,867	3,482,393
Other			
Number of projects (1,000)	829	514	315
Median expenditures ($)	1,500	2,250	S
Total expenditures (1,000)	3,429,179	2,945,964	483,215

Characteristics	Professional/Do-It-Yourself		
	Total	Professional	Do-It-Yourself
HOME IMPROVEMENT ACTIVITY IN LAST TWO YEARS (2011)			
Total			
Number of projects (1,000)	116,263	73,015	43,248
Median expenditures ($)[1]	1,000	1,999	500
Total expenditures (1,000)	348,536,558	287,026,972	61,509,586
Remodeling[2]			
Kitchen			
Number of projects (1,000)	3,608	2,081	1,527
Median expenditures ($)[1]	5,000	7,993	3,000
Total expenditures (1,000)	34,661,061	26,886,023	7,775,039
Bath			
Number of projects (1,000)	4,825	2,503	2,323
Median expenditures ($)[1]	2,500	4,000	1,500
Total expenditures (1,000)	22,723,885	16,388,045	6,335,840
Room Additions and Renovations[2]			
Kitchen			
Number of projects (1,000)	63	52	11
Median expenditures ($)[1]	27,353	30,000	8,000
Total expenditures (1,000)	1,830,275	1,683,443	146,832
Bath			
Number of projects (1,000)	713	392	321
Median expenditures ($)[1]	3,500	5,882	2,000
Total expenditures (1,000)	4,523,881	3,460,385	1,063,497
Bedroom			

Number of projects (1,000)	1,142	506	636
Median expenditures ($)[1]	2,500	5,000	1,500
Total expenditures (1,000)	8,537,461	5,954,937	2,582,524
Recreation Room			
Number of projects (1,000)	490	202	288
Median expenditures ($)[1]	3,000	6,882	1,600
Total expenditures (1,000)	3,486,584	2,662,713	823,871
Other			
Number of projects (1,000)	1,978	997	981
Median expenditures ($)[1]	3,000	5,000	1,500
Total expenditures (1,000)	16,627,399	13,298,699	3,328,700
Systems and Equipment[2]			
Plumbing/pipes			
Number of projects (1,000)	3,312	2,082	1,231
Median expenditures ($)[1]	500	900	180
Total expenditures (1,000)	4,506,681	3,955,534	551,146
Electrical system			
Number of projects (1,000)	4,434	2,864	1,569
Median expenditures ($)[1]	500	800	200
Total expenditures (1,000)	4,976,258	4,231,366	744,892
Plumbing fixtures			
Number of projects (1,000)	7,944	3,811	4,133
Median expenditures ($)[1]	305	500	200
Total expenditures (1,000)	6,207,328	4,125,458	2,081,870
HVAC			
Number of projects (1,000)	9,574	8,365	1,209
Median expenditures ($)[1]	3,000	3,176	1,500
Total expenditures (1,000)	33,214,557	30,498,058	2,716,499
Appliances/major equipment			

Number of projects (1,000)	17,913	11,276	6,637
Median expenditures ($)[1]	400	500	320
Total expenditures (1,000)	10,213,056	7,588,909	2,624,147
Exterior Additions and Replacements[2]			
Roofing			
Number of projects (1,000)	7,269	5,950	1,319
Median expenditures ($)[1]	4,800	5,276	1,807
Total expenditures (1,000)	42,534,922	38,896,570	3,638,351
Siding			
Number of projects (1,000)	2,154	1,444	710
Median expenditures ($)[1]	3,000	4,500	762
Total expenditures (1,000)	10,342,508	8,965,278	1,377,230
Windows/doors			
Number of projects (1,000)	8,676	5,629	3,047
Median expenditures ($)[1]	1,282	2,000	500
Total expenditures (1,000)	23,145,692	19,648,147	3,497,546
Interior Additions and Replacements[2]			
Insulation			
Number of projects (1,000)	4,085	2,116	1,970
Median expenditures ($)[1]	500	1,000	300
Total expenditures (1,000)	4,287,875	3,214,117	1,073,757
Flooring/paneling/ceiling			
Number of projects (1,000)	18,320	10,907	7,413
Median expenditures ($)[1]	1,000	1,510	500
Total expenditures (1,000)	31,910,709	25,087,900	6,822,809
Other interior			
Number of projects (1,000)	1,780	1,218	561
Median expenditures ($)[1]	1,000	1,500	500

Total expenditures (1,000)	4,129,829	3,416,024	713,805
Other Additions and Replacements[2]			
Deck/porch			
Number of projects (1,000)	505	287	217
Median expenditures ($)[1]	2,000	3,000	1,342
Total expenditures (1,000)	2,701,309	2,290,101	411,208
Patio/terrace/detached deck			
Number of projects (1,000)	3,500	1,835	1,665
Median expenditures ($)[1]	2,000	3,176	1,000
Total expenditures (1,000)	13,022,905	9,963,322	3,059,583
Garage			
Number of projects (1,000)	158	87	71
Median expenditures ($)[1]	15,000	20,250	5,000
Total expenditures (1,000)	2,621,310	2,165,996	455,314
Carport			
Number of projects (1,000)	158	82	76
Median expenditures ($)[1]	1,500	1,600	1,300
Total expenditures (1,000)	399,581	240,654	158,927
Shed			
Number of projects (1,000)	2,098	977	1,121
Median expenditures ($)[1]	1,429	2,600	800
Total expenditures (1,000)	8,599,423	5,927,181	2,672,242
Swimming pool/tennis court/recreational structures			
Number of projects (1,000)	713	414	300
Median expenditures ($)[1]	2,500	6,000	500
Total expenditures (1,000)	7,417,915	7,102,007	315,908
Other exterior			
Number of projects (1,000)	9,003	5,419	3,584
Median expenditures ($)[1]	1,247	2,000	500

Total expenditures (1,000)	22,898,421	18,263,708	4,634,713
Disaster Repairs			
Number of projects (1,000)	1,846	1,519	327
Median expenditures ($)[1]	7,000	8,000	2,736
Total expenditures (1,000)	23,015,733	21,112,396	1,903,337
Other interior			
Number of projects (1,000)	1,661	1,192	469
Median expenditures ($)	1,200	1,500	754
Total expenditures (1,000)	4,660,744	3,947,101	713,642
Lot or Yard Additions & Replacements[1]			
Driveways/walkways			
Number of projects (1,000)	4,099	2,712	1,387
Median expenditures ($)	1,500	2,000	500
Total expenditures (1,000)	10,744,436	9,123,787	1,620,649
Fencing/walls			
Number of projects (1,000)	4,369	2,289	2,080
Median expenditures ($)	1,000	2,000	600
Total expenditures (1,000)	9,239,951	6,722,489	2,517,462
Swimming pool/tennis court/recreational structures			
Number of projects (1,000)	806	445	361
Median expenditures ($)	4,000	7,000	800
Total expenditures (1,000)	8,864,172	7,345,981	1,518,191
Shed/detached garage/other building			
Number of projects (1,000)	2,359	1,023	1,337
Median expenditures ($)	1,500	2,500	1,000
Total expenditures (1,000)	9,333,571	5,637,621	3,695,950
Landscaping/sprinkler system			
Number of projects (1,000)	6,096	2,467	3,630

Median expenditures ($)	800	2,000	500
Total expenditures (1,000)	12,123,260	8,640,867	3,482,393
Other			
Number of projects (1,000)	829	514	315
Median expenditures ($)	1,500	2,250	S
Total expenditures (1,000)	3,429,179	2,945,964	483,215

Annex B - CDC Injury Data

2001 - 2017, United States
Fall Deaths and Rates per 100,000
All Races, Both Sexes, All Ages
ICD-10 Codes: W00-W19,X80,Y01,Y30

Number of Deaths	Population***	Crude Rate	Age-Adjusted Rate**
443,576	5,200,918,231	8.53	7.93

Reports for All Ages include those of unknown age.

* Rates based on 20 or fewer deaths may be unstable. Use with caution.

** Standard Population is 2000, all races, both sexes.

*** Population estimates are aggregated for multi-year reports to produce rates.

Produced by: National Center for Injury Prevention and Control, CDC
Data Source: NCHS Vital Statistics System for numbers of deaths. Bureau of Census for population estimates.

10 Leading Causes of Nonfatal Unintentional Emergency Department Visits, United States

2001 - 2017, All Races, Both Sexes, Disposition: All Cases

	Age Groups										
Rank	<1	1-4	5-9	10-14	15-24	25-34	35-44	45-54	55-64	65+	All Ages
1	Unintentional Fall 2,203,241	Unintentional Fall 14,695,505	Unintentional Fall 10,895,788	Unintentional Fall 10,193,254	Unintentional Struck by/ Against 16,379,505	Unintentional Fall 12,925,580	Unintentional Fall 12,965,891	Unintentional Fall 14,643,385	Unintentional Fall 13,392,906	Unintentional Fall 38,484,766	Unintentional Fall 144,895,252
2	Unintentional Struck by/ Against 533,293	Unintentional Struck by/ Against 6,058,063	Unintentional Struck by/ Against 6,868,690	Unintentional Struck by/ Against 9,721,402	Unintentional Fall 14,486,086	Unintentional Overexertion 11,152,537	Unintentional Overexertion 9,867,239	Unintentional Overexertion 7,534,235	Unintentional Struck by/ Against 4,040,364	Unintentional Struck by/ Against 4,271,311	Unintentional Struck by/ Against 74,260,233
3	Unintentional Other Bite/ Sting 211,421	Unintentional Other Bite/ Sting 2,496,959	Unintentional Cut/Pierce 1,921,531	Unintentional Overexertion 4,798,474	Unintentional MV-Occupant 12,889,729	Unintentional Struck by/ Against 10,688,727	Unintentional Struck by/ Against 8,646,276	Unintentional Struck by/ Against 6,849,399	Unintentional Overexertion 3,954,803	Unintentional Overexertion 3,338,390	Unintentional Overexertion 55,470,069
4	Unintentional Foreign Body 168,685	Unintentional Foreign Body 2,115,187	Unintentional Other Bite/ Sting 1,684,445	Unintentional Cut/Pierce 2,290,666	Unintentional Overexertion 12,057,868	Unintentional MV-Occupant 9,764,377	Unintentional MV-Occupant 7,404,124	Unintentional MV-Occupant 6,008,660	Unintentional MV-Occupant 3,674,071	Unintentional MV-Occupant 3,274,416	Unintentional MV-Occupant 46,257,031
5	Unintentional Fire/Burn 166,348	Unintentional Cut/Pierce 1,416,767	Unintentional Pedal Cyclist 1,438,614	Unintentional Pedal Cyclist 1,809,487	Unintentional Cut/Pierce 7,710,641	Unintentional Cut/Pierce 7,154,265	Unintentional Cut/Pierce 5,711,252	Unintentional Cut/Pierce 4,715,968	Unintentional Cut/Pierce 2,910,149	Unintentional Cut/Pierce 2,329,593	Unintentional Cut/Pierce 36,268,894
6	Unintentional Other Specified 134,502	Unintentional Overexertion 1,315,913	Unintentional Overexertion 1,354,807	Unintentional Unknown/ Unspecified 1,628,755	Unintentional Other Specified 4,030,764	Unintentional Other Specified 4,205,722	Unintentional Other Specified 4,087,399	Unintentional Other Specified 4,369,757	Unintentional Other Specified 2,336,522	Unintentional Other Bite/ Sting 1,433,760	Unintentional Other Specified 21,953,757
7	Unintentional Inhalation/ Suffocation 117,464	Unintentional Other Specified 932,167	Unintentional MV-Occupant 1,089,855	Unintentional MV-Occupant 1,437,342	Unintentional Other Bite/ Sting 2,956,648	Unintentional Other Bite/ Sting 2,807,584	Unintentional Poisoning 2,848,707	Unintentional Poisoning 3,189,281	Unintentional Poisoning 1,858,449	Unintentional Poisoning 1,409,344	Unintentional Other Bite/ Sting 18,634,091
8	Unintentional Cut/Pierce 106,012	Unintentional Fire/Burn 903,828	Unintentional Foreign Body 982,591	Unintentional Other Bite/ Sting 1,067,652	Unintentional Unknown/ Unspecified 2,697,889	Unintentional Poisoning 2,717,196	Unintentional Other Bite/ Sting 2,357,389	Unintentional Other Bite/ Sting 2,183,425	Unintentional Other Bite/ Sting 1,434,421	Unintentional Other Specified 1,124,089	Unintentional Poisoning 15,608,986
9	Unintentional Overexertion 94,101	Unintentional Poisoning 757,380	Unintentional Dog Bite 751,546	Unintentional Other Transport 903,792	Unintentional Poisoning 2,398,193	Unintentional Unknown/ Unspecified 1,865,642	Unintentional Unknown/ Unspecified 1,532,981	Unintentional Unknown/ Unspecified 1,303,370	Unintentional Unknown/ Unspecified 799,484	Unintentional Other Transport 1,096,837	Unintentional Unknown/ Unspecified 12,386,141
10	Unintentional Unknown/ Unspecified 90,681	Unintentional Unknown/ Unspecified 752,229	Unintentional Other Transport 689,682	Unintentional Dog Bite 598,757	Unintentional Other Transport 2,006,159	Unintentional Other Transport 1,563,933	Unintentional Other Transport 1,316,897	Unintentional Other Transport 1,149,322	Unintentional Other Transport 753,041	Unintentional Unknown/ Unspecified 1,054,400	Unintentional Foreign Body 9,979,708

National Center for Injury Prevention and Control, CDC

NEISS All Injury Program operated by the Consumer Product Safety Commission (CPSC).

Public Input No. 865-NFPA 70-2020 [Section No. 314.28(A)(1)]

(1) Straight Pulls.

In straight pulls, the length of the box or conduit body shall not be less than eight times the metric designator (trade size) of the largest raceway. The width of a box shall not be less than two times the metric designator (trade size) of the largest raceway.

Statement of Problem and Substantiation for Public Input

This would ensure adequate room for future changes from or through a box (splices). It would prevent "cutting corners" and creating unsafe installations because of lack of information on the width of a straight pull junction box.

Submitter Information Verification

Submitter Full Name: Curtis Fulster
Organization: E Light Electric
Street Address:
City:
State:
Zip:
Submittal Date: Mon Apr 13 19:13:15 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: There is no substantiation of a problem with the existing wording beyond a vague supposition of cutting corners on future work. The NEC [at 314.16(C)(1)] sets the minimum area of a comparable conduit body (usually a C fitting in this case) at twice the area of the raceway, or roughly 1.57 times the diameter; the wording in this PI would result in a box of somewhat over (after accounting for locknuts, etc.) 2 times the diameter at minimum for the same conductor manipulations. There is no substantiation to justify this.

Public Input No. 1326-NFPA 70-2020 [New Section after 314.28(A)(2)]

314.28 (A) (4) Splice and Junction boxes

Were splices are made the total area of all conductors, splices, and taps installed

at any cross section of the wiring space shall not exceed 75 percent of the cross-sectional area of that space. Pull through conductors shall also comply with the provision of 314.28 (A) (1),(2) and (3).

Statement of Problem and Substantiation for Public Input

314.16 States in Part: Number of Conductors in Outlet, Device, and Junction Boxes, and Conduit Bodies. Boxes and conduit bodies shall
be of an "approved size" to provide free space for all enclosed conductors. Then goes on to say Boxes and conduit bodies enclosing conductors 4 AWG or larger "shall also comply with the provisions of 314.28". so if you have conductors that are 4 AWG in the box, or with additional conductors larger than 4 AWG or with other conductors less than 4AWG. there is NO guidance for the AHJ to rely on. Only the general rule in 314.16 stating a approved size for the conductors. the hope was when you get to section 314.28 it would explain about box fill sizing and what to do about having to splice conductors with 4 AWG or large. however section 314.28(A) (2)Angle or U Pulls or Splice, states splices are to be deal with by the distance from one conduit to a another which has no baring when you only have splices in the box and/or other splice within the same box. Raceway distances are to help facilitate the installation of a continuous conductor, once a feed through conductor exist you are back to a dimensional box. However there is no guides for the splice box only. this new section treats the box fill just like a cabinet (312.8 (A)) and Wireway (376.56). Also if this passes renumber 314.28 (3) to 4.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 1328-NFPA 70-2020 [Section No. 314.28(A)(2)]	Box fill
Public Input No. 1328-NFPA 70-2020 [Section No. 314.28(A)(2)]	

Submitter Information Verification

Submitter Full Name: Alfio Torrisi

Organization: Master electrician

Street Address:

City:

State:

Zip:

Submittal Date: Mon Jun 01 14:37:36 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: CMP-9 concludes the current requirements are correct. The express application of the six times rule to splices began with the 1999 NEC (Comment 9-24). This was the first time that spliced conductors were provided with a dimensional specification, and prior enforcement was very uneven. The current wording is clear and, because the conductors entering a splice are necessarily different conductors, the spacing rule in the last paragraph of this section does not apply, lessening the severity of the requirement.

Public Input No. 1328-NFPA 70-2020 [Section No. 314.28(A)(2)]

(2) Angle or U Pulls~~, or Splices.~~

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

Exception: Where a raceway or cable entry is in the wall of a box or conduit body opposite a removable cover, the distance from that wall to the cover shall be permitted to comply with the distance required for one wire per terminal in Table 312.6(A).

The distance between raceway entries enclosing the same conductor shall not be less than six times the metric designator (trade size) of the larger raceway.

When transposing cable size into raceway size in 314.28(A)(1) and (A)(2), the minimum metric designator (trade size) raceway required for the number and size of conductors in the cable shall be used.

Statement of Problem and Substantiation for Public Input

dimensional spacing for Splices are not necessary however conductor fill is. removing splices from this section into a new section will account for and help in the enforcement of splices with 4 AWG or larger conductor. please see PI 1326

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 1326-NFPA 70-2020 [New Section after 314.28(A)(2)]	box conductor fill
Public Input No. 1326-NFPA 70-2020 [New Section after 314.28(A)(2)]	

Submitter Information Verification

Submitter Full Name: Alfio Torrisi
Organization: Master electrician
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 01 15:31:28 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: CMP-9 concludes the current requirements are correct. The express application of the six times rule to splices began with the 1999 NEC (Comment 9-24). This was the first time that spliced conductors were provided with a dimensional specification, and prior enforcement was very uneven. The current wording is clear and, because the conductors entering a splice are necessarily different conductors, the spacing rule in the last paragraph of this section does not apply, lessening the severity of the requirement.

Public Input No. 1217-NFPA 70-2020 [Section No. 314.28(C)]

(C) Covers.

All pull boxes, junction boxes, and conduit bodies shall be provided with covers compatible with the box or conduit body construction and suitable for the conditions of use. Where used, metal covers shall comply with the grounding requirements of 250.110. Covers that are attached through the use of screws shall utilize machine screws; wood screws, drywall screws or similar shall not be permitted.

Statement of Problem and Substantiation for Public Input

Add language to require machine screws used to attach covers to pull boxes, junction boxes, device boxes and similar that enter the box which contains wiring or devices to be of a design that lessens the possibility of damage to conductors.

Language requiring machine screws to attach covers similar in intent to 250.8 (A) (5) and (6) 404.10 (B) and 406.5 to prevent the use of screws such as wood or drywall screws.

Submitter Information Verification

Submitter Full Name:	Gary Hein
Organization:	Submission is independent of employer.
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sat May 23 09:19:52 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: FR-7821-NFPA 70-2020

Statement: CMP-9 is inserting language to protect against damage to conductors resulting from sharp projections from exposed threads of screws run through covers or sides of boxes. The location in Part I will make the requirement apply throughout the entire article. For correlation, CMP-9 is also inserting references to this rule throughout 314.70(A).

In all instances, the only permitted style of screw will be one with machine threads and a blunt end. This eliminates sharp points and coarse threads with the attendant sharp-edged thread exposures of typical sheet metal screws. The penetrating length varies depending on the application and location. First, a cover screw is the customary ½ inch screw provided with boxes, expressed as the penetrating amount, or 7/16 inch. They penetrate adjacent to a box wall at or near a corner, which tends to offer additional protection to an enclosed conductor. Other screws penetrating the cover are limited to 5/16-inch penetration, which allows the customary 3/8-inch faceplate screws used to attach devices to raised covers. It is understood that work directly with a cover inherently affords greater control over wire positioning than elsewhere in the box.

Large boxes, generally those covered in Sec. 314.28, have covers supplied with ½-in. long screws that enter close to an enclosure wall, and that therefore allow for a 7/16ths inch penetration. Outlet and device boxes (usually not over 100 in3) are more difficult because they are often more tightly packed and with severe visual obstruction of how wires are arranging themselves against a wall of the box. For that reason, screws added to a wall of such boxes are prohibited from any extension beyond the interior wall surface. There is correlating language with 314.23(B)(1) that allows for protected screws to run through the rearward portion of such boxes for mounting purposes.

A similar limitation is imposed on screws applied to conduit bodies. A screw entering any part of a conduit bodies is likely to create damage during any stage of the process of pulling wires, and in such cases the objection stands even with a cap nut on a projecting screw end.

The second exception addresses the short gang screws that are shipped with most steel device boxes holding the sides in place; when such boxes are ganged the same screws hold the ganged boxes together. These screws are made long enough to hold the sides in place, and extend into the box by about 3/32 in. when securing adjacent gangs. They are supplied by the box manufacturers and cannot be easily shortened to the point of being flush. CMP-9 is excusing them as well.

Public Input No. 967-NFPA 70-2020 [Section No. 314.28 [Excluding any Sub-Sections]]

Boxes and conduit bodies used as pull or junction boxes shall comply with 314.28(A) through (E).

Exception No 1 : Terminal housings supplied with motors shall comply with the provisions of 430.12.

Exception No.2: Section 314.28 (A) through (E) shall not apply to cables or conductors of communications systems. Pull and junction boxes shall be sized appropriate for the size of cable or conductor installed.

Statement of Problem and Substantiation for Public Input

Section 314.28 appears to apply only to power conductors or cables. The new exception relaxes the requirement for overly restrictive sizing requirements for pull and junction points installed in communications systems

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz
Organization: NECA
Street Address:
City:
State:
Zip:

Submittal Date: Wed May 06 10:03:00 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: There is no need to exclude communications cables from this section because by 90.3, Chapter 8 applications are not subject to requirements in the earlier chapters of the Code unless specifically referenced. No Chapter 8 article mandates compliance with 314.28. Therefore, there is no requirement to relax.

Public Input No. 13-NFPA 70-2019 [Section No. 314.29]

314.29 Boxes, Conduit Bodies, and Handhole Enclosures to Be Accessible.

Boxes, conduit bodies, and handhole enclosures shall be installed so that wiring and devices contained in ~~them~~ the boxes, conduit bodies, or handhole enclosures can be rendered accessible in accordance with 314.29(A) and (B).

(A) In Buildings and Other Structures.

Boxes and conduit bodies shall be installed so the contained wiring and devices can be accessed without removing any part of the building ~~or structure~~ , structure, or finished surface materials .

(B) Underground.

Underground boxes and handhole enclosures shall be installed so they are accessible without excavating sidewalks, paving, earth, or other substance that is to be used to establish the finished grade.

Exception to (B) : Listed boxes and handhole enclosures shall be permitted where covered by gravel, light aggregate, or noncohesive granulated soil if their ~~location is~~ locations are effectively ~~identified~~ marked and accessible for excavation. The marking shall be of sufficient durability to withstand the environment involved.

Statement of Problem and Substantiation for Public Input

• In addition to contained wiring that requires access for servicing, contained devices also require access for servicing or replacement. If the boxes, conduit bodies, or handhole enclosures are located such that the thin cover or cover plate can be removed and slid past the device but there's still insufficient access to the device itself due to the location of the box, conduit body, or handhole enclosure, this partial blockage is unsafe. Blockage to access of devices is not addressed by 314.20, which establishes solely box projection. Furthermore, blockage to access of devices is not restricted to flush-mounted installations. Because this access blockage is determined by the location of the box, conduit body, or handhole enclosure, it is not addressed by 406.6 or 406.6(A) or by 404.9(A).

• When the CMP subdivided 314.29 for 2020 NEC® into 314.29 charging text, 314.29(A), and 314.29(B), the Exception was not clearly indicated to which charging text or subdivision it applies in accordance with NEC® Style Manual 2.6.1. This Exception is specific to 314.29(B).

• In the Exception to 314.29(B), the reserved term "identified" is not being used in accordance with its Article 100 definition. The purpose is location of something obscured from view, not a matter of suitability. Furthermore, underground is within the definition of "Location, Wet". As such any marking should have durability capable of withstanding the environment [q.v. 110.21(A)(1)].

• In the Exception to 314.29(B), "boxes and handhole enclosures" are pluralized. Consequently, so should "their location is" as well.

Submitter Information Verification

Submitter Full Name: Brian Rock
Organization: Hubbell Incorporated
Street Address:
City:
State:

Zip:

Submittal Date: Fri Nov 01 16:56:50 EDT 2019

Committee: NEC-P09

Committee Statement

Resolution: FR-7764-NFPA 70-2020

Statement: CMP-9 is making editorial improvements to the wording in this section following the restructuring in the 2020 cycle. The operational parent text now will include the exact locations intended as the targets of the rules, along with the addition of devices, if any, that may be contained within them. Part (A) is simplified by the use of the term “accessible.” This term is defined in Art. 100 and the remainder of the former text covering the removal of parts of the building is redundant to the defined term as it applies to wiring methods. The underground wiring exception will now be specifically tied to Part (B), which is the part under exception. This is a NEC Style Manual requirement, at 2.6.1.

The panel is also removing the word “identified” from the exception, because the word is not being used in accordance with its Art. 100 definition. The objective of this requirement, now appropriately stated, is for there to be an accessible description of the box location so it can be easily found in the field.

Public Input No. 1332-NFPA 70-2020 [Section No. 314.29]

314.29 Boxes, Conduit Bodies, and Handhole Enclosures to Be Accessible.

~~Boxes, conduit bodies, and handhole enclosures shall be installed so that wiring contained in them can be rendered accessible in accordance with 314.29~~ (**A)** ~~and (B).~~

~~(A) In Buildings and Other~~

In or on Buildings or Structures.

Boxes

~~and~~

, conduit bodies shall be installed so

~~the~~

that wiring contained

~~wiring~~

in them can be

~~accessed without removing any part of the building or structure~~

rendered accessible without the removal of a obstacle .

(B) Underground.

Underground boxes and handhole enclosures shall be installed so they are accessible without excavating sidewalks, paving, earth, or other substance that is to be used to establish the finished grade.

Exception: Listed boxes and handhole enclosures shall be permitted where covered by gravel, light aggregate, or noncohesive granulated soil if their location is effectively identified and accessible for excavation.

Informational note: boxes containing a splice(s) shall meet the requirements of 110.26

Statement of Problem and Substantiation for Public Input

this section does not recognize all of the obstacles in the field such as foreign equipment, electrical systems and building or structural appurtenances. If it is required to be accessed then the definition of accessible shall apply. Boxes containing splices are also required to have a working space as required in section 110.26 Spaces About Electrical Equipment; an info note will remind installers and inspectors the general rule of work space is applicable.

Submitter Information Verification

Submitter Full Name: Alfio Torrisi
Organization: Master electrician
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 01 16:02:03 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: CMP-9 is resolving PI-1332 because the word “obstacle” is too broad and capable of wide variations of enforcement approaches, including potentially including transitory events. In addition, CMP-9 observes that 110.26 does not require working space at boxes. CMP-9 is, however, adding considerable detail to the description of the reach of this section, partially meeting the objectives of this PI.

Public Input No. 505-NFPA 70-2020 [Section No. 314.29(A)]

(A) In Buildings and Other Structures.

Boxes and conduit bodies shall be installed so the contained wiring ~~can be accessed without removing any part of the building or structure~~ is accessible .

Statement of Problem and Substantiation for Public Input

This revision is intended to simplify the language here using terms already defined in this Code, and to provide consistency with terminology.

Article 100 definition of “Accessible”- Capable of being removed or exposed without damaging the building structure or finish or not permanently closed in by the structure or finish of the building.

Submitter Information Verification

Submitter Full Name: Russ Leblanc

Organization: Leblanc Consulting Services

Street Address:

City:

State:

Zip:

Submittal Date: Thu Feb 20 16:04:07 EST 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7764-NFPA 70-2020

Statement: CMP-9 is making editorial improvements to the wording in this section following the restructuring in the 2020 cycle. The operational parent text now will include the exact locations intended as the targets of the rules, along with the addition of devices, if any, that may be contained within them. Part (A) is simplified by the use of the term “accessible.” This term is defined in Art. 100 and the remainder of the former text covering the removal of parts of the building is redundant to the defined term as it applies to wiring methods. The underground wiring exception will now be specifically tied to Part (B), which is the part under exception. This is a NEC Style Manual requirement, at 2.6.1.

The panel is also removing the word “identified” from the exception, because the word is not being used in accordance with its Art. 100 definition. The objective of this requirement, now appropriately stated, is for there to be an accessible description of the box location so it can be easily found in the field.

Public Input No. 946-NFPA 70-2020 [Section No. 314.40]

314.40 Metal Boxes, Conduit Bodies, and Fittings.

(A) Corrosion Resistant.

Metal boxes, conduit bodies, and fittings shall be corrosion resistant or shall be well-galvanized, enameled, or otherwise properly coated inside and out to prevent corrosion.

Informational Note: See 300.6 for limitation in the use of boxes and fittings protected from corrosion solely by enamel.

(B) Thickness of Metal.

Sheet steel boxes not over 1650 cm^3 (100 $in.^3$) in size shall be made from steel not less than 1.59 mm (0.0625 in.) thick. The wall of a malleable iron box or conduit body and a die-cast or permanent-mold cast aluminum, brass, bronze, or zinc box or conduit body shall not be less than 2.38 mm (3⁄32 in.) thick. Other cast metal boxes or conduit bodies shall have a wall thickness not less than 3.17 mm (1⁄8 in.). Metal boxes shall be permitted to be unlisted.

Exception No. 1: Listed boxes and conduit bodies shown to have equivalent strength and characteristics shall be permitted to be made of thinner or other metals.

Exception No. 2: The walls of listed short radius conduit bodies, as covered in 314.16(C)(2), shall be permitted to be made of thinner metal.

(C) Metal Boxes Over 1650 cm^3 (100 $in.^3$).

Metal boxes over 1650 cm^3 (100 $in.^3$) in size shall be constructed so as to be of ample strength and rigidity. If of sheet steel, the metal thickness shall not be less than 1.35 mm (0.053 in.) uncoated. Metal boxes shall be permitted to be unlisted.

(D) Equipment Grounding Conductor Provisions.

A means shall be provided in each metal box for the connection of an equipment grounding conductor. The means shall be permitted to be a tapped hole or equivalent.

Statement of Problem and Substantiation for Public Input

A common misinterpretation of the NEC by AHJ's is that all equipment and electrical materials in the NEC have to be listed. A common installation practice is the installation of custom built metal boxes to serve as pull boxes for straight, angle, or U pulls. As far as the NEC is concerned, as long as the metal box satisfies all of the applicable construction specifications in Part III of Article 314, a listing on the metal box should not be enforced by an AHJ.

Submitter Information Verification

Submitter Full Name: Brian Baughman

Organization:

Affiliation: myself

Street Address:

City:

State:

Zip:

Submittal Date: Mon May 04 16:41:30 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: CMP-9 generally agrees with the concept that large pull boxes should not be required to be listed. In fact, CMP-9 has aggressively refused to entertain affirmative requirements that would mandate listings. See for example, Comment 9-73 in the 1993 cycle and Proposal 9-90 in the 2005 cycle. However, this PI goes too far in denying to the AHJ any recourse to asking for a listing. CMP-9 does not want to intrude on the decisions relative to product acceptance an AHJ might feel compelled to make in a particular context. The rule will remain, not requiring a listing as a matter of black letter Code, but not prohibiting an AHJ from asking for one either. In the event listing requirements are being imposed routinely without good reason, then installers would need to avail themselves of whatever opportunities for appeal apply in the particular jurisdiction.

Public Input No. 4135-NFPA 70-2020 [Section No. 314.70(A)]

(A) Pull and Junction Boxes.

Where pull and junction boxes are used on systems over 1000 volts, the installation shall comply ~~with the provisions of~~ with Part IV and with the following general provisions of this article:

(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

Statement of Problem and Substantiation for Public Input

Deleting the words "the provisions of" does not change the meaning of the section.

Submitter Information Verification

Submitter Full Name: David Williams

Organization: Delta Charter Township

Street Address:

City:

State:

Zip:

Submittal Date: Wed Sep 09 21:46:00 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7772-NFPA 70-2020

Statement: CMP-9 is generally removing phrasing with respect to following the provisions of another section in favor of a simple reference to the necessary location. CMP-9 is also improving on the PI by specifying the subsection designations of the referenced text.

Part IV is changed to Part III.

Public Input No. 4136-NFPA 70-2020 [Section No. 314.70(B)]

(B) Conduit Bodies.

Where conduit bodies are used on systems over 1000 volts, the installation shall comply ~~with the provisions of~~ with Part IV and with the following general provisions of this article:

(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

Statement of Problem and Substantiation for Public Input

Deleting the words "the provisions of" does not change the meaning of the section.

Submitter Information Verification

Submitter Full Name: David Williams
Organization: Delta Charter Township
Street Address:
City:
State:
Zip:
Submittal Date: Wed Sep 09 21:47:04 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7774-NFPA 70-2020

Statement: CMP-9 is generally removing phrasing with respect to following the provisions of another section in favor of a simple reference to the necessary location. CMP-9 is also improving on the PI by specifying the subsection designations of the referenced text.

Part IV is changed to Part III.

Public Input No. 4137-NFPA 70-2020 [Section No. 314.70(C)]

(C) Handhole Enclosures.

Where handhole enclosures are used on systems over 1000 volts, the installation shall comply with ~~the provisions of~~ Part IV and with the following general provisions of this article:

(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

Statement of Problem and Substantiation for Public Input

Deleting the words "the provisions of" does not change the meaning of the section.

Submitter Information Verification

Submitter Full Name: David Williams

Organization: Delta Charter Township

Street Address:

City:

State:

Zip:

Submittal Date: Wed Sep 09 21:47:46 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7775-NFPA 70-2020

Statement: CMP-9 is generally removing phrasing with respect to following the provisions of another section in favor of a simple reference to the necessary location. CMP-9 is also improving on the PI by specifying the subsection designations of the referenced text.

Part IV is changed to Part III.

Public Input No. 2299-NFPA 70-2020 [Section No. 404.1]

404.1 Scope.

This article covers all switches, switching devices, and circuit breakers used as switches operating at 1000 volts and below, unless specifically referenced elsewhere in this *Code* for higher voltages.

Informational Note: It is not the intent that Article 404 be applied to wireless wall control devices where circuit conductors are not required as part of the devices installation.

Additional Proposed Changes

File Name	Description	Approved
Levven-Controls-switch-printed-instruction-sheet.pdf	Instruction sheet for a listed wireless wall control device.	

Statement of Problem and Substantiation for Public Input

Battery powered wireless lighting wall control devices are a new technology. I am aware of an AHJ that require that either a grounded conductor be installed, or that provisions for the future installation of a grounded conductor be provided by installing an approved raceway between the wireless lighting wall control device and the lighting outlet) [404.2(B)] before the AHJ would approve the use of this wireless product. Using the same logic, an AHJ could require an equipment grounding conductor for these wireless lighting wall control devices, as some are designed to permit the installation of a standard dacora style faceplate which would include ones made of metal [404.9(B)].

Submitter Information Verification

Submitter Full Name: Jeffrey Fecteau

Organization: UL LLC

Affiliation: UL LLC

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 13 20:17:41 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7889-NFPA 70-2020

Statement: In regards to PI-3280, the scope of Article 404 covers all switches, switching devices, and circuit breakers used as switches. The addition of the term "wall-mounted control devices" would be incorrect.

A wireless control device that initiates the switching function but does not connect to circuit conductors to operate, is not a "switching device", and therefore is not under the purview of Article 404.

Battery powered wireless control devices do not connect to circuit conductors.

CMP-9 realizes scope is under the purview of the Correlating Committee. CMP-9 requests the CC refer the FR to CMP-2 for information.

Public Input No. 3280-NFPA 70-2020 [Section No. 404.1]

404.1 Scope.

This article covers all switches, switching devices, wall-mounted control devices, and circuit breakers used as switches operating at 1000 volts and below, unless specifically referenced elsewhere in this *Code* for higher voltages.

Statement of Problem and Substantiation for Public Input

The term "wall-mounted control device" was added to 210.70 in the 2020 code. This device controls lights and should be covered by the scope of Article 404. It appears that they are not the same as a switch, because if they were the same there would have been no need to add a new term in 210.70.

Submitter Information Verification

Submitter Full Name: Don Ganiere

Organization: [Not Specified]

Street Address:

City:

State:

Zip:

Submittal Date: Mon Sep 07 14:28:48 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7889-NFPA 70-2020

Statement: In regards to PI-3280, the scope of Article 404 covers all switches, switching devices, and circuit breakers used as switches. The addition of the term "wall-mounted control devices" would be incorrect.

A wireless control device that initiates the switching function but does not connect to circuit conductors to operate, is not a "switching device", and therefore is not under the purview of Article 404.

Battery powered wireless control devices do not connect to circuit conductors.

CMP-9 realizes scope is under the purview of the Correlating Committee. CMP-9 requests the CC refer the FR to CMP-2 for information.

Public Input No. 2234-NFPA 70-2020 [Section No. 404.2(C)]

(C) Switches Controlling Lighting Loads.

The grounded circuit conductor for the controlled lighting circuit shall be installed at the location where switches control lighting loads that are supplied by a grounded general-purpose branch circuit ~~serving bathrooms, hallways, stairways, and habitable rooms or occupiable spaces as defined in the applicable building code~~ . Where multiple switch locations control the same lighting load such that the entire floor area of the room or space is visible from the single or combined switch locations, the grounded circuit conductor shall only be required at one location. A grounded conductor shall not be required to be installed at lighting switch locations under any of the following conditions:

(1) Where conductors enter the box enclosing the switch through a raceway, provided that the raceway is large enough for all contained conductors, including a grounded conductor

(2) Where ~~the box enclosing the switch is accessible for the installation of an additional or replacement cable without removing finish materials~~

~~Where~~

(3) snap switches with integral enclosures comply with 300.15(E)

(4) Where lighting in the area is controlled by automatic means

(5) Where a switch controls a receptacle load

The grounded conductor shall be extended to any switch location as necessary and shall be connected to switching devices that require line-to-neutral voltage to operate the electronics of the switch in the standby mode and shall meet the requirements of 404.22.

Exception: The connection requirement shall become effective on January 1, 2020. It shall not apply to replacement or retrofit switches installed in locations prior to local adoption of 404.2(C) and where the grounded conductor cannot be extended without removing finish materials. The number of electronic control switches on a branch circuit shall not exceed five, and the number connected to any feeder on the load side of a system or main bonding jumper shall not exceed 25. For the purpose of this exception, a neutral busbar, in compliance with 200.2(B) and to which a main or system bonding jumper is connected shall not be limited as to the number of electronic lighting control switches connected.

Informational Note: The provision for a (future) grounded conductor is to complete a circuit path for electronic lighting control devices.

Statement of Problem and Substantiation for Public Input

No. 1 Required the grounded conductor in every location not based on habitable or occupiable space. I have an electronic switch in my closet (and many others do as well), many storage rooms in commercial building have electronic switches.
No. 2 Remove the permissiont to add a neutral later for 'cable' installations. Let's be real, if an electrician is installing a switch, he/she is not going to get into the attic or crawl space to add a 'neutral' to the box.
Let's have the rules easier for future installations.

Submitter Information Verification

Submitter Full Name: Mike Holt

Organization: Mike Holt Enterprises Inc

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 12 09:49:27 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7883-NFPA 70-2020

Statement: CMP-9 is not removing the occupancy limitation because that represents the principal application of the rule.

CMP-9 removed the allowance that the grounded conductor would not be required to be installed at a lighting switch location where the box enclosing the switch is accessible for the installation of an additional or replacement cable without removing finish materials. Although the box may be accessible, the ease of installation of the grounded conductor after the initial installation is likely to be exceedingly more difficult than during the initial installation.

CMP-9 deletes the delayed implementation date in the exception and the word “future” in the Informational Note.

Public Input No. 1691-NFPA 70-2020 [Section No. 404.3]

404.3 Enclosure.

(A) General.

Switches and circuit breakers shall be of the externally operable type mounted in an enclosure listed for the intended use. The minimum wire-bending space at terminals and minimum gutter space provided in switch enclosures shall be as required in 312.6.

Exception No. 1: Pendant- and surface-type snap switches and knife switches mounted on an open-face switchboard or panelboard shall be permitted without enclosures.

Exception No. 2: Switches and circuit breakers installed in accordance with 110.27(A)(1), (A)(2), (A)(3), or (A)(4) shall be permitted without enclosures.

(B) Used as a Raceway.

Enclosures shall not be used as junction boxes, auxiliary gutters, or raceways for conductors feeding through or tapping off to other switches or overcurrent devices, unless the enclosure complies with 312.8.

<u>(C) Phase Arrangement. The B phase shall be that phase having the higher voltage to ground on 3-phase, 4-wire, delta-connected systems. Other phase arrangements shall be permitted for additions to existing installations and shall be marked.</u>

Statement of Problem and Substantiation for Public Input

Add (C) requiring the high-leg conductor to terminate to the “B” phase in a switch. Currently the high-leg is only required to terminate to the “B” phase of a panelboard [408.3(E)].

Submitter Information Verification

Submitter Full Name: Mike Holt

Organization: Mike Holt Enterprises Inc

Street Address:

City:

State:

Zip:

Submittal Date: Wed Jun 24 21:49:03 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: The consistent use of the high-leg conductor on the same phase throughout an installation is a good practice but, there could be instances where the mandatory use of the high-leg specifically on the B-phase could cause an unnecessary burden during installation. Circumstances may occur where equipment is configured to have the high leg on a phase other than the B phase and it may be substantially less difficult to change the phase arrangement than the equipment configuration. Both existing and new installations must be given the flexibility to adjust phase arrangements when necessary.

Public Input No. 1415-NFPA 70-2020 [Section No. 404.3(B)]

(B) Used as a Raceway.

~~Enclosures~~ Cabinet and cutout boxes shall not be used as junction boxes, auxiliary gutters, or raceways for conductors feeding through or tapping off to other switches or overcurrent devices, unless the enclosure complies with 312.8.

Statement of Problem and Substantiation for Public Input

The term 'enclosures' is way too vauge, in that the way the rule is currently worded, you could not use an outlet box for snap switches, unless you comply with 312.8. But 312.8 only applies to Cabinets and Cutout Boxes, not outlet boxes.

Submitter Information Verification

Submitter Full Name: Mike Holt
Organization: Mike Holt Enterprises Inc
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 02 12:50:32 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: The term "enclosures" is valid for these sections and warrants no additional change in language.

Public Input No. 4561-NFPA 70-2020 [Section No. 404.6(C)]

(C) Connection of Switches.

Single-throw knife switches and switches with butt contacts shall be connected such that their blades are de-energized when the switch is in the open position. Bolted pressure contact switches shall have barriers that prevent inadvertent contact with energized blades. Single-throw knife switches, bolted pressure contact switches, molded case switches, switches with butt contacts, and circuit breakers used as switches shall be connected so that the terminals supplying the load are de-energized when the switch is in the open position. The exception to 404.6(C) shall not apply to those photovoltaic systems that comply with 690.12 and are connected on the supply side of the service disconnect as permitted by 230.82(6).

Exception: The blades and terminals supplying the load of a switch shall be permitted to be energized when the switch is in the open position where the switch is connected to circuits or equipment inherently capable of providing a backfeed source of power. For such installations, a permanent sign shall be installed on the switch enclosure or immediately adjacent to open switches with the following words or equivalent: WARNING — LOAD SIDE TERMINALS MAY BE ENERGIZED BY BACKFEED. The warning sign or label shall comply with 110.21(B).

Statement of Problem and Substantiation for Public Input

This change is much needed in order reduce the greater associated hazards with the electric utility source as compared to the photovoltaic array source. Two obvious hazards associated with the utility source as compared to the photovoltaic source stand out.
(1)- The typical fault currents associated with a electric utility transformer far exceed the typical fault currents associated with a photovoltaic array, the short circuit current of most photovoltaic arrays is often little more than the maximum power current associated with the array.
(2)-Photovoltaic rapid shutdown devices will initiate upon loss of the utility source of power. The array output associated with the typical non-isolation, functionally grounded inverter types can de-energize all output power within seconds of rapid shutdown initiation, whereas the electric utility will remain energized without a utility scheduled shutdown.
Greater shock and fire hazards are present where the electric utility source is connected to the load terminals of a knife switch as permitted by the exception to 404.6(C), this leaves greater potential for accidental contact with un-insulated live parts in the knife switch as the load terminals cannot be broken from the fuses and fuse holders and are not required to have barriers.

Submitter Information Verification

Submitter Full Name: Chris Papp
Organization: [Not Specified]
Street Address:
City:
State:
Zip:

Submittal Date: Thu Sep 10 15:09:33 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: Installation of Photovoltaic Systems is covered in Article 690. 690.13(B) requires that the system disconnecting means be marked with sufficient warnings and similar requirements are unnecessary to be in Article 404.

Public Input No. 115-NFPA 70-2019 [Section No. 404.7]

404.7 Indicating.

General-use and motor-circuit switches, circuit breakers, and molded case switches, where mounted in ~~an enclosure~~ cabinets, cutout boxes, or meter socket enclosures as described in 404.3, shall indicate, in a location that is visible when accessing the external operating means, whether they are in the open (off) or closed (on) position.

Where these switch or circuit breaker handles are operated vertically rather than rotationally or horizontally, the up position of the handle shall be the closed (on) position.

Exception No. 1: Vertically operated double-throw switches shall be permitted to be in the closed (on) position with the handle in either the up or down position.

Exception No. 2: On busway installations, tap switches employing a center-pivoting handle shall be permitted to be open or closed with either end of the handle in the up or down position. The switch position shall be clearly indicating and shall be visible from the floor or from the usual point of operation.

Additional Proposed Changes

File Name	Description	Approved
DSCN0799.JPG	switches mounted in outlet boxes	

Statement of Problem and Substantiation for Public Input

This revision is necessary to clarify which types of switches this rule is applicable to. See my photo of snap switches mounted in outlet boxes. These switches in my photo could very well be mounted in outlet boxes that are "listed for the intended use" as specified in 404.3. Also, the wiring and bending space in these outlet boxes may certainly comply with 312.6 as specified in 404.3. No bending space is specified in Table 312.6(A) Column 1 for conductor sizes 14awg-10awg. Snap switches are by definition in Article 100, a form of "general-use switch", as specified in section 404.7. Outlet boxes are "enclosures", but not the enclosures covered by Article 312. I don't believe this rule is intended to apply to switches installed in outlet boxes as shown in my photo, nor is it intended to apply to 3-way switches, 4-way switches, or decora style snap switches. If 404.7 is intended to apply to snap switches installed in outlet boxes, then there are millions of switches out there right now that do not comply with the present wording!

Submitter Information Verification

Submitter Full Name: Russ Leblanc

Organization: Leblanc Consulting Services

Street Address:

City:

State:

Zip:

Submittal Date: Wed Nov 20 08:17:14 EST 2019

Committee: NEC-P09

Committee Statement

Resolution: The term "enclosures" is valid for these sections and warrants no additional change in language.


LUTRON
11 . 19 . 2019

Public Input No. 1844-NFPA 70-2020 [Section No. 404.8(A)]

(A) Location.

All switches and circuit breakers used as ~~switches~~ a required disconnecting means by this Code shall be located so that they may be operated from a readily accessible place. They shall be installed such that the center of the grip of the operating handle of the switch or circuit breaker, when in its highest position, is not more than 2.0 m (6 ft 7 in.) above the floor or working platform.

Exception No. 1: On busway installations, fused switches and circuit breakers shall be permitted to be located at the same level as the busway. Suitable means shall be provided to operate the handle of the device from the floor.

Exception No. 2: Switches and circuit breakers installed adjacent to motors, appliances, or other equipment that they supply shall be permitted to be located higher than 2.0 m (6 ft 7 in.) and to be accessible by portable means.

Exception No. 3: Hookstick operable isolating switches shall be permitted at greater heights.

Statement of Problem and Substantiation for Public Input

The current language requires general-use as well as maintenance bypass switches to be readily accessible. The rule is intended to apply to switches used as a disconnecting means, not general-use or maintenance bypass switches.

Submitter Information Verification

Submitter Full Name:	Mike Holt
Organization:	Mike Holt Enterprises Inc
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Fri Jul 10 13:49:23 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: PI-257 does not provide sufficient substantiation to add the Exception. “Non-service rated ATS” is a broad term and could include switches manufactured to include features that would need to be readily accessible. The existing text as sufficient to serve the needs of the code & electrical industry. PI-1844 substantiation statement does not provide sufficient reason to make a change.

Public Input No. 257-NFPA 70-2020 [Section No. 404.8(A)]

(A) Location.

All switches and circuit breakers used as switches shall be located so that they may be operated from a readily accessible place. They shall be installed such that the center of the grip of the operating handle of the switch or circuit breaker, when in its highest position, is not more than 2.0 m (6 ft 7 in.) above the floor or working platform.

Exception No. 1: On busway installations, fused switches and circuit breakers shall be permitted to be located at the same level as the busway. Suitable means shall be provided to operate the handle of the device from the floor.

Exception No. 2: Switches and circuit breakers installed adjacent to motors, appliances, or other equipment that they supply shall be permitted to be located higher than 2.0 m (6 ft 7 in.) and to be accessible by portable means.

Exception No. 3: Hookstick operable isolating switches shall be permitted at greater heights.

Exception No. 4: Automatic transfer switches for optional standby systems installed on one- or two- family dwelling units that do not contain a disconnecting means for the normal or alternate power source, shall be permitted to be located higher than 2.0 m (6ft 7in.) and to be accessible by portable means.

Additional Proposed Changes

File Name	Description	Approved
ATS_above_6_feet_7_inches.jpg	Non-service rated ATS installed above 6'7"	

Statement of Problem and Substantiation for Public Input

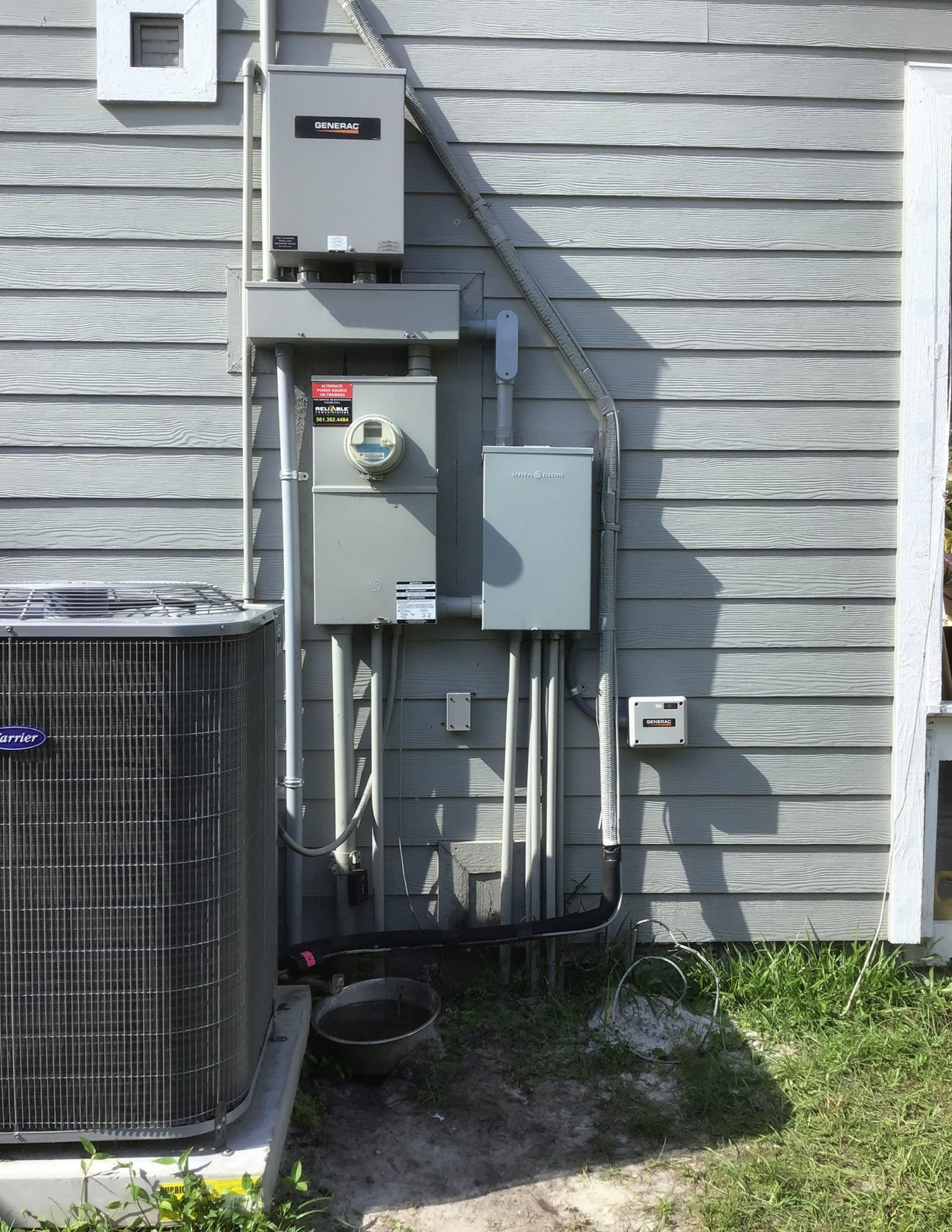
Article 404 has purview over all types of switches, and by definition in Article 100, includes transfer equipment. Relief should be able to be provided for residential optional standby ATS's that do not contain a disconnecting means for the normal or alternate sources of power within the ATS enclosure. These types of ATS's do not have to be reality accessible and are not listed or designed to be operated manually during normal operation.

Submitter Information Verification

Submitter Full Name: Brian Baughman
Organization: Generac Power Systems Inc.
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jan 07 16:04:26 EST 2020
Committee: NEC-P09

Committee Statement

Resolution: PI-257 does not provide sufficient substantiation to add the Exception. “Non-service rated ATS” is a broad term and could include switches manufactured to include features that would need to be readily accessible. The existing text as sufficient to serve the needs of the code & electrical industry. PI-1844 substantiation statement does not provide sufficient reason to make a change.


GENERAC
ALTERNATE POWER SOURCE ON PREMISES
FOR SERVICE OR MAINTENANCE PLEASE CALL
RELIABLE POWER SYSTEMS
561.362.4484
GENERAL ELECTRIC
GENERAC
Carrier

Public Input No. 4057-NFPA 70-2020 [Section No. 404.8(A)]

(A) Location.

The disconnect means shall be located in a readily accessible location. If the disconnecting means installed in dwellings exposes any energized terminals or wiring when physically open, the enclosure shall be locked or require a tool to open

All switches and circuit breakers used as switches shall be located so that they may be operated from a readily accessible place. They shall be installed such that the center of the grip of the operating handle of the switch or circuit breaker, when in its highest position, is not more than 2.0 m (6 ft 7 in.) above the floor or working platform.

Exception No. 1: On busway installations, fused switches and circuit breakers shall be permitted to be located at the same level as the busway. Suitable means shall be provided to operate the handle of the device from the floor.

Exception No. 2: Switches and circuit breakers installed adjacent to motors, appliances, or other equipment that they supply shall be permitted to be located higher than 2.0 m (6 ft 7 in.) and to be accessible by portable means.

Exception No. 3: Hookstick operable isolating switches shall be permitted at greater heights.

Statement of Problem and Substantiation for Public Input

The placement of disconnect switches in dwellings, in locations that are accessible by other than qualified personnel, particularly by children, is a potential hazard. Knife blade disconnect switches are the ONLY widely used piece of electrical equipment that does not require a tool to access the live components inside, thus they have no child safeguards. The disconnect enclosures can often be easily opened exposing potentially life-threatening voltages and current levels if contacted by personnel. The disconnect equipment often is being installed on accessible external and internal surfaces of dwellings, in garages, and in almost any room except bathrooms in dwellings. An opened disconnect enclosure contains wiring and terminals that can be touched with tools, probes or hands. There is a need to require, that they be locked, or require a tool to physically open these enclosures.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3738-NFPA 70-2020 [Section No. 110.25]	
Public Input No. 4071-NFPA 70-2020 [Section No. 440.11]	
Public Input No. 4080-NFPA 70-2020 [Section No. 680.13]	

Submitter Information Verification

Submitter Full Name:	Tommy Davis
Organization:	Master Electrician, Retired IBEW member, Retired Electrical Inspector
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Sep 09 19:35:35 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7861-NFPA 70-2020

Statement: Switches of this type may allow access to live parts with the door open that the user may contact. This change will restrict access to qualified persons.

Public Input No. 1414-NFPA 70-2020 [Section No. 404.8(B)]

(B) Voltage Between Adjacent Devices.

A snap switch shall not be grouped or ganged in enclosures with other snap switches, receptacles, or similar devices, unless they are arranged so that the voltage between adjacent devices does not exceed 300 volts, or unless they are installed in enclosures equipped with identified, securely installed barriers between adjacent devices.

