

**Public Comment No. 1394-NFPA 70-2021 [Global Input]**

Delete all of Part IX from Article 240.

Statement of Problem and Substantiation for Public Comment

This Public Comment 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, Tim Croushore, and Kevin Rogers.

This Public Comment was developed to address the change made by First Correlating Revision No. 388. In that revision, the Correlating Committee removed Part IX, Overcurrent Protection over 1000 Volts, Nominal, from the scope of Article 240, noting that these requirements were relocated to Articles 246 and 495. This Public Comment completes this transition by removing Part IX, from Article 240

Related Item

- FCR 388

Submitter Information Verification

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Submittal Date: Thu Aug 12 14:27:08 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8457-NFPA 70-2021](#)

Statement: The requirements of Part IX of 240 are moved to Article 245.

**Public Comment No. 1423-NFPA 70-2021 [Global Input]**

Modifications to Articles 215, 225, and 230, and additions to the new Article 235. See attached Word document

Additional Proposed Changes

<u>File Name</u>	<u>Description</u>	<u>Approved</u>
Global_PC_to_Create_235_215_225_and_230_to_235_.docx	PC to Expand Article 235 to include Feeder and Service Requirements	

Statement of Problem and Substantiation for Public Comment

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This Public Comment, was developed with the goal of improving usability and providing a platform to increase the focus on requirements associated with Medium or High Voltage.

Reconsider PI 3819 which includes the combining of the branch-circuits, feeders, outside feeders and branch-circuits, and service installations "over 1000-volts", in the "new" Article 235.

The new Article 235 intended to be created by CMP 2 (refer to PC 285) locates the MV requirements in one location for usability and clarity. With the addition of Article 235 that only covers branch-circuits over 1000-volts, the proposed combining all of the requirements for "over 1000-volt" installations from Article 215, 225 and 230, provides an opportunity to create a consistent approach to address MV installations. The MV Task Group is concerned that failure to look at a long-term solution for systems over 1000-volts may create a vacuum in which other standards look to fill that void. Requirements for systems rated over 1000-volts are not arranged consistently within the document as covered by the Technical Committees.

As an example, CMP-10 addresses MV requirements in different locations within their purview. The "over 1000-volts" requirements exist in a dedicated "Part" within the Article – such is the case with existing Articles 225 and 230, and in Article 215, the "over 1000-volts" are intermingled with the "under 1000-volt" requirements. In addition, the specific requirements in Article 215 related to the sizing of feeder conductors using the 125% factor are located under the rules for 600 volts or less. Also, the requirement in section 215.3 for Overcurrent protection allows for 100% rated breakers and does not appear to correlate with the 215.2(B). The present layout is lacking in usability and clarity.

Related Item

• PI 3819 • FR 9180

Submitter Information Verification

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Submittal Date: Fri Aug 13 08:42:11 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: [SR-8472-NFPA 70-2021](#)
Statement: This action will combine all the requirements under the purview of CMP-10 for feeders, outside branch circuits and feeders, and services over 1000 Vac or 1500 Vdc into the new Article 235. This action is to correlate with the actions taken by CMP-2 on PC-285 which created the new Article 235.

The corresponding sections from Articles 215, 225, and 230 will be deleted as the requirements have been relocated to the new Article 235.

The edition year ANSI/NETA ATS was removed so that it is automatically the latest edition as outlined in 90.1(C) pursuant to PC-853.

CMP-10 is requesting the correlating committee review the changes in scope of Articles 225 and 230. The scope change to Article 215 is addressed by SR-8369.

GLOBAL PC to Relocate Over 1000 Vac, 1500 Vdc requirements from Articles 215, 225 and 230, into Article 235:

Rationale:

This Public Comment 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, Tim Croushore, and Kevin Rogers.

This Public Comment, was developed with the goal of improving usability and providing a platform to increase the focus on requirements associated with Medium or High Voltage.

Reconsider PI 3819 which includes the combining of the branch-circuits, feeders, outside feeders and branch-circuits, and service installations "over 1000-volts", in the "new" Article 235.