Exception: Barriers shall not be required between devices having no exposed conductor terminals other than terminals for connections of equipment grounding conductors

Additional Proposed Changes

File Name	Description	Approved
4EB6CA39-2436-4E27-9FE1-1B3DD5A3A5A5.jpeg	dimmer 1	
4CB6EAA4-7388-4545-B47D-BD6F1C16A938.jpeg	receptacle 1	
EC048205-9130-4908-9849-989564C50582.jpeg	receptacle 2	
D49A4EA7-14C0-40CF-A51C-76DA9C12B711.jpeg	switch 1	
8C96D7B5-CA7B-42BA-8CD5-11947313B101.jpeg	switch 2	

Statement of Problem and Substantiation for Public Input

Devices with no exposed terminals effectively have “barriers” built-in as part of the design of the device. These types of devices pose much less of a shock hazard than devices having exposed energized terminals. The risk of an arc between devices is also greatly reduced since there are no exposed terminals. Barriers should not be required where these types of devices are installed.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 1417-NFPA 70-2020 [Section No. 406.5(J)]	voltage between adjacent devices
Public Input No. 1417-NFPA 70-2020 [Section No. 406.5(J)]	

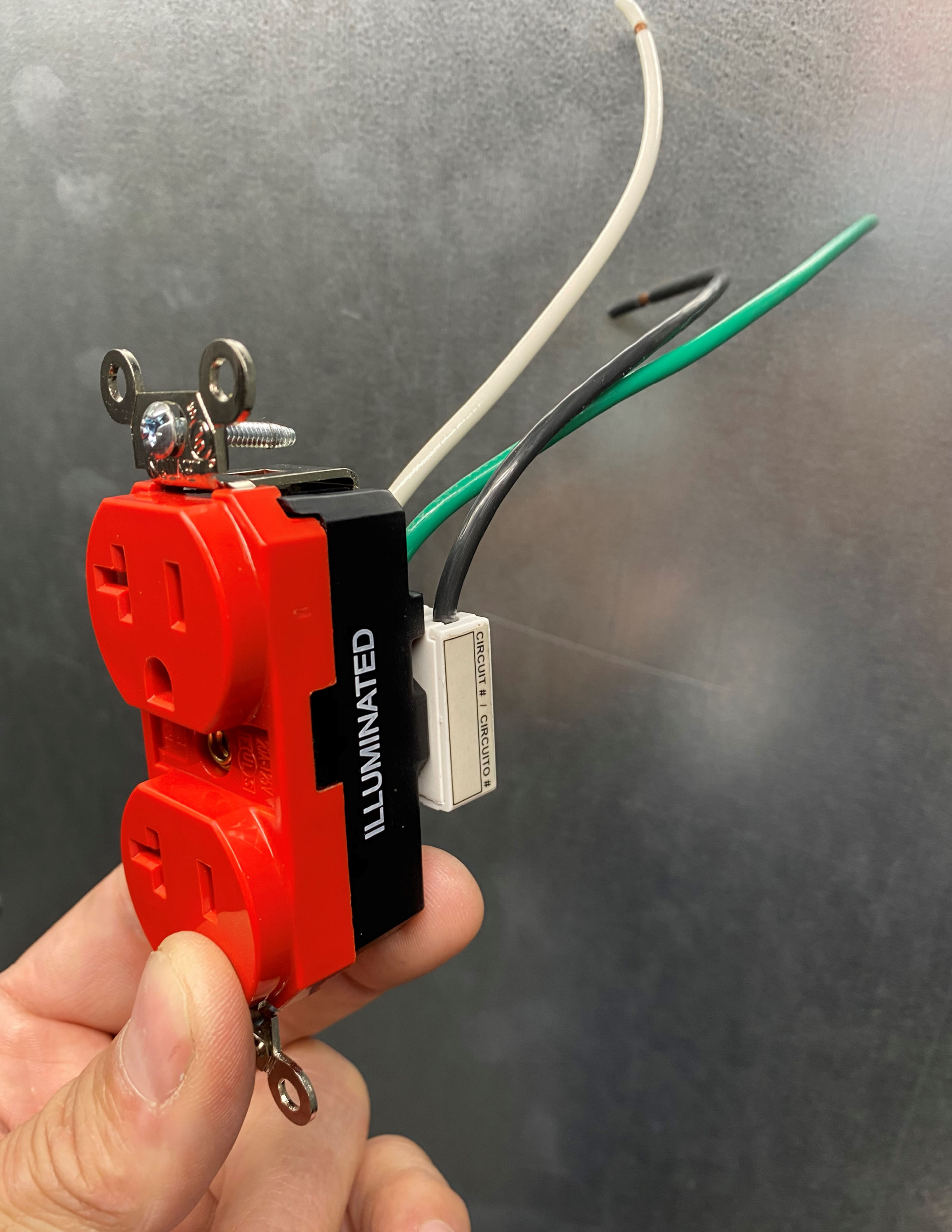
Submitter Information Verification

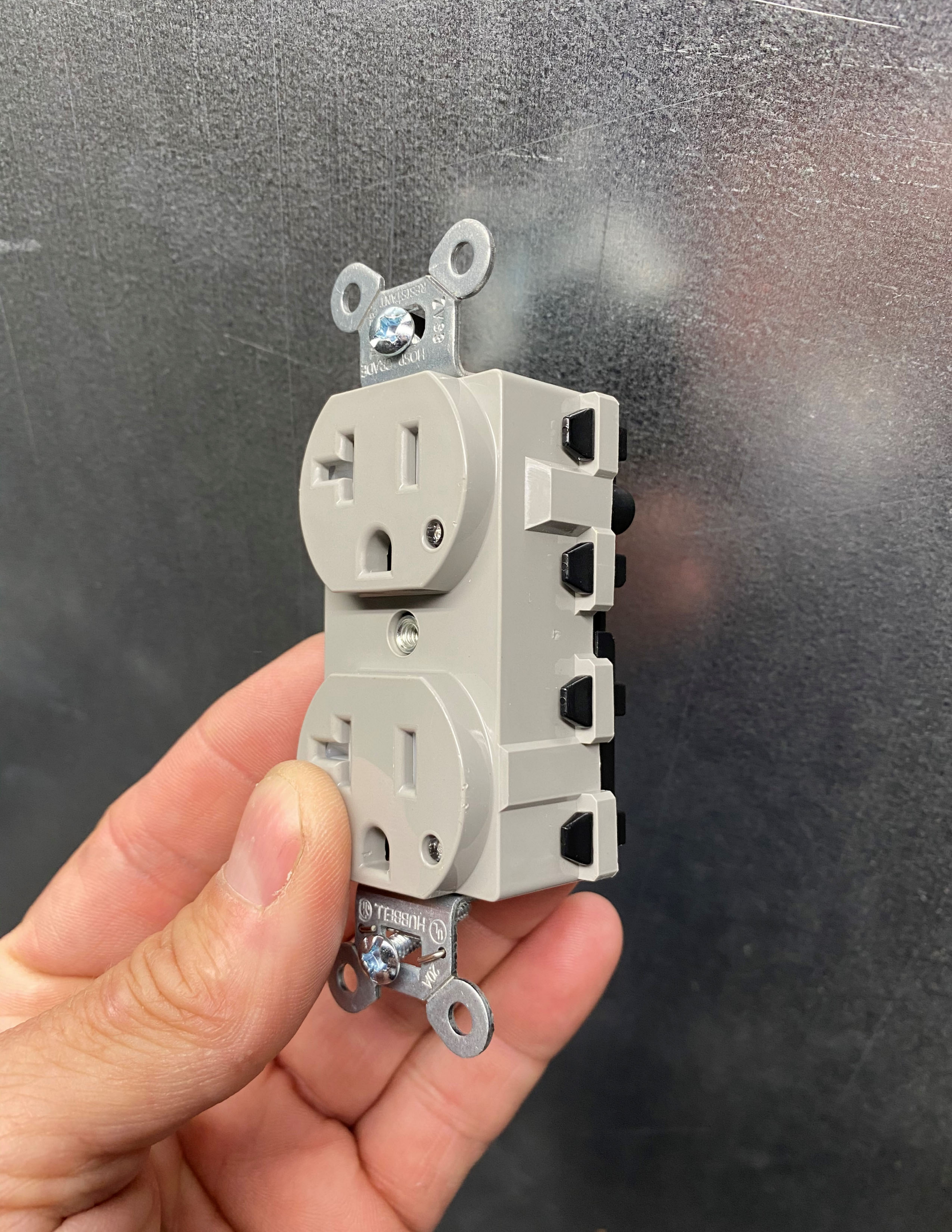
Submitter Full Name:	Russ Leblanc
Organization:	Leblanc Consulting Services
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Jun 02 12:46:08 EDT 2020
Committee:	NEC-P09

Committee Statement

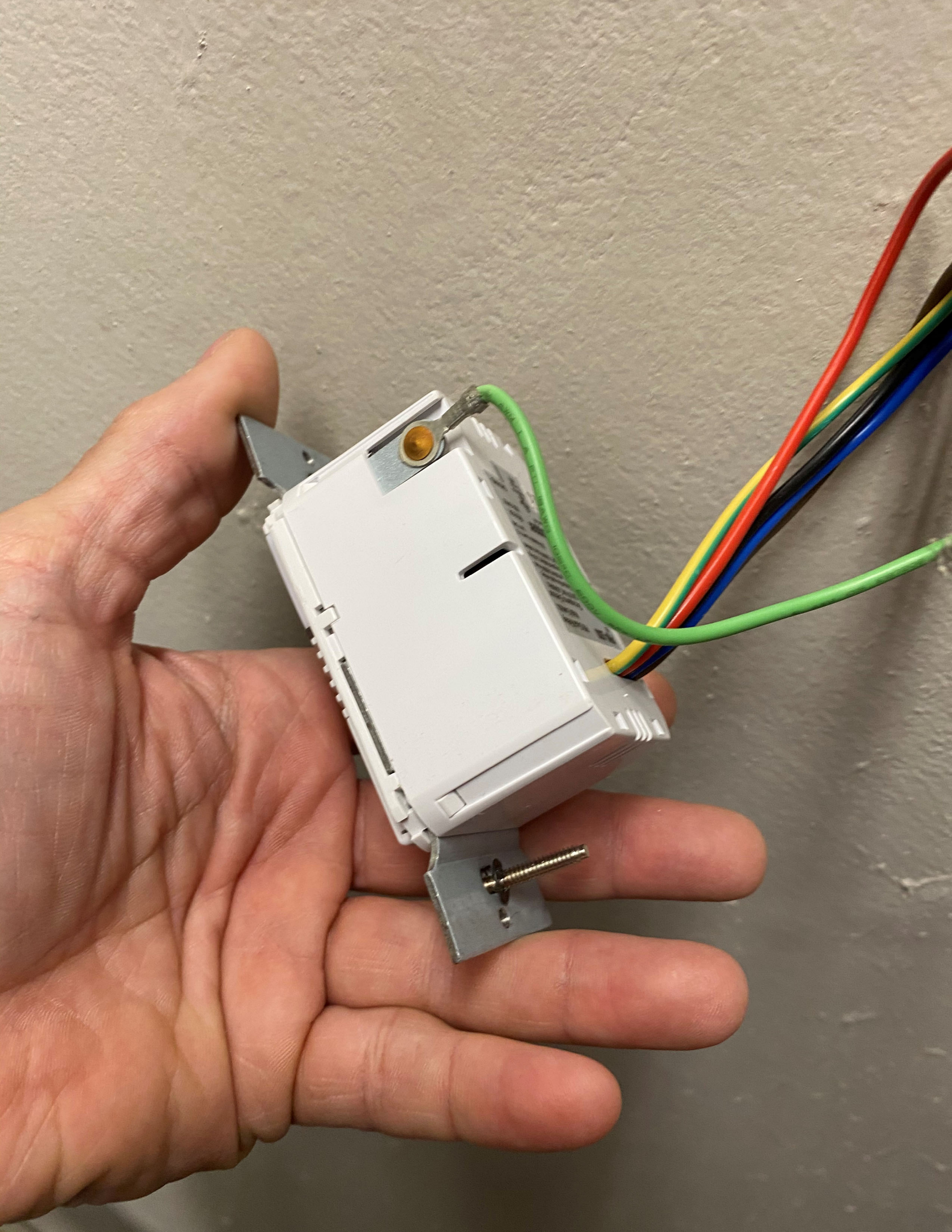
Resolution: Snap switches, receptacles, and similar devices exceeding 300 volts that have been grouped or ganged present a risk of arcing between exposed terminals. A device that does not inherently have an exposed terminal is not prevented from being replaced at its end-of-life by a device with exposed terminals. For this reason, a device that has an inherent barrier is not a sufficient replacement for a barrier installed between devices.


90C 600V OR 1032 90C 1000V


ILLUMINATED
CIRCUIT # / CIRCUITO #


HOSP GRADE
RESISTANT
HUBBELL
20A


STRIP GAGE
WS-301
T 3.0
PIR Wall Switch
Occupancy Sensor
c UL US
LISTED
Appliance
Control
88T9
E101196
120 or 277VAC, 60Hz
@120VAC 1000VA max:
Tungsten & Ballast &
E-ballast & LED ,1/4 HP
@277VAC 1200VA max :
Ballast & E-ballast &
LED ,1/4 HP
US Patents:
5,640,113
5,804,991
Indoor Use Only
legrand
www.legrand.us/wattstopper
24863r1
600V 18AWG
105°C



Public Input No. 4424-NFPA 70-2020 [Section No. 404.9]

404.9 General-Use Snap Switches, Dimmers, and Control Switches.

(A) Faceplates.

Faceplates provided for snap switches, dimmers, and control switches mounted in boxes and other enclosures shall be installed so as to completely cover the opening and, where the switch is flush mounted, seat against the finished surface.

(B) Grounding.

Snap switches, dimmers, and control switches shall be connected to an equipment grounding conductor and shall provide a means to connect metal faceplates to the equipment grounding conductor, whether or not a metal faceplate is installed. Metal faceplates shall be bonded to the equipment grounding conductor. Snap switches, dimmers, control switches, and metal faceplates shall be connected to an equipment grounding conductor using either of the following methods:

(1) The switch is mounted with metal screws to a metal box or metal cover that is connected to an equipment grounding conductor or to a nonmetallic box with integral means for connecting to an equipment grounding conductor.

(2) An equipment grounding conductor or equipment bonding jumper is connected to an equipment grounding termination of the snap switch.

Exception No. 1 to (B): Where no means exists within the enclosure for bonding to the equipment grounding conductor, or where the wiring method does not include or provide an equipment grounding conductor, a snap switch without a connection to an equipment grounding conductor shall be permitted for replacement purposes only. A snap switch wired under the provisions of this exception and located within 2.5 m (8 ft) vertically, or 1.5 m (5 ft) horizontally, of ground or exposed grounded metal objects shall be provided with a faceplate of nonconducting noncombustible material with nonmetallic attachment screws, unless the switch mounting strap or yoke is nonmetallic or the circuit is protected by a ground-fault circuit interrupter.

Exception No. 2 to (B): Listed kits or listed assemblies shall not be required to be bonded to an equipment grounding conductor if all of the following conditions are met:

(1) The device is provided with a nonmetallic faceplate, and the device is designed such that no metallic faceplate replaces the one provided.

(2) The device does not have mounting means to accept other configurations of faceplates.

(3) The device is equipped with a nonmetallic yoke.

(4) All parts of the device that are accessible after installation of the faceplate are manufactured of nonmetallic materials.

Exception No. 3 to (B): A snap switch with integral nonmetallic enclosure complying with 300.15(E) shall be permitted without a bonding connection to an equipment grounding conductor.

(C) Construction.

Metal faceplates shall be of ferrous metal not less than 0.76 mm (0.030 in.) in thickness or of nonferrous metal not less than 1.02 mm (0.040 in.) in thickness. Faceplates of insulating material shall be noncombustible and not less than 2.54 mm (0.100 in.) in thickness, but they shall be permitted to be less than 2.54 mm (0.100 in.) in thickness if formed or reinforced to provide adequate mechanical strength.

(D) Back wired switches

Back wired stab in switches shall not be allowed as a feed through means for connection of more than one conductor on each pole.

Statement of Problem and Substantiation for Public Input

Switch terminals that are used as a feed through connection with stab in back wired connections are making the device cary the entire load of the circuit instead of just the load connected that is connected to the switch.
In many cases it shows up that the device is failing after being installed due to the stab in connections being weakened by the loads being fed through the device.

Submitter Information Verification

Submitter Full Name:	Wendell Whistler
Organization:	IBEW Local 280
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Sep 10 12:50:51 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: The submitter did not provide adequate substantiation. The limitation is unnecessary as the product standard evaluates the capability of the terminals to conduct the rated current of the switch.

Public Input No. 1351-NFPA 70-2020 [Section No. 404.9(B)]

(B) Equipment Grounding Conductor .

(1) Switches. Snap switches, dimmers, and control switches shall be connected to an equipment grounding conductor and shall provide a means to connect metal faceplates to the equipment grounding conductor, whether or not a metal faceplate is installed.

~~Metal faceplates shall be bonded to the equipment grounding conductor. Snap~~
Snap switches, dimmers, control switches

~~, and metal faceplates~~
shall be connected to an equipment grounding conductor using either of the following methods:

(a) The switch is mounted with metal screws to a metal box or metal cover that is connected to an equipment grounding conductor or to a nonmetallic box with integral means for connecting to an equipment grounding conductor.

~~An~~
(b) The equipment grounding terminal of the switch is connected to the circuit equipment grounding conductor or equipment bonding jumper

~~is connected to an equipment grounding termination of the snap switch~~
.

Exception No. 1 to (B): Where no means exists within the enclosure for bonding to the equipment grounding conductor, or where the wiring method does not include or provide an equipment grounding conductor, a snap switch without a connection to an equipment grounding conductor shall be permitted for replacement purposes only. A snap switch wired under the provisions of this exception and located within 2.5 m (8 ft) vertically, or 1.5 m (5 ft) horizontally, of ground or exposed grounded metal objects shall be provided with a faceplate of nonconducting noncombustible material with nonmetallic attachment screws, unless the switch mounting strap or yoke is nonmetallic or the circuit is protected by a ground-fault circuit interrupter.

Exception No. 2 to (B): Listed kits or listed assemblies shall not be required to be bonded to an equipment grounding conductor if all of the following conditions are met:

(1) The device is provided with a nonmetallic faceplate, and the device is designed such that no metallic faceplate replaces the one provided.

(2) The device does not have mounting means to accept other configurations of faceplates.

(3) The device is equipped with a nonmetallic yoke.

(4) All parts of the device that are accessible after installation of the faceplate are manufactured of nonmetallic materials.

Exception No. 3 to (B): A snap switch with integral nonmetallic enclosure complying with 300.15(E) shall be permitted without a bonding connection to an equipment grounding conductor.

(2) Metal Faceplates. Metal Faceplates shall be considered connected to an equipment grounding conductor when secured to the s nap switches, dimmers, or control switches switch with two metal mounting screws.

Statement of Problem and Substantiation for Public Input

No. 1. According to the NFPA Style Manual, the Section Title needs to reflect the content of the rule. The rule is about the equipment grounding conductor, not about “Grounding.” No. 2. Reorganized the text to better describe the requirements, particularly the bonding requirements of a metal faceplate.

Submitter Information Verification

Submitter Full Name: Mike Holt
Organization: Mike Holt Enterprises Inc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 01 17:12:55 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: The proposed change does not add any significant clarity to the text. CMP-9 reviewed for compliance with the Style Manual.

Public Input No. 1069-NFPA 70-2020 [Section No. 404.11]

404.11 Circuit Breakers as Switches.

A hand-operable circuit breaker equipped with a lever or handle, or a power-operated circuit breaker capable of being opened by hand in the event of a power failure, shall be permitted to serve as a switch if it has the required number of poles.

Informational Note: See ~~the provisions contained in~~ Sections 240.81 and 240.83.

Statement of Problem and Substantiation for Public Input

The words “provisions contained in” are redundant and unnecessary. No context or meaning of the informational note is lost with this revision.

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz
Organization: NECA
Street Address:
City:
State:
Zip:
Submittal Date: Fri May 15 07:57:19 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7863-NFPA 70-2020

Statement: The term “provisions contained in” in the informational note to 404.11 is unnecessary. The changes comply with 2020 NEC Style Manual 4.1.3.

Public Input No. 1352-NFPA 70-2020 [Section No. 404.12]

404.12 ~~Grounding of Enclosures~~ Enclosure Connection to Equipment Grounding Conductor .

Metal enclosures for switches or circuit breakers shall be connected to an equipment grounding conductor as specified in Part IV of Article 250. Metal enclosures for switches or circuit breakers used as service equipment shall comply with the provisions of Part V of Article 250. Where nonmetallic enclosures are used with metal raceways or metal-armored cables, they shall comply with 314.3, Exception No. 1 or No. 2.

Except as covered in 404.9(B), Exception No. 1, nonmetallic boxes for switches shall be installed with a wiring method that provides or includes an equipment grounding conductor.

Statement of Problem and Substantiation for Public Input

According to the NFPA Style Manual, the Section Title needs to reflect the content of the rule. The rule is about the equipment grounding conductor, not about 'Grounding.

Submitter Information Verification

Submitter Full Name: Mike Holt

Organization: Mike Holt Enterprises Inc

Street Address:

City:

State:

Zip:

Submittal Date: Mon Jun 01 17:21:52 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: Grounding of enclosures meets the intent of the section. The section title is readily understood.

Public Input No. 382-NFPA 70-2020 [Section No. 404.12]

404.12 Grounding of Enclosures.

Metal enclosures for switches or circuit breakers shall be connected to an equipment grounding conductor as specified in Part IV of Article 250. ~~Metal~~ Where separate grounding conductors or bonding jumpers are installed, a terminal bar for all grounding and bonding conductor connections shall be bonded to the metal enclosure in accordance with 250.12. Equipment grounding conductors shall not be connected to a terminal bar provided for grounded conductors or neutral conductors unless the bar is identified for the purpose and is located where interconnection between equipment grounding conductors and grounded circuit conductors is permitted or required by Article 250. Metal enclosures for switches or circuit breakers used as service equipment shall comply with the provisions of Part V of Article 250. Where nonmetallic enclosures are used with metal raceways or metal-armored cables, they shall comply with 314.3, Exception No. 1 or No. 2.

Except as covered in 404.9(B), Exception No. 1, nonmetallic boxes for switches shall be installed with a wiring method that provides or includes an equipment grounding conductor.

Statement of Problem and Substantiation for Public Input

The purpose of this proposed change is twofold:

(1) Inspectors need to have one common point where they can view and check all grounding and bonding connections. This is especially true for services, when the inspector must examine inside the switch (SUSE). There is usually a hodgepodge of lugs untidily scattered about the switch enclosure. It is also not uncommon to find a single lug, containing two or more conductors (an obvious violation). As an inspector it would save me time, and also make for a safer installation if it was required that all equipment grounding conductors, bonding jumpers, and grounding electrode conductor(s) could be routed to a single point. It's cleaner, and safer. And we wouldn't have to spend so much time trying to "decipher" what is actually going on within the switch enclosure. I believe that the proposed language accomplishes this.

The second reason for the proposed change is for consistency within the NEC. Other code sections already have similar requirements, such as 450.10(A):

"450.10(A) Dry-Type Transformer Enclosures.
Where separate equipment grounding conductors and supply-side bonding jumpers are installed, a terminal bar for all grounding and bonding conductor connections shall be secured inside the transformer enclosure. The terminal bar shall be bonded to the enclosure in accordance with 250.12 and shall not be installed on or over any vented portion of the enclosure."

and 408.40:

"408.40 Grounding of Panelboards.
Panelboard cabinets and panelboard frames, if of metal, shall be in physical contact with each other and shall be connected to an equipment grounding conductor. Where the panelboard is used with nonmetallic raceway or cable or where separate equipment grounding conductors are provided, a terminal bar for the equipment grounding conductors shall be secured inside the cabinet. The terminal bar shall be bonded to the cabinet and panelboard frame, if of metal; otherwise it shall be connected to the equipment grounding conductor that is run with the conductors feeding the panelboard."

Please consider adding this language as it is desperately needed and will help the electrical inspector.

Submitter Information Verification

Submitter Full Name: Nick Sasso
Organization: Clark County Building and Fire
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 29 14:49:32 EST 2020
Committee: NEC-P09

Committee Statement

Resolution: CMP-9 resolves the PI as it needlessly duplicates other requirements in the Code.

Public Input No. 3256-NFPA 70-2020 [Section No. 404.14]

404.14 Rating and Use of Switches.

Switches shall be listed and used within their ratings. Switches of the types covered in 404.14(A) through (E) shall be limited to the control of loads as specified accordingly. Switches used to control cord-and-plug-connected loads shall be limited as covered in 404.14(~~F~~ G).

Informational Note No. 1: For switches for signs and outline lighting, see 600.6.

Informational Note No. 2: For switches controlling motors, see 430.83, 430.109, and 430.110.

(A) Alternating-Current General-Use Snap Switch.

This form of switch shall only be used on ac circuits and used for controlling the following:

(1) Resistive and inductive loads not exceeding the ampere rating of the switch at the voltage applied

(2) Tungsten-filament lamp loads not exceeding the ampere rating of the switch at 120 volts

(3) Electric discharge lamp loads not exceeding the marked ampere and voltage rating of the switch

(4) Motor loads not exceeding 80 percent of the ampere rating of the switch at its rated voltage

(5) Electronic ballasts, self-ballasted lamps, compact fluorescent lamps, and LED lamp loads with their associated drivers, not exceeding 20 amperes and not exceeding the ampere rating of the switch at the voltage applied

(B) Alternating-Current or Direct-Current General-Use Snap Switch.

This form of switch shall be permitted on either ac or dc circuits and used only for controlling the following:

(1) Resistive loads not exceeding the ampere rating of the switch at the voltage applied.

(2) Inductive loads not exceeding 50 percent of the ampere rating of the switch at the applied voltage. Switches rated in horsepower are suitable for controlling motor loads within their rating at the voltage applied.

(3) Tungsten-filament lamp loads not exceeding the ampere rating of the switch at the applied voltage if T-rated.

(4) Electronic ballasts, self-ballasted lamps, compact fluorescent lamps, and LED lamp loads with their associated drivers, not exceeding the ampere rating of the switch at the voltage applied.

(C) CO/ALR Snap Switches.

Snap switches directly connected to aluminum conductors and rated 20 amperes or less shall be marked CO/ALR.

(D) Snap Switches with Push-in Terminals. Push-in terminals of snap switches rated 15 amperes shall be directly connected solely to 14 AWG solid copper conductors. For listed snap switches rated 15 amperes and having push-in terminals that are identified additionally, and so marked, as suitable for 14 AWG solid copper-clad aluminum conductors, the push-in terminals shall be permitted to be directly connected to 14 AWG solid copper-clad aluminum in accordance with 240.4(D)(3).

(E) Alternating-Current General-Use Snap Switches Rated for 347 Volts.

This form of switch shall not be rated less than 15 amperes at a voltage of 347 volts ac, and they shall not be readily interchangeable in box mounting with switches covered in 404.14(A) and (B). These switches shall be used only for controlling any of the following:

(1) Noninductive loads other than tungsten-filament lamps not exceeding the ampere and voltage ratings of the switch.

(2) Inductive loads not exceeding the ampere and voltage ratings of the switch. Where particular load characteristics or limitations are specified as a condition of the listing, those restrictions shall be observed regardless of the ampere rating of the load.

(3) Electronic ballasts, self-ballasted lamps, compact fluorescent lamps, and LED lamp loads with their associated drivers, not exceeding 20 amperes and not exceeding the ampere rating of the switch at the voltage applied.

(~~E~~ F) Dimmer and Electronic Control Switches.

General-use dimmer switches shall be used only to control permanently installed incandescent luminaires unless listed for the control of other loads and installed accordingly. Other electronic control switches, such as timing switches and occupancy sensors, shall be used to control permanently connected loads. They shall be marked by their manufacturer with their current and voltage ratings and used for loads that do not exceed their ampere rating at the voltage applied.

(~~F~~ G) Cord- and Plug-Connected Loads.

Where a snap switch or control device is used to control cord-and-plug-connected equipment on a general-purpose branch circuit, each snap switch or control device controlling receptacle outlets or cord connectors that are supplied by permanently connected cord pendants shall be rated at not less than the rating of the maximum permitted ampere rating or setting of the overcurrent device protecting the receptacles or cord connectors, as provided in 210.21(B).

Informational Note: See 210.50(A) and 400.10(A)(1) for equivalency to a receptacle outlet of a cord connector that is supplied by a permanently connected cord pendant.

Exception: Where a snap switch or control device is used to control not more than one receptacle on a branch circuit, the switch or control device shall be permitted to be rated at not less than the rating of the receptacle.

Additional Proposed Changes

File Name	Description	Approved
Proposed_404.14_D_Draft_Fnl.docx	Word file attached for clarity.	
Terminal_and_Conductor_Temperature_Testing_Part_I_Fnl.pdf	Terminal temperature static heating test report as requested by task group	

Statement of Problem and Substantiation for Public Input

Task Group Statement

This public input is submitted on behalf of the task group formed in accordance with the direction of the NFPA Standards Council in their Decisions D#19-2 and D#19-23. This task group was appointed to identify potential proposed changes to the 2020 edition of the NEC in the form of proposed Tentative Interim Amendments (TIAs) or to the 2023 edition of the NEC in the form of Public Inputs (PIs) that within the Task Group's scope of activity as specified by the Standards Council.

These proposed PIs relate to new requirements covering the use of copper-clad aluminum conductors throughout the NEC as a coordinated set of new or revised requirements. These Public Inputs should not be misconstrued by the CMPs as precluding consideration of other Public Inputs, with supporting test data, submitted now or in the future, for other potentially eligible conductor materials or sizes.

The task group members are; David Hittinger-Chair, Todd Crisman, Roland Deike, Thomas Domitrovich, Peter Graser, Christel Hunter, Chuck Mello, Ken Riedl, Susan Newman Scearce, Susan Stene, George Straniero, Frank Tse and Brian Rock. This task group of balanced interests provided the expertise to develop these public inputs covering the use of copper-clad aluminum conductors.

Public Inputs are being submitted in the following sections: Article 100, definition of "copper-clad aluminum", 210.12, 210.18, 210.21(B)(1), 210.23, 210.24, 210.52(B), 240.4(D), 240.6, 310.3(A), 310.3(B), Table 310.16, Table 310.17, 330.104, 334.104, 336.104, 340.104,404.14(D), and 406.3(D).

Technical Substantiation

The UL standard and associated guide information under category code WJQR for snap switches with push in terminals permits only 14 AWG solid copper conductors to be used at this time.

"Screwless terminal connectors of the conductor push-in type (also known as "push-in terminals") are restricted to 15 A branch circuits and are intended for connection with 14 AWG solid copper wire only. They are not intended for use with aluminum or copper-clad aluminum wire, 14 AWG stranded copper wire, or 12 AWG solid or stranded copper wire."

The change to this section is to highlight this limitation for switches that may have push-in terminals provided. The introduction of 14 AWG copper-clad aluminum into the NEC for branch circuit wiring needs this limitation to ensure push-in terminals on wiring devices are being installed in accordance with their listing.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2864-NFPA 70-2020 [Section No. 210.18]	Branch circuit ratings added 10 amps
Public Input No. 2866-NFPA 70-2020 [Section No. 210.21(B)]	Individual branch circuit receptacle applications and limitations
Public Input No. 3261-NFPA 70-2020 [Section No. 210.23]	Branch circuit applications and limitations add 10 amps
Public Input No. 3940-NFPA 70-2020 [Section No. 210.24]	Summary branch circuit applications and limitations added 10 amps
Public Input No. 3241-NFPA 70-2020 [Section No. 310.3(A)]	Branch circuit conductors added 14 AWG copper-clad aluminum
Public Input No. 3247-NFPA 70-2020 [Section No. 330.104]	14 AWG copper-clad aluminum added for cables
Public Input No. 3248-NFPA 70-2020 [Section No. 334.104]	14 AWG copper-clad aluminum added for cables
Public Input No. 3249-NFPA 70-2020 [Section No. 336.104 [Excluding any Sub-Sections]]	14 AWG copper-clad aluminum added for cables
Public Input No. 3251-NFPA 70-2020 [Section No. 340.104]	14 AWG copper-clad aluminum added for cables
Public Input No. 3259-NFPA 70-2020 [Section No. 406.3]	Applications and limitations for receptacles
Public Input No. 2864-NFPA 70-2020 [Section No. 210.18]	
Public Input No. 2865-NFPA 70-2020 [Section No. 210.12]	
Public Input No. 2866-NFPA 70-2020 [Section No. 210.21(B)]	

Public Input No. 3237-NFPA 70-2020 [Section No. 210.52(B)(1)]

Public Input No. 3238-NFPA 70-2020 [Section No. 240.4(D)]

Public Input No. 3241-NFPA 70-2020 [Section No. 310.3(A)]

Public Input No. 3248-NFPA 70-2020 [Section No. 334.104]

Public Input No. 3249-NFPA 70-2020 [Section No. 336.104 [Excluding any Sub-Sections]]

Public Input No. 3251-NFPA 70-2020 [Section No. 340.104]

Public Input No. 3259-NFPA 70-2020 [Section No. 406.3]

Public Input No. 3261-NFPA 70-2020 [Section No. 210.23]

Public Input No. 3940-NFPA 70-2020 [Section No. 210.24]

Public Input No. 3960-NFPA 70-2020 [Section No. 310.21]

Submitter Information Verification

Submitter Full Name:	David Hittinger
Organization:	IEC
Affiliation:	NEC Correlating Committee Task Group
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon Sep 07 11:08:10 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: FR-7881-NFPA 70-2020

Statement: The UL standard and associated guide information under category code WJQR for snap switches with push in terminals permits only 14 AWG solid copper conductors to be used at this time.

“Screwless terminal connectors of the conductor push-in type (also known as "push-in terminals") are restricted to 15 A branch circuits and are intended for connection with 14 AWG solid copper wire only. They are not intended for use with aluminum or copper-clad aluminum wire, 14 AWG stranded copper wire, or 12 AWG solid or stranded copper wire.”

The change to this section is to highlight this limitation for switches that may have push-in terminals provided. The introduction of 14 AWG copper-clad aluminum into the NEC for branch circuit wiring needs this limitation to ensure push-in terminals on wiring devices are being installed in accordance with their listing. Nothing in the proposed language mandates that the push-in terminals must be used.

The marking addition ensures that the AHJ will be provided with the intended rating for use. The panel finds it necessary to write this requirement into NEC although it may already be present in other applicable standards.

404.14

404.14 Rating and Use of Switches. Switches shall be listed and used within their ratings. Switches of the types covered in 404.14(A) through (E) shall be limited to the control of loads as specified accordingly. Switches used to control cord-and-plug-connected loads shall be limited as covered in 404.14(~~F~~<u>G</u>).

Informational Note No. 1: For switches for signs and outline lighting, see 600.6.

Informational Note No. 2: For switches controlling motors, see 430.83, 430.109, and 430.110.

(A) Alternating-Current General-Use Snap Switch. This form of switch shall only be used on ac circuits and used for controlling the following:

(1) Resistive and inductive loads not exceeding the ampere rating of the switch at the voltage applied

(2) Tungsten-filament lamp loads not exceeding the ampere rating of the switch at 120 volts

(3) Electric discharge lamp loads not exceeding the marked ampere and voltage rating of the switch

(4) Motor loads not exceeding 80 percent of the ampere rating of the switch at its rated voltage

(5) Electronic ballasts, self-ballasted lamps, compact fluorescent lamps, and LED lamp loads with their associated drivers, not exceeding 20 amperes and not exceeding the ampere rating of the switch at the voltage applied

(B) Alternating-Current or Direct-Current General-Use Snap Switch. This form of switch shall be permitted on either ac or dc circuits and used only for controlling the following:

(1) Resistive loads not exceeding the ampere rating of the switch at the voltage applied.

(2) Inductive loads not exceeding 50 percent of the ampere rating of the switch at the applied voltage. Switches rated in horsepower are suitable for controlling motor loads within their rating at the voltage applied.

(3) Tungsten-filament lamp loads not exceeding the ampere rating of the switch at the applied voltage if T-rated.

(4) Electronic ballasts, self-ballasted lamps, compact fluorescent lamps, and LED lamp loads with their associated drivers, not exceeding the ampere rating of the switch at the voltage applied.

(C) CO/ALR Snap Switches. Snap switches directly connected to aluminum conductors and rated 20 amperes or less shall be marked CO/ALR.

<u>**(D) Snap Switches with Push-in Terminals.** Push-in terminals of snap switches rated 15 amperes shall be directly connected solely to 14 AWG solid copper conductors. For listed snap switches rated 15 amperes and having push-in terminals that are identified additionally, and so marked, as suitable for 14 AWG solid copper-clad aluminum conductors, the push-in terminals</u>

shall be permitted to be directly connected to 14 AWG solid copper-clad aluminum in accordance with 240.4(D)(3).

(~~D~~E) Alternating-Current General-Use Snap Switches Rated for 347 Volts. This form of switch shall not be rated less than 15 amperes at a voltage of 347 volts ac, and they shall not be readily interchangeable in box mounting with switches covered in 404.14(A) and (B). These switches shall be used only for controlling any of the following:

(1) Noninductive loads other than tungsten-filament lamps not exceeding the ampere and voltage ratings of the switch.

(2) Inductive loads not exceeding the ampere and voltage ratings of the switch. Where particular load characteristics or limitations are specified as a condition of the listing, those restrictions shall be observed regardless of the ampere rating of the load.

(3) Electronic ballasts, self-ballasted lamps, compact fluorescent lamps, and LED lamp loads with their associated drivers, not exceeding 20 amperes and not exceeding the ampere rating of the switch at the voltage applied.

(~~E~~F) Dimmer and Electronic Control Switches. General-use dimmer switches shall be used only to control permanently installed incandescent luminaires unless listed for the control of other loads and installed accordingly. Other electronic control switches, such as timing switches and occupancy sensors, shall be used to control permanently connected loads. They shall be marked by their manufacturer with their current and voltage ratings and used for loads that do not exceed their ampere rating at the voltage applied.

(~~F~~G) Cord- and Plug-Connected Loads. Where a snap switch or control device is used to control cord-and-plug-connected equipment on a general-purpose branch circuit, each snap switch or control device controlling receptacle outlets or cord connectors that are supplied by permanently connected cord pendants shall be rated at not less than the rating of the maximum permitted ampere rating or setting of the overcurrent device protecting the receptacles or cord connectors, as provided in 210.21(B).

Informational Note: See 210.50(A) and 400.10(A)(1) for equivalency to a receptacle outlet of a cord connector that is supplied by a permanently connected cord pendant.

Exception: *Where a snap switch or control device is used to control not more than one receptacle on a branch circuit, the switch or control device shall be permitted to be rated at not less than the rating of the receptacle.*

Substantiation:

Task Group Statement

This public input is submitted on behalf of the task group formed in accordance with the direction of the NFPA Standards Council in their Decisions D#19-2 and D#19-23. This task group was appointed to identify potential proposed changes to the 2020 edition of the NEC in the form of proposed Tentative Interim Amendments (TIAs) or to the 2023 edition of the NEC in the form of Public Inputs (PIs) that within the Task Group's scope of activity as specified by the Standards Council.

These proposed PIs relate to new requirements covering the use of copper-clad aluminum conductors throughout the NEC as a coordinated set of new or revised requirements. These Public Inputs should not be misconstrued by the CMPs as precluding consideration of other Public Inputs, with supporting test data, submitted now or in the future, for other potentially eligible conductor materials or sizes.

The task group members are; David Hittinger-Chair, Todd Crisman, Roland Deike, Thomas Domitrovich, Peter Graser, Christel Hunter, Chuck Mello, Ken Riedl, Susan Newman Scearce, Susan Stene, George Straniero, Frank Tse and Brian Rock. This task group of balanced interests provided the expertise to develop these public inputs covering the use of copper-clad aluminum conductors.

Public Inputs are being submitted in the following sections: Article 100, definition of "copper-clad aluminum", 210.12, 210.18, 210.21(B)(1), 210.23, 210.24, 210.52(B), 240.4(D), 240.6, 310.3(A), 310.3(B), Table 310.16, Table 310.17, 330.104, 334.104, 336.104, 340.104,404.14(D), and 406.3(D).

Technical Substantiation

The UL standard and associated guide information under category code WJQR for snap switches with push in terminals permits only 14 AWG solid copper conductors to be used at this time.

"Screwless terminal connectors of the conductor push-in type (also known as "push-in terminals") are restricted to 15 A branch circuits and are intended for connection with 14 AWG solid copper wire only. They are not intended for use with aluminum or copper-clad aluminum wire, 14 AWG stranded copper wire, or 12 AWG solid or stranded copper wire."

The change to this section is to highlight this limitation for switches that may have push-in terminals provided. The introduction of 14 AWG copper-clad aluminum into the NEC for branch circuit wiring needs this limitation to ensure push-in terminals on wiring devices are being installed in accordance with their listing.

Terminal and Conductor Temperature Testing of 14 AWG Copper-Clad Aluminum and 14 AWG Copper Conductors

Part I – Static Heating and Flexing Tests

For

Bimetallics Task Group

Conducted at

Eaton Laboratories
Menomonee Falls, Wisconsin

Report by

Chuck Mello
on behalf of Bimetallics Task Group

Report Date

August 28, 2020

Table of Contents

1.0 Introduction and Purpose

At the direction of the NFPA Standards Council in their Decisions D#19-2 and D#19-23, a Bimetallics Task Group of balanced interest was appointed. The scope was to review the proposed changes to the 2020 edition of the *NEC®* that relate to copper-clad aluminum conductors and recommend changes through tentative interim amendment(s) and/or to provide public inputs for the next revision cycle.

As the task group conducted the work, it was determined that testing data had been provided substantiating the ampacity of 14 AWG copper-clad aluminum but a number of related questions about 14 AWG copper-clad aluminum applications arose regarding terminal temperatures when applied to circuit breakers, wire splicing devices and device terminals. A testing plan was developed, reviewed over several task group meetings, and accepted by the task group to address the terminal temperature questions. This testing was completed at the Eaton Corporation laboratory facilities in Menomonee Falls, Wisconsin. The helpful assistance of Mr. Tom Domitrovich, Mr. Kevin Arnold, Mr. James Parrett, and Mr. Steve Averbeck with Eaton Corporation is greatly appreciated in arranging for and executing the testing.

This test report provides the testing arrangement, testing procedures and results for the static heating and the flexing tests. The Part I testing detailed in this report commenced July 30, 2020 and completed on August 26, 2020. Thermocycling testing is presently being conducted and those test results will be provided in a separate report. The separation of the reports is necessary to meet the NFPA deadline of September 10, 2020 to submit public inputs and any supporting data.

The purpose of this testing is to provide data, as requested by the Bimetallics Task Group, to understand certain installation and operating conditions when considering the application of 14 AWG copper-clad aluminum conductors at the proposed ampacity for branch circuits. The testing being completed also includes 14 AWG copper conductors at its *NEC®* ampacity for comparison and performance. The basis for comparison is at the 60ºC ampacity rating for copper (15 amps) and the proposed 60ºC ampacity rating for copper-clad aluminum (10 amps). This testing is designed to represent a typical installation to determine the following:

1) The temperature (temperature rise) on the terminals and conductor immediately adjacent to a 10 Amp and 15 Amp molded case circuit breaker, under normal and identified abnormal conditions
2) The temperature (temperature rise) on wire-splicing devices (e.g., Ideal Wire Nuts® or similar), and conductor immediately adjacent, commonly used for splicing in junction or device boxes or attaching leads from utilization equipment, under normal and abnormal conditions
3) The temperature (temperature rise) on wiring devices (single receptacle as representative) and conductor immediately adjacent under normal and abnormal conditions
4) Conductor retention on wiring devices after abnormal thermal-cycling
5) The flexing durability of 14 AWG copper-clad aluminum when installed and removed from a single-gang device box

Since the various product standards do not presently have requirements, procedures or parameters for 14 AWG copper-clad aluminum, the testing being conducted is based on the 10-ampere branch circuit rating at 60°C and percentage multipliers taken from the applicable standards. Where the standard does not provide a percentage value, then the current for the testing was interpolated from the values for relative copper and/or aluminum conductors from the standard. The values for testing of 14 AWG copper are taken from the applicable product safety standards with an ampacity basis of 15 Amps at 60°C

It is to be understood this testing is only being conducted to provide specific performance data and information as requested by the task group. The testing does not provide performance or data for certification of any of the components used for the testing. If 14 AWG copper-clad aluminum is accepted into the 2023 *NEC*®, then numerous UL standards will need to be revised and testing completed under the requirements established in those standards. This testing for certification could be more extensive and take much more time to complete than what is provided here. The goal again is to provide information for a typical installation specific to terminal temperatures. The changes to UL standards will not begin to occur until 14 AWG copper-clad aluminum is recognized for installation in the *NEC*®.

To provide a basis to consider the test results for 14 AWG copper-clad aluminum, duplicate test set ups were constructed using 14 AWG copper conductors. The only difference in the setup for 14 AWG copper is the circuit breaker was rated 15 Amps and the testing values were based on the 15 Amp ampacity. This additional testing data provides a direct comparison in the same environment at the 60ºC ampacity values for these two conductor types and assemblies.

2.0 Testing Arrangement and Setup

The test was conducted in a suitable facility with environmental controls and documented monitoring. The facility was free from extraneous changes in ambient temperature and from having random air flow (drafts) through the testing area. Ambient temperature was maintained between 20ºC and 25°C and recorded with thermocouples positioned in the testing area while temperature testing was completed.

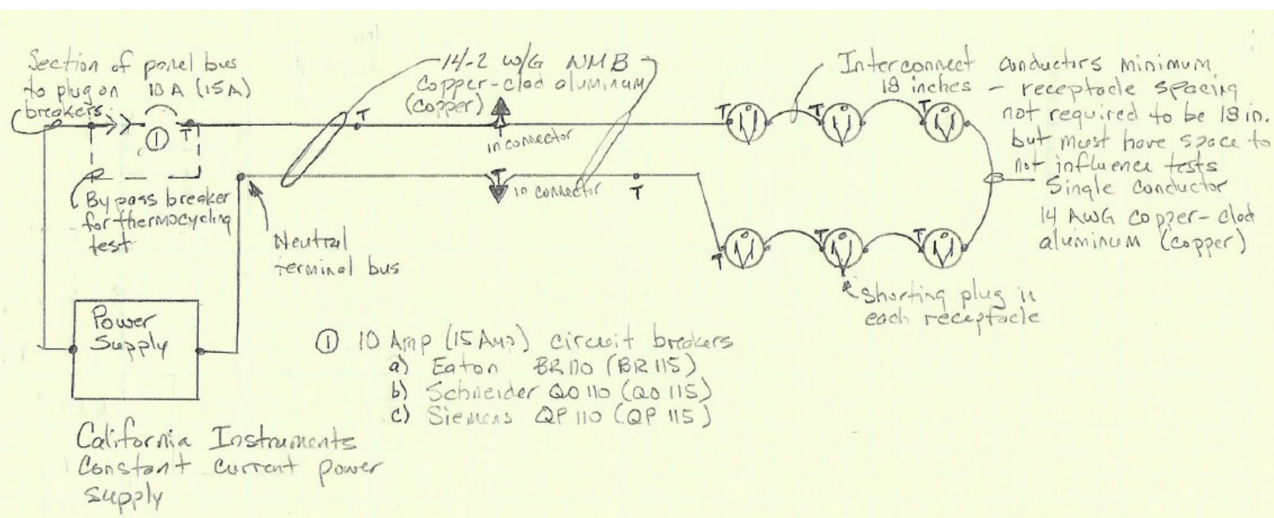


Figure 1 – Typical Test Circuit Diagram

The Eaton facility, being a division within a manufacturing company of wiring devices and circuit breakers, has laboratory technicians that are very familiar with testing of circuit components and equipment to UL standards.

The test circuit diagram shown in figure 1 above provides the basic layout of one (1) testing circuit consisting of one (1) circuit breaker, the conductor (14 AWG copper-clad aluminum or copper NM-B cable) two wire-splicing devices, and six (6) single receptacles. To complete tests 1 through 4 as described below, three (3) of these test circuits were assembled at a time. Photos 1 through 3 in Appendix A show the general test setup for completing the static heating testing. Each of the three (3) circuits have one of the manufacturer's (mfg. 1, mfg. 2, and mfg. 3) circuit breaker, the wire splicing devices on the black and white wire as described below, and three (3) each of receptacles from two of the manufacturers. Photos 4 through 7 show each of the setups with a sign indicating the circuit breaker, conductor material, wire splicing devices, and receptacles in that circuit.

For example, a setup had three (3) circuits with:

- Three different 10-amp circuit breakers (one each mfg. 1, mfg. 2, and mfg. 3)
- 14 AWG copper-clad aluminum NM-B conductors
- Mfg. 4 and mfg.5 wire splicing devices respectively, on the black and white conductors
- Three each of the mfg. 8 and mfg. 9 receptacles, and
- 14 AWG THHN copper-clad aluminum conductors for interconnection of the receptacles

These components were connected together to form a complete circuit. The second setup for 14 AWG copper-clad aluminum were same circuit breakers but with mfg.6 and mfg.7 wire spicing devices and with mfg. 10 and mfg.11 receptacles. The third and fourth setups were the same as 1 and 2 except using 15-amp circuit breakers and 14 AWG copper conductors.

Due to testing of several different circuit breakers, receptacles, and wire-splicing devices, the test arrangement was different than what may be used for certification testing of a single type of device. The test purpose was to approximate an actual installation under laboratory type conditions and not to establish certification type testing for any one device.

For tests 1 through 4 the three power supplies used were programmable constant current power supply sources. Each power supply was connected to one of the circuits and provided the current level specified for the tests being conducted.

For each of the four setups the following description is provided, see circuit diagram in figure 1 and Appendix A photos 1 through 7:

1) The three (3) circuits were mounted on an insulating sheet approximately 4 feet high and 8 feet wide. The partition had suitable framing to provide structural support for the partition to be in a vertical orientation to the floor.

2) During all testing, suitable barrier tape, safety cones, barriers, or other means was in place in accordance with the laboratory safety procedures to keep unauthorized persons out of the area and away from exposed live parts.

3) The individual conductors and devices were arranged horizontally with approximately 12 inches of vertical spacing between each horizontal assembly. Staples, or other fastening devices, such as cable ties, were used to keep the NM-B cable aligned with the respective test assembly.

4) For the circuit breaker testing the following was assembled:
   a) For the copper-clad aluminum conductors, three (3) 10-amp plug-on type panelboard circuit breakers were installed on sections of panelboard bus that are mounted onto the insulating board partition.
   b) For the copper conductors, three (3) 15-amp plug-on type panelboard circuit breakers were installed on sections of panelboard bus that are mounted onto the insulating board partition. The panelboard bus had a terminal for connection of one conductor from the power supply.
5) From the circuit breaker approximately 4 feet of 14-2 NM-B cable was installed and supported as provided above. From this center junction another 2 feet of 14-2 NM-B cable (copper-clad aluminum or copper as applicable) was installed. The junction in the middle had approximately 6 inches of exposed conductor and a splice completed with yellow wire-splicing devices as provided for the black, white and equipment grounding conductors. The following was applied to the two setups for the copper-clad aluminum conductors respectfully and repeated for the copper conductor setups.
   a) The black wire for the first circuit set of three used a mfg. 4 yellow wire-splicing devices
   b) The white wire for the first circuit set of three used an mfg. 5 yellow Wire Nuts®
   c) The black wire of the second circuit set of three used a mfg. 6 yellow wire-splicing devices
   d) The white wire of the second circuit set of three used a mfg. 7 yellow wire-splicing devices

   The manufacturer and location of the wire-splicing devices used was recorded for each test setup.
6) Six (6) receptacles were installed at the end of each horizontal assembly.
   a) The first set of circuits of copper-clad aluminum or of copper had three (3) mfg. 11 receptacles and then three (3) receptacles from mfg. 8 all connected in series.
   b) The second circuit of copper-clad aluminum or of copper had three (3) receptacles from mfg. 10 and then three (3) receptacles from mfg. 9 all connected in series.

   The receptacles were spaced a minimum of six (6) inches apart horizontally and/or vertically and were interconnected with a minimum of eighteen (18) inches of 14 AWG solid THHN copper-clad aluminum or copper conductors respectfully.

   The receptacles were mounted to the wall surface with screws, so that the face of the receptacle was approximately 1 1/2 inches from the insulating board partition surface.

   For each manufacturer the receptacles were connected to terminals as follows:
   a) One receptacle had the conductors installed at each wire binding screw and the conductors were wrapped counter-clockwise around the screw shank under the screw head, for 2/3 to 3/4 of wire binding screw circumference.

b) The second receptacle had the conductors installed into one side back terminal (entry hole) of the pressure plate terminal.

c) The third receptacle had two conductors installed into each back-side pressure plate terminal as follows: one conductor of the test circuit into each side (hot and neutral) of the pressure plate terminal and one additional short conductor of equal diameter and material into the other side (entry hole) of the same pressure plate terminal. The second conductor was to fill the slot only and is not required for any other purpose than to balance the mechanical clamping forces applied.

Each receptacle had a shorting plug installed as follows:

a) The ungrounded (BLACK) and grounded (WHITE) contacts of each receptacle being tested were connected together by a mated attachment plug having rigidly-attached solid blades.

b) The terminals of each attachment plug were short-circuited by the shortest feasible length of 14 AWG stranded copper conductor from type SJ flexible cord.

c) The flexible cord shorting conductor was mechanically terminated into the pressure plate terminals and the connection torqued to the manufacturer's specification.

7) The conductor from the neutral terminal of the last receptacle in the series was routed back using the white wire in the NM-B cable, through the wire-splicing devices and terminated at a terminal bar mounted to the support board for connection back to the power supply.

8) All connections were tightened as follows. Torquing tools were calibrated and calibration documented:

a) The circuit breaker terminals were torqued as specified on the circuit breaker nameplate.

b) The wire-splicing devices were torqued to the manufacturer's specification in the instructions. If there was no specification, then the 14 AWG copper-clad aluminum conductors were torqued to 2.47 lbf-in and the 14 AWG coper conductors were torqued to 4.11 lbf-in [Specification from UL 486C – 9.1.9.4]

c) The terminals of the receptacles and of the attachment plugs were torqued to the manufacturer's specification in the installation instructions. If there was no torque specification provided, then the terminals were torqued to 9 lbf-in.

9) Thermocouples were connected as shown in the diagram, figure 1 and as shown in Appendix A photos 8 and 11 through 14.

a) Thermocouples were installed on device terminals so that it did not interfere with the terminal.

For the wire-splicing devices, the thermocouples were attached into the wire bundle within the wire-splicing devices.

b) The thermocouples that measured center wire temperatures had a flap of the NM-B jacket and the conductor insulation peeled back to expose the conductor. The thermocouple was attached with thermo-cement to the conductor and the conductor insulation and jacket flap folded back to the original position with two wraps of black electrical tape wrapped to hold the flap in place.

c) A thermocouple was positioned midway in elevation to the test setup for each circuit and recorded the ambient temperature as testing was completed.

10) The power supply was a programable constant current power supply. The current was monitored and recorded by the data logger along with the temperature recordings. The power supply was connected to the lug on the panelboard bus serving the circuit breaker and to the neutral terminal bar where the return white conductor from the NM-B cable was terminated.

3.0 Materials for Testing

The generous support with the supplying of materials by Copperweld, Eaton, Hubbell, Legrand, Leviton, and Siemens are acknowledged and appreciated. The following materials were used to complete the setups as described above.

1) The circuit breakers for the copper-clad aluminum testing were single pole 10 Amp 120/240 Volt, 10,000 interrupting rating with five (5) each of the following (two (2) breakers to be used and the others as backup):

    a) Eaton BR110,

    b) Schneider QO110, and

    c) Siemens QP110.

2) The circuit breakers for the copper testing were single pole 15 Amp 120/240 Volt, 10,000 interrupting rating with five (5) each of the following (two (2) breakers to be used and the others as backup):

    a) Eaton BR115,

    b) Schneider QO115, and

    c) Siemens QP115.

3) The yellow wire-splicing devices were as follows:

    a) Gardner-Bender Ultra WingGard

    b) Ideal Wing-Twist

    c) 3M Performance Plus Red/Yellow+

    d) Commercial Electric WT4

4) The receptacles for both the copper-clad aluminum and copper testing were:
    a) Eaton (Cooper) model TR6250W, 5-15R single receptacle with wire binding screw and pressure plate terminals (back and side wired)
    b) Hubbell model HBL 5261, 5-15R single receptacle with both wire binding screw and pressure plate terminals (back and side wired)
    c) Legrand (Pass & Seymour) model TR 5251, 5-15R single receptacle with both wire binding screw and pressure plate terminals (back and side wired)
    d) Leviton model T 5015, 5-15R single receptacle with both wire binding screw and pressure plate terminals (back and side wired)
5) Thermocouples, UL calibrated, model UL 3055, with sufficient length to connect and route to datalogger recording device.
6) Datalogger recording device and laptop or another required device for the datalogger.
7) Programable power supplies from Eaton laboratory. Maximum current for the copper was 30 Amps and for the copper-clad aluminum was 20 amps.
8) Approximately 50 feet each of 14-2 w/ground copper-clad aluminum NM-B cable and of 14-2 w/ground copper NM-B cable.
9) Approximately 50 feet each of 14 AWG solid THHN copper-clad aluminum and 14 AWG solid THHN copper single conductors.

4.0 Test Procedures

4.1 Conductor Material Testing

A sample of each the 14-2 NM-B and 14 AWG THHN copper-clad aluminum conductors used for the testing was returned to the Copperweld factory laboratory for analysis. The testing was performed to confirm the conductors that were used for the testing at Eaton were in fact 14 AWG and met the requirements for copper-clad aluminum as specified in UL 83 Annex E and ASTM B566. The packaging was photo documented from the Eaton laboratory and the opening of the package at the Copperweld laboratory photo documented.

The Copperweld laboratory technician, who routinely performs the full ASTM B566 battery of testing, completed all the testing and documented it on a Copperweld laboratory test data sheet.

Standard materials testing was completed by Copperweld laboratory technicians including:

- DC resistance
- Copper thickness
- Copper Volume
- Tensile strength
- Elongation
- Adhesion
- Cohesion

The following tests, as completed by the Copperweld laboratory technician, were witnessed and documented by the UL Field Representative that normally completes follow-up inspections of copper-clad aluminum conductors as part of the recognized component program, under category DVVU2:

- DC resistance
- Copper thickness
- Tensile strength
- Elongation

4.2 Terminal Temperature Testing

The following test procedures, except the flexing test, used references from parts of UL 486(A)(B); UL 486(C); UL 489; UL 20; and UL 498.