The new Article 235 intended to be created by CMP 2 (refer to PC 285) locates the MV requirements in one location for usability and clarity. With the addition of Article 235 that only covers branch-circuits over 1000-volts, the proposed combining all of the requirements for "over 1000-volt" installations from Article 215, 225 and 230, provides an opportunity to create a consistent approach to address MV installations. The MV Task Group is concerned that failure to look at a long-term solution for systems over 1000-volts may create a vacuum in which other standards look to fill that void. Requirements for systems rated over 1000-volts are not arranged consistently within the document as covered by the Technical Committees.

As an example, CMP-10 addresses MV requirements in different locations within their purview. The "over 1000-volts" requirements exist in a dedicated "Part" within the Article – such is the case with existing Articles 225 and 230, and in Article 215, the "over 1000-volts" are intermingled with the "under 1000-volt" requirements. In addition, the specific requirements in Article 215 related to the sizing of feeder conductors using the 125% factor are located under the rules for 600 volts or less. Also, the requirement in section 215.3 for Overcurrent protection allows for 100% rated breakers and does not appear to correlate with the 215.2(B). The present layout is lacking in usability and clarity.

Proposal:

Article 215 Feeders (Modifications to 215 moved to 235)

215.1 Scope.

This article covers the installation requirements, overcurrent protection requirements, minimum size, and ampacity of conductors for feeders.

Exception: This article does not apply to feeders for electrolytic cells as covered in 668.3(C)(1) and (C)(4).

Informational Note: For requirements that supplement or modify this Article for Over 1000 Vac, 1500 Vdc installations, see article 235, Services, Feeders, & Branch Circuits Over 1000 Vac, 1500 Vdc, nominal.

~~215.2(B) Feeders over 1000 Volts.~~

~~The ampacity of conductors shall be in accordance with 310.14 and 315.60 as applicable. Where installed, the size of the feeder circuit grounded conductor shall not be smaller than that required by 250.122, except that 250.122(F) shall not apply where grounded conductors are run in parallel. Feeder conductors over 1000 volts shall be sized in accordance with 215.2(B)(1), (B)(2), or (B)(3).~~

~~(1) Feeders Supplying Transformers.~~

~~The ampacity of feeder conductors shall not be less than the sum of the nameplate ratings of the transformers supplied when only transformers are supplied.~~

~~(2) Feeders Supplying Transformers and Utilization Equipment.~~

~~The ampacity of feeders supplying a combination of transformers and utilization equipment shall not be less than the sum of the nameplate ratings of the transformers and 125 percent of the designed potential load of the utilization equipment that will be operated simultaneously.~~

~~(3) Supervised Installations.~~

~~For supervised installations, feeder conductor sizing shall be permitted to be determined by qualified persons under engineering supervision in accordance with 310.14(B) or 315.60(B). Supervised installations are defined as those portions of a facility where all of the following conditions are met:~~

- ~~(1) Conditions of design and installation are provided under engineering supervision.~~
- ~~(2) Qualified persons with documented training and experience in over 1000-volt systems provide maintenance, monitoring, and servicing of the system.~~

Article 225 Outside Branch Circuits and Feeders (Modifications from 225 moving to 235)

Part I. General

225.1 Scope.

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

Informational Note: ~~See ANSI/IEEE C2-2017, *National Electrical Safety Code*, for additional information on wiring over 1000 volts. For requirements that supplement or modify this Article for Over 1000 Vac, 1500 Vdc installations, see article 235, Services, Feeders, & Branch Circuits Over 1000 Vac, 1500 Vdc, nominal.~~

225.3 Other Articles.

Application of other articles, including additional requirements to specific cases of equipment and conductors, is shown in Table 225.3.

Table 225.3 Other Articles

Equipment/Conductors	Article
Branch circuits	210
Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits	725
Conductors for general wiring	310
Electrically driven or controlled irrigation machines	675
Electric signs and outline lighting	600
Feeders	215
Fire alarm systems	760
Fixed outdoor electric deicing and snow-melting equipment	426
Grounding and bonding	250
Hazardous (classified) locations	500
Hazardous (classified) locations — specific	510
Marinas and boatyards	555
Medium-voltage conductors and cable	311
Messenger-supported wiring	396

Equipment/Conductors	Article
Mobile homes, manufactured homes, and mobile home parks	550
Open wiring on insulators	398
Over 1000 volts, general	<u>490</u> 5
Overcurrent protection	240
<u>Overcurrent protection for Systems Rated Over 1000 Volts AC, 1500 Volts DC</u>	<u>245</u>
Services	230
<u>Services, Feeders, & Branch Circuits Over 1000 VAC, 1500 VDC, Nominal</u>	<u>235</u>
Solar photovoltaic systems	690
Swimming pools, fountains, and similar installations	680
Use and identification of grounded conductors	200

225.6 Conductor Size and Support.

(A) Overhead Spans.

Open individual conductors shall not be smaller than the following:

- (1) For 1000 volts, nominal, or less, 10 AWG copper or 8 AWG aluminum for spans up to 15 m (50 ft) in length, and 8 AWG copper or 6 AWG aluminum for a longer span unless supported by a messenger wire
- (2) For over 1000 volts, nominal, meet the requirements of 235.306 ~~6 AWG copper or 4 AWG aluminum where open individual conductors, and 8 AWG copper or 6 AWG aluminum where in cable~~

225.10 Wiring on Buildings (or Other Structures).

The installation of outside wiring on surfaces of buildings (or other structures) shall be permitted for circuits not exceeding 1000 volts, nominal, as the following:

- (1) Auxiliary gutters
- (2) Busways
- (3) Cable trays
- (4) Cablebus
- (5) Electrical metallic tubing (EMT)
- (6) Flexible metal conduit (FMC)
- (7) Intermediate metal conduit (IMC)
- (8) Liquidtight flexible metal conduit (LFMC)
- (9) Liquidtight flexible nonmetallic conduit (LFNC)
- (10) Messenger-supported wiring
- (11) Open wiring on insulators
- (12) Reinforced thermosetting resin conduit (RTRC)
- (13) Rigid metal conduit (RMC)
- (14) Rigid polyvinyl chloride conduit (PVC)
- (15) Type MC cable
- (16) Type MI cable
- (17) Type SE cable
- (18) Type TC-ER cable
- (19) Type UF cable

(20) Wireways

Circuits of over 1000 volts, nominal, shall be installed as provided in 300.37.

Part III. Over 1000 Volts.

225.50 Sizing of Conductors.

The sizing of conductors over 1000 volts shall be in accordance with 210.19(E) for branch circuits and 215.2(B) for feeders.

225.51 Isolating Switches.

Where oil switches or air, oil, vacuum, or sulfur hexafluoride circuit breakers constitute a building disconnecting means, an isolating switch with visible break contacts and meeting the requirements of 230.204(B), (C), and (D) shall be installed on the supply side of the disconnecting means and all associated equipment.

Exception: The isolating switch shall not be required where the disconnecting means is mounted on removable truck panels or switchgear units that cannot be opened unless the circuit is disconnected and that, when removed from the normal operating position, automatically disconnect the circuit breaker or switch from all energized parts.

225.52 Disconnecting Means.

(A) Location.

A building or structure disconnecting means shall be located in accordance with 225.31(B), or, if not readily accessible, it shall be operable by mechanical linkage from a readily accessible point. For multibuilding industrial installations under single management, it shall be permitted to be electrically operated by a readily accessible, remote-control device in a separate building or structure.

(B) Type.

Each building or structure disconnect shall simultaneously disconnect all ungrounded supply conductors it controls and shall have a fault closing rating not less than the available fault current at its supply terminals.

Exception: Where the individual disconnecting means consists of fused cutouts, the simultaneous disconnection of all ungrounded supply conductors shall not be required if there is a means to disconnect the load before opening the cutouts. A permanent legible sign shall be installed adjacent to the fused cutouts and shall read DISCONNECT LOAD BEFORE OPENING CUTOUTS.

Where fused switches or separately mounted fuses are installed, the fuse characteristics shall be permitted to contribute to the fault closing rating of the disconnecting means.

(C) Locking.

Disconnecting means shall be lockable open in accordance with 110.25.

Exception: Where an individual disconnecting means consists of fused cutouts, a suitable enclosure capable of being locked and sized to contain all cutout fuse holders shall be installed at a convenient location to the fused cutouts.