As stated, the tests 1 through 4 were completed with all three (3) manufacturer's circuit breakers in three circuits at one time. These tests are identified with the test number from below with an "a", "b" or "c' representing the representative circuit breaker used:

a. mfg. 1 circuit breaker

b. mfg. 2 circuit breaker

c. mfg. 3 circuit breaker

This same nomenclature is used in the data sheets found in Appendix C. To minimize test setups, and the number of times terminations are completed or taken apart, all four (4) static heating tests were completed for the "a", "b", and "c" circuit setups. After these tests were completed, then the next setup was assembled by changing the wire splicing devices and receptacles or changing the conductors from copper-clad aluminum to copper as applicable.

All static heating tests, tests 1 through 4 commenced with all components at ambient temperature.

For all testing temperature equilibrium is three consecutive readings taken at no less than 5-minute intervals indicating no further rise in temperature above the ambient temperature. For tests where the circuit breaker trips, which may be before temperature equilibrium was attained, the last three recorded temperatures were recorded onto the data sheets.

Test #1 – Rated Current Temperature

Each circuit was operated at 100% of the branch circuit rating (CCA - 10 Amps or Cu - 15 Amps) until temperature equilibrium was achieved. The final temperatures were recorded. All terminations were inspected for evidence of thermal damage. Temperature measurements were recorded at one-minute intervals.

Test #2 – Circuit Breaker Overload Temperature

Each circuit was operated at 135% of the branch circuit rating (CCA - 13.5 Amps or CU - 20.25 Amps) until temperature equilibrium was achieved or the circuit breaker tripped whichever came first. The circuit breaker elapsed trip time was recorded. Table 1, in section 4.3 below, provides the expected circuit breaker trip times from the manufacturer's time current curves. If the circuit breaker tripped, the last three recorded temperatures of the conductor, wire-splicing devices and wiring device were recorded on the datasheet. All terminations were inspected for evidence of thermal damage. Temperature measurements were recorded at 20-second intervals.

Test #3 – Wiring Device Overload Temperature

Each circuit was operated at 150% of the branch circuit rating (CCA - 15 Amps, or CU - 22.5 Amps) until temperature equilibrium was achieved or the circuit breaker tripped whichever came first. The circuit breaker elapsed trip time was recorded. Expected circuit breaker trip times are in a table 1 below in section 4.3 of procedure. If the circuit breaker tripped, the last three recorded temperatures of the conductor, wire-splicing devices and wiring device were recorded on the datasheet. All terminations were inspected for evidence of thermal damage. Temperature measurements were recorded at 10 second intervals.

Test #4 – Circuit Breaker Overload Temperature

Each circuit was operated at 200% of the branch circuit rating (CCA - 20 Amps, or CU 30 Amps) until temperature equilibrium was achieved or the circuit breaker trip tripped whichever came first. The circuit breaker elapsed trip time was recorded. Expected circuit breaker trip times are in a table 1 below in section 4.3 of procedure. If the circuit breaker tripped, the last three recorded temperatures of the conductor, wire-splicing devices and wiring device were recorded on the datasheet. All terminations were inspected for evidence of thermal damage. Temperature measurements were recorded at 7 second intervals.

Test #5 – Wiring Device Thermal Cycling

The thermocycling testing is underway at the time this report is being written. In order to meet NFPA public input deadlines, this report is for all testing completed at this time. A subsequent report will be written for the thermocycling testing.

Test # 6 – Conductor Flexing Test

a) A standard 2 x 3 device box was mounted to a wood stud fixed to a table for support. See Appendix A photo 15. The device box was mounted with screws through the back of the box.

b) A length of 14-2 AWG copper-clad aluminum NM-B cable was installed into the device box using NM cable clamps. The NM-B had a minimum of 1/4 inch of cable jacket projecting into the box past the clamping device.

c) The outside end of the NM-B cable was connected to a digital multimeter to indicate continuity of the circuit through the receptacle, see Appendix A photo 16.

d) The NM-B cable jacket was stripped and cut to length so that 6 inches of conductor projected beyond the cable entry to the box and 3 inches beyond the front edge of the device box. A receptacle was terminated to the NM-B cable conductors and the conductors shaped to fit back in the box so the receptacle yoke mated with the box front edge.

e) For the first test, the NM-B conductors were installed using the wire binding screw with the conductors wrapped counter-clockwise around the screw shank under the screw head, for 2/3 to 3/4 of wire binding screw circumference.

f) A shorting plug was installed into the receptacle.

g) The 6-32 screws were removed and approximately 4-inch-long 10-32 screws were fixed to the device box ears and through the yoke of the receptacle providing a guideway for repeated insertion and removal. The 10-32 screws had nuts installed in the inside and outside of the device box ears to make rigid to the box, see Appendix A photo 15.

h) With the assembly complete, the receptacle was pushed into and retracted from the box for 10 cycles and the continuity monitored on the digital multimeter, see Appendix A photos 17 through 19.

i) Steps ‘b’ through ‘h’ were repeated two more times with new lengths of 14-2 NM-B copper-clad aluminum cable.

   - For the second test the receptacle was assembled with the back-wiring pressure plate terminal and a single conductor.
   - For the third test the receptacle was assembled with the back-wiring pressure plate terminal and two conductors for mechanical balance on the wiring terminal.

4.3 Bimetallics Testing Circuit Breaker Trip Times

The below table provides the expected trip times based on the manufacturers time current curves at 40°C. The testing for this project was completed at about 22°C, based on the ambient temperatures recorded. Therefore, the trip times recorded from this testing may be somewhat higher but should not exceed the limits set in the UL Standard.

The UL standard specifies that calibration testing be competed at an ambient temperature of 25°C. The UL standard calibration testing at 25°C specifies that at:

- 135% of rating the maximum trip time for a 0 - 50-amp circuit breaker is 1 hour
- 200% of rating the maximum trip time for a breaker 0 – 30 amps is 2 minutes.

Table 1

Manufacturer	Catalog No.	Trip Time Range in Seconds @ 40°C			
		100% rated current	135% rated current	150% rated current	200% rated current
Eaton	BR110	No trip	35 - 3600	20 - 500	12 - 40
	BR115	No trip	35 - 3600	20 - 500	12 - 40
Schneider	QO110	No trip	40 - 500	26 - 240	10 - 60
	QO115	No trip	30 - 210	21 - 100	8 - 28
Siemens	QP110	No trip	60 -800	40 - 450	19 - 150
	QP115	No trip	30 - 250	20 - 100	9 - 38

5.0 Test Results

5.1 Copper-Clad Aluminum Conductor Material Testing

After the static heating testing was completed, Eaton laboratory technicians packed and shipped samples of the copper-clad aluminum conductor, NM-B cable and THHN single conductor, that had been used for the testing to Copperweld's laboratory for verification testing. Appendix A photos 22 to 24 show the samples the Eaton laboratory technicians packaged into the bag and shipped to the Copperweld laboratory. Note the date on these photos as August 24, 2020. Appendix B pages B1 and B2 show photos of the received package and opening of that package with these samples for the testing.

The samples of the 14 AWG copper-clad aluminum NM-B cable and the 14 AWG copper-clad aluminum THHN single conductors were tested in the Copperweld factory laboratory on August 27, 2020. The Copperweld laboratory testing data is provided in Appendix B page B3 and the calibration of the test equipment on pages B4 through B6.

The UL field engineer that routinely completes the quarterly follow-up inspections for the copper-clad aluminum conductor witnessed the testing required under the UL standard follow-up program that was completed on August 27, 2020. As shown in Appendix B, page B7, the UL field engineer confirmed that "*the 14 Awg from the NMB and THHN samples passed the UL tests for DVVUs, including Tensile, Elongation, copper thickness and DC resistance"*

The test results for the copper-clad aluminum confirm that the conductors used for this testing were 14 AWG and that the material tested met the requirements in ASTM B566.

5.2 Test Setup and Torquing

The test setups were as described in Section 2.0 of this report and shown with photographs in Appendix A. The terminations were tightened to the applicable torque value with a calibrated torque wrench. For the static heating testing the following tables show the torque values applied for each setup and device terminal.

Copper-Clad Aluminum conductors with mfg. 11 and mfg. 8 Receptacles

Torques applied:

Item being torqued	in/lbs	mfr. spec	default
mfg. 1 brkr	20	yes	no
mfg. 2 brkr	36	yes	no
mfg. 3 brkr	25	yes	no
mfg. 4 wire splicing device	2.47	no	yes
mfg. 5 wire splicing device	2.47	no	yes
mfg. 11 receptacles	9	no	yes
mfg. 8 receptacles	12	yes	no

Copper-Clad Aluminum conductors with mfg. 10 and mfg. 9 Receptacles

Torques applied:

Item being torqued	in/lbs	mfr. spec	default
mfg. 1 brkr	20	yes	no
mfg. 2 brkr	36	yes	no
mfg. 3 brkr	25	yes	no
mfg. 6wire splicing device	2.47	no	yes
mfg. 7 wire splicing device	2.47	no	yes
mfg. 10 receptacles	9	no	yes
mfg. 9 receptacles	9	no	yes

Copper conductors with mfg. 11 and mfg. 8 Receptacles

Torques applied:

Item being torqued	in/lbs	mfr. spec	default
mfg. 1 brkr	20	yes	no
mfg. 2 brkr	36	yes	no
mfg. 3 brkr	25	yes	no
mfg. 4 wire splicing device	4.11	no	yes
mfg. 5 wire splicing device	4.11	no	yes
mfg. 11 receptacle	9	no	yes
mfg. 8 receptacle	12	yes	no

Copper conductors with mfg. 10 and mfg. 9 Receptacles

Torques applied:

Item being torqued	in/lbs	mfr. spec	default
mfg. 1 brkr	20	yes	no
mfg. 2 brkr	36	yes	no
mfg. 3 brkr	25	yes	no
mfg. 6wire splicing device	4.11	no	yes
mfg. 7 wire splicing device	4.11	no	yes
mfg. 10 receptacle	9	no	yes
mfg. 9 receptacle	9	no	yes

5.3 Static Heating Test

The following are the results of the static heating testing, tests 1 through 4 with references to the applicable appendix pages. For all the testing data, the final three recorded temperature values are shown at either temperature equilibrium or the final three temperatures recorded before a circuit breaker tripped. All testing commenced with all test measurement points at ambient temperature. Also shown in the tables in the appendix are:

- The elapsed time from the start of the test,
- The ambient temperature recorded at the time of the recorded values, and
- The current at the time of the recorded values.

Since the UL standards reference temperature rise for most of the devices, those calculated values are shown immediately adjacent to the recorded values. The temperature rise was calculated by taking the recorded temperature and subtracting the ambient temperature recorded for that time.

Since the method of termination on each the three receptacles from one manufacturer was different (wire binding screw, back wired with pressure plate with one conductor and back wired with pressure plate with two conductors) exact data comparison of terminal temperature needs to be done line by line. For example, from appendix page C1 – 1, the line 1a for copper-clad aluminum, top table, needs to compare with line 1a for copper, bottom table.

Otherwise, data in general for terminal temperatures of specific devices, circuit breakers, wire splicing devices and receptacles as well as the conductor, can be compared in general. To facilitate ease of comparison, the pages in appendices C1 though C4 have been arranged so that each page has the copper-clad aluminum data in the top table and the related copper data in the bottom table.

5.3.1 Static Heating at 100% Rated Current

The data for the static heating testing at 100 percent of rated current are shown in Appendix C1. The recorded values are all after the temperatures being recorded had achieved temperature equilibrium. As can be seen in line by line or with general comparisons, the terminal and conductor temperatures for the copper-clad aluminum were less than those recorded for copper when operating at rated current. All temperatures recorded were less than the allowances in the applicable UL standards.

5.3.2 Static Heating at 135% Rated Current

The data for the static heating testing at 135 percent of rated current are shown in Appendix C2. The 135 percent current level is a calibration point for circuit breakers, rated up to 50 amps, where they are required to trip within 1 hour. The recorded values are the last three recorded temperatures before the circuit breaker tripped.

In doing analysis consideration must be given to the fact the temperatures recorded were still rising when the circuit breaker tripped. Therefore, when doing line by line or general comparisons, the circuit breaker trip time must be considered. It is noted the mfg. 1 10-amp circuit breaker tripped approximately twice as fast as the 15-amp circuit breaker, 8 vs. 19 seconds, and this resulted in higher recorded temperatures for copper. The test results with the mfg. 2 circuit breakers was reversed with the 15-amp breaker tripping in approximately half the time of the 10-amp circuit breaker, 3.5 vs. 5.5 seconds. Even with this time disparity the copper-clad aluminum with the longer time recorded lower temperatures than the copper. The trip times for the mfg. 3 circuit breakers had the 10-amp breaker tripping 3 times longer than the 15-amp breaker, but the copper-clad aluminum terminal temperatures still were less than or near to the copper terminal temperatures.

All temperatures recorded were less than the allowances in the applicable UL standards.

5.3.3 Static Heating at 150% Rated Current

The data for the static heating testing at 150 percent of rated current are shown in Appendix C3. The 150 percent current level is a static heating test current for wiring devices. The recorded values are the last three recorded temperatures before the circuit breaker tripped.

In doing analysis consideration must be given to the fact the temperatures recorded were still rising when the circuit breaker tripped. Therefore, when doing line by line or general comparisons, the circuit breaker trip time must be considered. The test data results shown in appendix C3 generally follow that same pattern as occurred with the 135 percent testing.

All temperatures recorded were less than the allowances in the applicable UL standards.

5.3.4 Static Heating at 200% Rated Current

The data for the static heating testing at 200 percent of rated current are shown in Appendix C4. The 200 percent current level is a calibration point for circuit breakers, rated up to 30 amps, where they are required to trip within 2 minutes. The recorded values are the last three recorded temperatures before the circuit breaker tripped.

In doing analysis consideration must be given to the fact the temperatures recorded were still rising when the circuit breaker tripped. Therefore, when doing line by line or general comparisons, the circuit breaker trip time must be considered. The test data results shown in appendix C4 generally follows the same pattern as occurred with the 135 percent and 150 percent testing.

All temperatures recorded were less than the allowances in the applicable UL standards.

5.3.5 Static Heating at 135% Rated Current – Circuit Breaker Did Not Trip

The first attempt at the 135 percent testing found the mfg. 2 10-amp circuit breaker not to trip within the required 1-hour time. The data for this static heating test at 100 percent and at 135 percent of rated current are shown in Appendix C5. The top table on this appendix page is the 100 percent test data and the bottom table is the 135 percent test data. As stated before, the 135 percent current level is a calibration point for circuit breakers, rated up to 50 amps, where they are required to trip within 1 hour.

Since the circuit breaker failed to trip the test was stopped shortly after the 1-hour time had elapsed. Analysis of the 135 percent data recorded found that after 1-hour at this current level, above the proposed rated current, none of the terminal or conductor temperatures had risen above UL standards allowances.

5.3.6 Flexing Tests

The data for the flexing testing is shown in Appendix D. There is no UL or other known industry standard for this specific test and the test process used was established and agreed to by the task group to represent an installation condition. Three tests were conducted, one with the receptacle terminated with the 14 AWG copper-clad aluminum wrapped around the wiring binding screw, the second with a single conductor back wired into the pressure plate and the third with two conductors back wired into the pressure plate.

The test results found that after 10 cycles of fully inserting and removing the receptacle to the full extended position, the copper-clad aluminum conductors for the back wired assemblies did not break and therefore passed this test.

For the wire binding screw termination, the first test found the flexing for the 10 cycles passed where the conductors did not break. But when the conductors were being removed both the black and white conductors broke off near the end of the insulation, see Appendix A photo 20. A second test was conducted and the black conductor was found to break off near the end of the insulation on the eighth cycle. A third test was completed, using a 14 AWG NM-B sample from another coil, and this assembly passed the 10 cycles and removal of conductors with no breaking or signs of weakening in the stripped portion of the conductor, see Appendix A photo 21.

As stated, there is no industry standard for completing this flexing test and the test was conducted due to specific questions asked by members of the task group. The results demonstrate that there may be limits to the amount of flexing these conductors can withstand, but it should be noted that in normal installations the insertion and removal of a wiring device occurs far less than the eight to ten times as conducted in this test.

6.0 Conclusions

The results from the temperature testing conducted in this project found the 14 AWG copper-clad aluminum to have terminal and conductor temperatures generally less than copper when tested at the 60°C ampacity values. In all cases, the temperature and temperature rise recorded were below those provided in the referenced UL standards. The flexing testing found that there may be some limitations to the number of flexing operations a 14 AWG copper-clad aluminum conductor can withstand, but the number of flexing operations to breakage is above those normally encountered in any installation.

As stated in the introduction, this testing project was to answer specific questions raised by the Bimetallics Task Group regarding temperature performance of 14 AWG copper-clad aluminum compared with 14 AWG copper in typical applications. **While testing conducted followed parts of several UL standards, it is to be understood the testing was only conducted to provide specific performance data and information as requested by the task group. The testing does not provide performance or data for certification of any of the components used for the testing.**

7.0 Test Equipment and Calibration

The following test and measurement equipment was used for the testing. The certificates of calibration for each of the above items is provided in Appendix E.

Description	manufacturer	Eaton Asset #	Cal Date	Cal Due
Thermocouples	Pacific Test and Measurement	N/A	7/10/2020	N/A
DACQ datalogger	Agilent (HP)	EM7054	7/16/2020	7/16/2021
DVM	Fluke	EM4437	7/16/2020	7/16/2021
DVM	Fluke	EM7014	7/16/2020	7/16/2021
DVM	Fluke	EM7024	7/16/2020	7/16/2021
CT	AEMC	EM6996	7/16/2020	7/16/2021
CT	AEMC	EM6997	7/16/2020	7/16/2021
CT	AEMC	EM8032	7/16/2020	7/16/2021
Torque wrench	CDI	EM8363	7/14/2020	7/14/2021
Tape measure	Stanley	EM6927	7/16/2020	7/16/2021

Appendix A - Photos

Photo 1 – Laboratory View

Photo 2 – Test Board and Test Equipment Arrangement

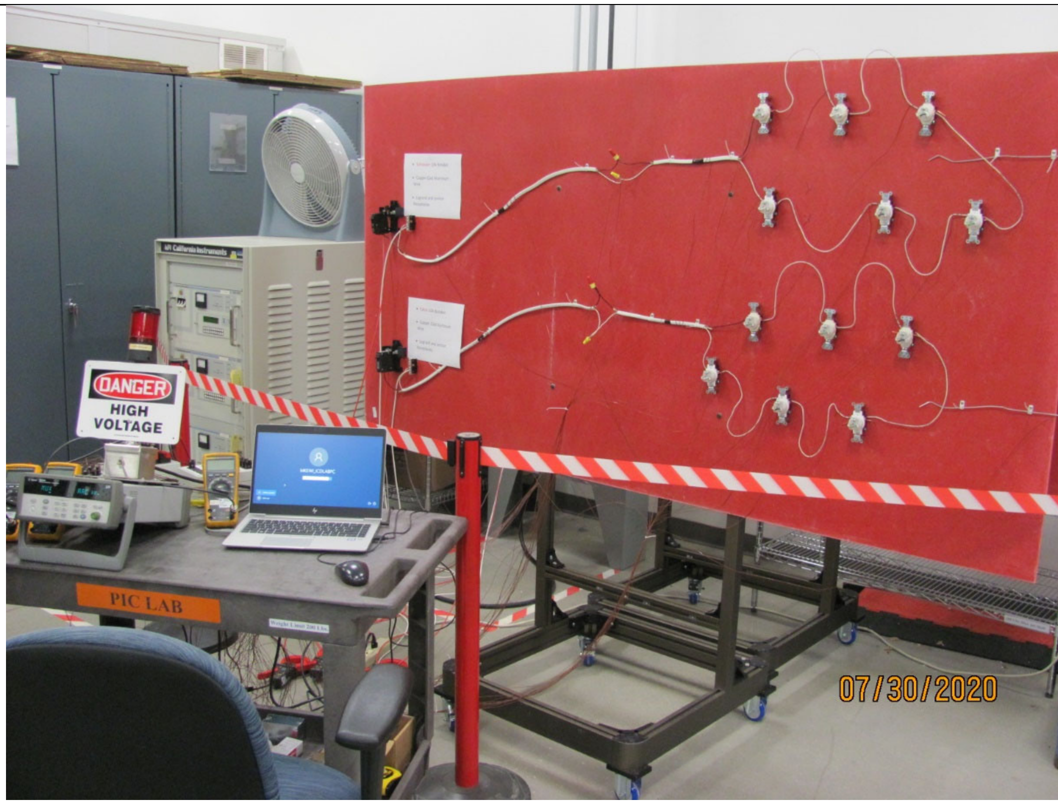


Photo 3 – Test Board and Test Equipment Arrangement

Photo 4 – Copper-Clad Aluminum with Eaton and Hubbell Receptacles

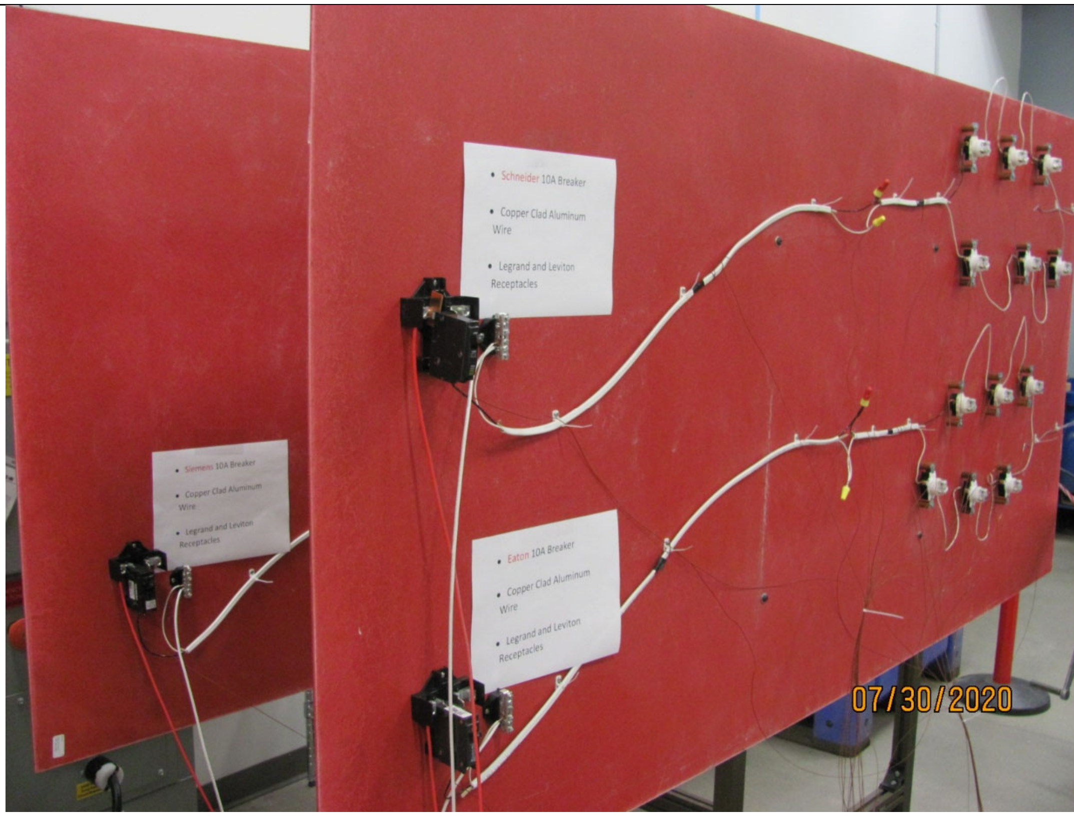


Photo 5 – Copper-Clad Aluminum with Legrand and Leviton Receptacles

Photo 6 – Copper with Eaton and Hubbell Receptacles

Photo 7 – Copper with Legrand and Leviton Receptacles

Photo 8 – Copper-Clad Aluminum NM-B Cable

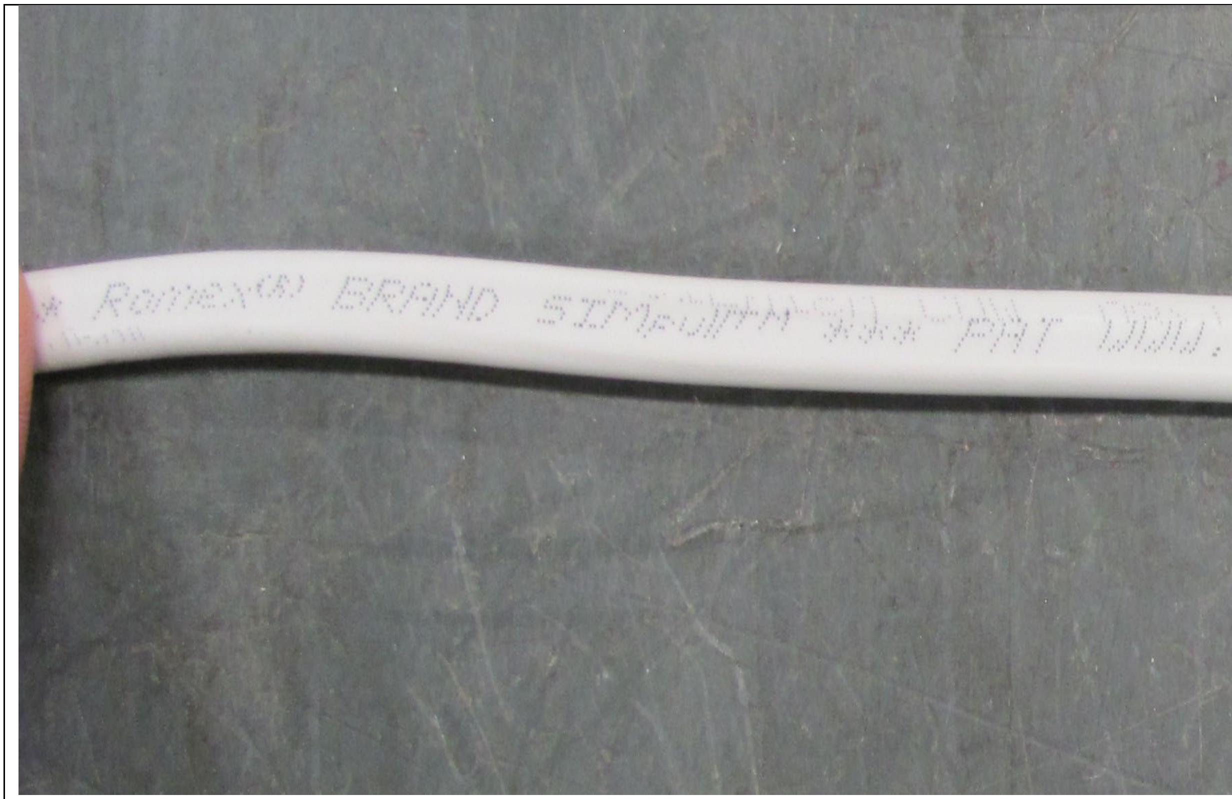


Photo 9 – Copper NM-B Cable

Photo 10 – Copper NM-B Cable Packaging

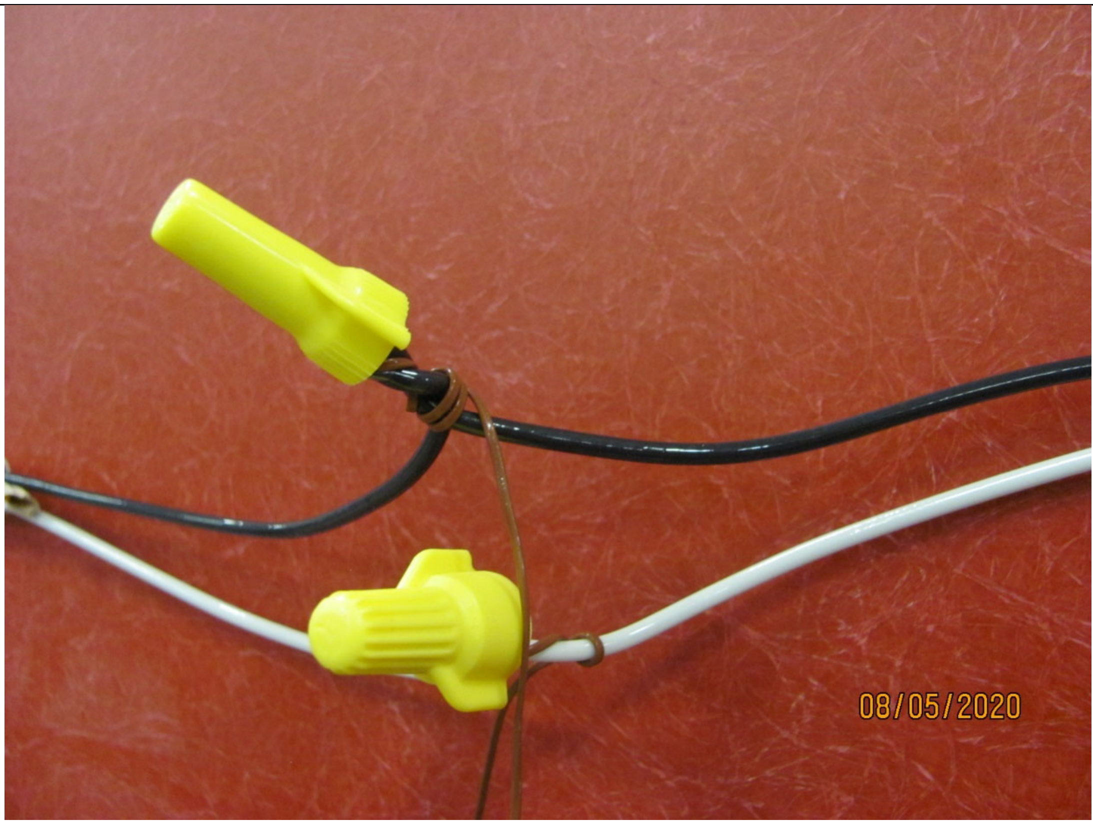


Photo 11 – Typical Installation of Wire Splicing Devices with Thermocouple

Photo 12 – Typical Installation of Receptacle using Wire Binding Screw

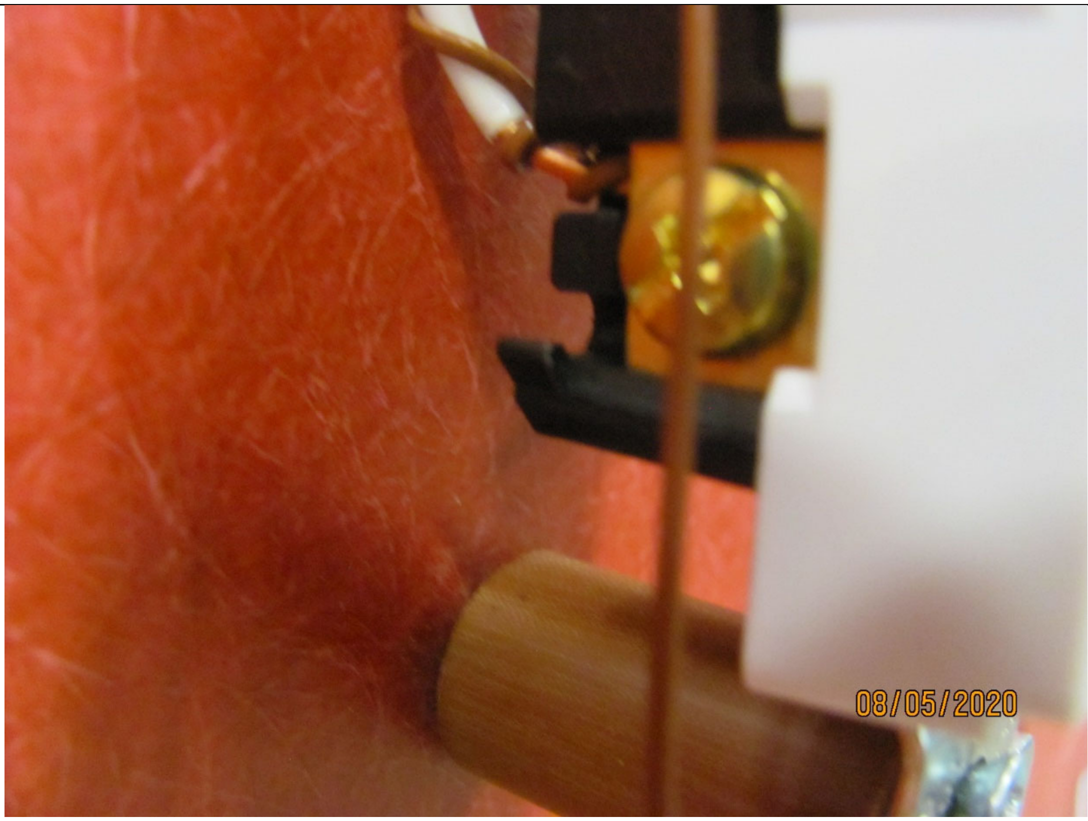


Photo 13 – Typical Installation of Receptacle Since Conductor Back Wired

Photo 14 – Typical Installation of Receptacle Two Conductors Back Wired

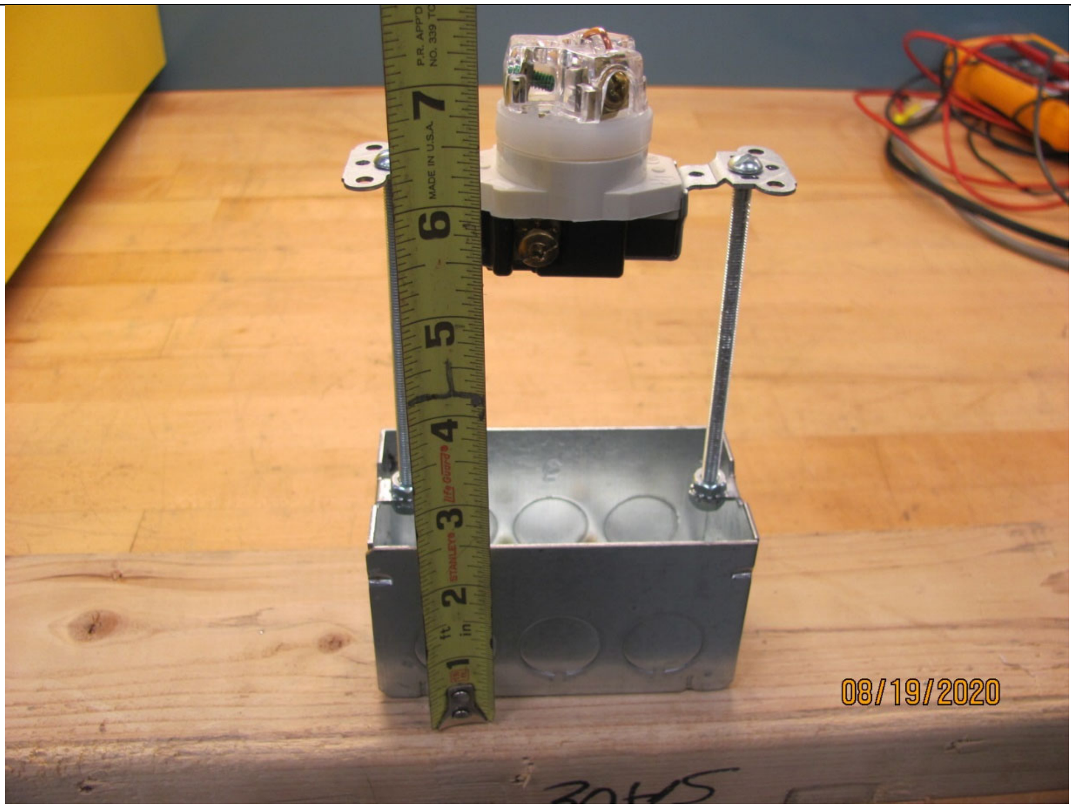


Photo 15 – Flexing Test Setup

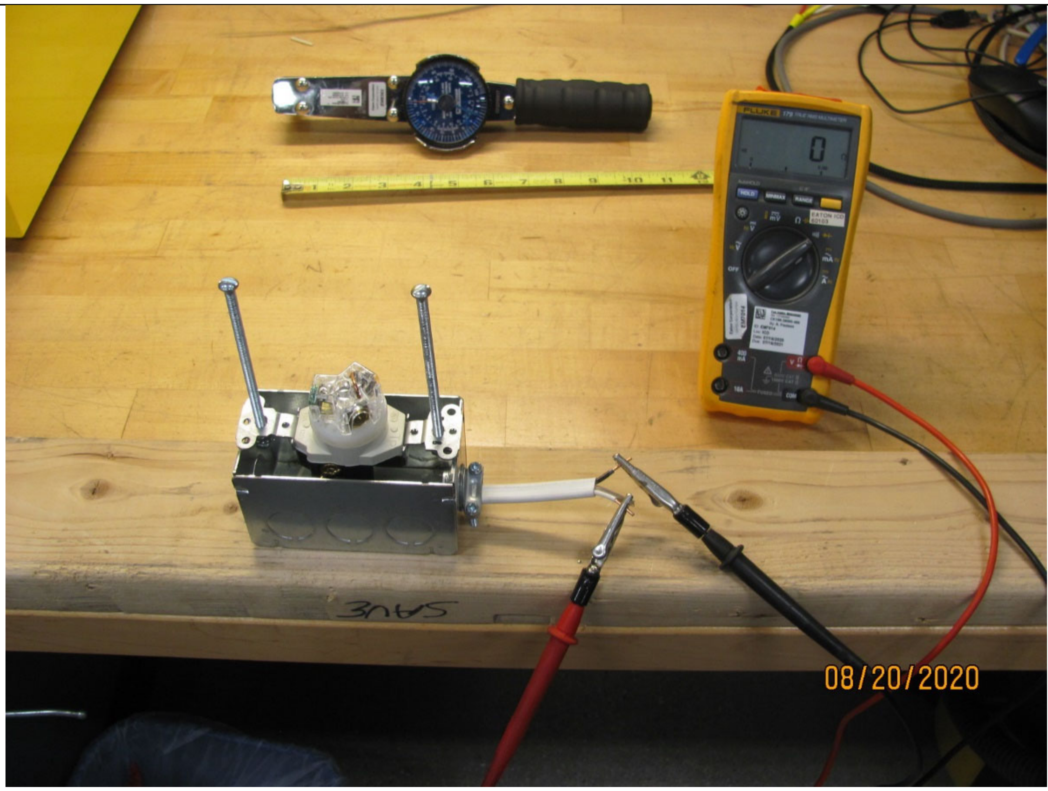


Photo 16 – Flexing Test Setup

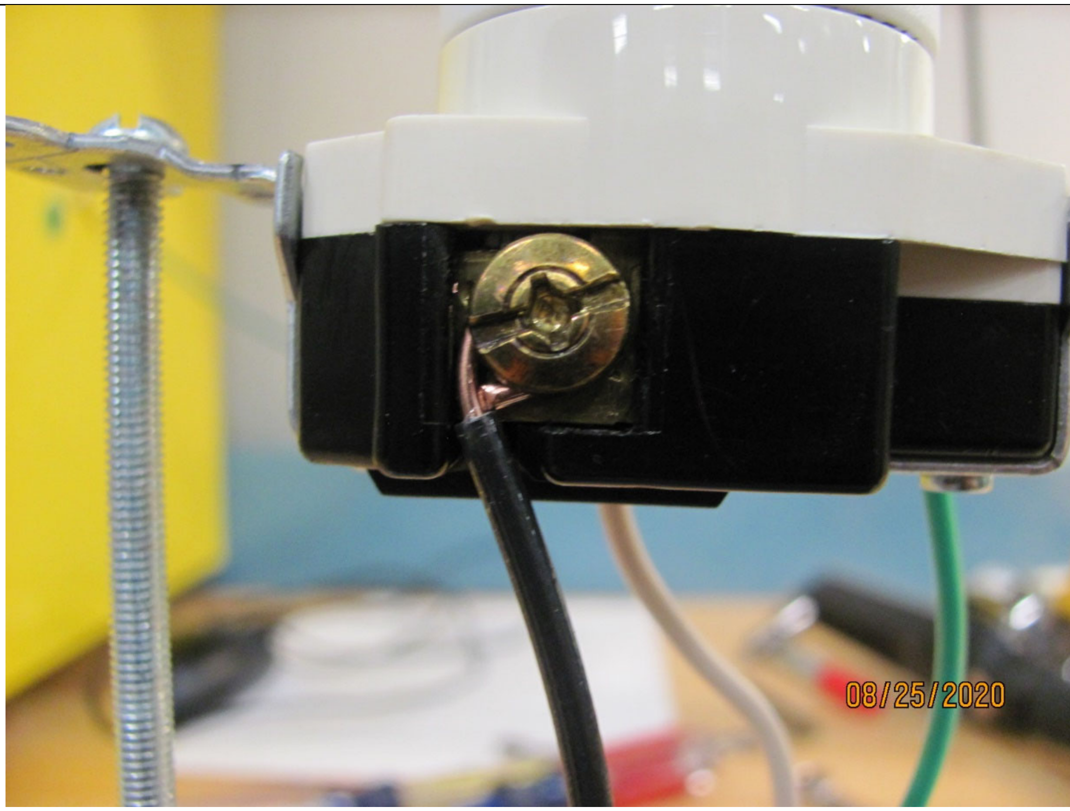


Photo 17 – Flexing Test Fully Extended

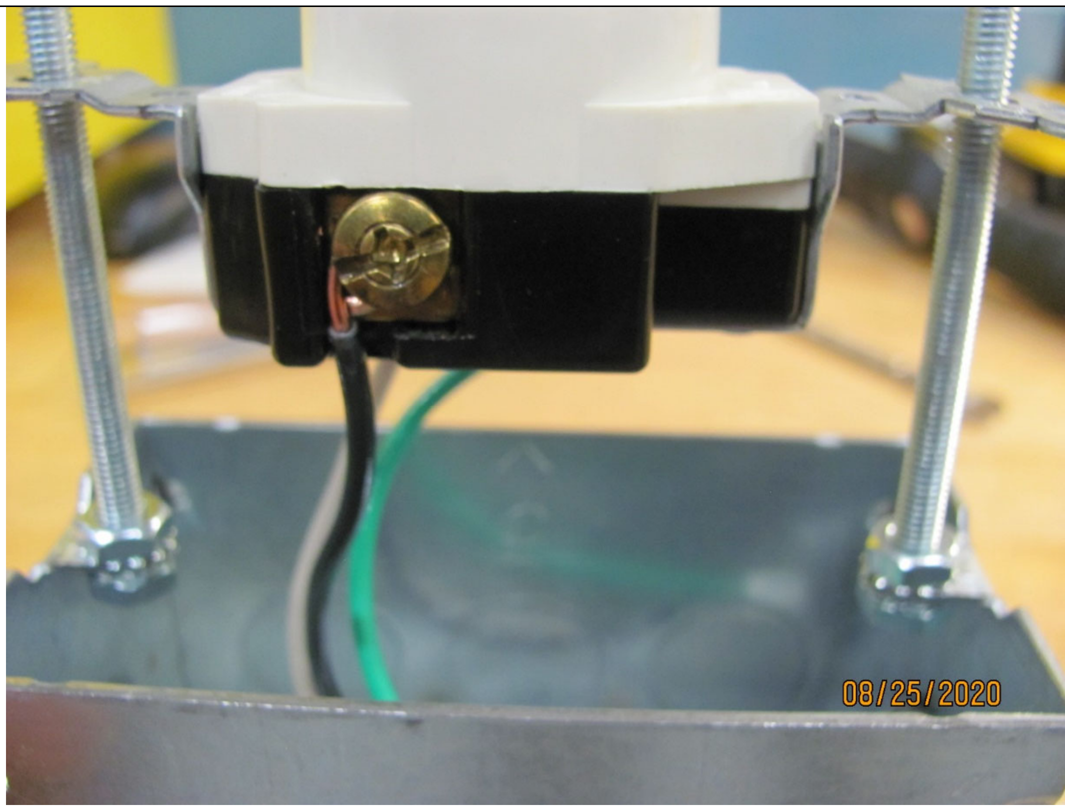


Photo 18 – Flexing Test Partial Insertion

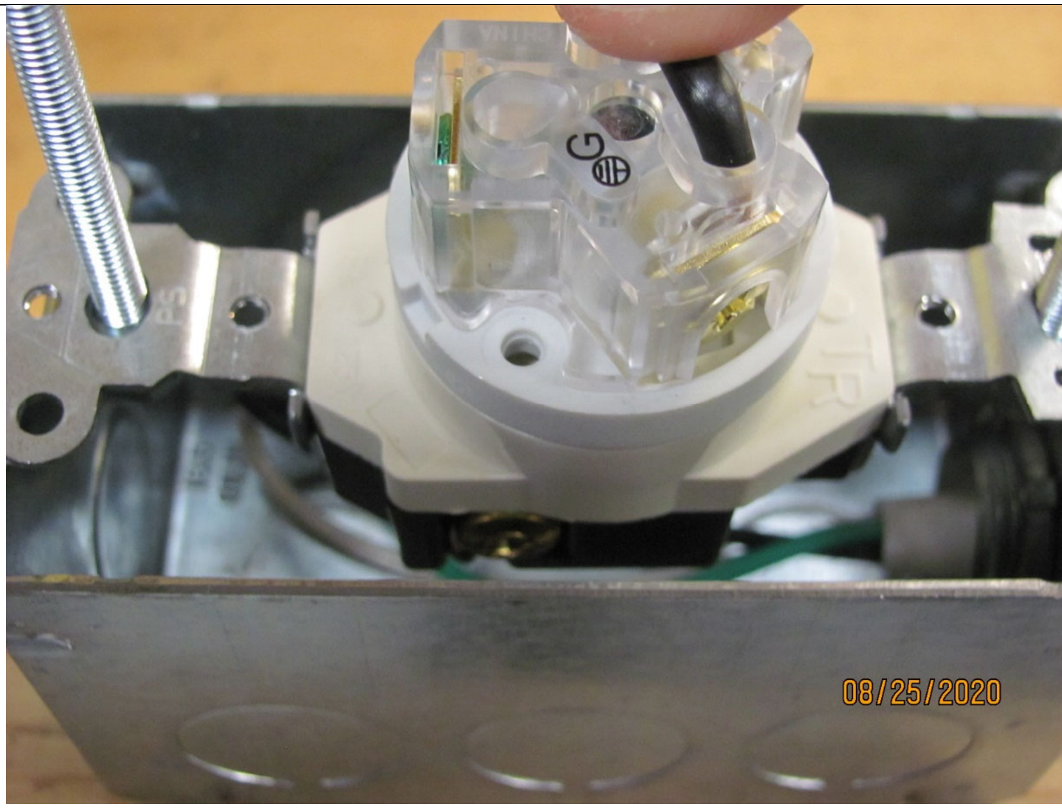


Photo 19 – Flexing Test Fully Inserted

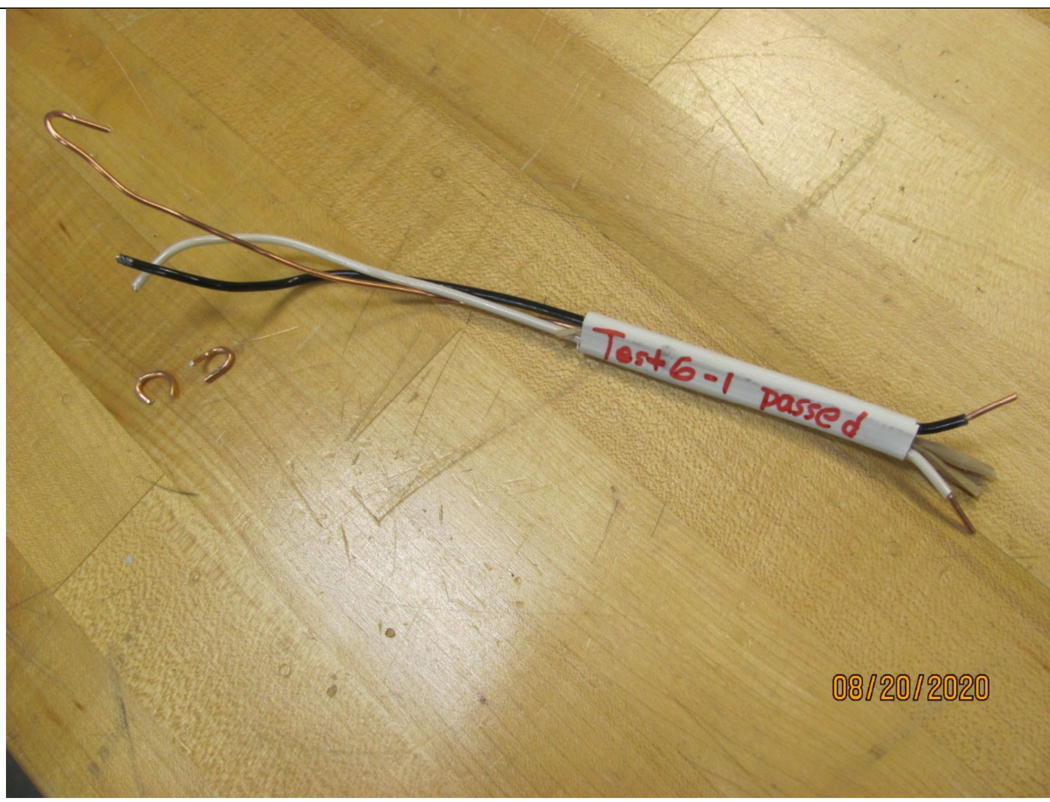


Photo 20 – Flexing Test Broken Conductors When Removing

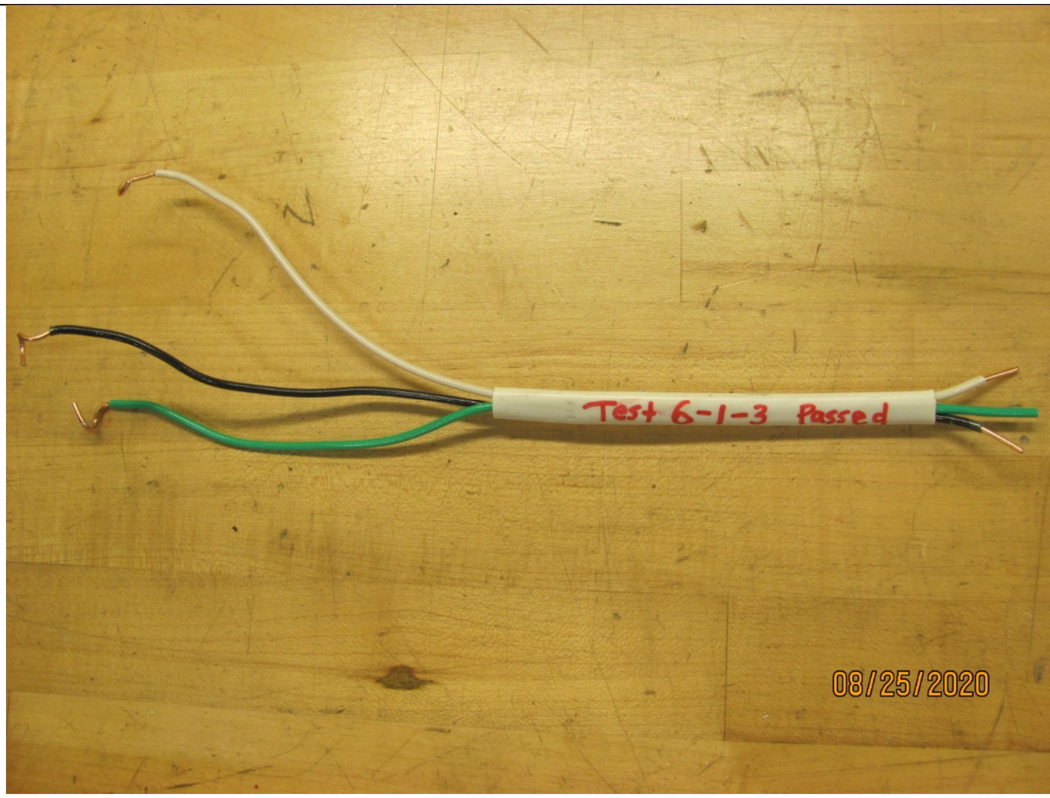


Photo 21 – Flexing Test Repeat No Conductor Breakage

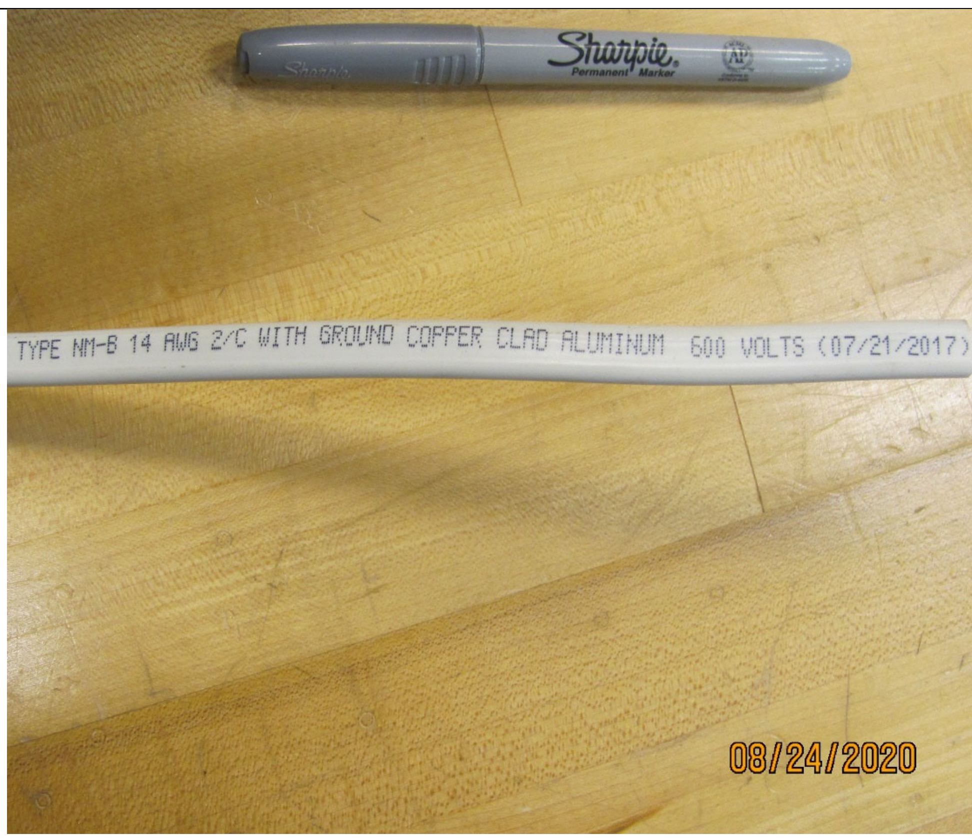
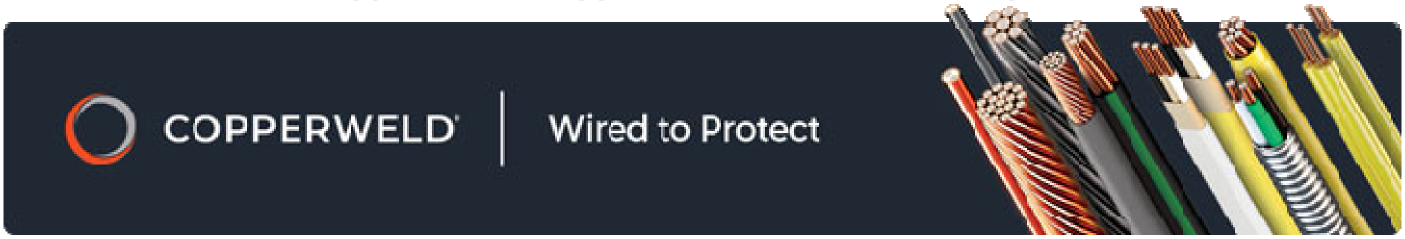


Photo 22 – Copper-Clad Aluminum NM-B Sample Packaging at Eaton

Photo 23 – Copper-Clad Aluminum THHN Sample Packaging at Eaton

Photo 24 – Copper-Clad Aluminum Sample Packaging at Eaton



The power of two

Metallurgical Laboratory Report

Customer:	**NEC Bimetallics Task Group**		
Subject:	**14 AWG Building Wire—NMB and THHN**		
Date:	**8-27-2020**	**Report No:**	**456**

Analysis By:	**Sammy Hampton --Metallographer**
Authored By:	**Sammy Hampton –Metallographer**
Approved By:	**Bill Lewey– QA Manager**

Tested to ASTM Designation: B 566-- 04a

The NM and THHN class samples in this report were sent to Copperweld via a sealed package by Eaton Menomonee Falls test lab. The chain of custody was not broken. The testing was witnessed by a third party as part of routine auditing service. The witnessing session was recorded. The copper clad aluminum conductor material from these samples that was tested on August 27, 2020 by the Copperweld Metallurgical Lab was manufactured by Copperweld Bimetallics to ASTM B566 standards.

Package as received from Eaton

Opening the Package

Package Contents

Appendix B - Copper-Clad Aluminum Lab Report

The wire consists of a core of aluminum with a continuous outer cladding of copper metallurgically bonded to the core throughout and meets the requirements of this specification (5.1).