(D) Indicating.

Disconnecting means shall clearly indicate whether they are in the open "off" or closed "on" position.

(E) Uniform Position.

Where disconnecting means handles are operated vertically, the "up" position of the handle shall be the "on" position.

Exception: A switching device having more than one "on" position, such as a double throw switch, shall not be required to comply with this requirement.

(F) Identification.

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

225.56 Inspections and Tests.

(A) Pre-Energization and Operating Tests.

The complete electrical system design, including settings for protective, switching, and control circuits, shall be prepared in advance and made available on request to the authority having jurisdiction and shall be performance tested when first installed on site. Each protective, switching, and control circuit shall be adjusted in accordance with the system design and tested by actual operation using current injection or equivalent methods as necessary to ensure that each and every such circuit operates correctly to the satisfaction of the authority having jurisdiction.

(1) Instrument Transformers.

All instrument transformers shall be tested to verify correct polarity and burden.

(2) Protective Relays.

Each protective relay shall be demonstrated to operate by injecting current or voltage, or both, at the associated instrument transformer output terminal and observing that the associated switching and signaling functions occur correctly and in proper time and sequence to accomplish the protective function intended.

(3) Switching Circuits.

Each switching circuit shall be observed to operate the associated equipment being switched.

(4) Control and Signal Circuits.

Each control or signal circuit shall be observed to perform its proper control function or produce a correct signal output.

(5) Metering Circuits.

All metering circuits shall be verified to operate correctly from voltage and current sources in a similar manner to protective relay circuits.

(6) Acceptance Tests.

Complete acceptance tests shall be performed, after the substation installation is completed, on all assemblies, equipment, conductors, and control and protective systems, as applicable, to verify the integrity of all the systems.

(7) Relays and Metering Utilizing Phase Differences.

All relays and metering that use phase differences for operation shall be verified by measuring phase angles at the relay under actual load conditions after operation commences.

(B) Test Report.

A test report covering the results of the tests required in 225.56(A) shall be delivered to the authority having jurisdiction prior to energization.

Informational Note: See ANSI/NETA ATS-2013, *Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems*, for an example of acceptance specifications.

225.60 Clearances over Roadways, Walkways, Rail, Water, and Open Land.**(A) 22 kV or Less to Ground.**

The clearances over roadways, walkways, rail, water, and open land for conductors and live parts up to 22 kV or less to ground shall be not less than the values shown in Table 225.60(A).

Table 225.60(A) Clearances over Roadways, Walkways, Rail, Water, and Open Land

	Location	Clearance	
		m	ft
	Open land subject to vehicles, cultivation, or grazing	5.6	18.5
	Roadways, driveways, parking lots, and alleys	5.6	18.5
	Walkways	4.1	13.5
	Rails	8.1	26.5
	Spaces and ways for pedestrians and restricted traffic	4.4	14.5
	Water areas not suitable for boating	5.2	17.0

(B) More Than 22 kV to Ground.

Clearances for the categories shown in Table 225.60(A) shall be increased by 10 mm (0.4 in.) per kV, or major fraction thereof, more than 22 kV.

(C) Special Cases.

For special cases, such as where crossings will be made over lakes, rivers, or areas using large vehicles such as mining operations, specific designs shall be engineered considering the special circumstances and shall be approved by the authority having jurisdiction.

Informational Note: See ANSI/IEEE C2-2017, *National Electrical Safety Code*, for additional information.

225.61 Clearances over Buildings and Other Structures.**(A) 22 kV or Less to Ground.**

The clearances over buildings and other structures for conductors and live parts up to 22 kV or less to ground shall be not less than the values shown in Table 225.61(A).

Table 225.61(A) Clearances over Buildings and Other Structures

Clearance from Conductors or Live Parts from:	Horizontal		-	Vertical	
	m	ft		m	ft
Building walls, projections, and windows	2.3	7.5	-	—	—
Balconies, catwalks, and similar areas accessible to people	2.3	7.5	-	4.1	13.5
Over or under roofs or projections not readily accessible to people	—	—	-	3.8	12.5
Over roofs accessible to vehicles but not trucks	—	—	-	4.1	13.5
Over roofs accessible to trucks	—	—	-	5.6	18.5
Other structures	2.3	7.5	-	—	—

(B) More Than 22 kV to Ground.