Test required	**Test result**	**ASTM B 566 requirement**	**Result**
Diameter	**0.0641"**	**± 0.0001 0.0640" minimum 0.0642" maximum**	**Pass**
Break load (lbs.)	55 pounds	64.4 pounds maximum	**Pass**
Tensile strength (psi)	17195 psi	20000 (psi) maximum	**Pass**
% elongation	22.78%	15.0% minimum	**Pass**
Copper thickness (minimum)	0.00148" = 4.6% of wire radius	minimum copper thickness= 3.5% of wire radius	**Pass**
Copper volume	10.05%	8% minimum 12% maximum	**Pass**
Adhesion test	No separation (see attached image 1)	The wire shall be repeatedly reverse bent to fracture by any convenient means. The copper clad aluminum wire shall be free from cladding delamination.	**Pass**
Cohesion test	No seams or splits (see attached images 2 and 3)	The copper clad aluminum wire shall be free from seams or splits	**Pass**

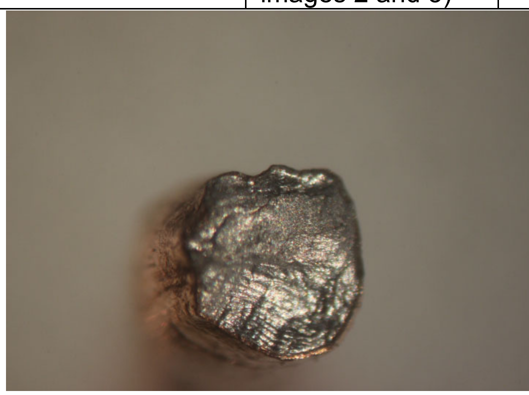


Image 1: adhesion test

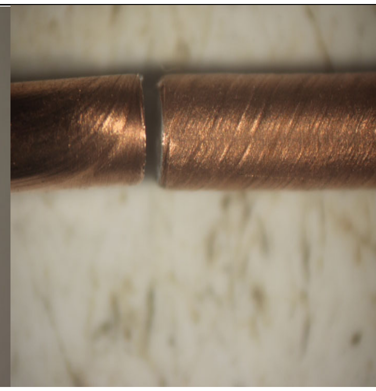


Image 2: cohesion test (torsion)

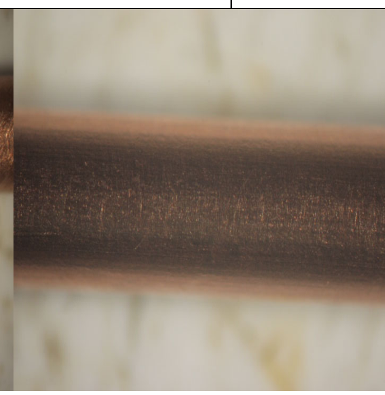


image 3: cohesion test (reverse torsion)

Test and measurement equipment

Equipment	**Gauge ID**	**In calibration**	**Next due calibration**
Micrometer	**CP-01**	**Yes**	**April 2021**
Tensile tester	**1755-2000**	**Yes**	**January 2022**
Ohmmeter	**62-1625**	**Yes**	**December 2020**
Calibration Certificates Attached below			

PCS PRECISION CALIBRATION SYSTEMS
107 N Porter St
Winchester, TN 37398
E-mail: info@pcsllctn.com
Phone: 866-521-3823
Website: www.pcsllctn.com

INSTRUMENT CALIBRATION REPORT

ilac-MRA PJLA Calibration Accreditation# 73403

Copperweld

Instrument ID CP-01
Description Micrometer
Calibrated 8/3/2020
Performed At Customer Location

Manufacturer Mitutoyo
Model Number 293-344-30
Serial Number 66936496
Cal Procedure QS0003JB2010

Location Main
Building 254 Cotton Mill Rd.
Fayetteville, TN 37334
Department Quality
Status In Service

Frequency Semi-Annual
Certificate # CO080320JM-03
Temp 73°F
Humidity 59%

Calibration Specifications

Group # 1
Group Name OD

Nom In Val / In Val	In Type	Std Accy	Acc %	+/-	Out Val	Out Type	Fnd As	Lft As	In Tol
0.25000 / 0.25000	Inch	Plus / Minus	0.000000	±0.00010	0.25000	Inch	0.25000	0.25000	Yes
0.50000 / 0.50000	Inch	Plus / Minus	0.000000	±0.00010	0.50000	Inch	0.50000	0.50000	Yes
1.00000 / 1.00000	Inch	Plus / Minus	0.000000	±0.00010	1.00000	Inch	1.00000	1.00000	Yes

Test Instruments Used During the Calibration

Test Instrument ID	Description	Manufacturer	Model Number	Serial Number	(As Of Cal Entry Date) Last Cal Date	Next Cal Date
Z-GA-010 GAGE BLCK SET STD SHOP	Gage Block 81pc Set Standard	China	Rectangular Steel	E1599	4/8/2016	4/30/2021

Notes about this calibration

Uncertainty = ± (64.9+5.2L) µin (95%CL; K=2)

Calibration Result Calibration Successful
Who Calibrated James Meadows
Finalized By James Meadows
Date Finalized 8/3/2020 9:19:05AM

Total expanded measurement uncertainties expressed are based on a confidence level of 95%; coverage factor of (k=2). Decision Rule: The statement of compliance in this certificate was issued without taking the uncertainty of measurement into consideration. The customer shall assess the results and uncertainty when determining if the results meet their needs. This is considered "shared responsibility." This calibration was conducted using standards traceable to the SI through NIST. The results on this certificate of accuracy apply only to the item described above.
Accredited to ISO/IEC 17025: 2017.

Laboratory Authorized Signature

Revision Date:05/08/2020
Rev: 04

Page 1 of 1

QF0016

PCS PRECISION CALIBRATION SYSTEMS
107 N Porter St
Winchester, TN 37398
E-mail: info@pcsllctn.com
Phone: 866-521-3823
Website: www.pcsllctn.com

INSTRUMENT CALIBRATION REPORT

ilac-MRA PJLA Calibration Accreditation# 73403

Copperweld

Instrument ID 1755-2000
Description Tensile Tester (2 Load cells)
Calibrated 8/4/2020
Performed At Customer Location

Manufacturer Thwing-Albert Instruments
Model Number EJA
Serial Number 1755-2000
Cal Procedure QS0033BG2013

Location Main
Building 254 Cotton Mill Rd.
Fayetteville, TN 37334
Department Quality
Status In Service

Frequency Semi-Annual
Certificate # CO080420JM-13
Temp 70°F
Humidity 57%

Calibration Specifications

Group # 1
Group Name 0-11lb Load Cell 627022

Nom In Val / In Val	In Type	Std Accy	Acc %	+/-	Out Val	Out Type	Fnd As	Lft As	In Tol
1 / 1	lbf	Pct of Range	0.500000	0.00	1.00	lbf	1.01	1.01	Yes
2 / 2	lbf	Pct of Range	0.500000	0.00	2.00	lbf	2.01	2.01	Yes
3 / 3	lbf	Pct of Range	0.500000	0.00	3.00	lbf	3.01	3.01	Yes
5 / 5	lbf	Pct of Range	0.500000	0.00	5.00	lbf	5.02	5.02	Yes
7 / 7	lbf	Pct of Range	0.500000	0.00	7.00	lbf	7.03	7.03	Yes
10 / 10	lbf	Pct of Range	0.500000	0.00	10.00	lbf	10.04	10.04	Yes

Group # 2
Group Name 0-225 lb Load cell 608236

Nom In Val / In Val	In Type	Std Accy	Acc %	+/-	Out Val	Out Type	Fnd As	Lft As	In Tol
5 / 5	lbf	Pct of Range	0.500000	0.00	5.00	lbf	5.00	5.00	Yes
20.446 / 20.446	lbf	Pct of Range	0.500000	0.00	20.45	lbf	20.48	20.48	Yes
50.414 / 50.414	lbf	Pct of Range	0.500000	0.00	50.41	lbf	50.48	50.48	Yes
88.532 / 88.532	lbf	Pct of Range	0.500000	0.00	88.53	lbf	88.64	88.64	Yes
99.044 / 99.044	lbf	Pct of Range	0.500000	0.00	99.04	lbf	99.15	99.15	Yes
117.60 / 117.60	lbf	Pct of Range	0.500000	0.00	117.60	lbf	117.73	117.73	Yes
131.71 / 131.71	lbf	Pct of Range	0.500000	0.00	131.71	lbf	131.83	131.83	Yes
151.04 / 151.04	lbf	Pct of Range	0.500000	0.00	151.04	lbf	151.22	151.22	Yes
161.19 / 161.19	lbf	Pct of Range	0.500000	0.00	161.19	lbf	161.38	161.38	Yes
207.76 / 207.76	lbf	Pct of Range	0.500000	0.00	207.76	lbf	207.99	207.99	Yes

Revision Date:05/08/2020
Rev: 04

QF0016

PCS PRECISION CALIBRATION SYSTEMS
107 N Porter St
Winchester, TN 37398
E-mail: info@pcsllctn.com
Phone: 866-521-3823
Website: www.pcsllctn.com

INSTRUMENT CALIBRATION REPORT

ilac-MRA PJLA Calibration Accreditation# 73403

Copperweld

Instrument ID 1755-2000
Description Tensile Tester (2 Load cells)
Calibrated 8/4/2020
Performed At Customer Location

Test Instruments Used During the Calibration

Test Instrument ID	Description	Manufacturer	Model Number	Serial Number	(As Of Cal Entry Date) Last Cal Date	Next Cal Date
Z-LO-005 5K LOAD CELL	Load Cell, 5000lb, Tension & Compression	Futek	LSB453	575093	1/7/2020	1/31/2022
Z-WE-003 HANGING WEIGHTS	Weight Set, 1-20lbs, Cast Iron	Rice Lake	ASTM Class 6	D7-D10 (20), D1-D4 (10), D1-D2 (2), 8MD8 (1), 8MB4 (2),8MB5 (5)	3/26/2019	3/31/2021

Notes about this calibration

Uncertainty = ± 0.23% of Reading (95%CL; K=2)

Calibration Result Calibration Successful
Who Calibrated James Meadows
Finalized By James Meadows
Date Finalized 8/4/2020 1:12:08PM

Total expanded measurement uncertainties expressed are based on a confidence level of 95%; coverage factor of (k=2). Decision Rule: The statement of compliance in this certificate was issued without taking the uncertainty of measurement into consideration. The customer shall assess the results and uncertainty when determining if the results meet their needs. This is considered "shared responsibility." This calibration was conducted using standards traceable to the SI through NIST. The results on this certificate of accuracy apply only to the item described above. Accredited to ISO/IEC 17025: 2017.

Laboratory Authorized Signature Raylene Flatt

Revision Date:05/08/2020
Rev: 04

QF0016

107 N Porter St
Winchester, TN 37398
E-mail: info@pcsllctn.com
Phone: 866-521-3823
Website: www.pcsllctn.com

INSTRUMENT CALIBRATION REPORT

Copperweld

Instrument ID 62-1625
Description Micro Ohm Meter
Calibrated 8/4/2020
Performed At Customer Location

Manufacturer	Valhalla Scientific	**Location**	Main	**Frequency**	Semi-Annual
Model Number	4176	**Building**	254 Cotton Mill Rd. Fayetteville, TN 37334	**Certificate #**	CO080420JM-03
Serial Number	62-1625	**Department**	Quality	**Temp**	70°F
Cal Procedure	QS0011JB2010	**Status**	In Service	**Humidity**	57%

Calibration Specifications

Group # 1
Group Name Ohm - Source

Nom In Val / In Val	In Type	Std Accy	Acc %	+/-	Out Val	Out Type	Fnd As	Lft As	In Tol
1.000 / 1.000	Ohm	Pct of Reading	0.040000	0.0000	1.0000	Ohm	0.9998	0.9998	Yes
10.000 / 10.000	Ohm	Pct of Reading	0.040000	0.000	10.000	Ohm	9.999	9.999	Yes
100.000 / 100.000	Ohm	Pct of Reading	0.040000	0.00	100.00	Ohm	99.99	99.99	Yes

Test Instruments Used During the Calibration

Test Instrument ID	Description	Manufacturer	Model Number	Serial Number	(As Of Cal Entry Date) Last Cal Date	Next Cal Date
Z-EL-020 DECADE RESISTANCE BOX	General Radio Small Decade Resistance Box	General Radio	1433-U	2545	12/18/2018	12/31/2020

Notes about this calibration

Uncertainty = ± 2 mOhm (95%CL; K=2)

Calibration Result Calibration Successful
Who Calibrated James Meadows
Finalized By James Meadows
Date Finalized 8/4/2020 12:47:33PM

Total expanded measurement uncertainties expressed are based on a confidence level of 95%; coverage factor of (k=2). Decision Rule: The statement of compliance in this certificate was issued without taking the uncertainty of measurement into consideration. The customer shall assess the results and uncertainty when determining if the results meet their needs. This is considered "shared responsibility." This calibration was conducted using standards traceable to the SI through NIST. The results on this certificate of accuracy apply only to the item described above.
Accredited to ISO/IEC 17025: 2017.

Laboratory Authorized Signature

Revision Date:05/08/2020
Rev: 04

Page 1 of 1

QF0016

Follow-up Service Inspection Report
E4911851200827165202

INSPECTION DETAILS			
Date:	2020-08-27	File Number.:	E491185
Responsible Office:	Melville	Volume:	1
Inspection Center:	232	CCN:	DVVU2
Product Type:	CCA Conductor	UL Rep Name:	Gregory Cornett
Deliverable Type:	Recognized	UL Rep ID:	20708
Party Site Number:	1626131	Subscriber Factory No.:	
Manufacturer Name:	Copperweld Bimetallics LLC	Factory Rep Name	Mr. Sammy Hampton
Manufacturer Address:	254 Cotton Mill Rd Fayetteville, TN 37334	Factory Rep Phone:	931-433-0495
		Factory Rep Email:	shampton@copperweld.com
Nature of visit:	Regular Inspection	Sample Status:	Sample requirements fulfilled for sample period
UL Marks Used?	Yes	UL Marks Removed?	No
Variation Notice Issued?	No	Inspection Conducted Remotely?	Yes
Comments After Submission:			

PRODUCT DOCUMENTS/PRODUCTION READY VISIT			
Model	**Product**	**Section**	**Multiple Listed**
14 Awg Class 10A	Copper Clad Aluminum	1	No

SAMPLE DOCUMENTS			
If samples are required to be sent to UL, indicate below. If required samples are not sent, explain in the Comments area.			
No Samples			
Additional Comments	14 Awg conductors from the NMB and THHN samples passed the UL tests for DVVU2, including Tensile, Elongation, copper thickness and DC Resistance.		

In addition to the requirements specified in the applicable UL Services agreement and Follow-Up Service Procedure, UL further defines responsibilities, duties and requirements for both manufacturers and UL representatives in the document titled "UL Mark Surveillance Requirements" that can be located at www.ul.com/fus, and in accordance with the applicable terms and conditions of the document at www.ul.com/responsibilities. Manufacturers without Internet access may obtain the current versions of these documents from their local UL customer service representative or UL field representative.

Appendix C1 Static Heating Testing at 100% Rated Current

Test 1a - thru Mfg. 1 10-amp breaker at 100% current (10A * 100% = 10A); max temps, reading every 60s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		124	129	134			
time (HH:MM:SS)		1:53:00	1:58:00	2:03:00			
1a	Mfg. 11 - 1	28.70	28.86	28.73	6.47	6.63	6.50
2a	Mfg. 11 - 2	28.89	29.01	28.84	6.66	6.78	6.61
3a	Mfg. 11 - 3	27.88	28.00	27.72	5.65	5.77	5.49
4a	Mfg. 8 - 1	29.18	29.27	29.25	6.95	7.04	7.02
5a	Mfg. 8 - 2	28.99	29.11	28.99	6.76	6.88	6.76
6a	Mfg. 8 - 3	29.00	29.15	28.92	6.77	6.92	6.69
7a	circuit breaker	32.68	32.65	32.75	10.45	10.42	10.52
8a	line wire	32.25	32.29	32.43	10.02	10.06	10.20
9a	line wire splicing device	29.84	29.65	29.07	7.61	7.42	6.84
10a	load wire	30.67	30.92	30.94	8.44	8.69	8.71
11a	load wire splicing device	30.11	29.88	29.27	7.88	7.65	7.04
12a	room ambient	22.39	22.44	21.87			
13a	current (amps)	10.03	10.03	10.03			

Test 1a - thru Mfg. 1 15-amp breaker at 100% current (15A * 100% = 15A); max temps, reading every 60s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		80	85	90			
time (HH:MM:SS)		1:17:00	1:22:00	1:27:00			
1a	Mfg. 11 - 1	33.06	33.61	33.40	11.02	11.58	11.36
2a	Mfg. 11 - 2	33.64	33.95	33.94	11.60	11.91	11.90
3a	Mfg. 11 - 3	31.05	31.56	31.60	9.01	9.52	9.56
4a	Mfg. 8 - 1	34.10	34.15	34.23	12.06	12.11	12.19
5a	Mfg. 8 - 2	33.60	34.20	33.86	11.56	12.16	11.82
6a	Mfg. 8 - 3	32.94	33.68	33.29	10.91	11.64	11.25
7a	circuit breaker	40.86	40.44	40.64	18.82	18.41	18.60
8a	line wire	33.93	34.21	33.87	11.89	12.17	11.83
9a	line wire splicing device	36.89	37.11	36.82	14.85	15.07	14.78
10a	load wire	32.70	33.48	32.99	10.66	11.44	10.95
11a	load wire splicing device	32.72	33.49	32.70	10.68	11.45	10.66
12a	room ambient	21.84	22.27	22.01			
13a	current (amps)	15.02	15.01	15.02			

Appendix C1 Static Heating Testing at 100% Rated Current

Test 1b - thru Mfg. 2 10-amp breaker at 100% current (10A * 100% = 10A); max temps, reading every 60s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		124	129	134			
time (HH:MM:SS)		1:53:00	1:58:00	2:03:00			
1b	Mfg. 11 - 1	28.57	28.60	28.36	6.49	6.52	6.27
2b	Mfg. 11 - 2	28.65	28.68	28.48	6.57	6.60	6.40
3b	Mfg. 11 - 3	27.37	27.39	27.10	5.28	5.31	5.02
4b	Mfg. 8 - 1	29.14	29.23	29.15	7.05	7.15	7.07
5b	Mfg. 8 - 2	30.65	30.75	30.48	8.57	8.66	8.40
6b	Mfg. 8 - 3	28.04	28.10	27.73	5.96	6.02	5.64
7b	circuit breaker	36.63	36.79	37.20	14.55	14.70	15.12
8b	line wire	30.98	31.03	30.93	8.90	8.95	8.85
9b	line wire splicing device	28.97	28.69	28.06	6.89	6.61	5.98
10b	load wire	28.60	28.55	28.00	6.52	6.47	5.92
11b	load wire splicing device	28.64	28.49	27.92	6.56	6.41	5.84
12b	room ambient	22.35	22.28	21.62			
13b	current (amps)	10.00	10.00	10.00			

Test 1b - thru Mfg. 2 15-amp breaker at 100% current (15A * 100% = 15A); max temps, reading every 60s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		80	85	90			
time (HH:MM:SS)		1:17:00	1:22:00	1:27:00			
1b	Mfg. 11 - 1	33.38	33.85	33.55	11.43	11.89	11.59
2b	Mfg. 11 - 2	33.29	33.49	33.67	11.34	11.54	11.72
3b	Mfg. 11 - 3	30.94	31.47	31.45	8.99	9.52	9.49
4b	Mfg. 8 - 1	34.03	34.28	34.44	12.07	12.32	12.48
5b	Mfg. 8 - 2	33.61	34.03	33.75	11.66	12.08	11.80
6b	Mfg. 8 - 3	33.00	33.71	33.25	11.05	11.75	11.29
7b	circuit breaker	44.97	44.86	45.02	23.02	22.91	23.06
8b	line wire	33.21	33.70	33.32	11.25	11.74	11.37
9b	line wire splicing device	30.81	31.77	30.80	8.86	9.82	8.85
10b	load wire	32.53	33.49	32.83	10.58	11.54	10.88
11b	load wire splicing device	31.51	32.52	31.43	9.56	10.56	9.47
12b	room ambient	21.76	22.22	21.88			
13b	current (amps)	15.01	15.01	15.01			

Test 1c - thru Mfg. 3 10-amp breaker at 100% current (10A * 100% = 10A); max temps, reading every 60s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		124	129	134			
time (HH:MM:SS)		1:53:00	1:58:00	2:03:00			
1c	Mfg. 11 - 1	29.46	29.56	29.18	7.40	7.50	7.12
2c	Mfg. 11 - 2	28.97	29.12	28.68	6.91	7.06	6.62
3c	Mfg. 11 - 3	27.82	28.02	27.47	5.76	5.96	5.41
4c	Mfg. 8 - 1	29.30	29.40	29.33	7.24	7.34	7.27
5c	Mfg. 8 - 2	28.68	28.72	28.43	6.62	6.66	6.37
6c	Mfg. 8 - 3	28.19	28.27	27.81	6.13	6.21	5.75
7c	circuit breaker	35.04	35.28	35.13	12.98	13.22	13.07
8c	line wire	31.23	31.27	30.87	9.17	9.21	8.81
9c	line wire splicing device	28.59	28.61	27.53	6.53	6.55	5.47
10c	load wire	30.74	30.84	30.26	8.68	8.78	8.20
11c	load wire splicing device	29.74	29.67	28.50	7.68	7.61	6.44
12c	room ambient	22.29	22.23	21.67			
13c	current (amps)	10.01	10.01	10.01			

Test 1c - thru Mfg. 3 15-amp breaker at 100% current (15A * 100% = 15A); max temps, reading every 60s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		80	85	90			
time (HH:MM:SS)		1:17:00	1:22:00	1:27:00			
1c	Mfg. 11 - 1	32.95	33.38	33.25	11.06	11.48	11.36
2c	Mfg. 11 - 2	33.50	33.89	33.73	11.61	12.00	11.84
3c	Mfg. 11 - 3	32.27	32.60	32.50	10.38	10.71	10.61
4c	Mfg. 8 - 1	33.33	33.66	33.62	11.44	11.77	11.72
5c	Mfg. 8 - 2	33.87	34.28	34.11	11.98	12.39	12.21
6c	Mfg. 8 - 3	32.50	32.88	32.80	10.61	10.99	10.91
7c	circuit breaker	42.51	42.65	42.50	20.62	20.75	20.60
8c	line wire	31.74	32.44	32.16	9.84	10.54	10.27
9c	line wire splicing device	32.46	33.55	32.53	10.57	11.66	10.64
10c	load wire	32.23	33.29	32.70	10.34	11.40	10.81
11c	load wire splicing device	29.96	31.50	30.18	8.07	9.61	8.29
12c	room ambient	21.65	22.13	21.90			
13c	current (amps)	15.02	15.02	15.02			

Appendix C1 Static Heating Testing at 100% Rated Current

Test 1a - thru Mfg. 1 10-amp breaker at 100% current (10A * 100% = 10A); max temps, reading every 60s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #	→	67	72	77			
time (HH:MM:SS)	→	1:04:00	1:09:00	1:14:00			
1a	Mfg. 10 - 1	33.35	33.09	33.35	11.17	10.90	11.17
2a	Mfg. 10 - 2	29.93	29.88	29.88	7.75	7.70	7.70
3a	Mfg. 10 - 3	28.83	28.80	28.74	6.65	6.62	6.56
4a	Mfg. 9 - 1	28.96	28.89	28.94	6.78	6.71	6.76
5a	Mfg. 9 - 2	29.33	29.07	29.09	7.15	6.89	6.91
6a	Mfg. 9 - 3	28.20	28.02	27.93	6.01	5.84	5.75
7a	circuit breaker	32.75	32.55	32.65	10.57	10.37	10.47
8a	line wire	32.76	32.27	32.44	10.58	10.09	10.26
9a	line wire splicing device	29.85	29.45	29.15	7.67	7.27	6.97
10a	load wire	31.09	30.73	31.01	8.91	8.55	8.83
11a	load wire splicing device	30.90	30.16	30.15	8.72	7.98	7.97
12a	room ambient	22.53	22.20	21.82			
13a	current (amps)	10.02	10.02	10.02			

Test 1a - thru Mfg. 1 15-amp breaker at 100% current (15A * 100% = 15A); max temps, reading every 60s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #	→	122	127	132			
time (HH:MM:SS)	→	2:00:00	2:05:00	2:10:00			
1a	Mfg. 10 - 1	38.41	38.10	38.31	17.09	16.78	16.99
2a	Mfg. 10 - 2	39.48	39.23	39.28	18.16	17.91	17.96
3a	Mfg. 10 - 3	34.47	34.18	34.12	13.15	12.87	12.80
4a	Mfg. 9 - 1	37.47	37.35	37.38	16.16	16.03	16.06
5a	Mfg. 9 - 2	38.46	38.17	38.12	17.14	16.85	16.80
6a	Mfg. 9 - 3	31.54	31.29	31.18	10.22	9.97	9.86
7a	circuit breaker	40.70	40.66	40.65	19.38	19.34	19.33
8a	line wire	34.07	34.00	34.12	12.75	12.69	12.80
9a	line wire splicing device	35.66	35.31	35.13	14.34	13.99	13.81
10a	load wire	32.81	32.43	32.75	11.49	11.11	11.43
11a	load wire splicing device	33.16	32.96	32.94	11.84	11.64	11.62
12a	room ambient	21.37	21.31	21.27			
13a	current (amps)	15.02	15.02	15.02			

Test 1b - thru Mfg. 2 10-amp breaker at 100% current (10A * 100% = 10A); max temps, reading every 60s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #	→	129	134	139			
time (HH:MM:SS)	→	2:06:07	2:11:06	2:16:07			
1b	Mfg. 10 - 1	31.13	31.54	31.37	9.64	10.05	9.88
2b	Mfg. 10 - 2	30.12	30.39	30.44	8.63	8.90	8.95
3b	Mfg. 10 - 3	28.95	29.13	29.19	7.46	7.64	7.70
4b	Mfg. 9 - 1	28.47	28.67	28.85	6.98	7.18	7.36
5b	Mfg. 9 - 2	28.62	29.01	28.85	7.13	7.52	7.36
6b	Mfg. 9 - 3	29.94	30.21	30.11	8.45	8.72	8.62
7b	circuit breaker	41.81	41.46	41.80	20.32	19.97	20.31
8b	line wire	31.66	31.83	32.15	10.17	10.34	10.66
9b	line wire splicing device	29.57	30.02	30.13	8.08	8.53	8.64
10b	load wire	28.92	29.64	29.57	7.43	8.15	8.08
11b	load wire splicing device	30.62	31.06	31.03	9.13	9.57	9.54
12b	room ambient	21.30	21.89	21.28			
13b	current (amps)	10.01	10.01	10.01			

Test 1b - thru Mfg. 2 15-amp breaker at 100% current (15A * 100% = 15A); max temps, reading every 60s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #	→	122	127	132			
time (HH:MM:SS)	→	2:00:00	2:05:00	2:10:00			
1b	Mfg. 10 - 1	39.02	38.87	38.81	17.86	17.72	17.65
2b	Mfg. 10 - 2	38.54	38.42	38.37	17.38	17.26	17.22
3b	Mfg. 10 - 3	35.00	34.94	34.56	13.84	13.78	13.40
4b	Mfg. 9 - 1	34.32	34.17	34.19	13.16	13.01	13.03
5b	Mfg. 9 - 2	33.68	33.52	33.44	12.52	12.36	12.29
6b	Mfg. 9 - 3	32.62	32.41	32.27	11.46	11.25	11.11
7b	circuit breaker	44.60	44.48	44.38	23.44	23.32	23.22
8b	line wire	33.27	33.12	33.14	12.11	11.96	11.98
9b	line wire splicing device	31.50	31.19	31.26	10.34	10.03	10.10
10b	load wire	31.96	31.65	31.72	10.81	10.49	10.56
11b	load wire splicing device	30.27	29.89	29.93	9.12	8.73	8.78
12b	room ambient	21.26	21.14	21.08			
13b	current (amps)	15.01	15.01	15.01			

Test 1c - thru Mfg. 3 10-amp breaker at 100% current (10A * 100% = 10A); max temps, reading every 60s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #	→	67	72	77			
time (HH:MM:SS)	→	1:04:00	1:09:00	1:14:00			
1c	Mfg. 10 - 1	31.05	30.92	30.45	9.04	8.91	8.44
2c	Mfg. 10 - 2	32.97	32.85	32.26	10.96	10.84	10.25
3c	Mfg. 10 - 3	29.07	28.94	28.28	7.06	6.93	6.27
4c	Mfg. 9 - 1	29.52	29.28	29.21	7.51	7.27	7.20
5c	Mfg. 9 - 2	30.06	29.90	29.40	8.05	7.89	7.39
6c	Mfg. 9 - 3	28.41	28.41	27.55	6.40	6.40	5.54
7c	circuit breaker	34.97	34.66	34.67	12.96	12.65	12.66
8c	line wire	31.77	31.18	30.88	9.76	9.17	8.87
9c	line wire splicing device	28.89	28.20	27.63	6.88	6.19	5.62
10c	load wire	31.27	30.69	30.26	9.26	8.68	8.25
11c	load wire splicing device	31.39	30.47	29.53	9.38	8.46	7.52
12c	room ambient	22.35	21.99	21.69			
13c	current (amps)	10.01	10.01	10.01			

Test 1c - thru Mfg. 3 15-amp breaker at 100% current (15A * 100% = 15A); max temps, reading every 60s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #	→	122	127	132			
time (HH:MM:SS)	→	2:00:00	2:05:00	2:10:00			
1c	Mfg. 10 - 1	36.19	35.94	35.85	15.02	14.77	14.68
2c	Mfg. 10 - 2	39.95	39.76	39.70	18.78	18.59	18.53
3c	Mfg. 10 - 3	39.01	39.15	38.69	17.85	17.98	17.52
4c	Mfg. 9 - 1	33.32	33.13	33.09	12.15	11.96	11.92
5c	Mfg. 9 - 2	34.01	33.90	33.74	12.84	12.74	12.57
6c	Mfg. 9 - 3	32.95	32.95	32.64	11.78	11.78	11.47
7c	circuit breaker	41.75	41.55	41.58	20.59	20.38	20.41
8c	line wire	30.73	30.68	30.61	9.56	9.51	9.44
9c	line wire splicing device	32.20	31.82	31.87	11.04	10.65	10.70
10c	load wire	31.34	31.12	31.14	10.17	9.95	9.97
11c	load wire splicing device	29.64	29.52	29.42	8.47	8.35	8.25
12c	room ambient	21.29	21.13	21.09			
13c	current (amps)	15.01	15.01	15.01			

Appendix C2 Static Heating Tests at 135% Rated Current

Test 2a - thru Mfg. 1 10-amp breaker at 135% current (10A * 135% = 13.5A); max temps, reading every 20s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan # →							
time (MM:SS) →		7:20	7:40	8:00			
	Breaker trip time	8:20					
1a	Mfg. 11 - 1	30.60	30.69	30.76	8.65	8.73	8.80
2a	Mfg. 11 - 2	30.73	30.83	30.87	8.78	8.88	8.92
3a	Mfg. 11 - 3	29.72	29.82	29.85	7.76	7.87	7.89
4a	Mfg. 8 - 1	30.66	30.77	30.88	8.70	8.81	8.93
5a	Mfg. 8 - 2	30.87	30.96	31.05	8.91	9.01	9.09
6a	Mfg. 8 - 3	30.39	30.50	30.55	8.43	8.54	8.59
7a	circuit breaker	34.21	34.43	34.65	12.26	12.47	12.70
8a	line wire	38.55	38.70	38.80	16.59	16.74	16.85
9a	line wire splicing device	34.64	34.68	34.50	12.68	12.72	12.55
10a	load wire	36.44	36.44	36.36	14.49	14.48	14.40
11a	load wire splicing device	35.04	35.05	34.84	13.09	13.09	12.88
12a	room ambient	22.00	21.97	21.91			
13a	current (amps)	13.52	13.52	13.52			

Test 2a - thru Mfg. 1 15-amp breaker at 135% current (15A * 135% = 20.25A); max temps, reading every 20s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan # →		60	61	62			
time (MM:SS) →		18:20	18:40	19:00			
	Breaker trip time	19:20					
1a	Mfg. 11 - 1	39.87	39.91	39.90	18.05	18.09	18.08
2a	Mfg. 11 - 2	40.66	40.69	40.70	18.84	18.87	18.88
3a	Mfg. 11 - 3	36.77	36.77	36.76	14.95	14.95	14.94
4a	Mfg. 8 - 1	40.83	40.88	40.89	19.01	19.06	19.07
5a	Mfg. 8 - 2	40.41	40.45	40.47	18.59	18.63	18.65
6a	Mfg. 8 - 3	39.06	39.09	39.15	17.24	17.27	17.33
7a	circuit breaker	51.78	51.96	52.02	29.96	30.14	30.20
8a	line wire	43.47	43.51	43.49	21.65	21.69	21.67
9a	line wire splicing device	48.83	48.80	48.22	27.02	26.99	26.40
10a	load wire	41.01	41.02	41.12	19.19	19.20	19.30
11a	load wire splicing device	42.69	42.60	42.48	20.87	20.78	20.66
12a	room ambient	21.84	21.84	21.78			
13a	current (amps)	19.97	19.97	20.24			

Appendix C2 Static Heating Tests at 135% Rated Current

Test 2b - thru Mfg. 2 10-amp breaker at 135% current (10A * 135% = 13.5A); max temps, reading every 20s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan # →		16	17	18			
time (MM:SS) →		4:20	4:40	5:00			
	Breaker trip time	5:20					
1b	Mfg. 11 - 1	29.25	29.41	29.55	6.91	7.07	7.21
2b	Mfg. 11 - 2	28.86	29.03	29.22	6.52	6.69	6.88
3b	Mfg. 11 - 3	28.34	28.44	28.54	6.00	6.10	6.20
4b	Mfg. 8 - 1	29.37	29.59	29.79	7.03	7.25	7.45
5b	Mfg. 8 - 2	30.27	30.43	30.67	7.93	8.09	8.33
6b	Mfg. 8 - 3	28.84	28.97	29.10	6.50	6.63	6.76
7b	circuit breaker	34.99	35.63	36.29	12.65	13.29	13.95
8b	line wire	34.20	34.58	34.92	11.86	12.24	12.58
9b	line wire splicing device	33.21	33.11	33.12	10.87	10.77	10.78
10b	load wire	30.95	31.14	31.38	8.61	8.80	9.04
11b	load wire splicing device	32.76	32.73	32.78	10.42	10.39	10.44
12b	room ambient	22.40	22.34	22.29			
13b	current (amps)	13.51	13.51	13.51			

Test 2b - thru Mfg. 2 15-amp breaker at 135% current (15A * 135% = 20.25A); max temps, reading every 20s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan # →		13	14	15			
time (MM:SS) →		2:20	2:40	3:00			
	Breaker trip time	3:20					
1b	Mfg. 11 - 1	31.85	32.56	33.17	9.91	10.62	11.23
2b	Mfg. 11 - 2	31.27	32.00	32.64	9.33	10.05	10.70
3b	Mfg. 11 - 3	30.01	30.61	31.08	8.07	8.67	9.14
4b	Mfg. 8 - 1	31.78	32.43	33.07	9.84	10.49	11.13
5b	Mfg. 8 - 2	32.35	32.97	33.48	10.41	11.03	11.54
6b	Mfg. 8 - 3	31.74	32.37	32.83	9.80	10.42	10.89
7b	circuit breaker	36.50	38.10	39.50	14.56	16.16	17.56
8b	line wire	32.89	33.90	34.83	10.95	11.96	12.89
9b	line wire splicing device	34.98	35.61	36.11	13.04	13.67	14.17
10b	load wire	33.90	34.76	35.58	11.96	12.82	13.64
11b	load wire splicing device	35.84	36.48	37.04	13.90	14.54	15.10
12b	room ambient	21.94	21.93	21.96			
13b	current (amps)	20.28	20.27	20.27			

Appendix C2 Static Heating Tests at 135% Rated Current

Test 2c - thru Mfg. 3 10-amp breaker at 135% current (10A * 135% = 13.5A); max temps, reading every 20s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		59	60	61			
time (MM:SS)		18:40	19:00	19:20			
	Breaker trip time	19:40					
1c	Mfg. 11 - 1	34.08	34.15	34.18	11.70	11.78	11.81
2c	Mfg. 11 - 2	33.23	33.27	33.31	10.85	10.89	10.93
3c	Mfg. 11 - 3	31.22	31.25	31.28	8.85	8.87	8.90
4c	Mfg. 8 - 1	33.48	33.50	33.56	11.10	11.13	11.19
5c	Mfg. 8 - 2	32.68	32.75	32.80	10.31	10.37	10.42
6c	Mfg. 8 - 3	31.96	32.03	32.09	9.58	9.66	9.71
7c	circuit breaker	43.05	43.08	43.19	20.67	20.71	20.81
8c	line wire	38.04	38.09	38.14	15.67	15.72	15.76
9c	line wire splicing device	33.55	33.75	33.89	11.17	11.38	11.51
10c	load wire	37.55	37.62	37.70	15.17	15.24	15.33
11c	load wire splicing device	35.83	36.09	36.28	13.46	13.71	13.91
12c	room ambient	22.51	22.28	22.34			
13c	current (amps)	13.51	13.51	13.51			

Test 2c - thru Mfg. 3 15-amp breaker at 135% current (15A * 135% = 20.25A); max temps, reading every 20s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		20	21	22			
time (MM:SS)		5:00	5:20	5:40			
	Breaker trip time	6:00					
1c	Mfg. 11 - 1	34.62	34.96	35.21	12.63	12.97	13.22
2c	Mfg. 11 - 2	35.65	35.96	36.17	13.65	13.97	14.18
3c	Mfg. 11 - 3	33.85	34.05	34.25	11.85	12.05	12.25
4c	Mfg. 8 - 1	34.94	35.23	35.47	12.95	13.24	13.48
5c	Mfg. 8 - 2	35.87	36.13	36.37	13.87	14.13	14.38
6c	Mfg. 8 - 3	34.38	34.60	34.74	12.38	12.61	12.75
7c	circuit breaker	42.69	43.47	44.15	20.69	21.47	22.16
8c	line wire	36.07	36.49	36.77	14.08	14.50	14.78
9c	line wire splicing device	38.93	39.23	39.49	16.94	17.24	17.49
10c	load wire	37.64	37.92	38.15	15.64	15.92	16.16
11c	load wire splicing device	35.65	35.84	35.95	13.66	13.85	13.96
12c	room ambient	21.95	22.09	21.93			
13c	current (amps)	20.19	20.19	20.17			

Appendix C2 Static Heating Tests at 135% Rated Current

Test 2a - thru Mfg. 1 10-amp breaker at 135% current (10A * 135% = 13.5A); max temps, reading every 20s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		26	27	28			
time (MM:SS)		7:40	8:00	8:20			
	Breaker trip time	8:40					
1a	Mfg. 10 - 1	33.38	33.55	33.72	11.54	11.72	11.89
2a	Mfg. 10 - 2	32.41	32.50	32.60	10.58	10.67	10.77
3a	Mfg. 10 - 3	30.50	30.58	30.68	8.66	8.75	8.85
4a	Mfg. 9 - 1	30.51	30.62	30.74	8.67	8.79	8.91
5a	Mfg. 9 - 2	30.63	30.73	30.86	8.80	8.89	9.02
6a	Mfg. 9 - 3	29.45	29.52	29.63	7.62	7.69	7.79
7a	circuit breaker	34.35	34.60	34.84	12.51	12.77	13.00
8a	line wire	38.69	38.85	39.02	16.85	17.01	17.18
9a	line wire splicing device	34.03	34.11	34.24	12.19	12.27	12.40
10a	load wire	36.42	36.48	36.58	14.59	14.65	14.74
11a	load wire splicing device	36.28	36.41	36.59	14.45	14.58	14.76
12a	room ambient	21.84	21.90	21.76			
13a	current (amps)	13.52	13.52	13.52			

Test 2a - thru Mfg. 1 15-amp breaker at 135% current (15A * 135% = 20.25A); max temps, reading every 20s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		65	66	67			
time (MM:SS)		20:00	20:20	20:40			
	Breaker trip time	21:00					
1a	Mfg. 10 - 1	47.14	47.05	47.05	26.19	26.10	26.09
2a	Mfg. 10 - 2	49.33	49.35	49.30	28.38	28.39	28.35
3a	Mfg. 10 - 3	43.32	43.29	43.14	22.36	22.34	22.19
4a	Mfg. 9 - 1	45.67	45.67	45.73	24.72	24.71	24.78
5a	Mfg. 9 - 2	46.98	46.95	46.85	26.03	25.99	25.90
6a	Mfg. 9 - 3	38.91	38.80	38.65	17.95	17.84	17.69
7a	circuit breaker	52.18	52.30	52.40	31.23	31.34	31.45
8a	line wire	43.36	43.34	43.31	22.40	22.39	22.35
9a	line wire splicing device	46.95	46.94	46.87	26.00	25.99	25.91
10a	load wire	41.51	41.36	41.20	20.56	20.41	20.25
11a	load wire splicing device	42.93	42.85	42.57	21.97	21.89	21.62
12a	room ambient	20.94	20.94	20.98			
13a	current (amps)	20.29	20.28	20.28			

Appendix C2 Static Heating Tests at 135% Rated Current

Test 2b - thru Mfg. 2 10-amp breaker at 135% current (10A * 135% = 13.5A); max temps, reading every 20s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		21	22	23			
time (MM:SS)		5:40	6:00	6:20			
	Breaker trip time	6:40					
1b	Mfg. 10 - 1	31.86	32.13	32.38	9.94	10.21	10.46
2b	Mfg. 10 - 2	32.09	32.28	32.45	10.17	10.36	10.53
3b	Mfg. 10 - 3	30.06	30.24	30.38	8.14	8.32	8.46
4b	Mfg. 9 - 1	29.45	29.60	29.73	7.53	7.68	7.81
5b	Mfg. 9 - 2	30.16	30.32	30.49	8.23	8.40	8.57
6b	Mfg. 9 - 3	29.34	29.52	29.64	7.42	7.60	7.72
7b	circuit breaker	37.11	37.68	38.17	15.19	15.76	16.25
8b	line wire	35.37	35.59	35.81	13.44	13.67	13.88
9b	line wire splicing device	32.21	32.37	32.46	10.28	10.45	10.54
10b	load wire	31.36	31.58	31.73	9.44	9.66	9.80
11b	load wire splicing device	35.28	35.40	35.49	13.36	13.47	13.56
12b	room ambient	21.93	21.95	21.88			
13b	current (amps)	13.50	13.50	13.50			

Test 2b - thru Mfg. 2 15-amp breaker at 135% current (15A * 135% = 20.25A); max temps, reading every 20s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		13	14	15			
time (MM:SS)		2:40	3:00	3:20			
	Breaker trip time	3:40					
1b	Mfg. 10 - 1	34.43	35.44	36.33	13.42	14.43	15.32
2b	Mfg. 10 - 2	35.56	36.51	37.33	14.56	15.51	16.33
3b	Mfg. 10 - 3	33.00	33.73	34.31	12.00	12.73	13.30
4b	Mfg. 9 - 1	32.70	33.42	34.00	11.69	12.41	13.00
5b	Mfg. 9 - 2	32.65	33.31	33.89	11.64	12.30	12.89
6b	Mfg. 9 - 3	30.85	31.44	31.99	9.85	10.43	10.98
7b	circuit breaker	36.44	37.96	39.35	15.44	16.96	18.34
8b	line wire	32.46	33.42	34.28	11.45	12.41	13.28
9b	line wire splicing device	35.23	35.84	36.40	14.22	14.84	15.39
10b	load wire	33.42	34.26	35.03	12.42	13.26	14.02
11b	load wire splicing device	33.28	33.92	34.50	12.27	12.91	13.49
12b	room ambient	20.93	21.01	21.08			
13b	current (amps)	20.28	20.28	20.28			

Appendix C2 Static Heating Tests at 135% Rated Current

Test 2c - thru Mfg. 3 10-amp breaker at 135% current (10A * 135% = 13.5A); max temps, reading every 20s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan # →		53	54	55			
time (MM:SS) →		16:20	16:40	17:00			
	Breaker trip time	17:20					
1c	Mfg. 10 - 1	35.58	35.62	35.62	13.37	13.41	13.41
2c	Mfg. 10 - 2	36.59	36.62	36.62	14.38	14.41	14.41
3c	Mfg. 10 - 3	32.94	32.95	32.98	10.73	10.74	10.77
4c	Mfg. 9 - 1	33.08	33.07	33.07	10.87	10.86	10.86
5c	Mfg. 9 - 2	33.95	33.93	33.90	11.73	11.72	11.69
6c	Mfg. 9 - 3	31.62	31.62	31.58	9.40	9.41	9.37
7c	circuit breaker	41.72	41.81	41.92	19.51	19.60	19.71
8c	line wire	38.68	38.60	38.52	16.47	16.39	16.31
9c	line wire splicing device	33.41	33.23	33.04	11.19	11.02	10.83
10c	load wire	37.53	37.41	37.27	15.31	15.20	15.06
11c	load wire splicing device	38.23	37.83	37.38	16.01	15.62	15.17
12c	room ambient	22.28	22.22	22.14			
13c	current (amps)	13.50	13.50	13.50			

Test 2c - thru Mfg. 3 15-amp breaker at 135% current (15A * 135% = 20.25A); max temps, reading every 20s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan # →		22	23	24			
time (MM:SS) →		5:40	6:00	6:20			
	Breaker trip time	6:40					
1c	Mfg. 10 - 1	37.66	38.19	38.64	16.09	16.61	17.07
2c	Mfg. 10 - 2	44.95	45.50	45.96	23.38	23.93	24.39
3c	Mfg. 10 - 3	44.95	45.37	45.69	23.38	23.80	24.12
4c	Mfg. 9 - 1	35.48	35.83	36.20	13.90	14.26	14.63
5c	Mfg. 9 - 2	38.33	38.69	39.10	16.75	17.12	17.52
6c	Mfg. 9 - 3	36.86	37.22	37.59	15.28	15.65	16.02
7c	circuit breaker	42.83	43.50	44.14	21.26	21.93	22.56
8c	line wire	35.89	36.21	36.61	14.32	14.64	15.04
9c	line wire splicing device	40.91	41.17	41.52	19.33	19.60	19.95
10c	load wire	37.99	38.35	38.72	16.42	16.78	17.15
11c	load wire splicing device	39.30	39.51	39.86	17.72	17.93	18.29
12c	room ambient	21.55	21.59	21.59			
13c	current (amps)	20.30	20.26	20.27			

Appendix C3 Static Heating Tests at 150% Rated Current

Test 3a - thru Mfg. 1 10-amp breaker at 150% current (10A * 150% = 15A); max temps, reading every 10s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan # →		19	20	21			
time (MM:SS) →		2:00	2:10	2:20			
	Breaker trip time	2:30					
1a	Mfg. 11 - 1	27.90	28.21	28.45	5.51	5.83	6.06
2a	Mfg. 11 - 2	27.85	28.17	28.44	5.46	5.79	6.06
3a	Mfg. 11 - 3	27.44	27.71	27.97	5.05	5.32	5.58
4a	Mfg. 8 - 1	28.03	28.30	28.55	5.64	5.91	6.17
5a	Mfg. 8 - 2	28.67	28.93	29.21	6.28	6.55	6.83
6a	Mfg. 8 - 3	28.12	28.37	28.63	5.73	5.98	6.24
7a	circuit breaker	29.23	29.65	30.04	6.84	7.27	7.65
8a	line wire	33.45	33.99	34.55	11.06	11.60	12.16
9a	line wire splicing device	33.38	33.88	34.38	10.99	11.49	11.99
10a	load wire	32.35	32.80	33.28	9.96	10.41	10.89
11a	load wire splicing device	34.69	35.13	35.60	12.30	12.74	13.21
12a	room ambient	22.40	22.39	22.37			
13a	current (amps)	15.02	15.02	15.02			

Test 3a - thru Mfg. 1 15-amp breaker at 150% current (15A * 150% = 22.5A); max temps, reading every 10s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan # →		31	32	33			
time (MM:SS) →		3:40	3:50	4:00			
	Breaker trip time	4:10					
1a	Mfg. 11 - 1	36.08	36.34	36.60	13.46	13.72	13.98
2a	Mfg. 11 - 2	36.41	36.67	36.97	13.79	14.05	14.35
3a	Mfg. 11 - 3	34.72	34.88	35.08	12.10	12.26	12.46
4a	Mfg. 8 - 1	36.33	36.58	36.86	13.71	13.96	14.24
5a	Mfg. 8 - 2	37.14	37.38	37.62	14.53	14.76	15.00
6a	Mfg. 8 - 3	36.40	36.56	36.84	13.78	13.94	14.22
7a	circuit breaker	40.83	41.35	41.83	18.21	18.73	19.21
8a	line wire	39.85	40.31	40.75	17.23	17.69	18.13
9a	line wire splicing device	49.53	49.93	50.18	26.91	27.31	27.56
10a	load wire	40.21	40.60	40.99	17.60	17.98	18.37
11a	load wire splicing device	45.48	45.83	46.22	22.86	23.21	23.60
12a	room ambient	22.65	22.62	22.58			
13a	current (amps)	22.56	22.53	22.53			

Appendix C3 Static Heating Tests at 150% Rated Current

Test 3b - thru Mfg. 2 10-amp breaker at 150% current (10A * 150% = 15A); max temps, reading every 10s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan # →		19	20	21			
time (MM:SS) →		2:00	2:10	2:20			
	Breaker trip time	2:30					
1b	Mfg. 11 - 1	28.11	28.40	28.72	5.67	5.96	6.28
2b	Mfg. 11 - 2	27.73	27.97	28.26	5.29	5.53	5.82
3b	Mfg. 11 - 3	27.57	27.80	28.05	5.12	5.36	5.60
4b	Mfg. 8 - 1	28.38	28.63	28.91	5.93	6.19	6.47
5b	Mfg. 8 - 2	29.23	29.50	29.82	6.79	7.06	7.37
6b	Mfg. 8 - 3	28.00	28.25	28.53	5.56	5.81	6.09
7b	circuit breaker	30.38	30.93	31.50	7.94	8.48	9.06
8b	line wire	31.30	31.79	32.30	8.85	9.34	9.86
9b	line wire splicing device	32.82	33.29	33.71	10.38	10.84	11.27
10b	load wire	28.66	29.10	29.50	6.21	6.66	7.06
11b	load wire splicing device	33.26	33.63	33.95	10.82	11.18	11.51
12b	room ambient	22.47	22.43	22.43			
13b	current (amps)	15.01	15.01	15.01			

Test 3b - thru Mfg. 2 15-amp breaker at 150% current (15A * 150% = 22.5A); max temps, reading every 10s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan # →		13	14	15			
time (MM:SS) →		:40	:50	1:00			
	Breaker trip time	1:10					
1b	Mfg. 11 - 1	26.84	27.76	28.60	4.39	5.31	6.15
2b	Mfg. 11 - 2	26.26	27.11	27.94	3.81	4.66	5.49
3b	Mfg. 11 - 3	26.03	26.75	27.44	3.58	4.30	4.99
4b	Mfg. 8 - 1	26.61	27.54	28.41	4.16	5.09	5.96
5b	Mfg. 8 - 2	27.59	28.55	29.46	5.14	6.10	7.01
6b	Mfg. 8 - 3	27.23	28.09	28.93	4.78	5.64	6.48
7b	circuit breaker	27.33	28.59	29.90	4.88	6.14	7.45
8b	line wire	26.59	27.53	28.44	4.14	5.08	5.99
9b	line wire splicing device	29.28	30.58	31.77	6.83	8.13	9.32
10b	load wire	27.88	28.93	29.91	5.43	6.48	7.46
11b	load wire splicing device	29.84	31.22	32.45	7.39	8.77	10.00
12b	room ambient	22.46	22.43	22.45			
13b	current (amps)	22.51	22.49	22.49			

Appendix C3 Static Heating Tests at 150% Rated Current

Test 3c - thru Mfg. 3 10-amp breaker at 150% current (10A * 150% = 15A); max temps, reading every 10s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #	→	37	38	39			
time (MM:SS)	→	5:00	5:10	5:20			
	Breaker trip time	5:30					
1c	Mfg. 11 - 1	32.34	32.46	32.62	9.83	9.96	10.12
2c	Mfg. 11 - 2	31.80	31.94	32.06	9.30	9.44	9.56
3c	Mfg. 11 - 3	29.96	30.07	30.17	7.46	7.56	7.67
4c	Mfg. 8 - 1	31.82	31.94	32.07	9.32	9.44	9.57
5c	Mfg. 8 - 2	31.64	31.77	31.86	9.13	9.26	9.36
6c	Mfg. 8 - 3	31.07	31.17	31.31	8.57	8.67	8.81
7c	circuit breaker	37.24	37.53	37.80	14.74	15.03	15.30
8c	line wire	38.50	38.75	39.00	16.00	16.25	16.50
9c	line wire splicing device	35.73	35.83	35.94	13.23	13.33	13.43
10c	load wire	37.84	38.06	38.26	15.33	15.56	15.75
11c	load wire splicing device	38.75	38.81	38.93	16.24	16.31	16.43
12c	room ambient	22.50	22.49	22.52			
13c	current (amps)	15.01	15.01	15.01			

Test 3c - thru Mfg. 3 15-amp breaker at 150% current (15A * 150% = 22.5A); max temps, reading every 10s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #	→	23	24	25			
time (MM:SS)	→	2:20	2:30	2:40			
	Breaker trip time	2:50					
1c	Mfg. 11 - 1	32.80	33.29	33.73	10.40	10.89	11.33
2c	Mfg. 11 - 2	34.13	34.67	35.12	11.73	12.27	12.72
3c	Mfg. 11 - 3	32.29	32.77	33.17	9.89	10.37	10.77
4c	Mfg. 8 - 1	33.21	33.67	34.07	10.81	11.27	11.67
5c	Mfg. 8 - 2	34.62	35.08	35.48	12.22	12.68	13.08
6c	Mfg. 8 - 3	32.76	33.21	33.64	10.36	10.81	11.24
7c	circuit breaker	37.29	38.07	38.83	14.89	15.67	16.43
8c	line wire	33.28	33.93	34.55	10.88	11.53	12.15
9c	line wire splicing device	40.01	40.55	41.07	17.61	18.15	18.67
10c	load wire	36.15	36.74	37.30	13.75	14.34	14.90
11c	load wire splicing device	37.79	38.32	38.82	15.39	15.92	16.42
12c	room ambient	22.38	22.41	22.41			
13c	current (amps)	22.43	22.44	22.42			

Test 3a - thru Mfg. 1 10-amp breaker at 150% current (10A * 150% = 15A); max temps, reading every 10s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan # →		23	24	25			
time (MM:SS) →		2:20	2:30	2:40			
	Breaker trip time	2:50					
1a	Mfg. 10 - 1	29.81	30.21	30.55	7.56	7.96	8.30
2a	Mfg. 10 - 2	29.70	30.02	30.29	7.44	7.77	8.04
3a	Mfg. 10 - 3	28.37	28.62	28.85	6.12	6.37	6.60
4a	Mfg. 9 - 1	28.22	28.46	28.69	5.97	6.21	6.44
5a	Mfg. 9 - 2	28.46	28.71	28.94	6.21	6.46	6.69
6a	Mfg. 9 - 3	27.73	27.96	28.13	5.48	5.71	5.88
7a	circuit breaker	29.83	30.21	30.53	7.58	7.96	8.28
8a	line wire	34.40	34.90	35.38	12.15	12.65	13.13
9a	line wire splicing device	32.53	32.88	33.18	10.28	10.63	10.93
10a	load wire	33.43	33.88	34.25	11.17	11.63	12.00
11a	load wire splicing device	37.25	37.47	37.66	15.00	15.22	15.41
12a	room ambient	22.28	22.24	22.24			
13a	current (amps)	15.02	15.02	15.02			

Test 3a - thru Mfg. 1 15-amp breaker at 150% current (15A * 150% = 22.5A); max temps, reading every 10s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan # →		38	39	40			
time (MM:SS) →		4:00	4:10	4:20			
	Breaker trip time	4:30					
1a	Mfg. 10 - 1	40.53	40.89	41.27	18.74	19.10	19.48
2a	Mfg. 10 - 2	42.28	42.67	43.05	20.49	20.88	21.26
3a	Mfg. 10 - 3	39.25	39.54	39.81	17.46	17.75	18.02
4a	Mfg. 9 - 1	39.03	39.37	39.68	17.24	17.58	17.89
5a	Mfg. 9 - 2	40.06	40.40	40.75	18.27	18.61	18.96
6a	Mfg. 9 - 3	35.92	36.14	36.35	14.14	14.35	14.56
7a	circuit breaker	41.66	42.13	42.62	19.87	20.34	20.83
8a	line wire	40.15	40.56	40.91	18.36	18.77	19.12
9a	line wire splicing device	47.60	47.94	48.23	25.81	26.16	26.44
10a	load wire	40.83	41.12	41.46	19.04	19.33	19.67
11a	load wire splicing device	46.50	46.62	46.74	24.72	24.83	24.95
12a	room ambient	21.81	21.79	21.76			
13a	current (amps)	22.35	22.35	22.35			

Appendix C3 Static Heating Tests at 150% Rated Current

Test 3b - thru Mfg. 2 10-amp breaker at 150% current (10A * 150% = 15A); max temps, reading every 10s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		21	22	23			
time (MM:SS)		2:00	2:10	2:20			
	Breaker trip time	2:30					
1b	Mfg. 10 - 1	28.72	29.12	29.50	6.58	6.98	7.36
2b	Mfg. 10 - 2	29.55	29.94	30.33	7.41	7.80	8.19
3b	Mfg. 10 - 3	28.01	28.30	28.56	5.87	6.16	6.42
4b	Mfg. 9 - 1	27.72	28.02	28.27	5.58	5.88	6.13
5b	Mfg. 9 - 2	27.97	28.28	28.55	5.83	6.14	6.41
6b	Mfg. 9 - 3	27.58	27.82	28.09	5.44	5.68	5.95
7b	circuit breaker	30.55	31.13	31.74	8.41	8.99	9.60
8b	line wire	31.18	31.69	32.20	9.04	9.55	10.06
9b	line wire splicing device	31.46	31.83	32.14	9.32	9.69	10.00
10b	load wire	28.42	28.81	29.21	6.28	6.67	7.07
11b	load wire splicing device	36.24	36.63	36.93	14.10	14.49	14.79
12b	room ambient	22.20	22.13	22.09			
13b	current (amps)	15.00	15.00	15.00			

Test 3b - thru Mfg. 2 15-amp breaker at 150% current (15A * 150% = 22.5A); max temps, reading every 10s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		18	19	20			
time (MM:SS)		:40	:50	1:00			
	Breaker trip time	1:10					
1b	Mfg. 10 - 1	25.84	26.82	27.77	4.13	5.12	6.06
2b	Mfg. 10 - 2	29.58	31.10	32.54	7.88	9.40	10.83
3b	Mfg. 10 - 3	32.64	34.09	35.41	10.93	12.39	13.71
4b	Mfg. 9 - 1	25.84	26.77	27.65	4.14	5.07	5.94
5b	Mfg. 9 - 2	27.74	28.90	29.94	6.03	7.19	8.24
6b	Mfg. 9 - 3	27.36	28.35	29.32	5.65	6.65	7.62
7b	circuit breaker	26.69	27.90	29.05	4.98	6.20	7.35
8b	line wire	25.29	26.13	26.94	3.59	4.42	5.23
9b	line wire splicing device	28.85	30.25	31.50	7.14	8.54	9.80
10b	load wire	27.35	28.42	29.40	5.65	6.72	7.70
11b	load wire splicing device	29.03	30.42	31.68	7.33	8.71	9.98
12b	room ambient	21.68	21.70	21.73			
13b	current (amps)	22.56	22.55	22.52			

Appendix C3 Static Heating Tests at 150% Rated Current

Test 3c - thru Mfg. 3 10-amp breaker at 150% current (10A * 150% = 15A); max temps, reading every 10s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #	→	44	45	46			
time (MM:SS)	→	5:50	6:00	6:10			
	Breaker trip time	6:20					
1c	Mfg. 10 - 1	33.95	34.06	34.18	12.26	12.38	12.49
2c	Mfg. 10 - 2	34.86	35.03	35.17	13.17	13.34	13.48
3c	Mfg. 10 - 3	32.06	32.16	32.23	10.37	10.47	10.55
4c	Mfg. 9 - 1	31.67	31.77	31.89	9.98	10.08	10.20
5c	Mfg. 9 - 2	31.89	31.99	32.07	10.20	10.30	10.39
6c	Mfg. 9 - 3	30.51	30.58	30.63	8.82	8.89	8.94
7c	circuit breaker	37.51	37.73	37.94	15.82	16.04	16.25
8c	line wire	38.17	38.32	38.46	16.48	16.63	16.77
9c	line wire splicing device	33.48	33.53	33.58	11.79	11.84	11.89
10c	load wire	37.25	37.38	37.51	15.57	15.70	15.82
11c	load wire splicing device	39.05	39.08	39.09	17.36	17.39	17.40
12c	room ambient	21.68	21.69	21.69			
13c	current (amps)	15.00	15.00	15.00			

Test 3c - thru Mfg. 3 15-amp breaker at 150% current (15A * 150% = 22.5A); max temps, reading every 10s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #	→	28	29	30			
time (MM:SS)	→	2:20	2:30	2:40			
	Breaker trip time	2:50					
1c	Mfg. 10 - 1	28.08	27.72	27.38	6.22	5.87	5.53
2c	Mfg. 10 - 2	27.85	27.43	27.08	5.99	5.58	5.23
3c	Mfg. 10 - 3	26.82	26.45	26.13	4.97	4.59	4.27
4c	Mfg. 9 - 1	26.62	26.30	26.02	4.76	4.45	4.17
5c	Mfg. 9 - 2	26.78	26.44	26.12	4.92	4.58	4.27
6c	Mfg. 9 - 3	26.00	25.71	25.47	4.15	3.86	3.62
7c	circuit breaker	30.09	29.81	29.54	8.23	7.95	7.68
8c	line wire	27.46	27.28	27.08	5.61	5.42	5.22
9c	line wire splicing device	27.03	26.55	26.12	5.18	4.69	4.26
10c	load wire	27.36	27.10	26.84	5.50	5.24	4.98
11c	load wire splicing device	27.70	27.09	26.53	5.84	5.23	4.67
12c	room ambient	21.89	21.86	21.82			
13c	current (amps)	22.40	22.39	22.39			

Appendix C4 Static Heating Tests at 200% Rated Current

Test 4a - thru Mfg. 1 10-amp breaker at 200% current (10A * 200% = 20A); max temps, reading every 7s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan # →		10	11	12			
time (MM:SS) →		:15	:21	:28			
	Breaker trip time	:35					
1a	Mfg. 11 - 1	24.11	24.67	25.32	2.07	2.62	3.28
2a	Mfg. 11 - 2	24.06	24.59	25.25	2.02	2.55	3.20
3a	Mfg. 11 - 3	24.07	24.57	25.16	2.03	2.52	3.12
4a	Mfg. 8 - 1	24.08	24.69	25.40	2.03	2.64	3.35
5a	Mfg. 8 - 2	24.66	25.33	26.11	2.61	3.28	4.06
6a	Mfg. 8 - 3	24.22	24.83	25.55	2.17	2.79	3.50
7a	circuit breaker	24.11	24.82	25.62	2.07	2.77	3.57
8a	line wire	27.40	28.75	30.11	5.35	6.71	8.06
9a	line wire splicing device	25.44	26.76	28.29	3.40	4.72	6.24
10a	load wire	26.61	27.77	28.96	4.57	5.72	6.91
11a	load wire splicing device	26.63	28.24	30.08	4.59	6.20	8.04
12a	room ambient	22.05	22.06	22.03			
13a	current (amps)	19.99	20.01	20.01			

Test 4a - thru Mfg. 1 15-amp breaker at 200% current (15A * 200% = 30A); max temps, reading every 7s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan # →		20	21	22			
time (MM:SS) →		:28	:35	:42			
	Breaker trip time	:49					
1a	Mfg. 11 - 1	27.71	28.87	30.04	5.22	6.37	7.55
2a	Mfg. 11 - 2	27.71	28.87	30.05	5.22	6.38	7.56
3a	Mfg. 11 - 3	27.95	28.97	30.04	5.46	6.47	7.54
4a	Mfg. 8 - 1	27.60	28.90	30.19	5.11	6.40	7.70
5a	Mfg. 8 - 2	28.56	29.91	31.25	6.06	7.42	8.76
6a	Mfg. 8 - 3	29.13	30.23	31.51	6.63	7.73	9.02
7a	circuit breaker	27.85	29.29	30.80	5.35	6.80	8.30
8a	line wire	29.17	30.44	31.74	6.68	7.95	9.24
9a	line wire splicing device	36.20	38.78	41.38	13.71	16.28	18.89
10a	load wire	29.69	31.07	32.48	7.20	8.58	9.98
11a	load wire splicing device	36.64	39.18	41.65	14.14	16.69	19.15
12a	room ambient	22.48	22.48	22.52			
13a	current (amps)	29.87	29.79	29.76			

Appendix C4 Static Heating Tests at 200% Rated Current

Test 4b - thru Mfg. 2 10-amp breaker at 200% current (10A * 200% = 20A); max temps, reading every 7s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan # →		10	11	12			
time (MM:SS) →		:15	:21	:28			
	Breaker trip time	:35					
1b	Mfg. 11 - 1	23.92	24.53	25.23	2.00	2.60	3.30
2b	Mfg. 11 - 2	23.87	24.40	25.03	1.95	2.48	3.10
3b	Mfg. 11 - 3	24.04	24.56	25.19	2.11	2.64	3.27
4b	Mfg. 8 - 1	24.03	24.67	25.43	2.11	2.74	3.51
5b	Mfg. 8 - 2	24.81	25.54	26.38	2.89	3.62	4.46
6b	Mfg. 8 - 3	24.09	24.69	25.38	2.17	2.77	3.46
7b	circuit breaker	23.99	24.68	25.52	2.07	2.75	3.60
8b	line wire	25.64	26.65	27.71	3.72	4.73	5.78
9b	line wire splicing device	25.15	26.44	27.96	3.22	4.52	6.03
10b	load wire	23.65	24.33	25.10	1.73	2.41	3.18
11b	load wire splicing device	26.05	27.55	29.19	4.13	5.63	7.27
12b	room ambient	21.94	21.92	21.90			
13b	current (amps)	20.00	20.00	20.00			

Test 4b - thru Mfg. 2 15-amp breaker at 200% current (15A * 200% = 30A); max temps, reading every 7s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan # →		16	17	18			
time (MM:SS) →		:00	:09	:15			
	Breaker trip time	:21					
1b	Mfg. 11 - 1	22.78	24.58	25.64	0.28	2.08	3.14
2b	Mfg. 11 - 2	22.55	23.95	24.94	0.05	1.45	2.44
3b	Mfg. 11 - 3	22.78	24.32	25.15	0.28	1.82	2.65
4b	Mfg. 8 - 1	22.67	24.22	25.26	0.17	1.72	2.76
5b	Mfg. 8 - 2	23.01	25.35	26.56	0.52	2.85	4.06
6b	Mfg. 8 - 3	23.06	25.22	26.32	0.57	2.72	3.83
7b	circuit breaker	22.89	24.64	25.66	0.39	2.15	3.17
8b	line wire	22.78	24.14	25.26	0.28	1.64	2.76
9b	line wire splicing device	22.80	25.27	27.08	0.30	2.77	4.59
10b	load wire	22.73	25.29	26.72	0.23	2.79	4.22
11b	load wire splicing device	22.84	25.76	27.75	0.34	3.26	5.26
12b	room ambient	22.49	22.49	22.51			
13b	current (amps)	29.72	29.67	29.65			

Test 4c - thru Mfg. 3 10-amp breaker at 200% current (10A * 200% = 20A); max temps, reading every 7s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #	→	16	17	18			
time (MM:SS)	→	:56	1:03	1:10			
	Breaker trip time	1:17					
1c	Mfg. 11 - 1	27.91	28.45	29.02	5.96	6.50	7.07
2c	Mfg. 11 - 2	27.83	28.34	28.85	5.88	6.39	6.90
3c	Mfg. 11 - 3	26.46	26.84	27.26	4.51	4.89	5.31
4c	Mfg. 8 - 1	28.33	28.89	29.46	6.38	6.94	7.51
5c	Mfg. 8 - 2	28.77	29.28	29.81	6.82	7.33	7.86
6c	Mfg. 8 - 3	27.76	28.25	28.71	5.81	6.30	6.76
7c	circuit breaker	30.95	31.72	32.52	8.99	9.77	10.56
8c	line wire	32.07	32.86	33.68	10.12	10.91	11.73
9c	line wire splicing device	31.50	32.36	33.19	9.54	10.41	11.24
10c	load wire	32.53	33.29	34.09	10.58	11.34	12.14
11c	load wire splicing device	36.35	37.44	38.34	14.40	15.49	16.39
12c	room ambient	22.03	21.91	21.92			
13c	current (amps)	20.00	20.00	20.00			

Test 4c - thru Mfg. 3 15-amp breaker at 200% current (15A * 200% = 30A); max temps, reading every 7s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #	→	18	19	20			
time (MM:SS)	→	:15	:21	:28			
	Breaker trip time	:35					
1c	Mfg. 11 - 1	24.86	25.82	26.97	2.56	3.52	4.67
2c	Mfg. 11 - 2	25.87	27.00	28.27	3.57	4.70	5.97
3c	Mfg. 11 - 3	25.45	26.38	27.49	3.15	4.08	5.19
4c	Mfg. 8 - 1	25.11	26.19	27.48	2.81	3.89	5.18
5c	Mfg. 8 - 2	26.49	27.73	29.14	4.19	5.43	6.85
6c	Mfg. 8 - 3	25.08	26.08	27.24	2.78	3.78	4.94
7c	circuit breaker	25.44	26.60	28.04	3.14	4.30	5.74
8c	line wire	24.49	25.44	26.52	2.20	3.15	4.22
9c	line wire splicing device	27.39	29.24	31.37	5.09	6.95	9.07
10c	load wire	26.18	27.74	29.43	3.88	5.44	7.13
11c	load wire splicing device	26.21	27.89	29.79	3.91	5.59	7.49
12c	room ambient	22.31	22.30	22.29			
13c	current (amps)	29.59	29.78	29.83			

Appendix C4 Static Heating Tests at 200% Rated Current

Test 4a - thru Mfg. 1 10-amp breaker at 200% current (10A * 200% = 20A); max temps, reading every 7s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		27	28	29			
time (MM:SS)		:15	:21	:28			
	Breaker trip time	:35					
1a	Mfg. 10 - 1	24.20	24.89	25.74	2.53	3.23	4.07
2a	Mfg. 10 - 2	24.11	24.81	25.65	2.45	3.14	3.99
3a	Mfg. 10 - 3	23.82	24.42	25.12	2.16	2.76	3.45
4a	Mfg. 9 - 1	23.70	24.28	24.96	2.04	2.62	3.29
5a	Mfg. 9 - 2	23.89	24.51	25.23	2.22	2.84	3.57
6a	Mfg. 9 - 3	23.66	24.22	24.90	1.99	2.55	3.23
7a	circuit breaker	23.81	24.47	25.29	2.14	2.80	3.63
8a	line wire	26.99	28.37	29.76	5.32	6.71	8.09
9a	line wire splicing device	24.05	25.15	26.46	2.39	3.48	4.79
10a	load wire	26.61	27.85	29.13	4.94	6.19	7.47
11a	load wire splicing device	28.24	30.24	32.42	6.58	8.58	10.75
12a	room ambient	21.68	21.67	21.66			
13a	current (amps)	20.02	20.03	20.03			

Test 4a - thru Mfg. 1 15-amp breaker at 200% current (15A * 200% = 30A); max temps, reading every 7s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		17	18	19			
time (MM:SS)		:28	:35	:42			
	Breaker trip time	:49					
1a	Mfg. 10 - 1	27.27	28.75	30.17	5.77	7.24	8.67
2a	Mfg. 10 - 2	28.89	30.53	32.07	7.38	9.02	10.56
3a	Mfg. 10 - 3	27.89	29.33	30.74	6.38	7.82	9.24
4a	Mfg. 9 - 1	27.16	28.54	29.90	5.66	7.04	8.39
5a	Mfg. 9 - 2	28.09	29.55	30.97	6.58	8.05	9.46
6a	Mfg. 9 - 3	27.93	29.14	30.27	6.43	7.64	8.77
7a	circuit breaker	26.82	28.27	29.71	5.32	6.77	8.20
8a	line wire	28.15	29.45	30.67	6.65	7.95	9.17
9a	line wire splicing device	34.08	36.63	38.99	12.57	15.13	17.49
10a	load wire	28.54	29.95	31.29	7.03	8.45	9.79
11a	load wire splicing device	35.97	38.68	41.18	14.47	17.17	19.67
12a	room ambient	21.49	21.52	21.51			
13a	current (amps)	29.88	29.83	29.82			

Test 4b - thru Mfg. 2 10-amp breaker at 200% current (10A * 200% = 20A); max temps, reading every 7s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #	→	27	28	29			
time (MM:SS)	→	:15	:21	:28			
	Breaker trip time	:35					
1b	Mfg. 10 - 1	23.68	24.31	25.08	2.15	2.79	3.55
2b	Mfg. 10 - 2	24.00	24.79	25.66	2.47	3.26	4.13
3b	Mfg. 10 - 3	23.96	24.59	25.27	2.43	3.06	3.74
4b	Mfg. 9 - 1	23.67	24.25	24.93	2.14	2.73	3.40
5b	Mfg. 9 - 2	23.75	24.36	25.10	2.22	2.84	3.58
6b	Mfg. 9 - 3	23.79	24.37	25.03	2.26	2.84	3.50
7b	circuit breaker	23.69	24.36	25.21	2.16	2.84	3.69
8b	line wire	25.34	26.37	27.40	3.81	4.84	5.88
9b	line wire splicing device	24.37	25.54	26.91	2.84	4.01	5.38
10b	load wire	23.38	24.06	24.84	1.86	2.54	3.32
11b	load wire splicing device	28.62	30.57	32.60	7.09	9.05	11.07
12b	room ambient	21.54	21.54	21.50			
13b	current (amps)	19.99	19.99	19.99			

Test 4b - thru Mfg. 2 15-amp breaker at 200% current (15A * 200% = 30A); max temps, reading every 7s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #	→	13	14	15			
time (MM:SS)	→	0:00	:09	:15			
	Breaker trip time	:21					
1b	Mfg. 10 - 1	21.91	23.26	24.56	0.52	1.87	3.16
2b	Mfg. 10 - 2	21.93	24.79	26.37	0.54	3.40	4.97
3b	Mfg. 10 - 3	21.91	23.93	25.26	0.52	2.54	3.87
4b	Mfg. 9 - 1	21.95	24.22	25.49	0.56	2.83	4.10
5b	Mfg. 9 - 2	21.93	24.57	25.87	0.54	3.18	4.48
6b	Mfg. 9 - 3	21.90	24.12	25.30	0.51	2.73	3.90
7b	circuit breaker	22.03	23.68	24.72	0.64	2.28	3.33
8b	line wire	22.07	23.08	24.22	0.68	1.69	2.83
9b	line wire splicing device	21.89	24.14	26.27	0.50	2.75	4.87
10b	load wire	21.93	24.17	25.69	0.54	2.78	4.30
11b	load wire splicing device	21.95	26.40	28.99	0.56	5.01	7.60
12b	room ambient	21.40	21.38	21.40			
13b	current (amps)	30.03	29.98	29.94			

Appendix C4 Static Heating Tests at 200% Rated Current

Test 4c - thru Mfg. 3 10-amp breaker at 200% current (10A * 200% = 20A); max temps, reading every 7s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		33	34	35			
time (MM:SS)		:56	1:03	1:10			
	Breaker trip time	1:17					
1c	Mfg. 10 - 1	28.89	29.56	30.22	7.33	8.01	8.67
2c	Mfg. 10 - 2	29.13	29.80	30.47	7.57	8.25	8.92
3c	Mfg. 10 - 3	28.24	28.82	29.43	6.69	7.27	7.87
4c	Mfg. 9 - 1	27.96	28.54	29.11	6.41	6.98	7.56
5c	Mfg. 9 - 2	27.95	28.55	29.13	6.40	6.99	7.58
6c	Mfg. 9 - 3	27.87	28.37	28.89	6.31	6.82	7.34
7c	circuit breaker	30.46	31.20	31.96	8.91	9.65	10.41
8c	line wire	31.76	32.54	33.32	10.20	10.99	11.77
9c	line wire splicing device	30.32	31.15	31.96	8.77	9.60	10.41
10c	load wire	32.17	32.94	33.69	10.62	11.39	12.14
11c	load wire splicing device	39.40	40.57	41.66	17.85	19.02	20.11
12c	room ambient	21.59	21.54	21.53			
13c	current (amps)	20.00	20.00	20.00			

Test 4c - thru Mfg. 3 15-amp breaker at 200% current (15A * 200% = 30A); max temps, reading every 7s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		16	17	18			
time (MM:SS)		:21	:28	:35			
	Breaker trip time	:42					
1c	Mfg. 10 - 1	24.57	25.84	27.05	3.19	4.45	5.67
2c	Mfg. 10 - 2	28.42	30.54	32.56	7.04	9.16	11.18
3c	Mfg. 10 - 3	33.47	35.78	37.86	12.09	14.40	16.48
4c	Mfg. 9 - 1	24.87	26.08	27.27	3.49	4.70	5.89
5c	Mfg. 9 - 2	27.04	28.63	30.11	5.66	7.25	8.73
6c	Mfg. 9 - 3	26.95	28.35	29.72	5.57	6.97	8.34
7c	circuit breaker	25.75	27.15	28.60	4.37	5.77	7.22
8c	line wire	24.57	25.65	26.68	3.19	4.27	5.30
9c	line wire splicing device	27.76	29.81	31.74	6.38	8.43	10.35
10c	load wire	26.52	28.22	29.72	5.14	6.84	8.34
11c	load wire splicing device	27.66	29.85	31.88	6.28	8.47	10.49
12c	room ambient	21.40	21.37	21.36			
13c	current (amps)	29.34	29.29	30.17			

Appendix C5 Static Heating Testing Schneider Circuit Breaker

Test 1b - thru Mfg. 2 10-amp breaker at 100% current (10A * 100% = 10A); max temps, reading every 60s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		67	72	77			
time (HH:MM:SS)		1:04:00	1:09:00	1:14:00			
1b	Mfg. 10 - 1	33.66	33.62	33.48	12.17	12.13	11.99
2b	Mfg. 10 - 2	30.46	30.56	30.61	8.97	9.07	9.12
3b	Mfg. 10 - 3	28.97	29.03	28.87	7.48	7.54	7.38
4b	Mfg. 9 - 1	28.59	28.61	28.68	7.10	7.12	7.19
5b	Mfg. 9 - 2	29.99	29.94	29.81	8.50	8.45	8.32
6b	Mfg. 9 - 3	28.44	28.40	28.15	6.95	6.91	6.66
7b	circuit breaker	41.26	41.48	41.60	19.77	19.99	20.11
8b	line wire	31.15	30.97	30.89	9.66	9.48	9.40
9b	line wire splicing device	28.63	28.27	28.01	7.14	6.78	6.52
10b	load wire	28.45	28.20	28.09	6.96	6.71	6.60
11b	load wire splicing device	30.47	29.94	29.87	8.98	8.45	8.38
12b	room ambient	22.46	22.07	21.66			
13b	current (amps)	10.01	10.01	10.01			

Test 2b - thru Mfg. 2 10-amp breaker at 135% current (10A * 135% = 13.5A); max temps, reading every 20s

data logger CH #	Location	Recorded Temperatures (°C)			Calculated Temperature Rise (°C)		
scan #		202	203	204			
time (MM:SS)		66:20	66:40	67:00			
	Breaker trip time	> 67 mins. (no trip)					
1b	Mfg. 10 - 1	40.89	40.89	40.88	18.96	18.97	18.96
2b	Mfg. 10 - 2	37.03	37.03	37.04	15.11	15.11	15.12
3b	Mfg. 10 - 3	34.24	34.26	34.21	12.31	12.34	12.29
4b	Mfg. 9 - 1	33.52	33.50	33.53	11.60	11.58	11.61
5b	Mfg. 9 - 2	35.79	35.78	35.75	13.87	13.86	13.83
6b	Mfg. 9 - 3	33.44	33.45	33.39	11.52	11.53	11.47
7b	circuit breaker	56.60	56.56	56.59	34.68	34.64	34.67
8b	line wire	38.73	38.68	38.65	16.81	16.76	16.72
9b	line wire splicing device	33.69	33.57	33.57	11.76	11.65	11.65
10b	load wire	33.57	33.50	33.50	11.65	11.57	11.58
11b	load wire splicing device	37.08	36.99	37.04	15.16	15.07	15.12
12b	room ambient	22.10	22.03	21.97			
13b	current (amps)	13.49	13.49	13.49			

Appendix D Flexing Tests

Conductor Flexing tests on 14-2 AWG copper-clad aluminum NMB cable:

test #	wire connection method	pass / fail (10x flexion)	comments
6-1	wrap around terminal screw	pass	ends of hot and neutral wires broke when removing them from their terminals after the test
6-2	single compression	pass	
6-3	double compression	pass	
6-1-1	wrap around terminal screw	failed	retest of 6-1; hot wire (black) broke on 8th flexion
6-1-2	wrap around terminal screw	pass	retest of 6-1 using copper wire
6-1-3	wrap around terminal screw	pass	retest of 6-1

NOTE: One Legrand receptacle was used for all 3 tests above and 9in/lbs was applied to all three terminal screws.

PACIFIC TEST AND MEASUREMENT

PO Box 2363, Clackamas, OR 97015
15648 114th Ave. Suite 109, Clackamas OR 97015
Phone: 503-406-4373 Fax: 503 905 0457
www.pacifictestandmeasurement.com

Certificate of Conformance

Issued to:	CDCMello Consulting LLC PO Box 872317 Vancouver, WA 98687
Customer PO:	Verbal Chuck Mello
Model:	UL3055
Lot Number:	952103-019
Report:	JK202006300-003
Description:	Type J, 30 Gauge FEP/FEP Teflon, Special Limits of Error Tolerance, 15 feet length, Thermocouple

Pacific Test and Measurement Inc certifies that the order of thermocouples meets all applicable instructions, specifications, and in accordance with DAP UL 00-OP-C0037 version 10.0. The preferred method of welding to produce a single point weld or bead using ThermX model 258B welder has been used to assemble the thermocouple junction which has been proven as reliable and repeatable through validation. The finish products were assembled from UL4047, a spool of described wire calibrated to accredited standards as described in the calibration report.

Certified by: ____________________ (Quality Department) Date: ___7-10-2020________

ACCREDITED
CERT #2496.01

Report of Calibration

Eustis Co.,Inc./Pyrocom Calibration lab
12407-B Mukilteo Speedway #200
Lynnwood, wa 98087

Report No: JK202006300-003

Model: UL4047 Serial: 952103-019 Description: TYPE J, 30AWG, FEP/FEP	Customer: . . CDCMello Consulting LLC PO Box 872317 Vancouver, WA 98687
Calibration Range: Limited Received Condition: New Current: N/A Procedure: ECP 339/341	

The unit under test (UUT) on this certificate has been calibrated by comparison method as covered by ASTM E220-13, and calibrated against standards traceable to the National Institute of Standards and Technology (NIST). Eustis Co., Inc./Pyrocom Calibration Lab meets the requirements of ANSI/NCSL Z540-1-1994 and ISO/IEC 17025 and is accredited by A2LA via Certificate Number 2496.01 for calibrations within the scope to which it applies. The uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2. All results contained within this certificate relate only to the item calibrated. Any number of factors may cause the calibrated item to drift out of calibration.

Nominal Value (Set-point) (C)	**Actual Value (Reference) (C)**	**UUT (Test Sensor) (C)**	**Error (C)**	**Measurement Uncertainty (C)**	**Method of Realization**
21.00	21.41	21.38	-0.03	+/- 0.31	COMP
40.00	40.08	40.02	-0.06	+/- 0.40	COMP
95.00	95.02	94.97	-0.05	+/- 0.40	COMP
150.00	150.02	150.10	0.08	+/- 0.50	COMP
200.00	200.01	200.23	0.22	+/- 0.50	COMP

Test Equipment

Manufacturer	Model	Description	Serial Number	Recall Date
Hart Scientific	1560	"Black Stack" Base Unit	96539	NCR
Hart Scientific	2560	SPRT Module	A25631	3/24/2021
Fluke	5628	4 Wire SPRT	4303	3/26/2021
Fluke	2566	Thermocouple Scanner	B7A380	3/24/2021
Fluke	9173	Metrology Well, 700 C	B47975	NCR
Fluke	7380	Bath, Ultra Low-Temperature	B2A527	NCR

Calibration Date: 6/18/2020
Temperature: 23.0 C
Humidity: 47%
Customer Order: 74523

Technician: Kulin
Julia Kulin

Approved By: WPaulson
Walter Paulson
QA Manager

Report of Calibration

Report No: JK202006300-003

Notes: The thermocouple wire meets or exceeds the criteria established for type "J" SPECIAL LIMITS OF ERROR per ASTM E230/E230M-17 table 1 & ISA-MC96.1-1982 Par. 2.5 Table 8 +/- 1.1°C OR +/- .4% whichever is greater. Lot calibration data supplied for your reference.
Calibrated item meets special limits of error for all results given according to the comparison of "error" reading to the specifications found in ASTM E230/E230M-17 table 1 & MC96.1-1982 table 8; acceptance determination is ultimately the responsibility of the customer, taking into account all uncertainties and other factors. The closer the results are to the specification limits, the greater the risk that the unit under test will be out of tolerance.

Report issue date: JUN 1 9 2020

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 ● Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ACCREDITED ISO IEC 17025 CALIBRATION AND TESTING LABORATORY
Certificate No. ACT-1272

Certification Number CK198-33105-466

For Eaton Corporation - ICD
W126 N7250 Flint Drive
Menomonee Falls, WI 53051

Purchase Order #	4044-671109
Test Instrument	Data Acquisition Unit
Make	Keysight
Model	34972A
Serial Number	MY49002695
Identification	EM7054
Customer Location	ICD
Condition Received	In Tolerance
Condition Returned	In Tolerance
Calibrated By	Alex Paulsen
Technical Review By	Tim Bending
Calibration Location	FVM
Calibration Conditions	67.8°F, 19.9°C, 57.3%RH
Calibration Date	07/16/2020
Recalibration Due	07/16/2021

Procedures Followed
FVE-000 rev. 2
FVE-006 rev. 2

Standards Used

Instrument	Serial Number	Trace Number	Next Cal
FVS-275A	RY11838	CJ191-70508-513	07/28/2020
FVS-737	4542903	CK041-57440-531	02/28/2021

Total expanded measurement uncertainties expressed are based on a confidence level of 95%; coverage factor of (k=2). The statement of compliance in this certificate was issued without taking the uncertainty of measurement into consideration. The customer shall assess the results and uncertainty when determining if the results meet their needs. (This is considered "shared responsibility.") Uncertainties expressed in nominal units.

All instruments have been calibrated against standards traceable to NIST. Calibration was completed in accordance with ISO/IEC 17025:2017, ANSI/NCSL Z540-1-1994 and ANSI/NCSL Z540.3-2006. Other standards listed upon request.

Calibration Results

* denotes "Out of Tolerance"

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
Root Difference Square guardbanding method used.						
UUT IDENTIFICATION						
Serial Number: MY49002695 Firmware Level: 1.11-1.12-02-01						
INPUT MODULE CHARACTERISTICS						
Model: 34901A Firmware Level: 2.3						
SELF TEST				Pass	Pass	

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 ● Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ACCREDITED
ISO IEC 17025
CALIBRATION AND TESTING LABORATORY
Certificate No. ACT-1272

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
INTERNAL DMM VERIFICATION						
ZERO OFFSET VERIFICATION						
DC CURRENT						
10 mA Range 0.00000 mA	0.00000	-0.00200	0.00200	0.00003	0.00003	0.000007
100 mA Range 0.0000 mA	0.0000	-0.0050	0.0050	0.0000	0.0000	0.00006
1 A Range 0.000000 A	0.000000	-0.000100	0.000100	0.000001	0.000001	0.0000006
DC VOLTS						
100 mV Range 0.0000 mV	0.0000	-0.0040	0.0040	0.0004	0.0004	0.00007
1 V Range 0.000000 V	0.000000	-0.000007	0.000007	0.000001	0.000001	0.0000007
10 V Range 0.00000 V	0.00000	-0.00005	0.00005	0.00000	0.00000	0.000007
100 V Range 0.0000 V	0.0000	-0.0006	0.0006	0.0000	0.0000	0.00006
300 V Range 0.000 V	0.000	-0.009	0.009	0.000	0.000	0.0006
2 WIRE □						
100 □ Range 0.0000 Ohm	0.0000	-4.0040	4.0040	0.0626	0.0626	0.00007
1 k□ Range 0.000000 kOhm	0.000000	-0.004010	0.004010	0.000065	0.000065	0.0000006
10 k□ Range 0.00000 kOhm	0.00000	-0.00410	0.00410	0.00008	0.00008	0.000006
100 k□ Range 0.0000 kOhm	0.0000	-0.0050	0.0050	0.0002	0.0002	0.00007
1 M□ Range 0.000000 MOhm	0.000000	-0.000014	0.000014	0.000000	0.000000	0.0000007
10 M□ Range						

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 ● Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

Certificate No. ACT-1272

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
0.00000 MOhm	0.00000	-0.00010	0.00010	0.00000	0.00000	0.000007
100 M? Range						
0.0000 MOhm	0.0000	-0.0100	0.0100	0.0000	0.0000	0.00006
4 WIRE □						
100 □ Range						
0.0000 Ohm	0.0000	-0.0040	0.0040	-0.0023	-0.0023	0.00006
1 k□ Range						
0.000000 kOhm	0.000000	-0.000010	0.000010	0.000000	0.000000	0.0000006
10 k□ Range						
0.00000 kOhm	0.00000	-0.00010	0.00010	0.00000	0.00000	0.000007
100 k□ Range						
0.0000 kOhm	0.0000	-0.0010	0.0010	0.0000	0.0000	0.00007
1 M□ Range						
0.000000 MOhm	0.000000	-0.000010	0.000010	0.000000	0.000000	0.0000006
10 M□ Range						
0.00000 MOhm	0.00000	-0.00010	0.00010	0.00000	0.00000	0.000006
100 M□ Range						
0.0000 MOhm	0.0000	-0.0100	0.0100	0.0000	0.0000	0.00007
GAIN VERIFICATION						
DC VOLTS						
100 mV Range						
100.0000 mV	100.0000	99.9910	100.0090	100.0000	100.0000	0.00006
-100.0000 mV	-100.0000	-100.0090	-99.9910	-99.9987	-99.9987	0.00007
1 V Range						
1.000000 V	1.000000	0.999953	1.000047	0.999993	0.999993	0.0000007
-1.000000 V	-1.000000	-1.000047	-0.999953	-0.999989	-0.999989	0.0000007
10 V Range						
10.00000 V	10.00000	9.99960	10.00040	9.99994	9.99994	0.000006
-10.00000 V	-10.00000	-10.00040	-9.99960	-9.99992	-9.99992	0.000006
100 V Range						
100.0000 V	100.0000	99.9949	100.0051	99.9996	99.9996	0.00007
-100.0000 V	-100.0000	-100.0051	-99.9949	-99.9993	-99.9993	0.00007
300 V Range						
300.000 V	300.000	299.978	300.022	299.998	299.998	0.0006

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 ● Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ilac-MRA ANAB ACCREDITED ISO/IEC 17025 CALIBRATION AND TESTING LABORATORY
Certificate No. ACT-1272

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
2 WIRE Ω						
100 Ω Range						
100.0000 Ohm	100.0000	95.9860	104.0140	100.0067	100.0067	0.00007
1 kΩ Range						
1.000000 kOhm	1.000000	0.995890	1.004110	1.000032	1.000032	0.0000006
10 kΩ Range						
10.00000 kOhm	10.00000	9.99490	10.00510	10.00035	10.00035	0.000007
100 kΩ Range						
100.0000 kOhm	100.0000	99.9850	100.0150	100.0029	100.0029	0.00006
1 MΩ Range						
1.000000 MOhm	1.000000	0.999886	1.000114	1.000016	1.000016	0.0000006
10 MΩ Range						
10.00000 MOhm	10.00000	9.99590	10.00410	9.99768	9.99768	0.000006
100 MΩ Range						
100.0000 MOhm	100.0000	99.1900	100.8100	100.3688	100.3688	0.00007
4 WIRE Ω						
100 Ω Range						
100.0000 Ohm	100.0000	99.9860	100.0140	100.0039	100.0039	0.00006
1 kΩ Range						
1.000000 kOhm	1.000000	0.999890	1.000110	1.000030	1.000030	0.0000007
10 kΩ Range						
10.00000 kOhm	10.00000	9.99890	10.00110	10.00032	10.00032	0.000006
100 kΩ Range						
100.0000 kOhm	100.0000	99.9890	100.0110	100.0021	100.0021	0.00007
1 MΩ Range						
1.000000 MOhm	1.000000	0.999890	1.000110	0.999970	0.999970	0.0000007
10 MΩ Range						
10.00000 MOhm	10.00000	9.99590	10.00410	9.99595	9.99595	0.000006
100 MΩ Range						
100.0000 MOhm	100.0000	99.1900	100.8100	99.8275	99.8275	0.00006
DC CURRENT						
10 mA Range						
10.00000 mA	10.00000	9.99300	10.00700	9.99898	9.99898	0.000007
-10.00000 mA	-10.00000	-10.00700	-9.99300	-9.99887	-9.99887	0.000007

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 ● Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ACCREDITED ISO IEC 17025 CALIBRATION AND TESTING LABORATORY
Certificate No. ACT-1272

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
100 mA Range						
100.0000 mA	100.0000	99.9450	100.0550	99.9882	99.9882	0.00006
-100.0000 mA	-100.0000	-100.0550	-99.9450	-99.9879	-99.9879	0.00006
1 A Range						
1.000000 A	1.000000	0.998900	1.001100	0.999534	0.999534	0.0000006
-1.000000 A	-1.000000	-1.001100	-0.998900	-0.999537	-0.999537	0.0000006
AC VOLTS						
100 mV Range						
10.0000 mV @ 1 kHz	10.0000	9.9540	10.0460	9.9997	9.9997	0.00006
100.0000 mV @ 1 kHz	100.0000	99.9000	100.1000	99.9912	99.9912	0.00006
100.0000 mV @ 50 kHz	100.0000	99.8300	100.1700	99.9383	99.9383	0.00006
1 V Range						
1.000000 V @ 20 Hz	1.000000	0.999000	1.001000	0.999803	0.999803	0.0000006
1.000000 V @ 1 kHz	1.000000	0.999000	1.001000	0.999950	0.999950	0.0000006
1.000000 V @ 20 kHz	1.000000	0.999000	1.001000	0.999888	0.999888	0.0000006
1.000000 V @ 50 kHz	1.000000	0.998300	1.001700	0.999504	0.999504	0.0000007
1.000000 V @ 100 kHz	1.000000	0.993200	1.006800	0.998811	0.998811	0.0000006
1.000000 V @ 200 kHz	1.000000	0.955000	1.045000	0.999068	0.999068	0.0000006
1.000000 V @ 250 kHz	1.000000	0.955000	1.045000	0.999202	0.999202	0.0000007
1.000000 V @ 300 kHz	1.000000	0.955000	1.045000	0.998797	0.998797	0.0000006
10 V Range						
0.10000 V @ 1 kHz	0.10000	0.08594	0.11406	0.10086	0.10086	0.000006
1.00000 V @ 1 kHz	1.00000	0.99540	1.00460	0.99992	0.99992	0.000006
10.00000 V @ 10 Hz	10.00000	9.99000	10.01000	9.99743	9.99743	0.000007
10.00000 V @ 1 kHz	10.00000	9.99000	10.01000	9.99855	9.99855	0.000006
10.00000 V @ 50 kHz	10.00000	9.98300	10.01700	9.99499	9.99499	0.000006
100 V Range						
100.0000 V @ 1 kHz	100.0000	99.9000	100.1000	99.9653	99.9653	0.00006
100.0000 V @ 50 kHz	100.0000	99.8300	100.1700	99.8943	99.8943	0.00006

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 ● Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

Certificate No. ACT-1272

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
300 V Range						
300.000 V @ 1 kHz	300.000	299.580	300.420	299.884	299.884	0.0006
200.000 V @ 50 kHz	200.000	199.400	200.600	199.750	199.750	0.0007
AC CURRENT						
10 mA Range						
10.00000 mA @ 1 kHz	10.00000	9.98600	10.01400	9.99766	9.99766	0.000007
100 mA Range						
100.0000 mA @ 1 kHz	100.0000	99.4000	100.6000	99.9484	99.9484	0.00007
1 A Range						
0.010000 A @ 1 kHz	0.010000	0.008590	0.011410	0.009960	0.009960	0.0000007
1.000000 A @ 1 kHz	1.000000	0.998600	1.001400	0.999502	0.999502	0.0000006
FREQUENCY						
100 Hz Range						
100.0000 Hz	100.0000	99.9000	100.1000	100.0056	100.0056	0.00007
100 kHz Range						
100.0000 kHz	100.0000	99.9900	100.0100	100.0001	100.0001	0.00007

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 • Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ACCREDITED
ISO IEC 17025
CALIBRATION AND TESTING LABORATORY
Certificate No. ACT-1272

Certification Number CK198-39504-466

For Eaton Corporation - ICD
W126 N7250 Flint Drive
Menomonee Falls, WI 53051

Purchase Order #	4044-671109
Test Instrument	Multimeter Digital Multimeter
Make	Fluke
Model	179
Serial Number	77840008
Identification	EM4437
Customer Location	ICD
Condition Received	In Tolerance
Condition Returned	In Tolerance
Calibrated By	Alex Paulsen
Technical Review By	Tim Bending
Calibration Location	FVM
Calibration Conditions	68.3°F, 20.2°C, 56.2%RH
Calibration Date	07/16/2020
Recalibration Due	07/16/2021

Procedures Followed
FVE-000 rev. 2
FVE-001 rev. 2

Standards Used

Instrument	Serial Number	Trace Number	Next Cal
FVS-275A	RY11838	CJ191-70508-513	07/28/2020
FVS-737	4542903	CK041-57440-531	02/28/2021

Total expanded measurement uncertainties expressed are based on a confidence level of 95%; coverage factor of (k=2). The statement of compliance in this certificate was issued without taking the uncertainty of measurement into consideration. The customer shall assess the results and uncertainty when determining if the results meet their needs. (This is considered "shared responsibility.") Uncertainties expressed in base units.

All instruments have been calibrated against standards traceable to NIST. Calibration was completed in accordance with ISO/IEC 17025:2017, ANSI/NCSL Z540-1-1994 and ANSI/NCSL Z540.3-2006. Other standards listed upon request.

Calibration Results

* denotes "Out of Tolerance"

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
AC VOLTS						
600 mV Range						
300.0 mV @ 45 Hz	300.0	296.7	303.3	299.2	299.2	0.07
6 V Range						
5.000 V @ 500 Hz	5.000	4.947	5.053	4.987	4.987	0.0007
5.000 V @ 1 kHz	5.000	4.897	5.103	4.949	4.949	0.0007
60 V Range						
50.00 V @ 45 Hz	50.00	49.47	50.53	49.98	49.98	0.007
50.00 V @ 1 kHz	50.00	48.97	51.03	50.02	50.02	0.007
600 V Range						
300.0 V @ 45 Hz	300.0	296.7	303.3	299.9	299.9	0.07
500.0 V @ 500 Hz	500.0	494.7	505.3	500.5	500.5	0.06
500.0 V @ 1 kHz	500.0	489.7	510.3	500.5	500.5	0.06
1000 V Range						
1000 V @ 45 Hz	1000	987	1013	1002	1002	0.7

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 ● Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ACCREDITED ISO IEC 17025 CALIBRATION AND TESTING LABORATORY
Certificate No. ACT-1272

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
AC VOLTS FREQUENCY						
45.00 Hz @ 1 V	45.00	44.95	45.06	45.01	45.01	0.007
50.00 kHz @ 5 V	50.00	49.94	50.06	50.00	50.00	0.006
DC VOLTAGE						
6 V Range						
5.000 V	5.000	4.994	5.007	4.997	4.997	0.0006
600 V Range						
300.0 V	300.0	299.5	300.5	299.8	299.8	0.06
1000 V Range						
1000 V	1000	997	1004	999	999	0.6
-1000 V	-1000	-1004	-997	-1000	-1000	0.7
DC VOLTS FREQUENCY						
45.00 Hz @ 3 V	45.00	44.95	45.06	45.01	45.01	0.007
50.00 kHz @ 30 V	50.00	49.94	50.06	50.00	50.00	0.007
DC MILLIVOLTS						
30.0 mV	30.0	29.8	30.2	30.0	30.0	0.06
-300.0 mV	-300.0	-300.5	-299.5	-299.9	-299.9	0.06
600.0 mV	600.0	599.3	600.7	599.7	599.7	0.07
TEMPERATURE						
0.0 °C	0.0	-1.0	1.0	1.0	1.0	0.06
-40.0 °C	-40.0	-41.4	-38.6	-39.0	-39.0	0.07
400.0 °C	400.0	395.0	405.0	400.9	400.9	0.06
OHMS						
600 Ohm Range						
19.0 Ohm	19.0	18.6	19.4	19.3	19.3	0.07
50 MOhm Range						
19.00 MOhm	19.00	18.68	19.32	19.00	19.00	0.006
CAPACITANCE						
1000 nF Range						
900 nF	900	887	913	899	899	0.6
CONTINUITY						
0 Ohms: Beeper On				Pass	Pass	
190 Ohms: Beeper Off				Pass	Pass	
DIODE TEST						

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 ● Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ACCREDITED ISO IEC 17025 CALIBRATION AND TESTING LABORATORY
Certificate No. ACT-1272

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
2.000 V	2.000	1.978	2.022	2.000	2.000	0.0007
AC MILLIAMPS						
60 mA Range						
3.00 mA @ 45 Hz	3.00	2.92	3.08	3.00	3.00	0.007
50.00 mA @ 1 kHz	50.00	49.22	50.78	50.06	50.06	0.006
400 mA Range						
400.0 mA @ 1 kHz	400.0	393.7	406.3	400.4	400.4	0.07
AC AMPS						
6 A Range						
4.000 A @ 45 Hz	4.000	3.937	4.063	4.005	4.005	0.0007
10A Range						
9.00 A @ 1 kHz	9.00	8.84	9.16	9.04	9.04	0.007
DC MILLIAMPS						
60 mA Range						
3.00 mA	3.00	2.94	3.06	3.00	3.00	0.006
50.00 mA	50.00	49.47	50.53	49.92	49.92	0.007
400 mA Range						
-400.0 mA	-400.0	-404.3	-395.7	-399.8	-399.8	0.07
DC AMPS						
6 A Range						
4.000 A	4.000	3.957	4.043	3.999	3.999	0.0007
10 A Range						
-9.00 A	-9.00	-9.12	-8.88	-9.01	-9.01	0.006

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 • Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

Certificate No. ACT-1272

Certification Number CK198-38060-466

For Eaton Corporation - ICD
W126 N7250 Flint Drive
Menomonee Falls, WI 53051

Purchase Order #	4044-671109
Test Instrument	Multimeter Digital Multimeter
Make	Fluke
Model	175
Serial Number	13700492
Identification	EM7014
Customer Location	ICD
Condition Received	In Tolerance
Condition Returned	In Tolerance
Calibrated By	Alex Paulsen
Technical Review By	Tim Bending
Calibration Location	FVM
Calibration Conditions	68.2°F, 20.1°C, 56.6%RH
Calibration Date	07/16/2020
Recalibration Due	07/16/2021

Procedures Followed
FVE-000 rev. 2
FVE-001 rev. 2

Standards Used

Instrument	Serial Number	Trace Number	Next Cal
FVS-275A	RY11838	CJ191-70508-513	07/28/2020
FVS-737	4542903	CK041-57440-531	02/28/2021

Total expanded measurement uncertainties expressed are based on a confidence level of 95%; coverage factor of (k=2). The statement of compliance in this certificate was issued without taking the uncertainty of measurement into consideration. The customer shall assess the results and uncertainty when determining if the results meet their needs. (This is considered "shared responsibility.") Uncertainties expressed in base units.

All instruments have been calibrated against standards traceable to NIST. Calibration was completed in accordance with ISO/IEC 17025:2017, ANSI/NCSL Z540-1-1994 and ANSI/NCSL Z540.3-2006. Other standards listed upon request.

* denotes "Out of Tolerance"

Calibration Results

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
AC VOLTS						
600 mV Range						
300.0 mV @ 45 Hz	300.0	296.7	303.3	299.9	299.9	0.07
6 V Range						
5.000 V @ 500 Hz	5.000	4.947	5.053	4.994	4.994	0.0007
5.000 V @ 1 kHz	5.000	4.897	5.103	4.955	4.955	0.0006
60 V Range						
50.00 V @ 45 Hz	50.00	49.47	50.53	49.94	49.94	0.007
50.00 V @ 1 kHz	50.00	48.97	51.03	50.06	50.06	0.006
600 V Range						
300.0 V @ 45 Hz	300.0	296.7	303.3	299.8	299.8	0.07
500.0 V @ 500 Hz	500.0	494.7	505.3	500.4	500.4	0.07
500.0 V @ 1 kHz	500.0	489.7	510.3	500.4	500.4	0.06
1000 V Range						
1000 V @ 45 Hz	1000	987	1013	996	996	0.6

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 ● Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ACCREDITED ISO IEC 17025 CALIBRATION AND TESTING LABORATORY
Certificate No. ACT-1272

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
AC VOLTS FREQUENCY						
45.00 Hz @ 1 V	45.00	44.95	45.06	45.00	45.00	0.007
50.00 kHz @ 5 V	50.00	49.94	50.06	50.00	50.00	0.007
DC VOLTAGE						
6 V Range						
5.000 V	5.000	4.990	5.010	5.000	5.000	0.0007
600 V Range						
300.0 V	300.0	299.4	300.6	300.0	300.0	0.06
1000 V Range						
1000 V	1000	997	1004	1000	1000	0.7
-1000 V	-1000	-1004	-997	-1000	-1000	0.7
DC VOLTS FREQUENCY						
45.00 Hz @ 3 V	45.00	44.95	45.06	45.00	45.00	0.007
50.00 kHz @ 30 V	50.00	49.94	50.06	50.00	50.00	0.007
DC MILLIVOLTS						
30.0 mV	30.0	29.8	30.2	30.0	30.0	0.07
-300.0 mV	-300.0	-300.6	-299.4	-299.9	-299.9	0.06
600.0 mV	600.0	598.9	601.1	599.9	599.9	0.06
OHMS						
600 Ohm Range						
19.0 Ohm	19.0	18.6	19.4	19.0	19.0	0.07
50 MOhm Range						
19.00 MOhm	19.00	18.68	19.32	18.99	18.99	0.006
CAPACITANCE						
1000 nF Range						
900 nF	900	887	913	900	900	0.7
CONTINUITY						
0 Ohms: Beeper On				Pass	Pass	
190 Ohms: Beeper Off				Pass	Pass	
DIODE TEST						
2.000 V	2.000	1.978	2.022	2.001	2.001	0.0006
AC MILLIAMPS						
60 mA Range						

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 ● Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ilac-MRA ANAB ACCREDITED ISO IEC 17025 CALIBRATION AND TESTING LABORATORY
Certificate No. ACT-1272

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
3.00 mA @ 45 Hz	3.00	2.92	3.08	3.01	3.01	0.007
50.00 mA @ 1 kHz	50.00	49.22	50.78	49.96	49.96	0.007
400 mA Range						
400.0 mA @ 1 kHz	400.0	393.7	406.3	399.4	399.4	0.06
AC AMPS						
6 A Range						
4.000 A @ 45 Hz	4.000	3.937	4.063	3.997	3.997	0.0007
10A Range						
9.00 A @ 1 kHz	9.00	8.84	9.16	9.00	9.00	0.007
DC MILLIAMPS						
60 mA Range						
3.00 mA	3.00	2.94	3.06	3.02	3.02	0.006
50.00 mA	50.00	49.47	50.53	49.99	49.99	0.006
400 mA Range						
-400.0 mA	-400.0	-404.3	-395.7	-400.0	-400.0	0.07
DC AMPS						
6 A Range						
4.000 A	4.000	3.957	4.043	3.999	3.999	0.0007
10 A Range						
-9.00 A	-9.00	-9.12	-8.88	-9.00	-9.00	0.007

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 • Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ilac-MRA · ANAB ACCREDITED ISO IEC 17025 CALIBRATION AND TESTING LABORATORY
Certificate No. ACT-1272

Certification Number CK198-38779-466

For Eaton Corporation - ICD
W126 N7250 Flint Drive
Menomonee Falls, WI 53051

Purchase Order #	4044-671109
Test Instrument	Multimeter Digital Multimeter
Make	Fluke
Model	179
Serial Number	14370601
Identification	EM7024
Customer Location	ICD
Condition Received	In Tolerance
Condition Returned	In Tolerance
Calibrated By	Alex Paulsen
Technical Review By	Tim Bending
Calibration Location	FVM
Calibration Conditions	68.2°F, 20.1°C, 56.6%RH
Calibration Date	07/16/2020
Recalibration Due	07/16/2021

Procedures Followed
FVE-000 rev. 2
FVE-001 rev. 2

Standards Used

Instrument	Serial Number	Trace Number	Next Cal
FVS-275A	RY11838	CJ191-70508-513	07/28/2020
FVS-737	4542903	CK041-57440-531	02/28/2021

Total expanded measurement uncertainties expressed are based on a confidence level of 95%; coverage factor of (k=2). The statement of compliance in this certificate was issued without taking the uncertainty of measurement into consideration. The customer shall assess the results and uncertainty when determining if the results meet their needs. (This is considered “shared responsibility.”) Uncertainties expressed in nominal units.

All instruments have been calibrated against standards traceable to NIST. Calibration was completed in accordance with ISO/IEC 17025:2017, ANSI/NCSL Z540-1-1994 and ANSI/NCSL Z540.3-2006. Other standards listed upon request.

Calibration Results

* denotes "Out of Tolerance"

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
AC VOLTS						
600 mV Range						
300.0 mV @ 45 Hz	300.0	296.7	303.3	300.0	300.0	0.06
6 V Range						
5.000 V @ 500 Hz	5.000	4.947	5.053	4.997	4.997	0.0006
5.000 V @ 1 kHz	5.000	4.897	5.103	4.961	4.961	0.0006
60 V Range						
50.00 V @ 45 Hz	50.00	49.47	50.53	49.97	49.97	0.006
50.00 V @ 1 kHz	50.00	48.97	51.03	50.10	50.10	0.007
600 V Range						
300.0 V @ 45 Hz	300.0	296.7	303.3	300.0	300.0	0.07
500.0 V @ 500 Hz	500.0	494.7	505.3	500.9	500.9	0.06
500.0 V @ 1 kHz	500.0	489.7	510.3	500.8	500.8	0.06
1000 V Range						
1000 V @ 45 Hz	1000	987	1013	997	997	0.7

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 ● Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ilac-MRA ANAB ACCREDITED ISO IEC 17025 CALIBRATION AND TESTING LABORATORY
Certificate No. ACT-1272

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
AC VOLTS FREQUENCY						
45.00 Hz @ 1 V	45.00	44.95	45.06	45.00	45.00	0.007
50.00 kHz @ 5 V	50.00	49.94	50.06	50.00	50.00	0.006
DC VOLTAGE						
6 V Range						
5.000 V	5.000	4.994	5.007	5.000	5.000	0.0006
600 V Range						
300.0 V	300.0	299.5	300.5	299.9	299.9	0.06
1000 V Range						
1000 V	1000	997	1004	1000	1000	0.7
-1000 V	-1000	-1004	-997	-1000	-1000	0.7
DC VOLTS FREQUENCY						
45.00 Hz @ 3 V	45.00	44.95	45.06	45.00	45.00	0.007
50.00 kHz @ 30 V	50.00	49.94	50.06	50.00	50.00	0.006
DC MILLIVOLTS						
30.0 mV	30.0	29.8	30.2	30.0	30.0	0.06
-300.0 mV	-300.0	-300.5	-299.5	-299.9	-299.9	0.06
600.0 mV	600.0	599.3	600.7	599.8	599.8	0.06
TEMPERATURE						
0.0 °C	0.0	-1.0	1.0	0.5	0.5	0.06
-40.0 °C	-40.0	-41.4	-38.6	-39.3	-39.3	0.06
400.0 °C	400.0	395.0	405.0	400.4	400.4	0.06
OHMS						
600 Ohm Range						
19.0 Ohm	19.0	18.6	19.4	19.0	19.0	0.06
50 MOhm Range						
19.00 MOhm	19.00	18.68	19.32	18.98	18.98	0.006
CAPACITANCE						
1000 nF Range						
900 nF	900	887	913	900	900	0.6
CONTINUITY						
0 Ohms: Beeper On				Pass	Pass	
190 Ohms: Beeper Off				Pass	Pass	
DIODE TEST						

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 ● Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ACCREDITED ISO IEC 17025 CALIBRATION AND TESTING LABORATORY
Certificate No. ACT-1272

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
2.000 V	2.000	1.978	2.022	2.001	2.001	0.0007
AC MILLIAMPS						
60 mA Range						
3.00 mA @ 45 Hz	3.00	2.92	3.08	3.02	3.02	0.006
50.00 mA @ 1 kHz	50.00	49.22	50.78	50.03	50.03	0.006
400 mA Range						
400.0 mA @ 1 kHz	400.0	393.7	406.3	399.9	399.9	0.06
AC AMPS						
6 A Range						
4.000 A @ 45 Hz	4.000	3.937	4.063	4.004	4.004	0.0006
10A Range						
9.00 A @ 1 kHz	9.00	8.84	9.16	9.01	9.01	0.007
DC MILLIAMPS						
60 mA Range						
3.00 mA	3.00	2.94	3.06	3.01	3.01	0.007
50.00 mA	50.00	49.47	50.53	49.99	49.99	0.007
400 mA Range						
-400.0 mA	-400.0	-404.3	-395.7	-399.9	-399.9	0.06
DC AMPS						
6 A Range						
4.000 A	4.000	3.957	4.043	3.998	3.998	0.0006
10 A Range						
-9.00 A	-9.00	-9.12	-8.88	-9.00	-9.00	0.007

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 • Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ilac-MRA ANAB ACCREDITED ISO IEC 17025 CALIBRATION AND TESTING LABORATORY

Certificate No. ACT-1272

Certification Number CK198-41226-466

For Eaton Corporation - ICD
W126 N7250 Flint Drive
Menomonee Falls, WI 53051

Purchase Order #	4044-671109
Test Instrument	Clamp Meter
Make	AEMC
Model	SR759
Serial Number	224137GKDV
Identification	EM6996
Customer Location	ICD
Condition Received	In Tolerance
Condition Returned	In Tolerance
Calibrated By	Alex Paulsen
Technical Review By	Tim Bending
Calibration Location	FVM
Calibration Conditions	67.8°F, 19.9°C, 56.3%RH
Calibration Date	07/16/2020
Recalibration Due	07/16/2021

Procedures Followed
FVE-007 rev. 2

Standards Used

Instrument	Serial Number	Trace Number	Next Cal
FVS-275A	RY11838	CJ191-70508-513	07/28/2020
FVS-546	24560221	CK093-41519-573	04/30/2021
FVS-737	4542903	CK041-57440-531	02/28/2021

Total expanded measurement uncertainties expressed are based on a confidence level of 95%; coverage factor of (k=2). The statement of compliance in this certificate was issued without taking the uncertainty of measurement into consideration. The customer shall assess the results and uncertainty when determining if the results meet their needs. (This is considered "shared responsibility.") Uncertainties expressed in nominal units.

All instruments have been calibrated against standards traceable to NIST. Calibration was completed in accordance with ISO/IEC 17025:2017, ANSI/NCSL Z540-1-1994 and ANSI/NCSL Z540.3-2006. Other standards listed upon request.

Calibration Results

* denotes "Out of Tolerance"

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
1A Range; 1000mV/A @60 Hz	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)
10 mA	10.0	8.7	11.3	10.1	10.1	0.07
100 mA	100.0	96.0	104.0	101.3	101.3	0.06
500 mA	500.0	495.5	504.5	504.5	504.5	0.06
	(V AC)	(V AC)	(V AC)	(V AC)	(V AC)	(V AC)
1 A	1.000	0.992	1.008	1.008	1.008	0.0006
10A Range; 100mV/A @60 Hz	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)
100 mA	10.0	9.7	10.3	10.0	10.0	0.07
1 A	100.0	99.3	100.7	100.4	100.4	0.07
5 A	500.0	497.5	502.5	501.8	501.8	0.06
	(V AC)	(V AC)	(V AC)	(V AC)	(V AC)	(V AC)
10 A	1.000	0.995	1.005	1.004	1.004	0.0007
100A Range; 10mV/A @60 Hz	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)
1 A	10.0	9.7	10.3	10.0	10.0	0.07
10 A	100.0	99.3	100.7	100.1	100.1	0.06

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 ● Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ilac-MRA

ANAB ACCREDITED ISO IEC 17025 CALIBRATION AND TESTING LABORATORY

Certificate No. ACT-1272

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
50 A	500.0	498.5	501.5	500.3	500.3	0.06
	(V AC)	(V AC)	(V AC)	(V AC)	(V AC)	(V AC)
100 A	1.000	0.998	1.002	1.001	1.001	0.0006
1000A Range; 1mV/A @60 Hz	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)
10 A	10.0	9.7	10.3	10.0	10.0	0.06
100 A	100.0	99.3	100.7	100.1	100.1	0.07
500 A	500.0	499.0	501.0	500.5	500.5	0.07
900 A	900.0	898.0	902.0	901.2	901.2	0.07

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 • Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ANAB ACCREDITED ISO IEC 17025 CALIBRATION AND TESTING LABORATORY
Certificate No. ACT-1272

Certification Number CK198-40179-466

For Eaton Corporation - ICD
W126 N7250 Flint Drive
Menomonee Falls, WI 53051

Purchase Order #	4044-671109
Test Instrument	Clamp Meter
Make	AEMC
Model	SR759
Serial Number	224139GKDV
Identification	EM6997
Customer Location	ICD
Condition Received	In Tolerance
Condition Returned	In Tolerance
Calibrated By	Alex Paulsen
Technical Review By	Tim Bending
Calibration Location	FVM
Calibration Conditions	67.8°F, 19.9°C, 56.3%RH
Calibration Date	07/16/2020
Recalibration Due	07/16/2021

Procedures Followed
FVE-007 rev. 2

Standards Used

Instrument	Serial Number	Trace Number	Next Cal
FVS-275A	RY11838	CJ191-70508-513	07/28/2020
FVS-546	24560221	CK093-41519-573	04/30/2021
FVS-737	4542903	CK041-57440-531	02/28/2021

Total expanded measurement uncertainties expressed are based on a confidence level of 95%; coverage factor of (k=2). The statement of compliance in this certificate was issued without taking the uncertainty of measurement into consideration. The customer shall assess the results and uncertainty when determining if the results meet their needs. (This is considered "shared responsibility.") Uncertainties expressed in nominal units.

All instruments have been calibrated against standards traceable to NIST. Calibration was completed in accordance with ISO/IEC 17025:2017, ANSI/NCSL Z540-1-1994 and ANSI/NCSL Z540.3-2006. Other standards listed upon request.

Calibration Results

* denotes "Out of Tolerance"

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
1A Range; 1000mV/A @60 Hz	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)
10 mA	10.0	8.7	11.3	10.1	10.1	0.06
100 mA	100.0	96.0	104.0	101.1	101.1	0.06
500 mA	500.0	495.5	504.5	504.5	504.5	0.06
	(V AC)	(V AC)	(V AC)	(V AC)	(V AC)	(V AC)
1 A	1.000	0.992	1.008	1.008	1.008	0.0006
10A Range; 100mV/A @60 Hz	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)
100 mA	10.0	9.7	10.3	10.0	10.0	0.07
1 A	100.0	99.3	100.7	100.2	100.2	0.06
5 A	500.0	497.5	502.5	500.9	500.9	0.06
	(V AC)	(V AC)	(V AC)	(V AC)	(V AC)	(V AC)
10 A	1.000	0.995	1.005	1.002	1.002	0.0006
100A Range; 10mV/A @60 Hz	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)
1 A	10.0	9.7	10.3	10.0	10.0	0.06
10 A	100.0	99.3	100.7	100.1	100.1	0.07

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 ● Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ilac-MRA ANAB ACCREDITED ISO IEC 17025 CALIBRATION AND TESTING LABORATORY
Certificate No. ACT-1272

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
50 A	500.0	498.5	501.5	500.1	500.1	0.06
	(V AC)	(V AC)	(V AC)	(V AC)	(V AC)	(V AC)
100 A	1.000	0.998	1.002	1.001	1.001	0.0006
1000A Range; 1mV/A @60 Hz	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)
10 A	10.0	9.7	10.3	10.0	10.0	0.07
100 A	100.0	99.3	100.7	100.1	100.1	0.06
500 A	500.0	499.0	501.0	500.3	500.3	0.06
900 A	900.0	898.0	902.0	901.4	901.4	0.06

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 • Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ACCREDITED ISO IEC 17025 CALIBRATION AND TESTING LABORATORY
Certificate No. ACT-1272

Certification Number CK198-41583-466

For Eaton Corporation - ICD
W126 N7250 Flint Drive
Menomonee Falls, WI 53051

Purchase Order #	4044-671109
Test Instrument	Clamp Meter
Make	AEMC
Model	SR759
Serial Number	239584HKDV
Identification	EM8032
Customer Location	ICD
Condition Received	In Tolerance
Condition Returned	In Tolerance
Calibrated By	Alex Paulsen
Technical Review By	Tim Bending
Calibration Location	FVM
Calibration Conditions	67.8°F, 19.9°C, 56.3%RH
Calibration Date	07/16/2020
Recalibration Due	07/16/2021

Procedures Followed
FVE-007 rev. 2

Standards Used

Instrument	Serial Number	Trace Number	Next Cal
FVS-275A	RY11838	CJ191-70508-513	07/28/2020
FVS-546	24560221	CK093-41519-573	04/30/2021
FVS-737	4542903	CK041-57440-531	02/28/2021

Total expanded measurement uncertainties expressed are based on a confidence level of 95%; coverage factor of (k=2). The statement of compliance in this certificate was issued without taking the uncertainty of measurement into consideration. The customer shall assess the results and uncertainty when determining if the results meet their needs. (This is considered "shared responsibility.") Uncertainties expressed in nominal units.

All instruments have been calibrated against standards traceable to NIST. Calibration was completed in accordance with ISO/IEC 17025:2017, ANSI/NCSL Z540-1-1994 and ANSI/NCSL Z540.3-2006. Other standards listed upon request.

Calibration Results

* denotes "Out of Tolerance"

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
1A Range; 1000mV/A @60 Hz	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)
10 mA	10.0	8.7	11.3	10.2	10.2	0.07
100 mA	100.0	96.0	104.0	101.1	101.1	0.07
500 mA	500.0	495.5	504.5	504.3	504.3	0.06
	(V AC)	(V AC)	(V AC)	(V AC)	(V AC)	(V AC)
1 A	1.000	0.992	1.008	1.007	1.007	0.0007
10A Range; 100mV/A @60 Hz	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)
100 mA	10.0	9.7	10.3	10.0	10.0	0.07
1 A	100.0	99.3	100.7	100.2	100.2	0.07
5 A	500.0	497.5	502.5	500.7	500.7	0.06
	(V AC)	(V AC)	(V AC)	(V AC)	(V AC)	(V AC)
10 A	1.000	0.995	1.005	1.002	1.002	0.0006
100A Range; 10mV/A @60 Hz	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)
1 A	10.0	9.7	10.3	10.0	10.0	0.07
10 A	100.0	99.3	100.7	100.0	100.0	0.07

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 ● Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

ACCREDITED
ISO IEC 17025
CALIBRATION AND TESTING LABORATORY
Certificate No. ACT-1272

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
50 A	500.0	498.5	501.5	500.0	500.0	0.07
	(V AC)	(V AC)	(V AC)	(V AC)	(V AC)	(V AC)
100 A	1.000	0.998	1.002	1.000	1.000	0.0007
1000A Range; 1mV/A @60 Hz	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)	(mV AC)
10 A	10.0	9.7	10.3	10.0	10.0	0.07
100 A	100.0	99.3	100.7	100.0	100.0	0.06
500 A	500.0	499.0	501.0	500.3	500.3	0.07
900 A	900.0	898.0	902.0	900.6	900.6	0.07

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 ● Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

Certificate No. ACT-1272

Certification Number CK196-72143-379

For Eaton Corporation - ICD
W126 N7250 Flint Drive
Menomonee Falls, WI 53051

Purchase Order #	4044-671109
Test Instrument	Torque Wrench
Make	CDI
Model	1502LDIN (3%)
Serial Number	0312910937
Identification	EM8363
Customer Location	ICD
Condition Received	In Tolerance
Condition Returned	In Tolerance
Calibrated By	Jim Peterson
Technical Review By	Kevin Dehne
Calibration Location	FVM
Calibration Conditions	69.0°F, 20.6°C, 54.2%RH
Calibration Date	07/14/2020
Recalibration Due	07/14/2021

Procedures Followed
FVE-014 rev. 2

Standards Used

Instrument	Serial Number	Trace Number	Next Cal
FVS-093	03111	CK191-31886-628	10/31/2020
FVS-275A	RY11838	CJ191-70508-513	07/28/2020

Total expanded measurement uncertainties expressed are based on a confidence level of 95%; coverage factor of (k=2). The statement of compliance in this certificate was issued without taking the uncertainty of measurement into consideration. The customer shall assess the results and uncertainty when determining if the results meet their needs. (This is considered "shared responsibility.") Uncertainties expressed in nominal units.

All instruments have been calibrated against standards traceable to NIST. Calibration was completed in accordance with ISO/IEC 17025:2017, ANSI/NCSL Z540-1-1994 and ANSI/NCSL Z540.3-2006. Other standards listed upon request.

* denotes "Out of Tolerance"

Calibration Results

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
Clockwise	(in lb)	(in lb)	(in lb)	(in lb)	(in lb)	(in lb)
	30.00	29.10	30.90	29.89	29.89	0.091
	90.00	87.30	92.70	90.23	90.23	0.271
	150.00	145.50	154.50	152.00	152.00	0.450
Counter Clockwise	(in lb)	(in lb)	(in lb)	(in lb)	(in lb)	(in lb)
	30.00	29.10	30.90	30.31	30.31	0.091
	90.00	87.30	92.70	89.53	89.53	0.271
	150.00	145.50	154.50	148.58	148.58	0.450

Fox Valley Metrology
3114 Medalist Drive
Oshkosh, WI 54902
(920) 426-5894 ● Fax (920) 426-8120
http://www.FoxValleyMetrology.com

CERTIFICATE OF CALIBRATION

Certificate No. ACT-1272

Certification Number CK198-49542-348

For Eaton Corporation - ICD
W126 N7250 Flint Drive
Menomonee Falls, WI 53051

Purchase Order #	4044-671109
Test Instrument	Tape Measure
Make	Stanley
Model	30-824
Serial Number	
Identification	EM6927
Customer Location	ICD Tony
Condition Received	In Tolerance
Condition Returned	In Tolerance
Calibrated By	Matthew Roughen
Technical Review By	Laura Fuhrmann
Calibration Location	FVM
Calibration Conditions	69.5°F, 20.8°C, 34.8%RH
Calibration Date	07/16/2020
Recalibration Due	07/16/2021

Procedures Followed
FVM-042 rev. 1

Standards Used

Instrument	Serial Number	Trace Number	Next Cal
FVM-044	C404R	CH121-20770-384	05/28/2022
FVM-079A	RY11924	CJ191-72229-513	07/28/2020

Total expanded measurement uncertainties expressed are based on a confidence level of 95%; coverage factor of (k=2). The statement of compliance in this certificate was issued without taking the uncertainty of measurement into consideration. The customer shall assess the results and uncertainty when determining if the results meet their needs. (This is considered "shared responsibility.") Uncertainties expressed in nominal units.

All instruments have been calibrated against standards traceable to NIST. Calibration was completed in accordance with ISO/IEC 17025:2017, ANSI/NCSL Z540-1-1994 and ANSI/NCSL Z540.3-2006. Other standards listed upon request.

Calibration Results

* denotes "Out of Tolerance"

Feature	Nominal	Lower Limit	Upper Limit	As Found	As Left	Uncertainty
Length	(in)	(in)	(in)	(in)	(in)	
	12.000	11.969	12.031	11.995	11.995	0.0006
	24.000	23.938	24.062	23.995	23.995	0.0007
	48.000	47.938	48.062	47.995	47.995	0.0007
	72.000	71.938	72.062	71.995	71.995	0.0007
	144.000	143.938	144.062	143.995	143.995	0.0006
	216.000	215.938	216.062	215.995	215.995	0.0006
	312.000	311.938	312.062	311.995	311.995	0.0007
Length	(cm)	(cm)	(cm)	(cm)	(cm)	(cm)
	500.00	499.00	501.00	499.87	499.87	0.007
	1000.00	999.00	1001.00	999.87	999.87	0.006
	5000.00	4999.00	5001.00	4999.87	4999.87	0.008
	8000.00	7999.00	8001.00	7999.87	7999.87	0.012

Public Input No. 4134-NFPA 70-2020 [New Section after 404.14(F)]

TITLE OF NEW CONTENT

404.16 Reconditioning, Snap switches of any type shall not be permitted to be reconditioned. Knife switches, switches with butt contacts, and bolted pressure contact switches shall be permitted to be reconditioned. The reconditioning process shall use design qualified parts verified under applicable standards, and and shall be performed in accordance with any instructions provided by the manufacturer. If equipment has been damaged by fire, products of combustion, or water, it shall be specifically evaluated by its manufacturer or a qualified testing laboratory prior to being returned to service. Reconditioned switches shall be listed or field labeled as *reconditioned* , and any previously applied listing marks on the enclosure shall be removed.

Statement of Problem and Substantiation for Public Input

This PI is intended as a placeholder for discussion with respect to potential reconditioning of switches. It assumes snap switches, no, and larger switches, perhaps, using the parameters set by CMP 9 in the 2020 cycle for switchgear. At some point, equipment gets big enough to merit reconditioning rather than replacement, and after the prior cycle the time is ripe for this conversation.

Submitter Information Verification

Submitter Full Name: Frederic Hartwell

Organization: Hartwell Electrical Services, IOnc.

Affiliation: self

Street Address:

City:

State:

Zip:

Submittal Date: Wed Sep 09 21:45:32 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7859-NFPA 70-2020

Statement: Lighting dimmer and electronic control switches are constructed using specialized materials, parts and techniques that are specified by the original equipment manufacturer. If these factors are not properly considered during reconditioning, important safety features may not function properly. Additionally, if proper materials, parts, or equipment are not used, the integrity of reconditioned devices may not be assured, and reliability or function may be compromised This change will clearly address reconditioning of these devices.

Snap switches are inexpensive and easy to replace and should not be reconditioned.

Knife switches, switches with butt contacts, and bolted pressure contact switches are open type and could be repaired or parts replaced if available

CMP-9 moves the requirement to 404.16 rather than 404.24 as this is more appropriate, adds corrosive influences to the list and makes reference to 110.21(A)(2).

Public Input No. 2782-NFPA 70-2020 [Section No. 404.14 [Excluding any Sub-Sections]]

Switches shall be listed and ~~used within~~ marked with their ratings. Switches of the types covered in 404.14(A) through (E) shall be limited to the control of loads as specified accordingly. Switches used to control cord-and-plug-connected loads shall be limited as covered in 404.14(F).

Informational Note No. 1: For switches for signs and outline lighting, see 600.6.

Informational Note No. 2: For switches controlling motors, see 430.83, 430.109, and 430.110.

Statement of Problem and Substantiation for Public Input

The marking provides the AHJ with the intended rating for use. This new requirement will provide the AHJ with the necessary information to determine compliance with the installation.

Submitter Information Verification

Submitter Full Name: Richard Hollander
Organization: Shums Coda Associates
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 31 20:53:53 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7881-NFPA 70-2020

Statement: The UL standard and associated guide information under category code WJQR for snap switches with push in terminals permits only 14 AWG solid copper conductors to be used at this time.

“Screwless terminal connectors of the conductor push-in type (also known as "push-in terminals") are restricted to 15 A branch circuits and are intended for connection with 14 AWG solid copper wire only. They are not intended for use with aluminum or copper-clad aluminum wire, 14 AWG stranded copper wire, or 12 AWG solid or stranded copper wire.”

The change to this section is to highlight this limitation for switches that may have push-in terminals provided. The introduction of 14 AWG copper-clad aluminum into the NEC for branch circuit wiring needs this limitation to ensure push-in terminals on wiring devices are being installed in accordance with their listing. Nothing in the proposed language mandates that the push-in terminals must be used.

The marking addition ensures that the AHJ will be provided with the intended rating for use. The panel finds it necessary to write this requirement into NEC although it may already be present in other applicable standards.

Public Input No. 3047-NFPA 70-2020 [New Section after 404.22]

404.24 Reconditioned Equipment

Lighting Dimmers and Electronic Control Switches shall not be permitted to be reconditioned.

Statement of Problem and Substantiation for Public Input

Lighting dimmer and electronic control switches are constructed using specialized materials, parts and techniques that are specified by the original equipment manufacturer. If these factors are not properly considered during reconditioning, important safety features may not function properly. Additionally, if proper materials, parts, or equipment are not used, the integrity of reconditioned devices may not be assured, and reliability or function may be compromised. Accordingly, the NEMA Technical Position on Reconditioned Equipment, CS 100-2020, specifies that lighting controls are components or assemblies that are not suitable for reconditioning. The proposed change will clearly address reconditioning of these devices.

Submitter Information Verification

Submitter Full Name: Megan Hayes
Organization: Nema
Street Address:
City:
State:
Zip:
Submittal Date: Fri Sep 04 10:48:00 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7859-NFPA 70-2020

Statement: Lighting dimmer and electronic control switches are constructed using specialized materials, parts and techniques that are specified by the original equipment manufacturer. If these factors are not properly considered during reconditioning, important safety features may not function properly. Additionally, if proper materials, parts, or equipment are not used, the integrity of reconditioned devices may not be assured, and reliability or function may be compromised This change will clearly address reconditioning of these devices.

Snap switches are inexpensive and easy to replace and should not be reconditioned.

Knife switches, switches with butt contacts, and bolted pressure contact switches are open type and could be repaired or parts replaced if available

CMP-9 moves the requirement to 404.16 rather than 404.24 as this is more appropriate, adds corrosive influences to the list and makes reference to 110.21(A)(2).

Public Input No. 4109-NFPA 70-2020 [New Section after 404.28]

TITLE OF NEW CONTENT

424.30 Switch Interiors Accessible While Energized. Switch mechanisms mounted within enclosures with doors shall be arranged so the door will require a tool to open when the switch is in the energized position.

Statement of Problem and Substantiation for Public Input

Enclosed switches are commonly placed in locations easily accessible to unqualified persons. Examples include air conditioning condenser disconnects at dwelling occupancies, frequently 3 ft above grade and where young children play. The industrial versions of these switches can be opened while energized, but only by using a tool to operate a defeater. It is time to consider sunsetting the switch designs that do not have this feature, perhaps with a three year delayed effective date. Many actions taken in Article 690 (e.g. 690.13 and 690.15) are in response to this issue, where there are now requirements that "where di9sconnecting means ... are readily accessible to unqualified persons, any enclosure door or hinged cover that exposes live parts when open shall be locked or require a tool to open." Aside from incorrect usage of "live parts" (should be "uninsulated live parts"), This PI is intended to open a general discussion about the prevalence and acceptability of these switch designs.

Submitter Information Verification

Submitter Full Name: Frederic Hartwell

Organization: Hartwell Electrical Services, Inc.

Affiliation: self

Street Address:

City:

State:

Zip:

Submittal Date: Wed Sep 09 21:03:13 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7861-NFPA 70-2020

Statement: Switches of this type may allow access to live parts with the door open that the user may contact. This change will restrict access to qualified persons.

Public Input No. 3252-NFPA 70-2020 [Section No. 408.1]

408.1 Scope.

This article covers switchboards, switchgear, and panelboards. It does not apply to equipment operating at over 1000 volts, except as specifically referenced elsewhere in the *Code*.

Informational Note: See IEEE 3004.11 Recommended Practice for Bus and Switchgear Protection in Industrial and Commercial Power Systems for additional information.

Statement of Problem and Substantiation for Public Input

This is another slice of updated content from the legacy "Red Book" IEEE 141 and "Gray Book: IEEE 241 into the new IEEE 3000 Standards Collection. From the project prospectus:

"Covered in this recommended practice is the protection of bus and switchgear used in industrial and commercial power systems. Also provided are fault protection and isolation strategies for the substation bus and switchgear, including the bus, circuit breakers, fuses, disconnecting devices, transformers, and the structures on which they are mounted."

https://standards.ieee.org/standard/3004_11-2019.html

Submitter Information Verification

Submitter Full Name:	Michael Anthony
Organization:	Standards Michigan
Affiliation:	IEEE Education & Healthcare Facilities Electrotechnology Committee
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon Sep 07 10:54:49 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: The use of an Informational Note to the scope of Article 408 is unwarranted and unrelated to the scope of the Article.

Public Input No. 3878-NFPA 70-2020 [Section No. 408.2]

~~**408.2** Other Articles.~~

~~Switches, circuit breakers, and overcurrent devices used on switchboards, switchgear, and panelboards and their enclosures shall comply with this article and also with the requirements of Articles 240 , 250 , 312 , 404 , and other articles that apply. Switchboards, switchgear, and panelboards in hazardous (classified) locations shall comply with the applicable provisions of Articles 500 through 517 .~~

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to the entire article, with the exception of Article 100. The Chapter 2 and Chapter 3 Articles identified apply based on Section 90.3. The hazardous location articles would supercede the general articles also in accordance with Section 90.3. Alternatively, the CMP may wish to identify "Other Articles" in a table format in compliance with Sections 2.3 and 2.5 of the Style Manual (see Table 409.3 as an example)..

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3885-NFPA 70-2020 [Section No. 408.53]	

Submitter Information Verification

Submitter Full Name: Richard Holub
Organization: The DuPont Company, Inc.
Street Address:
City:
State:
Zip:
Submittal Date: Wed Sep 09 14:41:07 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7890-NFPA 70-2020

Statement: The information in 408.2 is redundant and applies because of section 90.3. There is no need to reference here.

Public Input No. 206-NFPA 70-2019 [Section No. 408.4]

408.4 ~~Field~~ Identification Required.

(A) Circuit Directory or Circuit Identification.

Every circuit and circuit modification shall be legibly identified as to its clear, evident, and specific purpose or use. The identification shall include an approved degree of detail that allows each circuit to be distinguished from all others. Spare positions that contain unused overcurrent devices or switches shall be described accordingly. The identification shall be included in a circuit directory that is located on the face, inside of, or in an approved location adjacent to the panel door in the case of a panelboard and at each switch or circuit breaker in a switchboard or switchgear. No circuit shall be described in a manner that depends on transient conditions of occupancy.

(B) Source of Supply.

All switchboards, switchgear, and panelboards supplied by a feeder(s) in other than one- or two-family dwellings shall be permanently marked to indicate each device or equipment where the power originates. The label shall be permanently affixed, of sufficient durability to withstand the environment involved, and not handwritten.

Statement of Problem and Substantiation for Public Input

I have received pushback from a handful of electrical engineers who feel that they have no role whatsoever with regard to panel circuit identification. It makes things very difficult when the electrical engineer hides behind the title of this section in an effort to shirk any responsibility. I run into this frequently during electrical plan review. Removing the word "field" helps the electrical plans examiner to request changes, should panel circuit identification need correction at the plan review stage.

To this day, I still get vague panel schedules that state, "receptacles" and "lights," or worse yet - "RCPT" and "LTS." Here is one example of a correction comment that I use quite often:

"There are multiple violations with the panel schedules and the circuit identification. For panel identification in 2017 NEC, an approved degree of detail is required. Please read 2017 NEC Article 408.4(A) and see 2017 NEC handbook page 438. Identification must be more descriptive. Label by area, by station, by number, by location (north, south, east, or west), etc., some method that helps to describe one from another. THIS LIST MAY NOT BE ALL-INCLUSIVE. There are approximately 22 circuits that say, “receptacle.” There are approximately 10 circuits that say, “equipment.” There are approximately 3 circuits that say, “lighting.” This is what the code is trying to prohibit. Note: “Equipment” should be in concert with equipment that is indicated on the equipment schedule on page xxx. Revise all panel circuit identification to reflect 2017 NEC standards."

ALL electrical professionals share a responsibility for circuit identification - from design professional to the electrical plans examiner to the electrical worker on the jobsite. 95 times out of 100, the field identification is taken directly from the panel schedules on the approved set of plans. It is crucial and critical that electrical engineers realize their important contribution with regard to circuit descriptions. The starting point with any type of code enforcement is at plan review. This change is needed as it will assist the electrical plans examiner. The NEC is an enforcement document; this change will improve electrical code enforcement at the plan review stage. There is no reason to limit the scope of this provision solely to "the field." Please strike the word "FIELD."

In addition, mostly all architects and electrical engineers' practice acts (laws and rules) state that panel schedules must be provided as part of the minimum information to be contained on an electrical plan submittal. So in all reality, the counterargument becomes a logical fallacy.

All electrical professionals have a responsibility for circuit identification.
All electrical professionals have a responsibility for circuit identification.
All electrical professionals have a responsibility for circuit identification.

Submitter Information Verification

Submitter Full Name: Nick Sasso
Organization: Clark County Building and Fire
Street Address:
City:
State:
Zip:
Submittal Date: Thu Dec 26 17:29:49 EST 2019
Committee: NEC-P09

Committee Statement

Resolution: FR-7895-NFPA 70-2020

Statement: The removal of the word field is needed as it will assist the electrical plans examiner. The NEC is an enforcement document; this change will improve electrical Code enforcement at the plan review stage. There is no reason to limit the scope of this provision solely to "the field."

Identification is changed to description so as to not conflict with the defined term in Article 100.

The description should be marked in a permanent way to prevent fading over time. A specific language may not be appropriate in some areas. Legible handwriting is acceptable.

CMP-9 adds physical location for clarity. The location of where power originates is critical information for inspectors, service persons, and other individuals that may have need to locate the supply source. It is not always readily apparent where the location of the source is. For this reason, an identification of the location of the source should be provided in addition to the identification of the source itself.

In some circumstances the location of the supply source may be readily apparent, but it was determined that allowing for an exemption in these cases would lead to ambiguity and make the requirement too subjective. For this reason, the requirement is applied to all cases.

Public Input No. 2456-NFPA 70-2020 [Section No. 408.4(A)]

(A) Circuit Directory or Circuit Identification.

Every circuit and circuit modification shall be legibly identified as to its clear, evident, and specific purpose or use.The markings shall be completed with a permanent type marking, lead pencil type markings are not permitted. The identification shall include an approved degree of detail that allows each circuit to be distinguished from all others. Spare positions that contain unused overcurrent devices or switches shall be described accordingly. The identification shall be included in a circuit directory that is located on the face, inside of, or in an approved location adjacent to the panel door in the case of a panelboard and at each switch or circuit breaker in a switchboard or switchgear. No circuit shall be described in a manner that depends on transient conditions of occupancy.

Statement of Problem and Substantiation for Public Input

The additional language will help clarify pencil and similar types of markings which fade over time and then become unreadable will not be allowed. These pencil markings, even when located inside of a closed panelboard cover, will fade over time. Without this added language, it becomes difficult to require ink or other similar type markers to be used which will be permanent and cannot fade away over time.

Submitter Information Verification

Submitter Full Name: Robert Fahey
Organization: City of Janesville
Street Address:
City:
State:
Zip:

Submittal Date: Sun Aug 23 08:15:16 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7895-NFPA 70-2020

Statement: The removal of the word field is needed as it will assist the electrical plans examiner. The NEC is an enforcement document; this change will improve electrical Code enforcement at the plan review stage. There is no reason to limit the scope of this provision solely to "the field."

Identification is changed to description so as to not conflict with the defined term in Article 100.

The description should be marked in a permanent way to prevent fading over time. A specific language may not be appropriate in some areas. Legible handwriting is acceptable.

CMP-9 adds physical location for clarity. The location of where power originates is critical information for inspectors, service persons, and other individuals that may have need to locate the supply source. It is not always readily apparent where the location of the source is. For this reason, an identification of the location of the source should be provided in addition to the identification of the source itself.

In some circumstances the location of the supply source may be readily apparent, but it was determined that allowing for an exemption in these cases would lead to ambiguity and make the requirement too subjective. For this reason, the requirement is applied to all cases.

Public Input No. 2725-NFPA 70-2020 [Section No. 408.4(A)]

(A) Circuit Directory or Circuit Identification.

Every circuit and circuit modification shall be legibly identified in standard English as to its clear, evident, and specific purpose or use. The identification shall include an approved degree of detail that allows each circuit to be distinguished from all others. Spare positions that contain unused overcurrent devices or switches shall be described accordingly. The identification shall be included in a circuit directory that is located on the face, inside of, or in an approved location adjacent to the panel door in the case of a panelboard and at each switch or circuit breaker in a switchboard or switchgear. No circuit shall be described in a manner that depends on transient conditions of occupancy.

Statement of Problem and Substantiation for Public Input

Both Mr. Sasso and I documented the creative varieties of entries electricians put on circuit directories in the 2019 cycle. NFPA records will also show the science indicating that subject area specialists are prone to assume incorrectly that laypersons understand slang, abbreviations, and symbols with which only the experts--in this case electricians and inspectors--are familiar. In the 2019 cycle, the suggestion that directories be made intelligible to the intended users somehow was taken as meaning they should accommodate transient conditions of occupancy, which would directly contradict the final sentence of 408.4(A). Requiring standard English will simply mean that when someone needs to run to shut off a circuit, they don't have to run to a slang dictionary, a dictionary of abbreviations, or the original installer to figure out the entries. (In other countries that adopt NFPA 70, of course "English" could be replaced with the main language used by the AHJ.)

Submitter Information Verification

Submitter Full Name: David Shapiro

Organization: Safety First Electrical

Street Address:

City:

State:

Zip:

Submittal Date: Sat Aug 29 17:38:17 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7895-NFPA 70-2020

Statement: The removal of the word field is needed as it will assist the electrical plans examiner. The NEC is an enforcement document; this change will improve electrical Code enforcement at the plan review stage. There is no reason to limit the scope of this provision solely to "the field."

Identification is changed to description so as to not conflict with the defined term in Article 100.

The description should be marked in a permanent way to prevent fading over time. A specific language may not be appropriate in some areas. Legible handwriting is acceptable.

CMP-9 adds physical location for clarity. The location of where power originates is critical information for inspectors, service persons, and other individuals that may have need to locate the supply source. It is not always readily apparent where the location of the source is. For this reason, an identification of the location of the source should be provided in addition to the identification of the source itself.

In some circumstances the location of the supply source may be readily apparent, but it was determined that allowing for an exemption in these cases would lead to ambiguity and make the requirement too subjective. For this reason, the requirement is applied to all cases.

Public Input No. 590-NFPA 70-2020 [Section No. 408.4(A)]

(A) Circuit Directory or Circuit Identification.

Every circuit and circuit modification shall be ~~legibly identified~~ permanently affixed to the equipment or wiring method and identified as to its clear, evident, and specific purpose or use ~~.~~ ~~The~~ and shall not be (hand written). The identification shall include an approved degree of detail that allows each circuit to be distinguished from all others. Spare positions that contain unused overcurrent devices or switches shall be described accordingly. The identification shall be included in a circuit directory that is located on the face, inside of, or in an approved location adjacent to the panel door in the case of a panelboard and at each switch or circuit breaker in a switchboard or switchgear. No circuit shall be described in a manner that depends on transient conditions of occupancy.

Statement of Problem and Substantiation for Public Input

I strongly believe that life safety and property is at jeopardy when hand written panel legends are installed into panel boards and load centers, as an Electrical Inspector at the city of Parkland in Florida, 80 % of our inspections are new homes, and the end result at final inspection at these panel boards amounts to poor workmanship or scribble. The circuit identification is critical in my opinion, for example at one of the homes here in our city an exterior receptacle caught on fire and associated wiring began smoldering, the fire department responded and had to turn off many circuits at the electric panel due to an unclear an illegible panel legend. It is distressing to me to see this practice of hand written panel legends when it deals with the importance of the circuit identification, and also believe it is a disservice to the property owners and to my mission
to code compliance and life safety.

Submitter Information Verification

Submitter Full Name: Jose Nieves

Organization: City of Parkland

Street Address:

City:

State:

Zip:

Submittal Date: Tue Mar 03 06:51:24 EST 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7895-NFPA 70-2020

Statement: The removal of the word field is needed as it will assist the electrical plans examiner. The NEC is an enforcement document; this change will improve electrical Code enforcement at the plan review stage. There is no reason to limit the scope of this provision solely to "the field."

Identification is changed to description so as to not conflict with the defined term in Article 100.

The description should be marked in a permanent way to prevent fading over time. A specific language may not be appropriate in some areas. Legible handwriting is acceptable.

CMP-9 adds physical location for clarity. The location of where power originates is critical information for inspectors, service persons, and other individuals that may have need to locate the supply source. It is not always readily apparent where the location of the source is. For this reason, an identification of the location of the source should be provided in addition to the identification of the source itself.

In some circumstances the location of the supply source may be readily apparent, but it was determined that allowing for an exemption in these cases would lead to ambiguity and make the requirement too subjective. For this reason, the requirement is applied to all cases.

Public Input No. 1113-NFPA 70-2020 [Section No. 408.4(B)]

(B) Source of Supply.

All switchboards, switchgear, and panelboards supplied by a feeder(s) ~~in other than one- or two-family dwellings shall~~ shall be permanently marked to indicate ~~each device or equipment~~ where the power originates ~~. The label shall be permanently~~ unless the source is evident.

Remotely located power distribution centers, panelboards and electrical loads such as pedestals, signs, skids and similar shall be permanently marked to indicate where the power originates with a physical description, at minimum, unless the source is evident.

Labels shall be permanently affixed, of sufficient durability to withstand the environment involved, and not handwritten.

Exception: Receptacles and luminaires.

Statement of Problem and Substantiation for Public Input

Delete 'each device or equipment' and 'in other than one or two family dwellings' from the first paragraph.

'Unless the source is evident' is similar to 110.22(A) for labeling disconnecting means. It justifies labeling or not labeling the source origin for switchboards, switchgear, panelboards or remotely located distribution centers and electrical loads.

Writing 'where the power originates' is good but insufficient. Writing 'FED FROM PANEL L2B', for example, may be adequate in some cases. More remote electrically fed locations would greatly benefit by having a physical description of where it is fed from. The labeling could still include the name of the panel or gear it is fed from, but more important, it would now be required to write ' FED FROM 60 YARDS S.W.', for example.

The exception shows that not every load mandates the added labeling when the source is not evident (It doesn't prohibit it either).

Dwellings must be included. A subdivision type house wouldn't likely require this added field labeling. Many houses have acreage and with that outbuildings and several feeder panels. These installations would also benefit by having physical descriptions indicating where the power source originates.

This new public input is similar to 408.4A only it is at the other end of the circuit.

This new public input will aid property owners, service electricians, and emergency personnel.

Submitter Information Verification

Submitter Full Name:	Norman Feck
Organization:	State of Colorado
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sat May 16 17:18:05 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: FR-7895-NFPA 70-2020

Statement: The removal of the word field is needed as it will assist the electrical plans examiner. The NEC is an enforcement document; this change will improve electrical Code enforcement at the plan review stage. There is no reason to limit the scope of this provision solely to "the field."

Identification is changed to description so as to not conflict with the defined term in Article 100.

The description should be marked in a permanent way to prevent fading over time. A specific language may not be appropriate in some areas. Legible handwriting is acceptable.

CMP-9 adds physical location for clarity. The location of where power originates is critical information for inspectors, service persons, and other individuals that may have need to locate the supply source. It is not always readily apparent where the location of the source is. For this reason, an identification of the location of the source should be provided in addition to the identification of the source itself.

In some circumstances the location of the supply source may be readily apparent, but it was determined that allowing for an exemption in these cases would lead to ambiguity and make the requirement too subjective. For this reason, the requirement is applied to all cases.

Public Input No. 2619-NFPA 70-2020 [Section No. 408.4(B)]

(B) Source of Supply.

All switchboards, switchgear, and panelboards supplied by a feeder(s) in other than one- or two-family dwellings shall be permanently marked to indicate each device or equipment where the power originates and its location . The label shall be permanently affixed, of sufficient durability to withstand the environment involved, and not handwritten.

Statement of Problem and Substantiation for Public Input

This input is being submitted on behalf of the Minnesota Department of Labor and Industry. The Department's 15 office/field staff, and 65 plus contract electrical inspectors complete over 150,000 electrical inspections annually and are involved in the daily enforcement and interpretation of the National Electrical Code.
The marking should denote the location of the power source disconnecting means. The current language states that the power source disconnecting means may be marked by panel name only, which gives no indication to the power source location. The location identification will help service personnel to quickly locate the power source disconnect providing a safer installation.

Submitter Information Verification

Submitter Full Name: Dean Hunter

Organization: Minnesota Department of Labor

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 26 08:25:26 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7895-NFPA 70-2020

Statement: The removal of the word field is needed as it will assist the electrical plans examiner. The NEC is an enforcement document; this change will improve electrical Code enforcement at the plan review stage. There is no reason to limit the scope of this provision solely to "the field."

Identification is changed to description so as to not conflict with the defined term in Article 100.

The description should be marked in a permanent way to prevent fading over time. A specific language may not be appropriate in some areas. Legible handwriting is acceptable.

CMP-9 adds physical location for clarity. The location of where power originates is critical information for inspectors, service persons, and other individuals that may have need to locate the supply source. It is not always readily apparent where the location of the source is. For this reason, an identification of the location of the source should be provided in addition to the identification of the source itself.

In some circumstances the location of the supply source may be readily apparent, but it was determined that allowing for an exemption in these cases would lead to ambiguity and make the requirement too subjective. For this reason, the requirement is applied to all cases.

Public Input No. 2080-NFPA 70-2020 [Section No. 408.6]

408.6 Short-Circuit Current Rating.

Switchboards, switchgear, and panelboards shall have a short-circuit current rating not less than the available fault current. In other than one- and two-family dwelling units, the available fault current and the date the calculation was performed shall be field marked on the enclosure at the point of supply. The marking shall comply with 110.21(B)(3).

Exception to marking: Where an incident energy analysis has been completed, arc flash labels have been installed that indicate incident energy, and where records of such analysis are readily available upon request, marking of panels with the available fault current is not required.

Statement of Problem and Substantiation for Public Input

It is understood that the new requirement to add the available short circuit (fault) current and the date of the evaluation is for the inspector and/or the AHJ to verify that all of the components within a given enclosure can handle the available fault current.
Even though the arc flash label is not required to state available fault current, if an incident energy analysis has been performed, the available fault current would have been evaluated and records of the analysis should be available.

One of the primary concerns with this new requirement is the additional labeling that is required. Even though it provides valuable information to the inspector, it is yet another labeling requirement that may confuse the person who has to interact with the equipment. There are multiple labels that are required such as arc flash labels, manufacturer labels, circuit directories, conductor identification, equipment identifiers, disconnect locations etc.

A majority of the information reqarding worker safety already resides on the detailed arc flash label and it would be beneficial to avoid distracting the worker with another label.

Submitter Information Verification

Submitter Full Name: Henry Matthews
Organization: Marathon Petroleum Company
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jul 29 09:15:49 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: Available fault current is necessary information for proper inspection and the continued safe operation of equipment. Although records of analysis may be readily available upon request at the time of initial installation, they are likely to take longer to acquire or become more difficult to request over the life of the product. For this reason, it is the opinion of the panel that an exception to the requirement for marking of available fault current should not be provided where records may be made available upon request.

Public Input No. 4513-NFPA 70-2020 [Section No. 408.8(A)]

(A) Panelboards.

Panelboards shall not be permitted to be reconditioned. This shall not prevent the replacement of a panelboard within an enclosure. In the event the replacement has not been listed for the specific enclosure and the available fault current is greater than 10,000 amperes, the completed work shall be field labeled, and any previously applied listing marks on the cabinet that pertain to the panelboard shall be removed, except where permitted by Section 110 . 21(A)(2).

Statement of Problem and Substantiation for Public Input

Added language for addition to 110.21(A)(2)

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 4496-NFPA 70-2020 [Section No. 110.21(A)(2)]	

Submitter Information Verification

Submitter Full Name: Joshua Brackett
Organization:
Street Address:
City:
State:
Zip:
Submittal Date: Thu Sep 10 14:32:08 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7951-NFPA 70-2020

Statement: CMP-9 is rewording the provisions of 408.8 so as to avoid duplicating requirements in 110.21(A)(2). Other changes include adding “corrosive influences” to the list of items to consider in the parent language of 408.8, and adding “switchboards” to 408.8(B), since that was inadvertently overlooked during the 2020 Code Cycle.

Public Input No. 3980-NFPA 70-2020 [New Section after 408.8(B)]

Absence of Voltage Test & Indication

A means shall be provided to verify the absence of voltage in accordance with an acceptable industry practice that does not expose personnel to shock or arc flash hazards or live parts at the test point for the main disconnecting means and any compartments that are likely to require examination, adjustment, serviceing, or maintenance.

Informational Note: NFPA 70E-2021 Standard for Electrical Safety in the Workplace provides guidance for safely verifying the absence of voltage including the use of devices like a permanently mounted absence of voltage tester.

Statement of Problem and Substantiation for Public Input

Testing for absence of voltage is an important step that helps increase safety by detecting several conditions that could lead to an electrical incident:

- Power remains on if the wrong disconnecting means is utilized or the source is mislabeled (see examples from OSHA Summaries)
- Presence of stored electrical energy from a capacitor, present after the disconnect is opened and locked out (see examples from OSHA Summaries)
- Power remains present when the disconnect handle is in the off position if the disconnect experiences a mechanical failure (see Recall Notices below)

An easily accessible means to test for and visually convey the status of presence and absence of voltage that is part of the equipment installation at the point of work before accessing equipment would prevent this type of incident (see examples from OSHA below) and further the purpose of the code in practical safeguarding of persons and property by leveraging safety by design principles. Absence of Voltage Testers (AVT) listed to UL 1436 are permanently mounted testers that visually indicate when less than 3 V (ac and dc) is detected at the test point. This test is initiated before doors and covers are removed preventing accidental contact with energized parts. AVTs listed to UL 1436 have been recognized as an acceptable method to test for the absence of voltage in NFPA 70E since 2018 (120.5 (7) Exception 1).

Permanently mounted AVTs installed on or near the equipment increase the likelihood that the test for absence of voltage test occurs before the equipment is accessed when compared to portable voltage test instruments. Additionally, AVTs often have a feature to visually indicate when ac or dc voltage that would cause a shock hazard is present. In several incidents, the voltage presence indicators (for AC and DC) would have provided a visual warning that voltage was still present. This is particularly applicable to large equipment lineups with rear access where the disconnecting means and indicators are typically located at the front of the equipment. Installing a test point at the rear would help prevent incidents resulting from wrong covers being removed or adjacent compartments accessed.

OSHA Fatality and Catastrophe Investigation Summaries
A keyword search of the OSHA Fatality and Catastrophe Investigation Summaries (https://www.osha.gov/pls/imis/accidentsearch.html) reveals several incidents resulting in severe injury or death that are attributed to failure to test for absence of voltage after de-energizing the disconnecting means. Some examples:
Report ID 0950631
Two employees of an electrical contractor went to a site to wipe down surfaces and vacuum the bottoms of 4,160-volt cubicles in an electrical room. They had a rag and Simple Green cleaning fluid. Neither employee had previously worked on equipment of this voltage, and the employees did not know the operating voltage of the equipment. The onsite employer racked out and locked the

equipment to be cleaned, and Employee #1, an electrician, did a walk down with the employer to verify that the equipment was racked out. However, the two employees did not know that one of the cubicles remained energized from another source of electric energy. On the door of that cubicle was a red-stenciled sign that read, "CAUTION MAY BE ENERGIZED FROM AN ALTERNATE SOURCE." Neither employee noticed the sign, and the onsite employer did not mention the alternate energy source to the employees. The following day, after meeting with the onsite employer, the employees began to clean the cubicles. When Employee #2 was cleaning the still-energized cubicle, he felt a slight electric shock. He took out a 600-volt proximity tester, and it lit up without touching the conductors. Employee #1 retrieved a voltage meter rated for 750 volts and placed the meter leads on the conductors. The meter failed and the ensuing electric arc burned both employees. Employee #1 received second- and third-degree burns. He underwent skin graft surgery and was hospitalized for his injuries. Employee #2 was hospitalized for more than 24 hours. He received pain medication for his burns. (The original form did not list Employee #2 on an injury line.)

Disconnect Recall Notices
Several brands of disconnects that are commonly used in industrial and commercial applications have experienced recalls due to defects that allow power to remain present when the disconnect handle is in the off position, posing a shock hazard. This failure mode is an example of why testing for absence of voltage is critical in all applications.
Recalls (https://www.cpsc.gov/Recalls)

1. Example 1

Company A recalled more than a million safety switches manufactured between January 1, 2014 and January 18, 2018 because the power can stay on when the safety switch handle is in the off position, posing an electric shock or electrocution hazard. The switches may be installed in or around commercial buildings, outbuildings, apartments and homes with air conditioning units.

2. Example 2

Company B issued a safety recall of 26 models of safety switches that may not disconnect power when the handle is in the “off” position. The affected devices cover certain models of 30A and 60A heavy-duty safety switches manufactured between Nov. 19, 2015, and Jan. 23, 2018.

3. Example 3

Company C recalled 19,000 toggle and rotary switches. When switched OFF, one electrical pole may remain energized, posing a risk of electrical shock hazard. The switches are typically used with HVAC units, electric distribution and control panels and industrial uses. Primarily the switches are used commercially, however they may also be found in residential applications.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3835-NFPA 70-2020 [New Section after 110.25]	
Public Input No. 3908-NFPA 70-2020 [New Part after I.]	

Submitter Information Verification

Submitter Full Name:	Rachel Bugaris
Organization:	Panduit Corp
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Sep 09 16:39:47 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: An absence of voltage specific device should not be a requirement. Since it may be used without a reference in this document it should not be included as a specific allowance.

The Code does not prohibit the use of an absence of voltage listed device.

Public Input No. 228-NFPA 70-2019 [Section No. 408.8(B)]

(B)

~~Switchboards~~
Switchboards and Switchgear.

Switchboards and switchgear, or sections of switchboards or switchgear, shall be permitted to be reconditioned. Reconditioned switchgear shall be listed or field labeled

~~as~~

as *reconditioned* , and previously applied listing marks, if any, within the portions reconditioned shall be removed , except where permitted by Section 110 . 21(A)(2).

Statement of Problem and Substantiation for Public Input

Reconditioning of Switchgear components are very common and necessary in older health care facilities. However, not all of the older components can be purchased as "Rebuilt," "Refurbished," "Remanufactured," "Reconditioned" or "Renovated". If these components cannot be purchased as certified and the original listing must be removed then during the timeframe of attempting to get a field certification on sometimes 50+ year old equipment, the hospital would be using non-listed switchgear. This can cause compliance issues with health care's primary AHJ (CMS). Hospitals must remain operational and the committee should revisit reconditioning from an occupancy-based approach and include a more diverse focus group to discuss. There are other ANSI accredited standards that are approved for reconditioning of electrical equipment that cause direct conflict with the NFPA 70, 2020 edition.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 4496-NFPA 70-2020 [Section No. 110.21(A)(2)]	

Submitter Information Verification

Submitter Full Name: Joshua Brackett
Organization:
Street Address:
City:
State:
Zip:
Submittal Date: Tue Dec 31 11:12:14 EST 2019
Committee: NEC-P09

Committee Statement

Resolution: FR-7951-NFPA 70-2020

Statement: CMP-9 is rewording the provisions of 408.8 so as to avoid duplicating requirements in 110.21(A)(2). Other changes include adding "corrosive influences" to the list of items to consider in the parent language of 408.8, and adding "switchboards" to 408.8(B), since that was inadvertently overlooked during the 2020 Code Cycle.

Public Input No. 2298-NFPA 70-2020 [Section No. 408.8(B)]

(B) Switchboards and Switchgear.

Switchboards and switchgear, or sections of switchboards or switchgear, shall be permitted to be reconditioned. The reconditioning process shall use design qualified parts verified under applicable standards and be performed in accordance with any instructions provided by the manufacturer. Reconditioned switchboards and switchgear ~~shall be listed or field labeled as~~ *reconditioned* ~~,~~ ~~and previously~~ shall comply with one of the following;

(1) Retain original manufacturer's nameplate and listing marks. Or, if illegible, shall be replaced with new that mimics the content and detail of the original. The equipment's original listing(s) shall be qualified as valid, including where applicable to original equipment, all: ratings, performance attributes, terms of use, and compliance to qualified standard(s).

(2) Field labeled as reconditioned. Previously applied listing marks, if any,

~~within the portions~~

(1) associated with reconditioned elements shall be removed. Previously applied nameplate, if any, shall be replaced with new nameplate indicating date of recondition work, and shall include revision(s) to ratings as appropriate.

If equipment has been damaged by fire, products of combustion, or water, it shall be specifically evaluated by its manufacturer or a qualified testing laboratory prior to being returned to service. Provide label briefly summarizing extent of recondition event and each subsequent recondition event, with date of completion for each, and contact information for entity performing the work for each.

Informational Note; refer to 110.21(A)(2) for additional requirements.

Statement of Problem and Substantiation for Public Input

1) The existing statement "reconditioned switchgear shall be listed" requires clarification as it may be construed that reconditioned equipment can be listed anew. Or, that a caveat for equipment to be reconditioned is that it must have first been listed, or some other interpretation.
2) considering that the intent is that there are meant to be two options, then they would most clearly be identified if broken out into numbered headings.
3) If there are terms for listed equipment to be reconditioned so as to retain the equipment's original ratings and specifications, the terms for this are not yet identified clearly.
4) If there is an intent that the nameplate ratings may be allowed to differ from the original, or not, then integrity to this effect this needs to be clarified.
5) If there are terms for equipment that has been reconditioned once already, to be permitted to be reconditioned again, these terms have yet to be clarified.
6) if there is to be an intent that component level reconditioning is to be permitted, then perhaps some way of labeling a summary of reconditioning events should be clarified.
7) the name of the reconditioning entity and the date of recondition is required by 110.21(A)(2), but an informational note isn't provided as reference nor text to identify this requirement.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2395-NFPA 70-2020 [Section No. 490.49]	similar issues and intent

Public Input No. 2396-NFPA 70-2020 [Section No. 240.88]	similar topic
Public Input No. 2395-NFPA 70-2020 [Section No. 490.49]	
Public Input No. 2396-NFPA 70-2020 [Section No. 240.88]	

Submitter Information Verification

Submitter Full Name: John Blissett
Organization: Bernhard TME
Street Address:
City:
State:
Zip:
Submittal Date: Thu Aug 13 18:19:41 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7951-NFPA 70-2020

Statement: CMP-9 is rewording the provisions of 408.8 so as to avoid duplicating requirements in 110.21(A)(2). Other changes include adding “corrosive influences” to the list of items to consider in the parent language of 408.8, and adding “switchboards” to 408.8(B), since that was inadvertently overlooked during the 2020 Code Cycle.

Public Input No. 4151-NFPA 70-2020 [Section No. 408.8(B)]

(B) Switchboards and Switchgear.

Switchboards and switchgear, or sections of switchboards or switchgear, shall be permitted to be reconditioned. Reconditioned switchboards and switchgear shall be listed or field labeled as *reconditioned*, and previously applied listing marks, if any, within the portions reconditioned shall be removed.

Statement of Problem and Substantiation for Public Input

This corrects an editorial oversight in the 2020 cycle. There was no intention of compromising the applicability of this wording to switchboards.

Submitter Information Verification

Submitter Full Name: Frederic Hartwell
Organization: Hartwell Electrical Services, Inc.
Affiliation: self
Street Address:
City:
State:
Zip:
Submittal Date: Wed Sep 09 22:27:17 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7951-NFPA 70-2020

Statement: CMP-9 is rewording the provisions of 408.8 so as to avoid duplicating requirements in 110.21(A)(2). Other changes include adding "corrosive influences" to the list of items to consider in the parent language of 408.8, and adding "switchboards" to 408.8(B), since that was inadvertently overlooked during the 2020 Code Cycle.

Public Input No. 1230-NFPA 70-2020 [New Section after 408.23]

408.?? Grounding of Switchboards and Switchgear

Adapt an article similar to 408.40 to cover Part II of chapter 408 switchboards and switchgear.

Statement of Problem and Substantiation for Public Input

Adapt an article similar to 408.40 to cover Part II of chapter 408 switchboards and switchgear.

The NEC has improved significantly in large part due to improved formatting, use of language and consistency of requirements and application. This change will continue the trend of making the NEC consistent and predictable.

Submitter Information Verification

Submitter Full Name: Gary Hein

Organization: Submission is independent of employer.

Street Address:

City:

State:

Zip:

Submittal Date: Sat May 23 12:04:06 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: The substantiation does not provide adequate substantiation to warrant an additional section.

Public Input No. 1068-NFPA 70-2020 [Section No. 408.36(D)]

(D) Back-Fed Devices.

Plug-in-type overcurrent protection devices or plug-in type main lug assemblies that are backfed and used to terminate field-installed ungrounded supply conductors shall be secured in place by an additional fastener that requires other than a pull to release the device from the mounting means on the ~~panel~~ panelboard .

Statement of Problem and Substantiation for Public Input

The term “panelboard” is the correct term to use within this article covering panelboards. The term “panel” is used within Article 409.

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz
Organization: NECA
Street Address:
City:
State:
Zip:
Submittal Date: Fri May 15 07:55:41 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7891-NFPA 70-2020
Statement: CMP-9 changes the text as the the correct term is panelboard.

Public Input No. 1768-NFPA 70-2020 [Section No. 408.36 [Excluding any Sub-Sections]]

In addition to the requirement of 408.30, a panelboard shall be protected by an overcurrent protective device ~~having a rating not greater than that of the panelboard~~ . The ampere rating or setting of the overcurrent protective device shall not exceed the rating of the panelboard's bus or, where applicable, the panelboard's common power bus . This overcurrent protective device shall be located within or at any point on the supply side of the panelboard.

Exception No. 1: Individual protection shall not be required for a panelboard protected by two main circuit breakers or two sets of fuses in other than service equipment, having a combined rating not greater than that of the panelboard. A panelboard constructed or wired under this exception shall not contain more than 42 overcurrent devices. For the purposes of determining the maximum of 42 overcurrent devices, a 2-pole or a 3-pole circuit breaker shall be considered as two or three overcurrent devices, respectively.

Exception No. 2: For existing panelboards, individual protection shall not be required for a panelboard used as service equipment for an individual residential occupancy.

Statement of Problem and Substantiation for Public Input

Some panelboards, such as Square D's I-Line combo panelboards, have a main common power bus and reduced bus ratings that may feed smaller components within the panelboard. These reduced ratings are permitted by UL 67 section 29.2. This proposed change will align the NEC with the provisions of UL 67 section 29.2. Additionally, this proposed change aligns the overcurrent protection requirements for panelboards with the overcurrent protection requirements for motor control centers found in NEC section 430.94.

Submitter Information Verification

Submitter Full Name: Jason Rohe
Organization: Schnackel Engineers
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 30 08:52:14 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: There is no requirement in UL 67 for a main power bus rating. The existing wording properly covers the requirement.

Public Input No. 1894-NFPA 70-2020 [Section No. 408.36 [Excluding any Sub-Sections]]

In addition to the requirement of 408.30, a panelboard shall be protected by an overcurrent protective device having a rating not greater than that of the panelboard. This overcurrent protective device shall be located within or at any point on the supply side of the panelboard.

Exception No. 1: Individual protection shall not be required for a panelboard protected by two main circuit breakers or two sets of fuses in other than service equipment, having a combined rating not greater than that of the panelboard. A panelboard constructed or wired under this exception shall not contain more than 42 overcurrent devices. For the purposes of determining the maximum of 42 overcurrent devices, a 2-pole or a 3-pole circuit breaker shall be considered as two or three overcurrent devices, respectively.

Exception No. 2: For existing panelboards, individual protection shall not be required for a panelboard used as service equipment for an individual residential occupancy.

Informational Note: See section 240.6 of this document for information on how the ampere ratings of overcurrent protection devices are determined.

Statement of Problem and Substantiation for Public Input

This PI was created as a result of questions that have been posed related correctly matching adjustable trip circuit breakers and panel boards with respect to ampere rating. The change proposed in this PI improves code usability by pointing the reader to the section in this code that specifies how ampere ratings are determined for circuit breakers and fuses.

Submitter Information Verification

Submitter Full Name: John Cowans

Organization: Siemens

Street Address:

City:

State:

Zip:

Submittal Date: Tue Jul 14 09:40:02 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: The existing text is sufficient to serve the needs of the electrical industry. The Informational Note would not provide significant additional usability of the code.

Public Input No. 3082-NFPA 70-2020 [Section No. 408.37]

408.37 Panelboards in Damp or Wet Locations.

Panelboards in damp or wet locations <u>or installed within 1.8m (6 ft) of a sink </u> shall be installed to comply with 312.2<u>.</u>

Statement of Problem and Substantiation for Public Input

Panelboards located within 6 ft. of the sink are getting wet and can be physically touched along with the wet sink equipment presenting an electric shock hazard. This spacing is needed in kitchens, basements, workshops or any area where they are closer than 6 ft. apart.

Submitter Information Verification

Submitter Full Name:	Mark Rochon
Organization:	[Not Specified]
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Fri Sep 04 14:10:49 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: The description of the problem does not adequately describe a needed change as many indoor locations within 6 ft of a sink would not meet the definition of a damp or wet location.

Public Input No. 897-NFPA 70-2020 [Section No. 408.38]

408.38 Enclosure.

Panelboards shall be mounted in cabinets, cutout boxes, <u>switchboards, industrial control panels, dimming control equipment, explosionproof enclosures,</u> or identified enclosures and shall be dead-front.

Exception: Panelboards other than of the dead-front, externally operable type shall be permitted where accessible only to qualified persons.

Statement of Problem and Substantiation for Public Input

The term panelboard as defined in Article 100 is restrictive with respect to the various types of enclosures in which they are often and installed today. A companion proposal has been submitted for the definition of Panelboard which is also under the purview of CMP-9. While cabinets are the common enclosure for panelboards, they are being installed in several other types of enclosures. The revision to this section makes the title plural and incorporates additional enclosure types that reflect common real-world applications and installations of today.

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz
Organization: NECA
Street Address:
City:
State:
Zip:
Submittal Date: Tue Apr 21 13:12:42 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: The additional detail of types of enclosures is not necessary. The information is included in the identified enclosures reference.

Public Input No. 1356-NFPA 70-2020 [Section No. 408.40]

408.40 Equipment Grounding ~~of~~ Conductors, Panelboards.

Panelboard cabinets and panelboard frames, if of metal, shall be in physical contact with each other and shall be connected to an equipment grounding conductor. Where the panelboard is used with nonmetallic raceway or cable or where separate equipment grounding conductors are provided, a terminal bar for the equipment grounding conductors shall be secured inside the cabinet. The terminal bar shall be bonded to the cabinet and panelboard frame, if of metal; otherwise it shall be connected to the equipment grounding conductor that is run with the conductors feeding the panelboard.

Exception: Where an isolated equipment grounding conductor for a branch circuit or a feeder is provided as permitted by 250.146(D), the insulated equipment grounding conductor that is run with the circuit conductors shall be permitted to pass through the panelboard without being connected to the panelboard's equipment grounding terminal bar.

Equipment grounding conductors shall not be connected to a terminal bar provided for grounded conductors or neutral conductors unless the bar is identified for the purpose and is located where interconnection between equipment grounding conductors and grounded circuit conductors is permitted or required by Article 250.

Statement of Problem and Substantiation for Public Input

According to the NFPA Style Manual, the Section Title needs to reflect the content of the rule. The rule is about the equipment grounding conductor, not about 'Grounding.'

Submitter Information Verification

Submitter Full Name: Mike Holt
Organization: Mike Holt Enterprises Inc
Street Address:
City:
State:
Zip:

Submittal Date: Mon Jun 01 17:39:15 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7945-NFPA 70-2020

Statement: The title complies with the Style Manual and adequately describes the code section. Equipment grounding conductors are covered in Part II of and Part VII of Article 250. The last sentence in 408.40 was revised as Section 4.1.4 of the 2020 NEC Style Manual prohibits reference to an entire article, other than Article 100.

Public Input No. 3881-NFPA 70-2020 [Section No. 408.40]

408.40 Grounding of Panelboards.

Panelboard cabinets and panelboard frames, if of metal, shall be in physical contact with each other and shall be connected to an equipment grounding conductor. Where the panelboard is used with nonmetallic raceway or cable or where separate equipment grounding conductors are provided, a terminal bar for the equipment grounding conductors shall be secured inside the cabinet. The terminal bar shall be bonded to the cabinet and panelboard frame, if of metal; otherwise it shall be connected to the equipment grounding conductor that is run with the conductors feeding the panelboard.

Exception: Where an isolated equipment grounding conductor for a branch circuit or a feeder is provided as permitted by 250.146(D), the insulated equipment grounding conductor that is run with the circuit conductors shall be permitted to pass through the panelboard without being connected to the panelboard's equipment grounding terminal bar.

Equipment grounding conductors shall not be connected to a terminal bar provided for grounded conductors or neutral conductors unless the bar is identified for the purpose and is located where interconnection between equipment grounding conductors and grounded circuit conductors is permitted or required ~~by Article 250~~ elsewhere in this Code .

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(r) Style Manual prohibits reference to an entire article, other than Article 100. As such, it is proposed to delete this reference to Article 250 as shown or alternatively, the CMP may wish to revise this reference to the specific part of Article 250 they wish to reference.

Submitter Information Verification

Submitter Full Name: Richard Holub
Organization: The DuPont Company, Inc.
Street Address:
City:
State:
Zip:
Submittal Date: Wed Sep 09 14:50:12 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7945-NFPA 70-2020

Statement: The title complies with the Style Manual and adequately describes the code section. Equipment grounding conductors are covered in Part II of and Part VII of Article 250. The last sentence in 408.40 was revised as Section 4.1.4 of the 2020 NEC Style Manual prohibits reference to an entire article, other than Article 100.

Public Input No. 3059-NFPA 70-2020 [New Section after 408.43]

TITLE OF NEW CONTENT

Type your content here ..Flush - Mounted Cabinet installation.

Repairing surfaces that are broken or incomplete around the cabinet of noncombustible or combustible surfaces shall be repaired so there will be no gaps or open spaces greater than 3 mm (1/8 in.) at the edge of the cabinet and filled with a noncombustible material.

Statement of Problem and Substantiation for Public Input

New flush mount installations or panel changes in existing walls or new walls need to be patched around the cabinet to prevent any possible ignitable area of combustible material located between the cover and cabinet.

Submitter Information Verification

Submitter Full Name:	Mark Rochon
Organization:	[Not Specified]
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Fri Sep 04 12:13:01 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: The problem stated is already addressed by 312.4. Panelboards are located in cabinets.

Public Input No. 1705-NFPA 70-2020 [Section No. 408.43]

408.43 Panelboard Orientation.

~~Panelboards~~ Unless a panelboard is installed in a listed commercial appliance outlet center enclosure designed for floor mounting, panelboards shall not be installed in the face-up position.

Additional Proposed Changes

File Name	Description	Approved
Public_Input_No._1705-NFPA_70-2020_Section_408.43_.docx	Clean MSWord DOCX copy of this Public Input No. 1705 WITHOUT TerraView alteration of the Submitter's intent	

Statement of Problem and Substantiation for Public Input

See the uploaded attachment of a manual entry of this Public Input with text content that hasn't been Terrarized and is consequently readable.

.

This new 2020 NEC® Section has had in some jurisdictions the consequence of potentially disallowing a long-existing listed product type: in-floor-mounted commercial appliance outlet centers, composed of factory- or field-installed panelboards and commercial appliance outlet center enclosures. Because of the generalizations of this new 2020 NEC® Section 408.43, it is essential to recognize explicitly these in-floor-mounted commercial appliance outlet centers having face-up panelboards accessed from the top.

.

The definition for “Panelboard” in Article 100 is indicated as being “designed to be placed in a cabinet”. For hotels, warehouses, convention centers, exhibition halls, casinos, gaming facilities, et alibi, commercial appliance outlet centers are listed to receive factory- or field-installed panelboards and are listed for in-floor mounting in large facilities and venues (not all assembly occupancies), to supply electrical power and other services. Such listed commercial appliance outlet centers and listed commercial appliance outlet center enclosures that provide for diversion and routing of water spillage away from face-up panelboards installed flat or slightly angled within and for adequate drainage, and can be found in UL Product Category AUUZ.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 1731-NFPA 70-2020 [Definition: Panelboard.]	correlated clarifications and corrected definition
Public Input No. 1761-NFPA 70-2020 [Section No. 518.5]	correlated clarifications but only for assembly occupancies
Public Input No. 1731-NFPA 70-2020 [Definition: Panelboard.]	
Public Input No. 1761-NFPA 70-2020 [Section No. 518.5]	

Submitter Information Verification

Submitter Full Name: Brian Rock

Organization: Hubbell Incorporated
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 25 14:20:55 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7944-NFPA 70-2020

Statement: This change in the 2020 NEC revision cycle addressing the installation of a panelboard in a face-up position is necessary. The mounting of an electrical panelboard in a face up position does not provide a safe working environment necessary for electrical safety of installers/maintainers when servicing the panelboard. The likelihood for contaminants accumulating on the overcurrent devices and panelboard bussing is increased significantly, creating a hazard. Can the working space requirements mandated by 110.26 be satisfied with a panelboard mounted in a face up position?

The face-down position criteria is added to 408.43 mainly due to working space concerns. Even with acceptable working space it would be very difficult for a qualified worker to safely work in this position. The only movement away from an arc blast or arc fault event might be left or right from the equipment due to the installer laying, kneeling, or standing on a concrete floor looking up. In some cases, the panelboard overcurrent protective devices would only be accessible utilizing a step ladder. This type of installation is unsafe and is addressed.

Panelboards in general applications should not be installed in a face up or face down position.

CMP-9 acknowledges that conditions within special occupancies such as those in Article 518 may warrant a modification to this general rule.

PI-1761 may accomplish this and is under the purview of CMP-15.

Public Input No. 3452-NFPA 70-2020 [Section No. 408.43]

408.43 Panelboard Orientation.

Panelboards shall not be installed in the face-up or face-down position.

Statement of Problem and Substantiation for Public Input

This change in the 2020 NEC revision cycle addressing the installation of a panelboard in a face-up position was necessary. The mounting of an electrical panelboard in a face up position does not provide a safe working environment necessary for electrical safety of installers/maintainers when servicing the panelboard. The likelihood for contaminants accumulating on the overcurrent devices and panelboard bussing is increased significantly, creating a hazard. Can the working space requirements mandated by 110.26 be satisfied with a panelboard mounted in a face up position?

The face-down position should be added to 408.43 mainly due to working space concerns. Even with acceptable working space it would be very difficult for a qualified worker to safely work in this position. The only movement away from an arc blast or arc fault event might be left or right from the equipment due to the installer laying, kneeling, or standing on a concrete floor looking up. In some cases, the panelboard overcurrent protective devices would only be accessible utilizing a step ladder. This type of installation is unsafe and should be addressed in the upcoming edition of the NEC.

Submitter Information Verification

Submitter Full Name: Rudolph Garza

Organization: IAEI

Affiliation: IAEI

Street Address:

City:

State:

Zip:

Submittal Date: Tue Sep 08 15:23:31 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7944-NFPA 70-2020

Statement: This change in the 2020 NEC revision cycle addressing the installation of a panelboard in a face-up position is necessary. The mounting of an electrical panelboard in a face up position does not provide a safe working environment necessary for electrical safety of installers/maintainers when servicing the panelboard. The likelihood for contaminants accumulating on the overcurrent devices and panelboard bussing is increased significantly, creating a hazard. Can the working space requirements mandated by 110.26 be satisfied with a panelboard mounted in a face up position?

The face-down position criteria is added to 408.43 mainly due to working space concerns. Even with acceptable working space it would be very difficult for a qualified worker to safely work in this position. The only movement away from an arc blast or arc fault event might be left or right from the equipment due to the installer laying, kneeling, or standing on a concrete floor looking up. In some cases, the panelboard overcurrent protective devices would only be accessible utilizing a step ladder. This type of installation is unsafe and is addressed.

Panelboards in general applications should not be installed in a face up or face down position.

CMP-9 acknowledges that conditions within special occupancies such as those in Article 518 may warrant a modification to this general rule.

PI-1761 may accomplish this and is under the purview of CMP-15.

Public Input No. 4255-NFPA 70-2020 [Section No. 408.43]

408.43 Panelboard Orientation.

Panelboards shall not be installed in the face-up or face down position.

Statement of Problem and Substantiation for Public Input

The change addressing the installation of a panelboard in a face-up position was necessary. The mounting of an electrical panelboard in a face up position does not provide a safe working environment necessary for electrical safety of installers/maintainers when servicing the panelboard. The likelihood for contaminants accumulating on the overcurrent devices and panelboard bussing is increased significantly, creating a hazard. Can the working space requirements mandated by 110.26 be satisfied with a panelboard mounted in a face up position?

The face-down position should be added to 408.43 mainly due to working space concerns. Even with acceptable working space it would be very difficult for a qualified worker to safely work in this position. The only movement away from an arc blast or arc fault event might be left or right from the equipment due to the installer laying on a concrete floor looking up. In some cases, the panelboard overcurrent protective devices would only be accessible utilizing a step ladder. It is my opinion that this type of installation is unsafe and should be addressed in the upcoming edition of the NEC.

Submitter Information Verification

Submitter Full Name: Joseph Wages
Organization: Self
Street Address:
City:
State:
Zip:

Submittal Date: Thu Sep 10 08:39:07 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7944-NFPA 70-2020

Statement: This change in the 2020 NEC revision cycle addressing the installation of a panelboard in a face-up position is necessary. The mounting of an electrical panelboard in a face up position does not provide a safe working environment necessary for electrical safety of installers/maintainers when servicing the panelboard. The likelihood for contaminants accumulating on the overcurrent devices and panelboard bussing is increased significantly, creating a hazard. Can the working space requirements mandated by 110.26 be satisfied with a panelboard mounted in a face up position?

The face-down position criteria is added to 408.43 mainly due to working space concerns. Even with acceptable working space it would be very difficult for a qualified worker to safely work in this position. The only movement away from an arc blast or arc fault event might be left or right from the equipment due to the installer laying, kneeling, or standing on a concrete floor looking up. In some cases, the panelboard overcurrent protective devices would only be accessible utilizing a step ladder. This type of installation is unsafe and is addressed.

Panelboards in general applications should not be installed in a face up or face down position.

CMP-9 acknowledges that conditions within special occupancies such as those in Article 518 may warrant a modification to this general rule.

PI-1761 may accomplish this and is under the purview of CMP-15.

Public Input No. 3885-NFPA 70-2020 [Section No. 408.53]

~~**408.53** Component Parts.~~

~~Switches, fuses, and fuseholders used on panelboards shall comply with the applicable requirements of Articles 240 and 404 .~~

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(r) Style Manual prohibits reference to an entire article, other than Article 100. This requirement also appears to duplicate the requirements formerly stated in Section 408.2. As stated in PI 3878, if the CMP wishes to identify "other articles", they should create a table as required by Sections 2.3 and 2.5 of the 2020 NEC(r) Style Manual. Alternatively, a reference to a specific part of the referenced articles or section could be used here as well.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3878-NFPA 70-2020 [Section No. 408.2]	

Submitter Information Verification

Submitter Full Name: Richard Holub
Organization: The DuPont Company, Inc.
Street Address:
City:
State:
Zip:
Submittal Date: Wed Sep 09 14:53:15 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7896-NFPA 70-2020

Statement: 408.53 refers to entire Articles and is deleted to comply with the NEC Style Manual. It is also noted that reference to specific sections of other articles is unnecessary for usability of the code.

Public Input No. 2993-NFPA 70-2020 [Section No. 450.1]

450.1 Scope.

This article covers the installation of all transformers.

Exception No. 1: Current transformers.

Exception No. 2: Dry-type transformers that constitute a component part of other apparatus and comply with the requirements for such apparatus.

Exception No. 3: Transformers that are an integral part of an X-ray, high-frequency, or electrostatic-coating apparatus.

Exception No. 4: Transformers used with Class 2 and Class 3 circuits that comply with Article 725.

Exception No. 5: Transformers for sign and outline lighting that comply with Article 600.

Exception No. 6: Transformers for electric-discharge lighting that comply with Article 410.

Exception No. 7: Transformers used for power-limited fire alarm circuits that comply with Part III of Article 760.

Exception No. 8: Transformers used for research, development, or testing, where effective arrangements are provided to safeguard persons from contacting energized parts.

This article covers the installation of transformers dedicated to supplying power to a fire pump installation as modified by Article ~~695~~ 703 .

This article also covers the installation of transformers in hazardous (classified) locations as modified by Articles 501 through 504.

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13). This change aligns with an effort to re-organize the alternative energy sources NEC Articles into a series of articles closely located together. This reorganization places all sources alternate sources as follows: 689 On-Site Energy Sources 690 Solar Photovoltaic (PV) Systems 691 Large-Scale Photovoltaic (PV) Systems 692 Fuel Cell Systems 693 Generators 694 Wind Electric Systems 695 Energy Storage Systems 696 Storage Batteries This public input aligns with changes that movie 695 to 703. This input supports this effort and to better align with the fact that this Article is closely related to emergency systems. The requirements of this new 703 focus on more than just a fire pump and arguably more so focuses on fire pump systems which is closely aligned with Chapter 7 of the NEC. This moves makes way for alignment of alternative energy sources article arrangement. These articles are closely related to each other and this change is in alignment with the direction by the correlating committee to review alternative energy sources for conflicts and usability. This new alignment will create a similar structure as that found for hazardous locations. The new Article 689 is the a combination of Articles 705, 710 and 712 and will act to be the new general requirements for this series of alternative energy sources.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2987-NFPA 70-2020 [Article 695]	Moving 695 to 703

Submitter Information Verification

Submitter Full Name: Thomas Domitrovich
Organization: Eaton Corporation
Street Address:
City:
State:
Zip:
Submittal Date: Thu Sep 03 19:57:04 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7782-NFPA 70-2020

Statement: The section is rewritten to meet the requirements of the Style Manual. The last two sentences of the section were removed based on the application of 90.3.

CMP-9 understands that the scope is within the purview of the Correlating Committee and recommends that the CC take this action.

Public Input No. 4317-NFPA 70-2020 [Section No. 450.1]

450.1 Scope.

This article covers the installation of all transformers.

~~*Exception No. 1: Current transformers.*~~

~~Exception No. 2: Dry~~

This article does not cover current transformers, dry -type transformers that constitute a component part of other apparatus and comply with the requirements for such apparatus

~~. Exception No. 3: Transformers~~

, transformers that are an integral part of an X-ray, high-frequency, or electrostatic-coating apparatus

~~. Exception No. 4: Transformers~~

, transformers used with

~~Class 2~~

Class 2 and

~~Class 3 circuits that comply with Article 725 . Exception No. 5: Transformers~~

Class 2 circuits, transformers for sign and outline lighting

~~that comply with Article 600 . Exception No. 6: Transformers~~

, transformers for electric-discharge lighting

~~that comply with Article 410 . Exception No. 7: Transformers~~

, transformers used for power-limited fire alarm circuits

~~that comply with Part III of Article 760 . Exception No. 8: Transformers~~

, and transformers used for research, development

~~,~~

or testing

~~,~~

where effective arrangements are provided to safeguard persons from contacting energized parts.

~~For those transformers not covered by this article, the relevant parts of the applicable specific code articles shall be followed in lieu of the requirements in this article. This article covers the installation of transformers dedicated to supplying power to a fire pump installation as modified by Article 695 . This Finally, this article also covers the installation of transformers in hazardous (classified) locations as modified by Articles 501 through 504 the hazardous location requirements .~~

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. In addition, section 3.1.4.1 of the Style Manual requires exceptions to be written in complete sentences. As such, it is proposed to rewrite this scope statement in the form of a paragraph without changing the intent of the section. The CMP is encouraged to carefully review this attempt to ensure that this has been achieved while conforming to Style Manual requirements. It is noted that the previous reference to "as modified by Articles 501 through 504" was not correct as it did not include the Zone articles nor the special occupancy articles 510-517. The more generic language recommended corrects this problem. It is recommended that this PI also be submitted to CMP14 for information and/or comment.

Submitter Information Verification

Submitter Full Name:	Richard Holub
Organization:	The DuPont Company, Inc.
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Sep 10 10:00:24 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: FR-7782-NFPA 70-2020

Statement: The section is rewritten to meet the requirements of the Style Manual. The last two sentences of the section were removed based on the application of 90.3.

CMP-9 understands that the scope is within the purview of the Correlating Committee and recommends that the CC take this action.

Public Input No. 3634-NFPA 70-2020 [Section No. 450.2]

(Relocate all definitions in the 450. 2 to Article 100, arrange them in alphabetical order and without any subdivisions.)

450. 2 Definition.

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

Transformer.

An individual transformer, single- or polyphase, identified by a single nameplate, unless otherwise indicated in this article.

Statement of Problem and Substantiation for Public Input

"The National Electrical Code has definitions in multiple parts in Article 100 and many definitions scattered through out the code many of them in the .2 section of the articles.
Most of the other standards under NFPA have their definitions in one location and this will allow the NEC the same requirement. The revisions to the NEC Style Manual require all the definitions to be relocated to Article 100. "

Submitter Information Verification

Submitter Full Name: David Williams
Organization: Delta Charter Township
Street Address:
City:
State:
Zip:
Submittal Date: Wed Sep 09 09:54:50 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7975-NFPA 70-2020

Statement: This FR moves all existing definitions under the purview of CMP-9 to Article 100 and revises these definitions for compliance with Section 2.2.2 of the NEC Style Manual. Additionally all definition sections (XXX.2) in the articles under the responsibility of CMP-9 are deleted.

The term “Medium Voltage” is commonly used to describe circuits and equipment operating at voltage levels greater than 1000 volts, and up to 52 kV. As this is a commonly used term, it is included in an Informational Note. CMP-9 chooses not to change the term “High Voltage”, as this term is specific to Article 490, and it has not been suggested to change the usage of that term within that Article. Additionally, product Standards and their associated listings do not consistently apply the terms “Medium” vs. “High” voltage.

Public Input No. 1022-NFPA 70-2020 [Section No. 450.3(B)]

(B) Transformers 1000 Volts, Nominal, or Less.

Overcurrent protection shall be provided in accordance with Table 450.3(B).

Exception: Where the transformer is installed as a motor control circuit transformer in accordance with 430.72(C)(1) through (C)(5).

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

Location Limitations	Transformer Rated Impedance	Primary Protection over 1000 Volts		Secondary Protection (See Note 2.)		
				Over 1000 Volts		1000 Volts or Less
		Circuit Breaker (See Note 4.)	Fuse Rating	Circuit Breaker (See Note 4.)	Fuse Rating	Circuit Breaker or Fuse Rating
Any location	Not more than 6%	600% (See Note 1.)	300% (See Note 1.)	300% (See Note 1.)	250% (See Note 1.)	125% (See Note 1.)
	More than 6% and not more than 10%	400% (See Note 1.)	300% (See Note 1.)	250% (See Note 1.)	225% (See Note 1.)	125% (See Note 1.)
Supervised locations only (See Note 3.)	Any	300% (See Note 1.)	250% (See Note 1.)	Not required	Not required	Not required
	Not more than 6%	600%	300%	300% (See Note 5.)	250% (See Note 5.)	250% (See Note 5.)
	More than 6% and not more than 10%	400%	300%	250% (See Note 5.)	225% (See Note 5.)	250% (See Note 5.)

Notes:

1. Where the required fuse rating or circuit breaker setting does not correspond to a standard rating or setting, a higher rating or setting that does not exceed the following shall be permitted:

a. The next higher standard rating or setting for fuses and circuit breakers 1000 volts and below, or

b. The next higher commercially available rating or setting for fuses and circuit breakers above 1000 volts.

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

3. A supervised location is a location where conditions of maintenance and supervision ensure that only qualified persons monitor and service the transformer installation.

4. Electronically actuated fuses that may be set to open at a specific current shall be set in

accordance with settings for circuit breakers.

5. A transformer equipped with a coordinated thermal overload protection by the manufacturer shall be permitted to have separate secondary protection omitted.

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

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

Notes:

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

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

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

Informational Note to Table 450.3(B): Momentary primary-side inrush currents greater than 20 times the current rating of the transformer can occur due to magnetization of the coil upon energization. Transformer primary-side inrush currents and the use of time-current coordination curves for the primary overcurrent protection device should both be considered to provide adequate performance.

Statement of Problem and Substantiation for Public Input

It is a common mistake, even among seasoned engineers, to set the overcurrent protection device rating at 1.25 times the current of the Xfmr, especially on small dry type transformers. While it does not present a dangerous condition, choosing an overcurrent device size in this manner without checking the time current curves of the overcurrent protection device may result in nuisance tripping of the breaker or blowing the fuse. This note would provide information to users not familiar with inrush saturation currents and how high they can be- even if they are just momentary.

Submitter Information Verification

Submitter Full Name: Paul Guidry
Organization: Fluor Enterprises, Inc.
Affiliation: Associated Builders and Contractors, Inc.
Street Address:

City:

State:

Zip:

Submittal Date: Mon May 11 11:57:06 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: The submitters show no substantiation for safety improvement so no changes are made. The submitter of PI-415 suggests an interesting topic but provided no substantiation to the suggested change.

Public Input No. 1164-NFPA 70-2020 [Section No. 450.3(B)]

(B) Transformers 1000 Volts, Nominal, or Less.

Overcurrent protection shall be provided in accordance with Table 450.3(B).

Exception: Where the transformer is installed as a motor control circuit transformer in accordance with 430.72(C)(1) through (C)(5).

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

~~required~~

Location Limitations	Transformer Rated Impedance		Primary Protection over 1000 Volts		Secondary Protection (See Note 2.)		
					Over 1000 Volts		1000 Volts or Less
			Circuit Breaker (See Note 4.)	Fuse Rating	Circuit Breaker (See Note 4.)	Fuse Rating	Circuit Breaker or Fuse Rating
Any location	Not more than 6%		600% (See Note 1.)	300% (See Note 1.)	300% (See Note 1.)	250% (See Note 1.)	125% (See Note 1.)
	More than 6% and not more than 10%		400% (See Note 1.)	300% (See Note 1.)	250% (See Note 1.)	225% (See Note 1.)	125% (See Note 1.)
Supervised locations only (See Note 3.)	~~Any~~	~~300% (See Note 1.)~~	~~250% (See Note 1.)~~				
	Not	~~Not required~~	~~Not required~~	~~Not~~ more than 6%	600%	300%	300% (See Note 5.)
	More than 6% and not more than 10%		400%	300%	250% (See Note 5.)	225% (See Note 5.)	250% (See Note 5.)

Notes:

1. Where the required fuse rating or circuit breaker setting does not correspond to a standard rating or setting, a higher rating or setting that does not exceed the following shall be permitted:

a. The next higher standard rating or setting for fuses and circuit breakers 1000 volts and below, or

b. The next higher commercially available rating or setting for fuses and circuit breakers above 1000 volts.

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

are used as the overcurrent device, the total of the device ratings shall not exceed that allowed for fuses.

3. A supervised location is a location where conditions of maintenance and supervision ensure that only qualified persons monitor and service the transformer installation.

4. Electronically actuated fuses that may be set to open at a specific current shall be set in accordance with settings for circuit breakers.

5. A transformer equipped with a coordinated thermal overload protection by the manufacturer shall be permitted to have separate secondary protection omitted.

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

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

Notes:

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

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

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

Statement of Problem and Substantiation for Public Input

This would clear up confusion when using the table. Currently there is no reason to use any other row under the "Supervised Location" Section in 450.3(A) Besides the "Any" row due to the way it was written. This change still covers all transformers in a "Supervised Location" and still makes sure there is adequate overcurrent protection for any type.

Submitter Information Verification

Submitter Full Name: Jordan Locher

Organization: E-Light Electric

Affiliation: Employee

Street Address:

City:

State:

Zip:

Submittal Date: Tue May 19 19:49:18 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: The submitters show no substantiation for safety improvement so no changes are made. The submitter of PI-415 suggests an interesting topic but provided no substantiation to the suggested change.

Public Input No. 415-NFPA 70-2020 [Section No. 450.3(B)]

(B)_ Transformers 1000 Volts, Nominal, or Less.

Overcurrent protection shall be provided in accordance with Table 450.3(B).

Exception: Where the transformer is installed as a motor control circuit transformer in accordance with 430.72(C)(1) through (C)(5).

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

Location Limitations	Transformer Rated Impedance		
	Primary Protection over 1000 Volts		
	Secondary Protection (See Note 2.)		
	Over 1000 Volts		
	1000 Volts or Less		
	Circuit Breaker (See Note 4.)	Fuse Rating	
	Circuit Breaker (See Note 4.)	Fuse Rating	
		Circuit Breaker or Fuse Rating	
Any location	Not more than 6%		
	600% (See Note 1.)	300% (See Note 1.)	
	300% (See Note 1.)	250% (See Note 1.)	
			125% (See Note 1.)
More than 6% and not more than 10%			
	400% (See Note 1.)	300% (See Note 1.)	

250% (See Note 1.)	225% (See Note 1.)
-	
	125% (See Note 1.)
Supervised locations only (See Note 3.)	Any
-	
300% (See Note 1.)	250% (See Note 1.)
-	
Not required	Not required
-	
	Not required
Not more than 6%	
-	
600%	300%
-	
300% (See Note 5.)	250% (See Note 5.)
-	
	250% (See Note 5.)
More than 6% and not more than 10%	
-	
400%	300%
-	
250% (See Note 5.)	225% (See Note 5.)
-	
250% (See Note 5.)	

Notes:

1. Where the required fuse rating or circuit breaker setting does not correspond to a standard rating or setting, a higher rating or setting that does not exceed the following shall be permitted:

a. The next higher standard rating or setting for fuses and circuit breakers 1000 volts and below, or

b. The next higher commercially available rating or setting for fuses and circuit breakers above 1000 volts.

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

3. A supervised location is a location where conditions of maintenance and supervision ensure that only qualified persons monitor and service the transformer installation.

4. Electronically actuated fuses that may be set to open at a specific current shall be set in accordance with settings for circuit breakers.

5. A transformer equipped with a coordinated thermal overload protection by the manufacturer shall be permitted to have separate secondary protection omitted.

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

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

Notes:

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

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

3. A transformer equipped with coordinated thermal overload protection by the manufacturer

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

Statement of Problem and Substantiation for Public Input

For transformers of 2A or less, if primary and secondary protection is provided, why is the rating of the primary protection more restrictive than for the case where only primary protection is provided? It would seem that there should be no safety issue with permitting the primary protection to be 300% when both primary and secondary protection is provided.

Submitter Information Verification

Submitter Full Name:	Todd Sauve
Organization:	Rockwell Automation
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Feb 04 06:28:45 EST 2020
Committee:	NEC-P09

Committee Statement

Resolution: The submitters show no substantiation for safety improvement so no changes are made. The submitter of PI-415 suggests an interesting topic but provided no substantiation to the suggested change.

Public Input No. 4306-NFPA 70-2020 [New Section after 450.3(C)]

(D) Three-Phase Transformers Rated 150kVA and Larger. Three-phase transformers rated 150kVA and larger, with a solidly grounded secondary shall be provided with arc energy reduction protection for first level equipment supplied by the transformer secondary conductors in accordance with (D)(1), (D)(2) and (D)(3).

(1) Secondary Overcurrent Protective Device . Transformer secondary conductors shall terminate in overcurrent protective device installed in an individual enclosure, or compartment of a panelboard or other distribution equipment, that does not contain additional overcurrent protective devices or other equipment.

(2) Methods to Reduce Clearing Time. The overcurrent protective device required in (D)(1) shall have a clearing time of 0.07 seconds or less at the available arcing current of the next level distribution equipment or one of the following methods for arc energy reduction shall be installed:

(1) **Energy-reducing maintenance switching with local status indicator**

(2) **Energy-reducing active arc flash mitigation system**

(3) **An instantaneous trip setting. Temporary adjustment of the instantaneous trip setting to achieve arc energy reduction shall not be permitted.**

(4) **An instantaneous override**

(5) **Current-limiting, electronically actuated fuse**

(6) **An approved equivalent means**

(3) Marking . Equipment supplied directly from transformer secondary conductors shall be marked to indicate the method of arc energy reduction when any of the options in (D)(2) are used.

Statement of Problem and Substantiation for Public Input

The requirements of 240.67 and 240.87 address arc energy reduction for fuses and circuit breakers at 1200 amps or larger. There are public inputs to reduce that threshold to 1000 amps or lower. Means and methods to reduce the level of incident energy have evolved rapidly and this level of protection is absolutely necessary where justified energized work is performed. It is extremely important to note that the advancements in technology have made this type of protection extremely feasible.
I am certain that CMP-9 members reading this for the first time already have a significant question. We have 240.67 and 240.87, so why do we need this for transformers?
The answer is that due to the inrush current, primary overcurrent protective devices will allow significant energy tto be released in the first level downstream equipment. This is where we see significant levels of incident energy. Once we get downstream of the OCPD that the transformer secondary conductors terminate in the potential energy released in an arcing fault is significantly

reduced.
The key here is a separate enclosure or compartment for the OCPD that the transformer secondary conductors terminate in. In most cases the fuse or circuit breaker at that point will have an instantaneous trip or override that opens in less than 0.07 seconds and no additional means of arc energy reduction would be required. The arc energy reduction methods provided are readily available and are proven technologies. List item (6) allows for any other approved method which could include an energy reduction maintenance swith installed on the transformer primary OCPD.
Good code is practical, easy to read and easy to enforce. This proposed requirement is practical, it is feasible, easy to read and easy to enforce. The time has come for the installation standard to require cost effective measures to be put in place to provide installer/maintainers with the level of safety addressed in 90.1(A).

Submitter Information Verification

Submitter Full Name:	James Dollard
Organization:	IBEW Local Union 98
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Sep 10 09:52:15 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: CMP-9 chooses to resolve for the following reasons: Secondary main is not required per existing transformer protection requirements but would be required by the submitter. No justification is provided for the 0.07 second operation time of overcurrent device. There is no definition of compartment for the secondary main protection device. There is no definition of additional equipment that is excluded from protection device compartment. Articles 240.67 and 240.87 already require energy reduction methods for specific protection devices.

Public Input No. 2119-NFPA 70-2020 [Section No. 450.3 [Excluding any Sub-Sections]]

Overcurrent protection of transformers shall comply with 450.3(A), (B), or (C). As used in this section, the word *transformer* shall mean a transformer or polyphase bank of two or more single-phase transformers operating as a unit. <u>Each transformer shall be protected by an individual overcurrent protective device.</u>

Informational Note No. 1: See 240.4, 240.21, ~~240.100 , and 240.101~~ - <u>and Article 241</u> for overcurrent protection of conductors.

Informational Note No. 2: Nonlinear loads can increase heat in a transformer without operating its overcurrent protective device.

Statement of Problem and Substantiation for Public Input

Some industrial locations try to feed multiple 3-phase, medium voltage transformers by daisy chaining them together on the primary side without a load-break switch or individual overcurrent protection on the supply side of each transformer. This often doesn"t provide protection for the smallest rated transformer, especially when there is a wide volt-ampere range among the transformers.

Submitter Information Verification

Submitter Full Name: Paul Guidry

Organization: Fluor Enterprises, Inc.

Affiliation: Associated Builders and Contractors

Street Address:

City:

State:

Zip:

Submittal Date: Sat Aug 01 22:25:23 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: The submitter is referencing where service personal should utilize the disconnecting means and aesthetics. The intent of the code is for safety. The submitter recommended adding a reference to Article 241. There is no Article 241 in the 2020 NEC. Transformer protection must meet the existing requirements in 450.3. Daisy chaining transformers does not negate that requirement.

Public Input No. 3266-NFPA 70-2020 [Section No. 450.3 [Excluding any Sub-Sections]]

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

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

Informational Note No. 2: Nonlinear loads can increase heat in a transformer without operating its overcurrent protective device.

<u>Informational Note No. 3. See IEEE 3002.8 Recommended Practice for Conducting Harmonic Studies and Analysis of Industrial and Commercial Power Systems for additional information.</u>

Statement of Problem and Substantiation for Public Input

This is another slice of updated content from the legacy "Red Book" IEEE 141 and "Gray Book: IEEE 241 into the new IEEE 3000 Standards Collection. From the project prospectus:

"Harmonic studies and analysis of industrial and commercial power systems are described. The basic concepts involved in such studies are described first. This is followed by a discussion of how to determine the need for a harmonic study, how to assemble the required data, how to recognize potential problems, and how to implement corrective measures."

https://standards.ieee.org/standard/3002_8-2018.html

Submitter Information Verification

Submitter Full Name:	Michael Anthony
Organization:	Standards Michigan
Affiliation:	IEEE Education & Healthcare Facilities Electrotechnology Committee
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon Sep 07 12:19:09 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: FR-7787-NFPA 70-2020

Statement: Informational Note 2 is revised to include reference to IEEE standard.

Public Input No. 4070-NFPA 70-2020 [Section No. 450.6(C)]

(C) Grounding.

Where the secondary tie system is grounded, each transformer secondary supplying the tie system shall be grounded in accordance ~~with the requirements of~~ with 250.30 for separately derived systems.

Statement of Problem and Substantiation for Public Input

Deleting the words "the requirements of" does not change the meaning of the section.

Submitter Information Verification

Submitter Full Name:	David Williams
Organization:	Delta Charter Township
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Sep 09 19:55:41 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: FR-7788-NFPA 70-2020

Statement: Changes were made to improve the clarity of the requirement.

Public Input No. 3260-NFPA 70-2020 [Section No. 450.8]

450.8 Guarding.

Transformers shall be guarded as specified in 450.8(A) through (D).

(A) Mechanical Protection.

Appropriate provisions shall be made to minimize the possibility of damage to transformers from external causes where the transformers are exposed to physical damage.

(B) Fencing.

Outdoor transformer installations shall have perimeter fencing at an adequate distance to allow service access by qualified persons only.

(C) Case or Enclosure.

Dry-type transformers shall be provided with a noncombustible moisture-resistant case or enclosure that provides protection against the accidental insertion of foreign objects.

(~~C~~ D) Exposed Energized Parts.

Switches or other equipment operating at 1000 volts, nominal, or less and serving only equipment within a transformer enclosure shall be permitted to be installed in the transformer enclosure if accessible to qualified persons only. All energized parts shall be guarded in accordance with 110.27 and 110.34.

(~~D~~ E) Voltage Warning.

The operating voltage of exposed live parts of transformer installations shall be indicated by signs or visible markings on the equipment or structures.

Statement of Problem and Substantiation for Public Input

Transformer installations, particularly pad-mounted units, continue to be installed by contractors and utilities without any fencing to keep persons away from the units. It is accepted that the enclosures as specified by IEEE standards are sufficient for safety. However, utilities are regularly publishing public announcements and other communications on the dangers of these units and the need to keep away from them, particularly for kids. A quick internet search on "pad mounted transformer dangers" reveals a multitude of such communications. Some utilities have instituted their own mandatory fencing requirements. This input proposes to make it mandatory to require fencing to protect persons from the hazards associated with transformer installations.

Submitter Information Verification

Submitter Full Name: Karl Cunningham
Organization: Self Employed
Street Address:
City:
State:
Zip:
Submittal Date: Mon Sep 07 11:25:05 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: The submitter provided no substantiation for safety for other than utility owned equipment which is outside the scope of the NEC. The concern is already addressed in Articles 110.27 and 110.34.

Public Input No. 901-NFPA 70-2020 [Section No. 450.9]

450.9 Ventilation.

The ventilation shall dispose of the transformer full-load heat losses without creating a temperature rise that is in excess of the transformer rating.

Informational Note No. 1: See IEEE C57.12.00-2015, *General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers*, and IEEE C57.12.01-2015, *General Requirements for Dry-Type Distribution and Power Transformers*.

Informational Note No. 2: Additional losses occur in some transformers where nonsinusoidal currents are present, resulting in increased heat in the transformer above its rating. See IEEE C57.110-2008, *Recommended Practice for Establishing Liquid-Filled and Dry-Type Power and Distribution Transformer Capability When Supplying Nonsinusoidal Load Currents*, where transformers are utilized with nonlinear loads.

Transformers with ventilating openings shall be installed so that the ventilating openings are not blocked by walls or other obstructions. The required clearances shall be clearly marked on the transformer. ~~Transformer~~ The top surfaces of dry-type ventilated transformer enclosures that are horizontal and readily accessible shall be marked to prohibit storage.

Statement of Problem and Substantiation for Public Input

Without being specific, tops of all types of transformers would have to be marked to prohibit storage.

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz
Organization: NECA
Street Address:
City:
State:
Zip:
Submittal Date: Tue Apr 21 14:10:01 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: The submitter proposed changes that will restrict the requirement to one type of transformer. The requirement to mark transformer horizontal top surfaces that are readily accessible is required regardless of transformer type.

Public Input No. 1363-NFPA 70-2020 [Section No. 450.10]

450.10 Grounding and Bonding .

(A) Dry-Type Transformer Enclosures.

Where separate equipment grounding conductors and supply-side bonding jumpers are installed, a terminal bar for all grounding and bonding conductor connections shall be secured inside the transformer enclosure. The terminal bar shall be bonded to the enclosure in accordance with 250.12 and shall not be installed on or over any vented portion of the enclosure.

Exception: Where a dry-type transformer is equipped with wire-type connections (leads), the grounding and bonding connections shall be permitted to be connected together using any of the methods in 250.8 and shall be bonded to the enclosure if of metal.

(B) Other Metal Parts.

Exposed non–current-carrying metal parts of transformer installations, including fences, guards, and so forth, shall be grounded and bonded under the conditions and in the manner specified for electrical equipment and other exposed metal parts in Parts V, VI, and VII of Article 250.

Statement of Problem and Substantiation for Public Input

According to the NFPA Style Manual, the Section Title needs to reflect the content of the rule. The rule is about both Grounding and Bonding.

Submitter Information Verification

Submitter Full Name: Mike Holt
Organization: Mike Holt Enterprises Inc
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jun 01 19:46:24 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7790-NFPA 70-2020

Statement: Word changes meet the NEC Style Manual and creates clarity as both grounding and bonding are addressed in this section.

Public Input No. 779-NFPA 70-2020 [New Section after 450.14]

TITLE OF NEW CONTENT

Type your content here ...

450.15 Electromagnetic Pulse (EMP) Protection. Where transformers are utilized to supply the manufacturing, production, transportation, distribution, sales, and business systems in facilities that are required to be EMP-protected, EMP protection for transformers against the effects of electromagnetic pulses shall be provided. See 709.7 for levels of electromagnetic pulse protection.

This requirement shall become effective January 1, 2026.

Statement of Problem and Substantiation for Public Input

A devastating electromagnetic pulse (EMP), caused by a sun-spot or a nuclear bomb exploded high in the atmosphere, can impress 50,000 volts per meter on unprotected electrical and electronic equipment. It is similar to a radio wave impressing a very small voltage on a radio antenna, only orders of magnitude larger. The problem is that a significant EMP will fry every electrical/electronic component or piece of equipment that is not protected.

The EMP won't directly harm or injure people, but because there is no longer a working electrical infrastructure, which may take years to repair/rebuild, people will die from the lack of clean water, medicine, food, fuel, and eventual rioting due to the breakdown of society. Unclassified studies, referenced at the end of this substantiation, have estimated from 66% to 90% of the US population will die within one year if a significant sun spot were to occur or if a nuclear explosion were to occur 25 to 250 miles over the Midwest.

Our US military already "hardens" systems/buildings so that our country's critical defensive capabilities are not completely destroyed. There are two major methods of protecting electrical/electronic systems. The first is that surge protective devices are installed on all "incoming" power and communications cables, shunting overvoltages to ground. The second is that Faraday cages are installed around equipment/rooms, preventing the EMP from reaching critical equipment/components.

The NEC® needs to address EMP protection for equipment, systems and special occupancies that are critical to our survival. Electrical and electronic equipment can and must be protected, as has been achieved by our military. Unfortunately, there are no requirements to protect civilian electrical and electronic equipment/systems from EMPs.

The NEC Correlating Committee has informally advised that an EMP Protection Article, if passed and adopted into the NEC®, would be most appropriately located after Article 708 (COPS). Thus, Public Input 756 has suggested a new Article 709 under jurisdiction of CMP 13, which already has purview over Emergency Systems (Article 700), Legally Required Standby Systems (Article 701), Optional Standby Systems (Article 702), and Critical Operations Power Systems (Article 708).

Levels of protection and associated protection requirements listed in the Public Input(s) are based upon the unclassified National Cybersecurity and Communications Integration Center report "Electromagnetic Pulse (EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment". This study explains electromagnetic pulses and provides the necessary protective measures. It also contains estimates of the costs associated with properly protecting our electrical infrastructure.

The following table contains critical infrastructure components/special occupancies and the maximum time for outages caused by an EMP. Electrical components/infrastructure that is not functioning for periods longer than shown in this table may begin to cause injury or death to people and harm to society/economy.

Critical Infrastructure Component/Special Occupancy	Permitted Outage Time
Branch banking facilities	10 hours
Critical Operations Power Systems	10 minutes
Data centers	10 minutes
Direct current microgrids	10 hours
Drug stores/distribution centers	10 hours
Electrically driven or controlled irrigation machines	1 week
Elevators, dumbwaiters, escalators, moving walks, platform lifts, and stairway chairlifts	See facility requirements
Emergency systems	10 hours
Energy storage systems	10 hours
Fire alarm systems	1 week
Fire houses/stations	10 hours
Fire pumps	10 hours
Food processing and storage facilities	10 hours
Fuel cell systems	10 hours
Generators	10 hours
Grocery stores	10 hours
Hardware stores/home centers	10 hours
Healthcare facilities	See NFPA 99
Information technology equipment	10 minutes
Interconnected electric power production sources	10 minutes
Jails and prisons	10 minutes
Large-scale photovoltaic (PV) electric supply stations	10 hours
Legally required standby systems	10 hours
Modular data centers	10 minutes
Motor fuel dispensing facilities	1 week
Motors, motor circuits, and controllers	See facility requirements
Nuclear reactors	10 seconds
Optional standby systems	1 week
Petrochemical plants/facilities	10 hours
Pharmaceutical plants/facilities	10 hours
Police stations	10 minutes
Solar photovoltaic (PV) systems	10 hours
Stand-alone systems	10 hours
Storage batteries	See facility requirements
Transformers	See facility requirements
Waste water treatment facilities	10 minutes
Water supply facilities	10 hours
Wind electric systems	10 hours

An effectivity date of January 1, 2026 is chosen to allow time for engineering and industry to adequately pan and prepare for the required changes.

Opponents of EMP protection requirements will likely charge that it is too costly to protect our critical infrastructure, and that the NEC® is not a war-time document. A close reading of 90.1 reveals that there is no mention of the “cost” of safeguarding persons and property. Neither does 90.1 mention that safeguarding persons and property is only required during peacetime. Additionally, a significant EMP event, caused by a sunspot, would be an act of God, not an act of war.

The novel, “One Second After”, provides an understanding of what happens when the majority of all unprotected electrical and electronic equipment/systems is destroyed during an EMP event. An audio version of this book is available in two parts, for free, on YouTube.

This link provides the unclassified report “Electromagnetic Pulse (EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment”
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=2ahUKEwjQhp2-77DoAhXBHM0KHboOB2QQFjACegQIBRAC&url=https%3A%2F%2Fwww.cisa.gov%2Fsites%2Fdefault%2Ffiles%2Fpublications%2F19_0307_CISA_EMP-Protection-Resilience-Guidelines.pdf&usg=AOvVaw2n7jLtJAUJtOJKHPMqWsTE

This link provides the study predicting up to 90% of our population could die from an EMP event http://www.firstempcommission.org/uploads/1/1/9/5/119571849/nuclear_emp_attack_scenarios_and_combined-arms_cyber_warfare_by_peter_pry_july_2017.pdf

This link provides unclassified guidelines for facility EMP protection https://info.publicintelligence.net/DHS-FacilitiesGuidelinesEMP.pdf

These links provide Parts 1 and 2 of a national plan for EMP protection.
https://interferencetechnology.com/a-national-plan-for-emp-protection-part-1/
https://interferencetechnology.com/national-plan-emp-protection-part-2-protection-buildings/

We have all just witnessed the chaos and pain caused by not having the "protections" in place to quickly defeat the Covid-19 virus. As unfortunate, costly, painful, and deadly as Covid-19 was, it would be child's play when compared to a significant EMP event if our critical electrical/electronic infrastructure remains unprotected. Quite simply, NEC® requirements to protect electrical and electronic equipment from an EMP event, could literally save millions of American lives.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 756-NFPA 70-2020 [New Section after 708.64]	
Public Input No. 756-NFPA 70-2020 [New Section after 708.64]	

Submitter Information Verification

Submitter Full Name: Vincent Saporita
Organization: Saporita Consulting
Affiliation: Saporita Consulting
Street Address:
City:
State:
Zip:
Submittal Date: Mon Mar 23 16:17:45 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: This requirement only affects facilities that require EMP protection. The proposed language suggests that a design requirement should be a Code requirement.

Public Input No. 101-NFPA 70-2019 [Section No. 450.14]

450.14 Disconnecting Means.

Transformers, other than Class 2 or Class 3 transformers, shall have a disconnecting means located either in sight of the transformer or in a remote location. Where located in a remote location, the disconnecting means shall be lockable open in accordance with 110.25, and its location shall be field marked on the transformer.

(A) Minimum Rating.

Where a disconnecting means is required, the minimum ampere rating for the primary and secondary side shall be not less than (1) or (2), and (3) and (4):

(1) 115% of the transformer volt-ampere base rating

(2) 115% of the transformer volt-ampere fan-cooled rating

(3) 100% of the overcurrent device rating required by Tables 450.3(A) and (B)

(4) 100% of the continuous and non-continuous load, plus 115% of the largest motor full-load current as required by 430.6 for motors less than 1000V, or Part XI for motors over 1000V

Statement of Problem and Substantiation for Public Input

This is a companion proposal to a new addition to Art. 450 requiring transformers to be able to carry 100% of the maximum calculated load continuously. In addition, it aligns with 430.110(A) and Art. 430 Part XI for motors more than 1000V.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 102-NFPA 70-2019 [New Part after I.]	Minimum rating of transformers
Public Input No. 102-NFPA 70-2019 [New Part after I.]	

Submitter Information Verification

Submitter Full Name: Paul Guidry

Organization: Fluor Enterprises, Inc.

Affiliation: Associated Builders and Contractors

Street Address:

City:

State:

Zip:

Submittal Date: Tue Nov 12 17:08:22 EST 2019

Committee: NEC-P09

Committee Statement

Resolution: The submitter has not provided substantiation that current requirements are inadequate or unsafe. Minimum ratings are addressed in the 450.3 tables. Additional rating requirements are not required.

Public Input No. 3570-NFPA 70-2020 [Section No. 450.43(C)]

(C) Locks.

Doors shall be equipped with locks, and doors shall be kept locked, with access being allowed only to qualified persons. Personnel doors shall open at least 90 degrees in the direction of egress and be equipped with listed fire exit hardware.

Additional Proposed Changes

File Name	Description	Approved
Door_obstruction.jpg	sprinkler pipe preventing electric room door from fully opening	

Statement of Problem and Substantiation for Public Input

Doors must be able to open at least 90 degrees in order for people to escape danger in an emergency situation such as an electrical explosion or arc flash event. If the door were to come to a sudden stop at only 30 degrees open due to an obstruction, people rushing through the door could be hindered or even injured during their escape. I have actually been "stunned" and even disoriented by doors not opening fully and coming to an unexpected and sudden early stop. Now imagine that scenario during an panic situation! It could result in injuries or even death.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3563-NFPA 70-2020 [Section No. 110.26(C)(3)]	unobstructed door swing
Public Input No. 3566-NFPA 70-2020 [Section No. 110.33(A)(3)]	unobstructed door swing
Public Input No. 3568-NFPA 70-2020 [Section No. 480.10(E)]	unobstructed door swing
Public Input No. 3575-NFPA 70-2020 [Section No. 646.19 [Excluding any Sub-Sections]]	
Public Input No. 3582-NFPA 70-2020 [Section No. 110.31(A)(4)]	

Submitter Information Verification

Submitter Full Name: Russ Leblanc
Organization: Leblanc Consulting Services
Street Address:
City:
State:
Zip:
Submittal Date: Wed Sep 09 08:07:25 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7791-NFPA 70-2020

Statement: CMP-9 changes the 450.43(C) title from "Locks" to "Accessibility" since the section addressed more than locks.

The revised wording ensures vault doorways open wide enough to provide proper access and egress to provide safety.


THIS IS A RATED F
DO NOT PENETRAT
AT EXT. 6-2422 FOR

Public Input No. 2084-NFPA 70-2020 [New Article after 490]

Part VI. Resistance-Type Boilers

490.80 General. The provisions of Part VI shall apply to boilers operating over 1000 volts, nominal, employing resistance-type heating elements.

490.81 Electrical Supply System. Resistance-type boilers shall be supplied from a 3-phase solidly (or resistance) grounded delta system , or from isolating transformers arranged to provide such a system. Control circuit voltages shall not exceed 150 volts, shall be supplied from a grounded system, and shall have the controls in the ungrounded conductor.

490.82 Branch-Circuit Requirements.

(A) Rating. Each boiler shall be supplied from an individual branch circuit rated not less than 100 percent of the total load.

(B) Common-Trip Fault-Interrupting Device. The circuit shall be protected by a 3-phase, common-trip fault-interrupting device, which shall be permitted to automatically reclose the circuit upon removal of an overload condition but shall not reclose after a fault condition.

(C) Phase-Fault Protection. Phase-fault protection shall be provided in each phase, consisting of a separate phase overcurrent relay connected to a separate current transformer in the phase.

(D) Ground Current Detection. Means shall be provided for detection of the sum of the neutral conductor and equipment grounding conductor currents and shall trip the circuit interrupting device if the sum of those currents exceeds the greater of 5 amperes or 7.5 percent of the boiler full-load current for 10 seconds or exceeds an instantaneous value of 25 percent of the boiler full-load current.

(E) Grounded Neutral Conductor. The grounded neutral conductor shall be as follows:

(1) Connected to the pressure vessel containing the resistance-type heating elements

(2) Insulated for not less than 1000 volts

(3) Have not less than the ampacity of the largest ungrounded branch-circuit conductor

(4) Installed with the ungrounded conductors in the same raceway, cable, or cable tray, or, where installed as open conductors, in close proximity to the ungrounded conductors

(5) Not used for any other circuit

490.83 Pressure and Temperature Limit Control. Each boiler shall be equipped with a means to limit the maximum temperature, pressure, or both, by directly or indirectly interrupting all current flow through the resistance-type heating elements . Such means shall be in addition to the temperature, pressure, or both, regulating systems and pressure relief or safety valves.

490.84 Bonding. All exposed non–current-carrying metal parts of the boiler and associated exposed metal structures or equipment shall be bonded to the pressure vessel or to the neutral conductor to which the vessel is connected in accordance with 250.102, except the ampacity of the bonding jumper shall not be less than the ampacity of the neutral conductor.

Statement of Problem and Substantiation for Public Input

Chromalox has developed electric-resistance type heating elements that operate at over 1000 volts. Chromalox currently installs these heating elements into process heating equipment that has been sold to several dozen clients. The heating elements have been proven to operate safely and Chromalox has obtained various third-party certifications for the elements. Chromalox has developed electric-resistance type boilers operating that utilize these elements operating over 1000 volts. Chromalox needs to make changes to NFPA 70 in order to obtain UL 834 certification for the boiler product line.

Submitter Information Verification

Submitter Full Name: James Hadley

Organization: Chromalox

Street Address:

City:

State:

Zip:

Submittal Date: Wed Jul 29 13:32:15 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7970-NFPA 70-2020

Statement: The use of larger resistance type boilers is becoming more prevalent as users move to de-carbonization and away from fossil fuels for heating. Other standards are referencing the NEC for evaluation and resistance type boilers operating over 1000V are not addressed in Article 490. Part V already addresses “Electrode-Type Boilers”, and rather than create a new “Part VI” that has identical requirements, Part V is revised to refer to “Boilers” more generically. The existing requirements for “Electrode-Type Boilers” would apply equally to other types of Boilers, including “Resistance-Type Boilers”. Changes are made throughout Part V to refer generically to “Boilers”.

Public Input No. 3639-NFPA 70-2020 [Section No. 490.2]

(Relocate all definitions in the 490. 2 to Article 100, arrange them in alphabetical order and without any subdivisions.)

490. 2 Definition.

The definition in this section shall apply only within this article.

High Voltage.

A potential difference of more than 1000 volts, nominal.

Statement of Problem and Substantiation for Public Input

"The National Electrical Code has definitions in multiple parts in Article 100 and many definitions scattered through out the code many of them in the .2 section of the articles.
Most of the other standards under NFPA have their definitions in one location and this will allow the NEC the same requirement. The revisions to the NEC Style Manual require all the definitions to be relocated to Article 100. "

Submitter Information Verification

Submitter Full Name:	David Williams
Organization:	Delta Charter Township
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Sep 09 09:58:17 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: FR-7975-NFPA 70-2020

Statement: This FR moves all existing definitions under the purview of CMP-9 to Article 100 and revises these definitions for compliance with Section 2.2.2 of the NEC Style Manual. Additionally all definition sections (XXX.2) in the articles under the responsibility of CMP-9 are deleted.

The term “Medium Voltage” is commonly used to describe circuits and equipment operating at voltage levels greater than 1000 volts, and up to 52 kV. As this is a commonly used term, it is included in an Informational Note. CMP-9 chooses not to change the term “High Voltage”, as this term is specific to Article 490, and it has not been suggested to change the usage of that term within that Article. Additionally, product Standards and their associated listings do not consistently apply the terms “Medium” vs. “High” voltage.

Public Input No. 1089-NFPA 70-2020 [Definition: High Voltage.]

~~High~~ Medium Voltage.

A potential difference of more than 1000 volts, nominal.

Statement of Problem and Substantiation for Public Input

The term medium voltage harmonizes with other references to voltages greater than 1000 volts nominal throughout this Code. High voltage is used variously as a level above 35,000 volts for some references, or above 100,000 volts for others.

Submitter Information Verification

Submitter Full Name:	David Bredhold
Organization:	Db Technical Services
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sat May 16 09:31:15 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: FR-8279-NFPA 70-2020

Statement: The term "Medium Voltage" is commonly used to describe circuits and equipment operating at voltage levels greater than 1000 volts, and up to 52 kV. As this is a commonly used term, it is included in an Informational Note. CMP-9 chooses not to change the term "High Voltage", as this term is specific to Article 490, and it has not been suggested to change the usage of that term within that Article. Additionally, product Standards and their associated listings do not consistently apply the terms "Medium" vs. "High" voltage.

Public Input No. 4358-NFPA 70-2020 [Section No. 490.3(A)]

(A) Oil-Filled Equipment.

Installation of electrical equipment, other than transformers covered in ~~Article 450~~ the transformer article , containing more than 38 L (10 gal) of flammable oil per unit shall meet the requirements of Parts II and III of Article 450.

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. The first reference to Article 450 is in violation of the style manual and changing to the more generic language will address this. I would have proposed pointing to the scope statement of Article 450 but that scope statement includes both what is covered by the article and what is not covered by the article and could be confusing to the user.

Submitter Information Verification

Submitter Full Name: Richard Holub

Organization: The DuPont Company, Inc.

Street Address:

City:

State:

Zip:

Submittal Date: Thu Sep 10 11:13:53 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7960-NFPA 70-2020

Statement: In accordance with Clause 4.1.4 of the NEC Style Manual, the reference to the entire Article 450 is removed. There is no need in referencing “transformers” in a Section that references other oil filled equipment. The revised text improves clarity.

Public Input No. 3209-NFPA 70-2020 [Section No. 490.24]

490.24 Minimum Space Separation.

In field-fabricated installations, the minimum air separation between bare live conductors and between such conductors and adjacent grounded surfaces shall not be less than the values given in Table 490.24. These values shall not apply to interior portions or exterior terminals of equipment designed, manufactured, and tested in accordance with accepted national standards.

Table 490.24 Minimum Clearance of Live Parts

Nominal Voltage Rating (kV)	Impulse Withstand, Basic Impulse Level B.I.L (kV)		-	Minimum Clearance of Live Parts										
				Phase-to-Phase					-	Phase-to-Ground				
			-	Indoors		-	Outdoors		-	Indoors		-	Outdoors	
	Indoors	Outdoors	-	mm	in.	-	mm	in.	-	mm	in.	-	mm	in.
2.4–4.16	60	95	-	115	4.5	-	180	7	-	80	3.0	-	155	6
7.2	75	95	-	140	5.5	-	180	7	-	105	4.0	-	155	6
13.8	95	110	-	195	7.5	-	305	12	-	130	5.0	-	180	7
14.4	110	110	-	230	9.0	-	305	12	-	170	6.5	-	180	7
23	125	150	-	270	10.5	-	385	15	-	190	7.5	-	255	10
34.5	150	150	-	320	12.5	-	385	15	-	245	9.5	-	255	10
	-	200	200 -		460	18.0 -		460	18 -		335	13.0 -		335 1
46	—	200	-	—	—	-	460	18	-	—	—	-	335	13
	-	—	250 -		—	— -		535	21 -		—	— -		435 1
69	—	250	-	—	—	-	535	21	-	—	—	-	435	17
	-	—	350 -		—	— -		790	31 -		—	— -		635 2
115	—	550	-	—	—	-	1350	53	-	—	—	-	1070	42
138	—	550	-	—	—	-	1350	53	-	—	—	-	1070	42
	-	—	650 -		—	— -		1605	63 -		—	— -		1270 5
161	—	650	-	—	—	-	1605	63	-	—	—	-	1270	50
	-	—	750 -		—	— -		1830	72 -		—	— -		1475 5
230	—	750	-	—	—	-	1830	72	-	—	—	-	1475	58
	-	—	900 -		—	— -		2265	89 -		—	— -		1805 7
	—	1050	-	—	—	-	2670	105	-	—	—	-	2110	83

Note: The values given are the minimum clearance for rigid parts and bare conductors under favorable service conditions. They shall be increased for conductor movement or under unfavorable service conditions or wherever space limitations permit. The selection of the associated impulse withstand voltage for a particular system voltage is determined by the characteristics of the ~~surge~~ overvoltage protective equipment.

Additional Proposed Changes

File Name	Description	Approved
Code_Input.docx	input to improve overvoltage protection requirements	

Statement of Problem and Substantiation for Public Input

In the 2020 NEC cycle, ARTICLES 280 and 285 were combined to make ARTICLE 242. This was a positive change that began to address the issue of OVERVOLTAGE as a technical subject apart from particular product methods (SPDs and Surge Arresters). There are other technologies and products to address the issue of OVERVOLTAGE. This input attempts to add one such technology as well as correlate the other code references to the subject of OVERVOLTAGE, surge protective devices, and surge arresters to be consistent. This is important to allow for other technologies to be utilized without prejudice to certain products promoted by manufacturers.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3200-NFPA 70-2020 [Section No. 242.1]	
Public Input No. 3202-NFPA 70-2020 [New Article after 100]	
Public Input No. 3203-NFPA 70-2020 [New Article after 242]	
Public Input No. 3205-NFPA 70-2020 [Section No. 501.35]	
Public Input No. 3206-NFPA 70-2020 [Section No. 502.35]	
Public Input No. 3208-NFPA 70-2020 [Section No. 551.72(E)]	
Public Input No. 3210-NFPA 70-2020 [Section No. 490.48(A)]	
Public Input No. 3211-NFPA 70-2020 [Section No. 620.51(E)]	
Public Input No. 3212-NFPA 70-2020 [Section No. 645.18]	
Public Input No. 3214-NFPA 70-2020 [Section No. 670.6]	
Public Input No. 3216-NFPA 70-2020 [Section No. 694.7(D)]	
Public Input No. 3217-NFPA 70-2020 [Section No. 695.15]	
Public Input No. 3218-NFPA 70-2020 [Section No. 700.8]	
Public Input No. 3219-NFPA 70-2020 [Section No. 708.20(D)]	

Submitter Information Verification

Submitter Full Name: Karl Cunningham
Organization: Self Employed
Street Address:
City:
State:
Zip:
Submittal Date: Sun Sep 06 18:28:08 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7961-NFPA 70-2020

Statement: Article 242 (new to the 2020 Code) covers "surge equipment"; however, the title of the Article is "Overvoltage Protection", as that is a more generic term. This revision aligns this text with the title of Article 242, and also includes the term "surge" as this has historically been used to describe this equipment.

The use of the generic term "overvoltage protection" allows for a broader application of products that provide this protection.

Substantiation for Changes: In the 2020 NEC cycle, ARTICLES 280 and 285 were combined to make ARTICLE 242. This was a positive change that began to address the issue of OVERVOLTAGE as a technical subject apart from particular product methods (SPDs and Surge Arresters). There are other technologies and products to address the issue of OVERVOLTAGE. This input attempts to add one such technology as well as correlate the other code references to the subject of OVERVOLTAGE, surge protective devices, and surge arresters to be consistent. This is important to allow for other technologies to be utilized without prejudice to certain products promoted by manufacturers.

ARTICLE 100 - DEFINITIONS

Voltage Stabilizing Ground Reference (VSGR) System – an engineered assembly of interconnected passive inductive devices that utilize mutual counter electro-magnetic inductance to stabilize phase voltages of a connected supply system with respect to each other and to ground.

ARTICLE 242 Overvoltage Protection

Part I. General

242.1 Scope.

This article provides the general requirements, installation requirements, and connection requirements for overvoltage protection and overvoltage protective devices. Part II covers surge-protective devices (SPDs) permanently installed on premises wiring systems of not more than 1000 volts, nominal, while Part III covers surge arresters permanently installed on premises wiring systems over 1000 volts, nominal. Part IV covers Voltage Stabilizing Ground Reference (VSGR) systems permanently installed on premises wiring systems for any voltage.

Informational Note: Article 242 combines and replaces Articles 280 and 285 in *NFPA 70*-2017.

242.3 Other Articles.

Equipment shall be protected against overvoltage in accordance with the article in this *Code* that covers the type of equipment or location specified in Table 242.3.

Table 242.3 Other Articles

Equipment	Article
Class I locations	501
Class II locations	502
Community antenna television and radio distribution systems	820
Critical operations power systems	708

Table 242.3 Other Articles

Equipment	Article
Elevators, dumbwaiters, escalators, moving walks, platform lifts, and stairway chairlifts	620
Emergency systems	700
Equipment over 1000 volts, nominal	490
Fire pumps	695
Industrial machinery	670
Information technology equipment	645
Modular data centers	646
Outdoor overhead conductors over 1000 volts	399
Radio and television equipment	810
Receptacles, cord connectors, and attachment plugs (caps)	406
Wind electric systems	694

Part II. Surge-Protective Devices (SPDs), 1000 Volts or Less

Informational Note: Surge arresters 1000 volts or less are also known as Type 1 SPDs.

242.6 Uses Not Permitted.

An SPD device shall not be installed in the following:

1. (1)

   Circuits over 1000 volts

2. (2)

   On ungrounded systems, impedance grounded systems, or corner grounded delta systems unless listed specifically for use on these systems

3. (3)

   Where the rating of the SPD is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application

242.8 Listing.
An SPD shall be a listed device.

242.10 Short-Circuit Current Rating.
The SPD shall be marked with a short-circuit current rating and shall not be installed at a point on the system where the available fault current is in excess of that rating. This marking requirement shall not apply to receptacles.

242.12 Type 1 SPDs.
Type 1 SPDs shall be installed in accordance with 242.12(A) and (B).

242.12(A) Installation.
Type 1 SPDs shall be permitted to be connected in accordance with one of the following:

1. (1)

   To the supply side of the service disconnect as permitted in 230.82(4)

2. (2)

   As specified in 242.14

242.12(B) At the Service.
When installed at services, Type 1 SPDs shall be connected to one of the following:

1. (1)

   Grounded service conductor

2. (2)

   Grounding electrode conductor

3. (3)

   Grounding electrode for the service

4. (4)

   Equipment grounding terminal in the service equipment

242.14 Type 2 SPDs.
Type 2 SPDs shall be installed in accordance with 242.14(A) through (C).

242.14(A) Service-Supplied Building or Structure.
Type 2 SPDs shall be connected anywhere on the load side of a service disconnect overcurrent device required in 230.91 unless installed in accordance with 230.82(8).

242.14(B) Feeder-Supplied Building or Structure.
Type 2 SPDs shall be connected at the building or structure anywhere on the load side of the first overcurrent device at the building or structure.

242.14(C) Separately Derived System.
The SPD shall be connected on the load side of the first overcurrent device in a separately derived system.

242.16 Type 3 SPDs.
Type 3 SPDs shall be permitted to be installed on the load side of branch-circuit overcurrent protection up to the equipment served. If included in the manufacturer's instructions, the Type 3 SPD connection shall be a minimum 10 m (30 ft) of conductor distance from the service or separately derived system disconnect.

242.18 Type 4 and Other Component Type SPDs.
Type 4 component assemblies and other component type SPDs shall only be installed by the equipment manufacturer.

242.20 Number Required.
Where used at a point on a circuit, the SPD shall be connected to each ungrounded conductor.

242.22 Location.
SPDs shall be permitted to be located indoors or outdoors and shall be made inaccessible to unqualified persons unless listed for installation in accessible locations.

242.24 Routing of Connections.
The conductors used to connect the SPD to the line or bus and to ground shall not be any longer than necessary and shall avoid unnecessary bends.

242.26 Connection.
Where an SPD device is installed, it shall comply with 242.12, 242.14, 242.16, 242.28. and 242.30.

242.28 Conductor Size.
Line and grounding conductors shall not be smaller than 14 AWG copper or 12 AWG aluminum.

242.30 Connection Between Conductors.
An SPD shall be permitted to be connected between any two conductors — ungrounded conductor(s), grounded conductor, equipment grounding conductor, or grounding electrode conductor. The grounded conductor and the equipment grounding conductor shall be interconnected only by the normal operation of the SPD during a surge.

242.32 Grounding Electrode Conductor Connections and Enclosures.
Except as indicated in this article, SPD grounding connections shall be made as specified in Article 250, Part III. Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).

Part III. Surge Arresters, Over 1000 Volts

242.40 Uses Not Permitted.
A surge arrester shall not be installed where the rating of the surge arrester is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application.

242.42 Surge Arrester Selection.
The surge arresters shall comply with 242.42(A) and (B).

242.42(A) Rating.
The rating of a surge arrester shall be equal to or greater than the maximum continuous operating voltage available at the point of application.

242.42(A)(1) Solidly Grounded Systems.
The maximum continuous operating voltage shall be the phase-to-ground voltage of the system.

242.42(A)(2) Impedance or Ungrounded System.

The maximum continuous operating voltage shall be the phase-to-phase voltage of the system.

242.42(B) Silicon Carbide Types.

The rating of a silicon carbide-type surge arrester shall be not less than 125 percent of the rating specified in 242.42(A).

Informational Note No. 1: For further information on surge arresters, see IEEE C62.11-2012, *Standard for Metal-Oxide Surge Arresters for Alternating-Current Power Circuits (>1 kV)*, and IEEE C62.22-2009, *Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems*.

Informational Note No. 2: The selection of a properly rated metal oxide arrester is based on considerations of maximum continuous operating voltage and the magnitude and duration of overvoltages at the arrester location as affected by phase-to-ground faults, system grounding techniques, switching surges, and other causes. See the manufacturer's application rules for selection of the specific arrester to be used at a particular location.

242.44 Number Required.

Where used at a point on a circuit, a surge arrester shall be connected to each ungrounded conductor. A single installation of such surge arresters shall be permitted to protect a number of interconnected circuits if no circuit is exposed to surges while disconnected from the surge arresters.

242.46 Location.

Surge arresters shall be permitted to be located indoors or outdoors. Surge arresters shall be made inaccessible to unqualified persons unless listed for installation in accessible locations.

242.48 Routing of Surge Arrester Equipment Grounding Conductors.

The conductor used to connect the surge arrester to line, bus, or equipment and to an equipment grounding conductor or grounding electrode connection point as provided in 242.50 shall not be any longer than necessary and shall avoid unnecessary bends.

242.50 Connection.

The arrester shall be connected to one of the following:

1. (1)

   Grounded service conductor

2. (2)

   Grounding electrode conductor

3. (3)

   Grounding electrode for the service

4. (4)

   Equipment grounding terminal in the service equipment

242.52 Surge-Arrester Conductors.

The conductor between the surge arrester and the line, and the surge arrester and the grounding connection, shall not be smaller than 6 AWG copper or aluminum.

242.54 Interconnections.

The surge arrester protecting a transformer that supplies a secondary distribution system shall be interconnected as specified in 242.54(A), (B), or (C).

242.54(A) Metal Interconnections.

A metal interconnection shall be made to the secondary grounded circuit conductor or the secondary circuit grounding electrode conductor, if, in addition to the direct grounding connection at the surge arrester, the connection complies with 242.54(A)(1) or (A)(2).

242.54(A)(1) Additional Grounding Connection.

The grounded conductor of the secondary has a grounding connection elsewhere to a continuous metal underground water piping system. In urban water-pipe areas where there are at least four water-pipe connections on the neutral conductor and not fewer than four such connections in each mile of neutral conductor, the metal interconnection shall be permitted to be made to the secondary neutral conductor with omission of the direct grounding connection at the surge arrester.

242.54(A)(2) Multigrounded Neutral System Connection.

The grounded conductor of the secondary system is part of a multigrounded neutral system or static wire of which the primary neutral conductor or static wire has at least four grounding connections in each 1.6 km (1 mile) of line in addition to a grounding connection at each service.

242.54(B) Through Spark Gap or Device.

Where the surge arrester grounding electrode conductor is not connected as in 242.54(A), or where the secondary is not grounded as in 242.54(A) but is otherwise grounded as in 250.52, an interconnection shall be made through a spark gap or listed device as required by 242.54(B)(1) or (B)(2).

242.54(B)(1) Ungrounded or Unigrounded Primary System.

For ungrounded or unigrounded primary systems, the spark gap for a listed device shall have a 60-Hz breakdown voltage of at least twice the primary circuit voltage but not necessarily more than 10 kV, and there shall be at least one other ground on the grounded conductor of the secondary that is not less than 6.0 m (20 ft) distant from the surge-arrester grounding electrode.

242.54(B)(2) Multigrounded Neutral Primary System.

For multigrounded neutral primary systems, the spark gap or listed device shall have a 60-Hz breakdown of not more than 3 kV, and there shall be at least one other ground on the grounded conductor of the secondary that is not less than 6.0 m (20 ft) distant from the surge-arrester grounding electrode.

242.54(C) By Special Permission.

An interconnection of the surge-arrester ground and the secondary neutral conductor, other than as provided in 242.54(A) or (B), shall be permitted to be made only by special permission.

242.56 Grounding Electrode Conductor Connections and Enclosures.

Except as indicated in this article, surge-arrester grounding electrode conductor connections shall be made as specified in Article 250, Parts III and X. Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).

Part IV. Voltage Stabilizing Ground Reference (VSGR) systems.

242.68 Listing.

A VSGR shall be a listed device or system composed of listed components.

242.70 Short-Circuit Current Rating.

The VSGR shall be marked with a short-circuit current rating and shall not be installed at a point on the system where the available fault current is in excess of that rating.

242.71 Voltage Rating.

The rating of the VSGR shall be equal to or greater than the maximum system continuous operating voltage at the point of application.

242.72 Installation.

VSGRs shall be installed in accordance with 242.72(A) through (C).

242.72(A) Service-Supplied Building or Structure.

VSGR shall be connected anywhere on the load side of a service disconnect overcurrent device required in 230.91 unless installed in accordance with 230.82(8).

242.72(B) Feeder-Supplied Building or Structure.

VSGR shall be connected at the building or structure anywhere on the load side of the first overcurrent device at the building or structure.

242.72(C) Separately Derived System.

VSGR shall be connected on the load side of the first overcurrent device in a separately derived system.

242.82 Location.

VSGRs shall be permitted to be located indoors or outdoors and shall be made inaccessible to unqualified persons unless listed for installation in accessible locations.

242.84 Conductor Size.

Line and grounding conductors shall not be smaller than 14 AWG copper or 12 AWG aluminum.

242.90 Connection Between Conductors.

VSGR connections shall follow the manufacturer's instructions for the system connections.

242.92 Grounding Electrode Conductor Connections and Enclosures.

Except as indicated in this article, VSGR grounding connections shall be made as specified in Article 250, Part III. Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).

501.35 Overvoltage ~~Surge~~ Protection.

501.35(A) Class I, Division 1.

Overvoltage protection devices, surge arresters, surge-protective devices, and capacitors shall be installed in enclosures identified for Class I, Division 1 locations. Surge-protective capacitors shall be of a type designed for specific duty.

501.35(B) Class I, Division 2.

Overvoltage protection devices, surge arresters and surge-protective devices shall be nonarcing, such as metal-oxide varistor (MOV) sealed type, and surge-protective capacitors shall be of a type designed for specific duty. Enclosures shall be permitted to be of the general-purpose type. Overvoltage ~~Surge~~ protection of types other than described in this paragraph shall be installed in enclosures identified for Class I, Division 1 locations.

502.35 Overvoltage ~~Surge~~ Protection — Class II, Divisions 1 and 2.

Overvoltage protection devices, surge arresters and surge-protective devices installed in a Class II, Division 1 location shall be in suitable enclosures. Surge-protective capacitors shall be of a type designed for specific duty.

551.72(E) Connected Devices.

The use of autotransformers shall not be permitted. The use of listed overvoltage and surge protective devices shall be permitted.

Table 490.24 Minimum Clearance of Live Parts

Note: The values given are the minimum clearance for rigid parts and bare conductors under favorable service conditions. They shall be increased for conductor movement or under unfavorable service conditions or wherever space limitations permit. The selection of the associated impulse withstand voltage for a particular system voltage is determined by the characteristics of the overvoltage ~~surge~~ protective equipment.

490.48(A) Design and Documentation.

(12) Overvoltage ~~Surge~~ arresters

620.51(E) Overvoltage ~~Surge~~ Protection.

Overvoltage protection shall be provided where any of the disconnecting means in 620.51 has been designated as supplying an emergency system load, a legally required system load, or a critical operation power system load, ~~listed surge protection shall be provided.~~

645.18 Overvoltage ~~Surge~~ Protection for Critical Operations Data Systems.

Overvoltage ~~Listed surge~~ protection shall be provided for critical operations data systems.

670.6 Surge Protection.

Industrial machinery with safety interlock control devices not effectively protected from voltage surges on the incoming supply circuit shall have overvoltage ~~surge~~ protection installed.

694.7(D) Overvoltage Protection ~~Surge Protective Devices (SPD).~~

Overvoltage protection ~~A surge protective device~~ shall be installed between a wind electric system and any loads served by the premises electrical system. The ~~surge~~ protective device shall be permitted to be a VSGR, or a Type 3 SPD on the circuit serving a wind electric system, or a Type 2 SPD located anywhere on the load side of the service disconnect. Overvoltage ~~Surge~~ protective devices shall be installed in accordance with Part II of Article 242.

695.15 Overvoltage ~~Surge~~ Protection.

Overvoltage ~~A listed surge~~ protection ~~device~~ shall be provided for ~~installed in or on~~ the fire pump controller.

700.8 Overvoltage ~~Surge~~ Protection.

Overvoltage protection ~~A listed SPD~~ shall be provided-installed in ~~or on~~ for all emergency systems switchboards and panelboards.

708.20(D) Overvoltage ~~Surge~~ Protection ~~Devices~~.

Surge protection devices shall be provided at all facility distribution voltage levels

Public Input No. 867-NFPA 70-2020 [Section No. 490.24]

490.24 Minimum Space Separation.

In field-fabricated installations, the minimum air separation between bare live conductors and between such conductors and adjacent grounded surfaces shall not be less than the values given in Table 490.24. These values shall not apply to interior portions or exterior terminals of equipment designed, manufactured, and tested in accordance with accepted national standards.

Table 490.24 Minimum Clearance of Live Parts

Nominal Voltage Rating (kV)	Impulse Withstand, Basic Impulse Level B.I.L (kV)		-	Minimum Clearance of Live Parts									
				Phase-to-Phase					-	Phase-to-G			
			-	Indoors		-	Outdoors		-	Indoors		-	
	Indoors	Outdoors	-	mm	in.	-	mm	in.	-	mm	in.	-	
2.4–4.16	60~~95~~	60	-	115	4.5		125 ~~180~~	5 ~~7~~	-	80	3.0		
7.2	75	95	-	140	5.5		200 ~~180~~	8 ~~7~~	-	105	4.0		
13.8	95	110	-	195	7.5		230 ~~305~~	9 ~~12~~	-	130	5.0		
14.4	110	110	-	230	9.0		230 ~~305~~	9 ~~12~~	-	170	6.5		
23	125	150	-	270	10.5		315 ~~385~~	12 ~~15~~	-	190	7.5		
34.5	150	150	-	320	12.5		315 ~~385~~	12 ~~15~~	-	245	9.5		
	-	200	200 -	460	18.0		420 ~~460~~	16 ~~18~~	-	335	13.0		
46	—	200	-	—	—		420 ~~460~~	16 ~~18~~	-	—	—		
	—	250	-	—	—		525 ~~535~~	21	-	—	—		
69	—	250	-	—	—		525 ~~535~~	21	-	—	—		
	—	350	-	—	—		730 ~~790~~	29 ~~31~~	-	—	—		
115	—	550	-	—	—		1150 ~~1350~~	45 ~~53~~	-	—	—		1
138	—	550	-	—	—		1150 ~~1350~~	45 ~~53~~	-	—	—		1
	—	650	-	—	—		1360 ~~1605~~	54 ~~63~~	-	—	—		1
161	—	650	-	—	—		1360 ~~1605~~	54 ~~63~~	-	—	—		1
	—	750	-	—	—		1570 ~~1830~~	62 ~~72~~	-	—	—		1
230	—	750	-	—	—		1570 ~~1830~~	62 ~~72~~	-	—	—		1
	—	900	-	—	—		1880 ~~2265~~	74 ~~89~~	-	—	—		1
	—	1050	-	—	—		2200 ~~2670~~	86 ~~105~~	-	—	—		2

Note: The values given are the minimum clearance for rigid parts and bare conductors under favorable service conditions. They shall be increased for conductor movement or under unfavorable service conditions or wherever space limitations permit. The selection of the associated impulse withstand voltage for a particular system voltage is determined by the characteristics of the surge protective equipment.

Statement of Problem and Substantiation for Public Input

Change the "Outdoors" values in Table 490.24 to match IEEE Std 1427-2006 Table 3.

The present values in Table 490.24 appear to come from IEEE Std C37.30.1-2011 Table 14, which is intended for "station class outdoor air switches" and is not intended for field-fabricated installations. Instead, IEEE Std 1427-2006 is intended for substations in general, including field-fabricated bus structures. Therefore, it would be more appropriate for the values in NEC Table 490.24 to be reduced to the values in IEEE Std 1427-2006 Table 3. This would allow for substation buswork that was constructed to meet IEEE Std 1427 to also meet NEC Table 490.24.

Furthermore, IEEE Std 1427-2006 Table 3 includes lower BIL values (30, 34, 60, and 75 kV) than IEEE Std C37.30.1-2011 Table 14 (which starts at 95 kV BIL). Updating the NEC Table 490.24 would account for the lower clearance requirements for 2400 V and 4160 V systems.

Submitter Information Verification

Submitter Full Name: Andy Kunze
Organization: Enbridge
Street Address:
City:
State:
Zip:
Submittal Date: Tue Apr 14 09:59:00 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: Applying Table 3 of IEEE 1427-2006 to Table 490.24 discounts the complex interaction between BIL, BSL, surge protection and many other factors in determining clearances. These factors are clearly outlined in IEEE1427-2006. Other factors that also apply that affect clearances include: Mechanical stress, animal protection, dielectric stress, installations 1km above sea level, insulation tracking, and corona / RFI. CMP-9 does not support a reduction in clearances that do not incorporate all factors indicated in IEEE 1427-2006.

Public Input No. 1367-NFPA 70-2020 [Section No. 490.36]

490.36 Equipment Grounding Conductor .

Frames of switchgear and control assemblies shall be connected to an equipment grounding conductor or, where permitted, the grounded conductor.

Statement of Problem and Substantiation for Public Input

According to the NFPA Style Manual, the Section Title needs to reflect the content of the rule. The rule is about the equipment grounding conductor, not about 'Grounding.'

Submitter Information Verification

Submitter Full Name:	Mike Holt
Organization:	Mike Holt Enterprises Inc
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon Jun 01 19:52:16 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: FR-7963-NFPA 70-2020

Statement: Requirements in sections 490.36 and 490.37 address different equipment, but have the same requirement. Since “Equipment”, as defined in Article 100 is a generic term, it covers all items identified in both sections. Rather than repeat the same requirement twice, they are combined into a single section, and a reference to the section in Article 250 that covers equipment grounding is added.

Public Input No. 3210-NFPA 70-2020 [Section No. 490.48(A)]

(A) Design and Documentation.

Substations shall be designed by a qualified licensed professional engineer. Where components or the entirety of the substation are listed by a qualified electrical testing laboratory, documentation of internal design features subject to the listing investigation shall not be required. The design shall address but not be limited to the following topics, and the documentation of this design shall be made available to the authority having jurisdiction:

(1) Clearances and exits

(2) Electrical enclosures

(3) Securing and support of electrical equipment

(4) Fire protection

(5) Safety ground connection provisions

(6) Guarding live parts

(7) Transformers and voltage regulation equipment

(8) Conductor insulation, electrical and mechanical protection, isolation, and terminations

(9) Application, arrangement, and disconnection of circuit breakers, switches, and fuses

(10) Provisions for oil filled equipment

(11) Switchgear

(12) ~~Surge arresters~~ Overvoltage protection equipment

Additional Proposed Changes

File Name	Description	Approved
Code_Input.docx	input to improve overvoltage protection requirements	

Statement of Problem and Substantiation for Public Input

In the 2020 NEC cycle, ARTICLES 280 and 285 were combined to make ARTICLE 242. This was a positive change that began to address the issue of OVERVOLTAGE as a technical subject apart from particular product methods (SPDs and Surge Arresters). There are other technologies and products to address the issue of OVERVOLTAGE. This input attempts to add one such technology as well as correlate the other code references to the subject of OVERVOLTAGE, surge protective devices, and surge arresters to be consistent. This is important to allow for other technologies to be utilized without prejudice to certain products promoted by manufacturers.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3200-NFPA 70-2020 [Section No. 242.1]	
Public Input No. 3202-NFPA 70-2020 [New Article after 100]	
Public Input No. 3203-NFPA 70-2020 [New Article after 242]	
Public Input No. 3205-NFPA 70-2020 [Section No. 501.35]	
Public Input No. 3206-NFPA 70-2020 [Section No. 502.35]	

Public Input No. 3208-NFPA 70-2020 [Section No. 551.72(E)]
Public Input No. 3209-NFPA 70-2020 [Section No. 490.24]
Public Input No. 3211-NFPA 70-2020 [Section No. 620.51(E)]
Public Input No. 3212-NFPA 70-2020 [Section No. 645.18]
Public Input No. 3214-NFPA 70-2020 [Section No. 670.6]
Public Input No. 3216-NFPA 70-2020 [Section No. 694.7(D)]
Public Input No. 3217-NFPA 70-2020 [Section No. 695.15]
Public Input No. 3218-NFPA 70-2020 [Section No. 700.8]
Public Input No. 3219-NFPA 70-2020 [Section No. 708.20(D)]

Submitter Information Verification

Submitter Full Name: Karl Cunningham
Organization: Self Employed
Street Address:
City:
State:
Zip:
Submittal Date: Sun Sep 06 18:32:06 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7965-NFPA 70-2020

Statement: Article 242 (new to the 2020 Code) covers "surge equipment"; however, the title of the Article is "Overvoltage Protection", as that is a more generic term. This revision aligns this text with the title of Article 242, and also includes the term "surge" as this has historically been used to describe this equipment.

The use of the generic term "overvoltage protection" allows for a broader application of products that provide this protection.

Substantiation for Changes: In the 2020 NEC cycle, ARTICLES 280 and 285 were combined to make ARTICLE 242. This was a positive change that began to address the issue of OVERVOLTAGE as a technical subject apart from particular product methods (SPDs and Surge Arresters). There are other technologies and products to address the issue of OVERVOLTAGE. This input attempts to add one such technology as well as correlate the other code references to the subject of OVERVOLTAGE, surge protective devices, and surge arresters to be consistent. This is important to allow for other technologies to be utilized without prejudice to certain products promoted by manufacturers.

ARTICLE 100 - DEFINITIONS

Voltage Stabilizing Ground Reference (VSGR) System – an engineered assembly of interconnected passive inductive devices that utilize mutual counter electro-magnetic inductance to stabilize phase voltages of a connected supply system with respect to each other and to ground.

ARTICLE 242 Overvoltage Protection

Part I. General

242.1 Scope.
This article provides the general requirements, installation requirements, and connection requirements for overvoltage protection and overvoltage protective devices. Part II covers surge-protective devices (SPDs) permanently installed on premises wiring systems of not more than 1000 volts, nominal, while Part III covers surge arresters permanently installed on premises wiring systems over 1000 volts, nominal. Part IV covers Voltage Stabilizing Ground Reference (VSGR) systems permanently installed on premises wiring systems for any voltage.

Informational Note: Article 242 combines and replaces Articles 280 and 285 in *NFPA 70*-2017.

242.3 Other Articles.
Equipment shall be protected against overvoltage in accordance with the article in this *Code* that covers the type of equipment or location specified in Table 242.3.

Table 242.3 Other Articles

Equipment	Article
Class I locations	501
Class II locations	502
Community antenna television and radio distribution systems	820
Critical operations power systems	708

Table 242.3 Other Articles

Equipment	Article
Elevators, dumbwaiters, escalators, moving walks, platform lifts, and stairway chairlifts	620
Emergency systems	700
Equipment over 1000 volts, nominal	490
Fire pumps	695
Industrial machinery	670
Information technology equipment	645
Modular data centers	646
Outdoor overhead conductors over 1000 volts	399
Radio and television equipment	810
Receptacles, cord connectors, and attachment plugs (caps)	406
Wind electric systems	694

Part II. Surge-Protective Devices (SPDs), 1000 Volts or Less

Informational Note: Surge arresters 1000 volts or less are also known as Type 1 SPDs.

242.6 Uses Not Permitted.

An SPD device shall not be installed in the following:

1. (1)

   Circuits over 1000 volts

2. (2)

   On ungrounded systems, impedance grounded systems, or corner grounded delta systems unless listed specifically for use on these systems

3. (3)

   Where the rating of the SPD is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application

242.8 Listing.
An SPD shall be a listed device.

242.10 Short-Circuit Current Rating.
The SPD shall be marked with a short-circuit current rating and shall not be installed at a point on the system where the available fault current is in excess of that rating. This marking requirement shall not apply to receptacles.

242.12 Type 1 SPDs.
Type 1 SPDs shall be installed in accordance with 242.12(A) and (B).

242.12(A) Installation.
Type 1 SPDs shall be permitted to be connected in accordance with one of the following:

1. (1)

   To the supply side of the service disconnect as permitted in 230.82(4)

2. (2)

   As specified in 242.14

242.12(B) At the Service.
When installed at services, Type 1 SPDs shall be connected to one of the following:

1. (1)

   Grounded service conductor

2. (2)

   Grounding electrode conductor

3. (3)

   Grounding electrode for the service

4. (4)

   Equipment grounding terminal in the service equipment

242.14 Type 2 SPDs.
Type 2 SPDs shall be installed in accordance with 242.14(A) through (C).

242.14(A) Service-Supplied Building or Structure.
Type 2 SPDs shall be connected anywhere on the load side of a service disconnect overcurrent device required in 230.91 unless installed in accordance with 230.82(8).

242.14(B) Feeder-Supplied Building or Structure.
Type 2 SPDs shall be connected at the building or structure anywhere on the load side of the first overcurrent device at the building or structure.

242.14(C) Separately Derived System.

The SPD shall be connected on the load side of the first overcurrent device in a separately derived system.

242.16 Type 3 SPDs.

Type 3 SPDs shall be permitted to be installed on the load side of branch-circuit overcurrent protection up to the equipment served. If included in the manufacturer's instructions, the Type 3 SPD connection shall be a minimum 10 m (30 ft) of conductor distance from the service or separately derived system disconnect.

242.18 Type 4 and Other Component Type SPDs.

Type 4 component assemblies and other component type SPDs shall only be installed by the equipment manufacturer.

242.20 Number Required.

Where used at a point on a circuit, the SPD shall be connected to each ungrounded conductor.

242.22 Location.

SPDs shall be permitted to be located indoors or outdoors and shall be made inaccessible to unqualified persons unless listed for installation in accessible locations.

242.24 Routing of Connections.

The conductors used to connect the SPD to the line or bus and to ground shall not be any longer than necessary and shall avoid unnecessary bends.

242.26 Connection.

Where an SPD device is installed, it shall comply with 242.12, 242.14, 242.16, 242.28. and 242.30.

242.28 Conductor Size.

Line and grounding conductors shall not be smaller than 14 AWG copper or 12 AWG aluminum.

242.30 Connection Between Conductors.

An SPD shall be permitted to be connected between any two conductors — ungrounded conductor(s), grounded conductor, equipment grounding conductor, or grounding electrode conductor. The grounded conductor and the equipment grounding conductor shall be interconnected only by the normal operation of the SPD during a surge.

242.32 Grounding Electrode Conductor Connections and Enclosures.

Except as indicated in this article, SPD grounding connections shall be made as specified in Article 250, Part III. Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).

Part III. Surge Arresters, Over 1000 Volts

242.40 Uses Not Permitted.

A surge arrester shall not be installed where the rating of the surge arrester is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application.

242.42 Surge Arrester Selection.

The surge arresters shall comply with 242.42(A) and (B).

242.42(A) Rating.

The rating of a surge arrester shall be equal to or greater than the maximum continuous operating voltage available at the point of application.

242.42(A)(1) Solidly Grounded Systems.

The maximum continuous operating voltage shall be the phase-to-ground voltage of the system.

242.42(A)(2) Impedance or Ungrounded System.

The maximum continuous operating voltage shall be the phase-to-phase voltage of the system.

242.42(B) Silicon Carbide Types.

The rating of a silicon carbide-type surge arrester shall be not less than 125 percent of the rating specified in 242.42(A).

Informational Note No. 1: For further information on surge arresters, see IEEE C62.11-2012, *Standard for Metal-Oxide Surge Arresters for Alternating-Current Power Circuits (>1 kV)*, and IEEE C62.22-2009, *Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems*.

Informational Note No. 2: The selection of a properly rated metal oxide arrester is based on considerations of maximum continuous operating voltage and the magnitude and duration of overvoltages at the arrester location as affected by phase-to-ground faults, system grounding techniques, switching surges, and other causes. See the manufacturer's application rules for selection of the specific arrester to be used at a particular location.

242.44 Number Required.

Where used at a point on a circuit, a surge arrester shall be connected to each ungrounded conductor. A single installation of such surge arresters shall be permitted to protect a number of interconnected circuits if no circuit is exposed to surges while disconnected from the surge arresters.

242.46 Location.

Surge arresters shall be permitted to be located indoors or outdoors. Surge arresters shall be made inaccessible to unqualified persons unless listed for installation in accessible locations.

242.48 Routing of Surge Arrester Equipment Grounding Conductors.

The conductor used to connect the surge arrester to line, bus, or equipment and to an equipment grounding conductor or grounding electrode connection point as provided in 242.50 shall not be any longer than necessary and shall avoid unnecessary bends.

242.50 Connection.

The arrester shall be connected to one of the following:

1. (1)

   Grounded service conductor

2. (2)

   Grounding electrode conductor

3. (3)

   Grounding electrode for the service

4. (4)

   Equipment grounding terminal in the service equipment

242.52 Surge-Arrester Conductors.

The conductor between the surge arrester and the line, and the surge arrester and the grounding connection, shall not be smaller than 6 AWG copper or aluminum.

242.54 Interconnections.

The surge arrester protecting a transformer that supplies a secondary distribution system shall be interconnected as specified in 242.54(A), (B), or (C).

242.54(A) Metal Interconnections.
A metal interconnection shall be made to the secondary grounded circuit conductor or the secondary circuit grounding electrode conductor, if, in addition to the direct grounding connection at the surge arrester, the connection complies with 242.54(A)(1) or (A)(2).

242.54(A)(1) Additional Grounding Connection.
The grounded conductor of the secondary has a grounding connection elsewhere to a continuous metal underground water piping system. In urban water-pipe areas where there are at least four water-pipe connections on the neutral conductor and not fewer than four such connections in each mile of neutral conductor, the metal interconnection shall be permitted to be made to the secondary neutral conductor with omission of the direct grounding connection at the surge arrester.

242.54(A)(2) Multigrounded Neutral System Connection.
The grounded conductor of the secondary system is part of a multigrounded neutral system or static wire of which the primary neutral conductor or static wire has at least four grounding connections in each 1.6 km (1 mile) of line in addition to a grounding connection at each service.

242.54(B) Through Spark Gap or Device.
Where the surge arrester grounding electrode conductor is not connected as in 242.54(A), or where the secondary is not grounded as in 242.54(A) but is otherwise grounded as in 250.52, an interconnection shall be made through a spark gap or listed device as required by 242.54(B)(1) or (B)(2).

242.54(B)(1) Ungrounded or Unigrounded Primary System.
For ungrounded or unigrounded primary systems, the spark gap for a listed device shall have a 60-Hz breakdown voltage of at least twice the primary circuit voltage but not necessarily more than 10 kV, and there shall be at least one other ground on the grounded conductor of the secondary that is not less than 6.0 m (20 ft) distant from the surge-arrester grounding electrode.

242.54(B)(2) Multigrounded Neutral Primary System.
For multigrounded neutral primary systems, the spark gap or listed device shall have a 60-Hz breakdown of not more than 3 kV, and there shall be at least one other ground on the grounded conductor of the secondary that is not less than 6.0 m (20 ft) distant from the surge-arrester grounding electrode.

242.54(C) By Special Permission.
An interconnection of the surge-arrester ground and the secondary neutral conductor, other than as provided in 242.54(A) or (B), shall be permitted to be made only by special permission.

242.56 Grounding Electrode Conductor Connections and Enclosures.
Except as indicated in this article, surge-arrester grounding electrode conductor connections shall be made as specified in Article 250, Parts III and X. Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).

Part IV. Voltage Stabilizing Ground Reference (VSGR) systems.

242.68 Listing.
A VSGR shall be a listed device or system composed of listed components.

242.70 Short-Circuit Current Rating.
The VSGR shall be marked with a short-circuit current rating and shall not be installed at a point on the system where the available fault current is in excess of that rating.

242.71 Voltage Rating.
The rating of the VSGR shall be equal to or greater than the maximum system continuous operating voltage at the point of application.

242.72 Installation.
VSGRs shall be installed in accordance with 242.72(A) through (C).

242.72(A) Service-Supplied Building or Structure.
VSGR shall be connected anywhere on the load side of a service disconnect overcurrent device required in 230.91 unless installed in accordance with 230.82(8).

242.72(B) Feeder-Supplied Building or Structure.
VSGR shall be connected at the building or structure anywhere on the load side of the first overcurrent device at the building or structure.

242.72(C) Separately Derived System.
VSGR shall be connected on the load side of the first overcurrent device in a separately derived system.

242.82 Location.
VSGRs shall be permitted to be located indoors or outdoors and shall be made inaccessible to unqualified persons unless listed for installation in accessible locations.

242.84 Conductor Size.
Line and grounding conductors shall not be smaller than 14 AWG copper or 12 AWG aluminum.

242.90 Connection Between Conductors.
VSGR connections shall follow the manufacturer's instructions for the system connections.

242.92 Grounding Electrode Conductor Connections and Enclosures.
Except as indicated in this article, VSGR grounding connections shall be made as specified in Article 250, Part III. Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).

501.35 Overvoltage ~~Surge~~ Protection.

501.35(A) Class I, Division 1.
Overvoltage protection devices, surge arresters, surge-protective devices, and capacitors shall be installed in enclosures identified for Class I, Division 1 locations. Surge-protective capacitors shall be of a type designed for specific duty.

501.35(B) Class I, Division 2.
Overvoltage protection devices, surge arresters and surge-protective devices shall be nonarcing, such as metal-oxide varistor (MOV) sealed type, and surge-protective capacitors shall be of a type designed for specific duty. Enclosures shall be permitted to be of the general-purpose type. Overvoltage ~~Surge~~ protection of types other than described in this paragraph shall be installed in enclosures identified for Class I, Division 1 locations.

502.35 Overvoltage ~~Surge~~ Protection — Class II, Divisions 1 and 2.
Overvoltage protection devices, surge arresters and surge-protective devices installed in a Class II, Division 1 location shall be in suitable enclosures. Surge-protective capacitors shall be of a type designed for specific duty.

551.72(E) Connected Devices.
The use of autotransformers shall not be permitted. The use of listed overvoltage and surge protective devices shall be permitted.

Table 490.24 Minimum Clearance of Live Parts

Note: The values given are the minimum clearance for rigid parts and bare conductors under favorable service conditions. They shall be increased for conductor movement or under unfavorable service conditions or wherever space limitations permit. The selection of the associated impulse withstand voltage for a particular system voltage is determined by the characteristics of the overvoltage ~~surge~~ protective equipment.

490.48(A) Design and Documentation.

(12) Overvoltage ~~Surge~~ arresters

620.51(E) Overvoltage ~~Surge~~ Protection.

Overvoltage protection shall be provided where any of the disconnecting means in 620.51 has been designated as supplying an emergency system load, a legally required system load, or a critical operation power system load, ~~listed surge protection shall be provided.~~

645.18 Overvoltage ~~Surge~~ Protection for Critical Operations Data Systems.

Overvoltage ~~Listed surge~~ protection shall be provided for critical operations data systems.

670.6 Surge Protection.

Industrial machinery with safety interlock control devices not effectively protected from voltage surges on the incoming supply circuit shall have overvoltage ~~surge~~ protection installed.

694.7(D) Overvoltage Protection ~~Surge Protective Devices (SPD).~~

Overvoltage protection ~~A surge protective device~~ shall be installed between a wind electric system and any loads served by the premises electrical system. The ~~surge~~ protective device shall be permitted to be a VSGR, or a Type 3 SPD on the circuit serving a wind electric system, or a Type 2 SPD located anywhere on the load side of the service disconnect. Overvoltage ~~Surge~~ protective devices shall be installed in accordance with Part II of Article 242.

695.15 Overvoltage ~~Surge~~ Protection.

Overvoltage ~~A listed surge~~ protection ~~device~~ shall be provided for ~~installed in or on~~ the fire pump controller.

700.8 Overvoltage ~~Surge~~ Protection.

Overvoltage protection ~~A listed SPD~~ shall be provided-installed in ~~or on~~ for all emergency systems switchboards and panelboards.

708.20(D) Overvoltage ~~Surge~~ Protection ~~Devices~~.

Surge protection devices shall be provided at all facility distribution voltage levels

Public Input No. 2395-NFPA 70-2020 [Section No. 490.49]

490.49 Reconditioned Switchgear.

Switchgear, or sections of switchgear, within the scope of this article shall be permitted to be reconditioned. The reconditioning process shall use design qualified parts verified under applicable standards and be performed in accordance with any instructions provided by the manufacturer. Reconditioned switchgear shall be listed or field labeled as *reconditioned*, and previously applied listing marks, if any, within the portions reconditioned shall comply with one of the following;

(1) Retain original manufacturer's nameplate and listing marks. Or, if illegible, shall be replaced with new that mimics the content and detail of the original. The equipment's original listing(s) shall be qualified as valid, including where applicable to original equipment, all: ratings, performance attributes, terms of use, and compliance to qualified standard(s).

(2) Field labeled as reconditioned. Previously applied listing marks, if any, associated with reconditioned elements shall be removed. Previously applied nameplate, if any, shall be replaced with new nameplate indicating date of recondition work, and shall include revision(s) to ratings as appropriate.

If equipment has been damaged by fire, products of combustion, or water, it shall be specifically evaluated by its manufacturer or a qualified testing laboratory prior to being returned to service. Provide label briefly summarizing extent of recondition event and each subsequent recondition event, with date of completion for each, and contact information for entity performing the work for each.

Informational Note; refer to 110.21(A)(2) for additional requirements.

Statement of Problem and Substantiation for Public Input

1) The existing statement "reconditioned switchgear shall be listed" requires clarification as it may be construed that reconditioned equipment can be listed anew. Or, that a caveat for equipment to be reconditioned is that it must have first been listed, or some other interpretation.
2) considering that the intent is that there are meant to be two options, then they would most clearly be identified if broken out into numbered headings.
3) If there are terms for listed equipment to be reconditioned so as to retain the equipment's original ratings and specifications, the terms for this are not yet identified clearly.
4) If there is an intent that the nameplate ratings may be allowed to differ from the original, or not, then integrity to this effect this needs to be clarified.
5) If there are terms for equipment that has been reconditioned once already, to be permitted to be reconditioned again, these terms have yet to be clarified.
6) if there is to be an intent that component level reconditioning is to be permitted, then perhaps some way of labeling a summary of reconditioning events should be clarified.
7) the name of the reconditioning entity and the date of recondition is required by 110.21(A)(2), but an informational note isn't provided as reference nor text to identify this requirement.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2298-NFPA 70-2020 [Section No. 408.8(B)]	similar issues and intent
Public Input No. 2396-NFPA 70-2020 [Section No. 240.88]	similar topic

Public Input No. 2298-NFPA 70-2020 [Section No. 408.8(B)]

Public Input No. 2396-NFPA 70-2020 [Section No. 240.88]

Submitter Information Verification

Submitter Full Name: John Blissett

Organization: Bernhard TME

Street Address:

City:

State:

Zip:

Submittal Date: Tue Aug 18 18:02:51 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: The proposed requirements are in conflict with requirements in 110.21. As noted in 90.3, Chapters 1 – 4 apply generally. Changes to the general marking requirements for Reconditioned Equipment in Section 110.21(A)(2) should be submitted to CMP-1 for consideration.

Public Input No. 4517-NFPA 70-2020 [Section No. 490.49]

490.49 Reconditioned Switchgear.

Switchgear, or sections of switchgear, within the scope of this article shall be permitted to be reconditioned. The reconditioning process shall use design qualified parts verified under applicable standards and be performed in accordance with any instructions provided by the manufacturer. Reconditioned switchgear shall be listed or field labeled as *reconditioned*, and previously applied listing marks, if any, within the portions reconditioned shall be removed, except where permitted by Section 110 . 21(A)(2) . If equipment has been damaged by fire, products of combustion, or water, it shall be specifically evaluated by its manufacturer or a qualified testing laboratory prior to being returned to service.

Statement of Problem and Substantiation for Public Input

Added language for addition to 110.21(A)(2)

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 4496-NFPA 70-2020 [Section No. 110.21(A)(2)]	

Submitter Information Verification

Submitter Full Name: Joshua Brackett

Organization:

Street Address:

City:

State:

Zip:

Submittal Date: Thu Sep 10 14:33:27 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7966-NFPA 70-2020

Statement: CMP-9 eliminates the statement to remove previously installed labels, as this is a general requirement contained in Chapter 1.

Public Input No. 4361-NFPA 70-2020 [Section No. 490.51(B)]

~~**(B)** Other Requirements.~~

~~The requirements of this part shall be additional to, or amendatory of, those prescribed in Articles 100 through 725 of this *Code* . Special attention shall be paid to Article 250 .~~

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. Section 90.3 makes the overall code arrangement clear, so this statement is not required for the enforcement or usability of the code. Alternatively, if there are specific sections or parts which should be referenced in this requirement, that could be done in lieu of deleting this section. If the latter option is chosen, other sections should be identified in the form of a table as required by Sections 2.5 and 2.3 of the Style Manual.

Submitter Information Verification

Submitter Full Name: Richard Holub

Organization: The DuPont Company, Inc.

Street Address:

City:

State:

Zip:

Submittal Date: Thu Sep 10 11:17:25 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: FR-7967-NFPA 70-2020

Statement: Section 4.1.4 of the 2020 NEC® Style Manual prohibits references to an entire articles, with the exception of Article 100. The intent here is to point to the bonding and grounding parts that would apply in Article 250, which is Part X since this is "high voltage equipment", and requirements for portable equipment appear in Part X.

Public Input No. 4367-NFPA 70-2020 [Section No. 490.56]

490.56 High-Voltage Portable Cable for Main Power Supply.

Flexible high-voltage cable supplying power to portable or mobile equipment shall comply with the bonding and grounding requirements in Parts V, VI, and X of Article 250 and the flexible cable requirements of Article 400, Part III.

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. I believe the intent here is to point the user to the bonding and grounding parts that would apply in Article 250, which are Parts V, VI, and X since this is "high voltage equipment".

Submitter Information Verification

Submitter Full Name: Richard Holub
Organization: The DuPont Company, Inc.
Street Address:
City:
State:
Zip:
Submittal Date: Thu Sep 10 11:23:14 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7968-NFPA 70-2020

Statement: Section 4.1.4 of the 2020 NEC® Style Manual prohibits references to an entire articles, with the exception of Article 100. The intent here is to point to the bonding and grounding parts that would apply in Article 250, which are Parts V, VI, and X since this is "high voltage equipment". The structure of this section is reordered for consistency, with “Part” occurring prior to “Article”.

Public Input No. 102-NFPA 70-2019 [New Part after I.]

450.15 Minimum Rating.

Transformer volt-ampere ratings shall not be less than 100% of the load calculated in Article 220 for feeders, except it is not necessary to multiply continuous loads the transformer will supply by 125%. The volt-ampere rating can either be the base rating of the transformer, or the fan-cooled rating where fans are installed.

Statement of Problem and Substantiation for Public Input

While it should be common sense, there should not be any need to install a transformer of a kVA load rating less than which it will be expected to be able to supply. But as of the 2020 NEC, there are no provisions prohibiting the use of transformers that are too small for the load. Adding this simple verbiage will make it clear transformers shouldn't be overloaded, but do not need to be sized greater than 100% of the kVA rating for continuous loads since they are built to carry 100% of their volt-ampere rating.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 101-NFPA 70-2019 [Section No. 450.14]	Minimum rating of disconnecting means
Public Input No. 101-NFPA 70-2019 [Section No. 450.14]	

Submitter Information Verification

Submitter Full Name: Paul Guidry
Organization: Fluor Enterprises, Inc.
Affiliation: Associated Builders and Contractors
Street Address:
City:
State:
Zip:
Submittal Date: Tue Nov 12 17:42:51 EST 2019
Committee: NEC-P09

Committee Statement

Resolution: The submitter shows no substantiation for safety other than it should be common sense. No evidence shows transformers are being misused and creating hazards from overloads.

Public Input No. 4365-NFPA 70-2020 [Part I.]

Part I. ~~– Scope and Installation~~ General

Statement of Problem and Substantiation for Public Input

"Article 312 is subdivided into multiple parts and needs to comply with the revised NEC Style Manual on Parts 2.1.4 Part titles shall be descriptive and as concise as possible.
2.4.2.1 ...Where an article has multiple parts, Part I. shall be titled "General". "

Submitter Information Verification

Submitter Full Name: David Williams
Organization: Delta Charter Township
Street Address:
City:
State:
Zip:
Submittal Date: Thu Sep 10 11:22:16 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7700-NFPA 70-2020
Statement: CMP-9 is revising the title of Part 1 to comply with the new Style Manual, Sec. 2.4.2.1

Public Input No. 4366-NFPA 70-2020 [Part I.]

Part I. ~~Scope and~~ General

Statement of Problem and Substantiation for Public Input

"Article 314 is subdivided into multiple parts and needs to comply with the revised NEC Style Manual on Parts 2.1.4 Part titles shall be descriptive and as concise as possible.
2.4.2.1 ...Where an article has multiple parts, Part I. shall be titled “General”. "

Submitter Information Verification

Submitter Full Name: David Williams
Organization: Delta Charter Township
Street Address:
City:
State:
Zip:
Submittal Date: Thu Sep 10 11:23:06 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7715-NFPA 70-2020
Statement: CMP-9 is revising the title of Part I to comply with the new Style Manual, Sec. 2.4.2.1.

Public Input No. 4371-NFPA 70-2020 [Part I.]

Part I. – ~~Installation~~ General

Statement of Problem and Substantiation for Public Input

"Article 404 is subdivided into multiple parts and needs to comply with the revised NEC Style Manual on Parts 2.1.4 Part titles shall be descriptive and as concise as possible.
2.4.2.1 ...Where an article has multiple parts, Part I. shall be titled “General”. "

Submitter Information Verification

Submitter Full Name:	David Williams
Organization:	Delta Charter Township
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Sep 10 11:25:17 EDT 2020
Committee:	NEC-P09

Committee Statement

Resolution: FR-7862-NFPA 70-2020

Statement: Per the style manual, where an article has multiple parts, Part I, shall be titled “General.”

Public Input No. 4373-NFPA 70-2020 [Part I.]

Part I. ~~General Provisions~~ General

Statement of Problem and Substantiation for Public Input

"Article 450 is subdivided into multiple parts and needs to comply with the revised NEC Style Manual on Parts 2.1.4 Part titles shall be descriptive and as concise as possible.
2.4.2.1 ...Where an article has multiple parts, Part I. shall be titled “General”. "

Submitter Information Verification

Submitter Full Name: David Williams
Organization: Delta Charter Township
Street Address:
City:
State:
Zip:
Submittal Date: Thu Sep 10 11:26:26 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7784-NFPA 70-2020
Statement:

CMP-9 Edits title to Part I for clarity to meet Style Manual requirements.

Public Input No. 977-NFPA 70-2020 [Part I.]

Part I. ~~General Provisions~~ General

Statement of Problem and Substantiation for Public Input

The word “Provisions” is unnecessary and redundant.

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz
Organization: NECA
Street Address:
City:
State:
Zip:

Submittal Date: Wed May 06 11:48:34 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: FR-7784-NFPA 70-2020
Statement:

CMP-9 Edits title to Part I for clarity to meet Style Manual requirements.

Public Input No. 1091-NFPA 70-2020 [New Part after II.]

TITLE OF NEW CONTENT

Type your content here .. **Retrofit Trip Units for Power Circuit Breakers.** Retrofit trip units shall be listed for use with the specific circuit breaker with which it is installed.

Statement of Problem and Substantiation for Public Input

To apply to power circuit breakers used in assemblies covered by Section 408.

Submitter Information Verification

Submitter Full Name: David Bredhold
Organization: DB Technical Services
Street Address:
City:
State:
Zip:
Submittal Date: Sat May 16 09:39:07 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: Retrofit trip units are part of the overcurrent protective device and therefore this requirement belongs in Article 240. CMP-9 understands that PIs to this effect have been submitted to CMP-10.

Public Input No. 659-NFPA 70-2020 [New Part after II.]

314.14 Dissimilar Metals.

Where practicable, dissimilar metals in contact anywhere in the system shall be avoided to eliminate

the possibility of galvanic action. Aluminum boxes and conduit bodies shall be permitted to be used with galvanized steel fittings,

where not subject to severe corrosive influences. Stainless steel boxes and conduit bodies shall only be used with stainless steel fittings and approved accessories, and raceways

Statement of Problem and Substantiation for Public Input

Currently there is no requirement to avoid dissimilar metals. Boxes should also note material compatibility with other fittings or raceways.

Submitter Information Verification

Submitter Full Name: Alfio Torrisi
Organization: Master electrician
Street Address:
City:
State:
Zip:
Submittal Date: Mon Mar 16 10:39:23 EDT 2020
Committee: NEC-P09

Committee Statement

Resolution: CMP-9 concludes that the issues of contact between dissimilar metals are adequately addressed in the various metal raceway articles, generally at Sec. 14. CMP-9 also concludes that an action on its part in this article would create the ongoing possibility of conflicts with those raceway sections, and therefore represent poor code administration.

Public Input No. 3255-NFPA 70-2020 [Sections Part II., 404.20, 404.22, 404.26, 404.27, 404.28]

~~**Sections Part II., 404.20, 404.22, 404.26, 404.27, 404.28**~~

~~**Part II.** Construction Specifications~~

~~**404.20** Marking.~~

~~**(A)** Ratings.~~

~~Switches shall be marked with the current, voltage, and, if horsepower rated, the maximum rating for which they are designed.~~

~~**(B)** Off Indication.~~

~~Where in the off position, a switching device with a marked OFF position shall completely disconnect all ungrounded conductors to the load it controls.~~

~~**404.22** Electronic Control Switches.~~

~~Electronic control switches shall be listed. Electronic control switches shall not introduce current on the equipment grounding conductor during normal operation. The requirement to not introduce current on the equipment grounding conductor shall take effect on January 1, 2020.~~

~~*Exception: Electronic control switches that introduce current on the equipment grounding conductor shall be permitted for applications covered by 404.2(C) , Exception. Electronic control switches that introduce current on the equipment grounding conductor shall be listed and marked for use in replacement or retrofit applications only.*~~

~~**404.26** Knife Switches Rated 600 to 1000 Volts.~~

~~Auxiliary contacts of a renewable or quick-break type or the equivalent shall be provided on all knife switches rated 600 to 1000 volts and designed for use in breaking current over 200 amperes.~~

~~**404.27** Fused Switches.~~

~~A fused switch shall not have fuses in parallel except as permitted in 240.8 .~~

~~**404.28** Wire-Bending Space.~~

~~The wire-bending space required by 404.3 shall meet Table 312.6(B) spacings to the enclosure wall opposite the line and load terminals.~~

Statement of Problem and Substantiation for Public Input

This is covered by product standard (UL 20) and does not need to be repeated in the CODE.

Submitter Information Verification

Submitter Full Name: Karl Cunningham
Organization: Self Employed
Street Address:
City:
State:
Zip:
Submittal Date: Mon Sep 07 11:01:06 EDT 2020

Committee: NEC-P09

Committee Statement

Resolution: It is true that product standard organizations like UL will often extract text from the NEC to help develop product safety standards. These safety standards are written to help manufacturers and other interested parties comply with the requirements of the NEC. Part II of the article establishes overall policy parameters that provide guidance for product standards and retain their importance regardless of particular provisions within those standards. The new 404.30 on enclosure doors being added in this cycle is an example of this process at work.