Clearances for the categories shown in Table 225.61(A) shall be increased by 10 mm (0.4 in.) per kV, or major fraction thereof, more than 22 kV.

Informational Note: See ANSI/IEEE C2-2017,

Article 230 Services (Modifications from 230 to 235)

Part I. General

230.1 Scope.

This article covers service conductors and equipment for control and protection of services and their installation requirements.

Informational Note No. 1: For requirements that supplement or modify this Article for Over 1000 Vac, 1500 Vdc installations, see article 235, Services, Feeders, & Branch Circuits Over 1000 Vac, 1500 Vdc, nominal.

~~Part VIII. Services Exceeding 1000 Volts, Nominal~~

~~230.200 General.~~

~~Service conductors and equipment used on circuits exceeding 1000 volts, nominal, shall comply with all the applicable preceding sections of this article and with the following sections that supplement or modify the preceding sections. In no case shall the provisions of Part VIII apply to equipment on the supply side of the service point. Informational Note: See ANSI/IEEE C2-2017, National Electrical Safety Code, for clearances of conductors of over 1000 volts, nominal.~~

~~230.202 Service Entrance Conductors.~~

~~Service entrance conductors to buildings or enclosures shall be installed to conform to 230.202(A) and (B).~~

~~(A) Conductor Size.~~

~~Service entrance conductors shall not be smaller than 6 AWG unless in multiconductor cable. Multiconductor cable shall not be smaller than 8 AWG.~~

~~(B) Wiring Methods.~~

~~Service entrance conductors shall be installed by one of the wiring methods covered in 300.37 and 305.15.~~

~~230.204 Isolating Switches.~~

~~(A) Where Required.~~

~~Where oil switches or air, oil, vacuum, or sulfur hexafluoride circuit breakers constitute the service disconnecting means, an isolating switch with visible break contacts shall be installed on the supply side of the disconnecting means and all associated service equipment.~~

~~Exception: An isolating switch shall not be required where the circuit breaker or switch is mounted on removable truck panels or switchgear units where both of the following conditions apply:~~

~~(1) Cannot be opened unless the circuit is disconnected~~

~~(2) Where all energized parts are automatically disconnected when the circuit breaker or switch is removed from the normal operating position~~

~~(B) Fuses as Isolating Switch.~~

~~Where fuses are of the type that can be operated as a disconnecting switch, a set of such fuses shall be permitted as the isolating switch.~~

~~(C) Accessible to Qualified Persons Only.~~

~~The isolating switch shall be accessible to qualified persons only.~~

~~(D) Connection to Ground.~~

~~Isolating switches shall be provided with a means for readily connecting the load-side conductors to a grounding electrode system, equipment ground busbar, or grounded steel structure when disconnected from the source of supply.~~

~~A means for grounding the load-side conductors to a grounding electrode system, equipment grounding busbar, or grounded structural steel shall not be required for any duplicate isolating switch installed and maintained by the electric supply company.~~

~~230.205 Disconnecting Means.~~

~~(A) Location.~~

~~The service disconnecting means shall be located in accordance with 230.70.~~

~~For either overhead or underground primary distribution systems on private property, the service disconnect shall be permitted to be located in a location that is not readily accessible, if the disconnecting means can be operated by mechanical linkage from a readily accessible point, or electronically in accordance with 230.205(C), where applicable.~~

~~(B) Type.~~

~~Each service disconnect shall simultaneously disconnect all ungrounded service conductors that it controls and shall have a fault-closing rating that is not less than the available fault current at its supply terminals.~~

Where fused switches or separately mounted fuses are installed, the fuse characteristics shall be permitted to contribute to the fault-closing rating of the disconnecting means.

~~(C) Remote Control.~~

~~For multibuilding, industrial installations under single management, the service disconnecting means shall be permitted to be located at a separate building or structure. In such cases, the service disconnecting means shall be permitted to be electrically operated by a readily accessible, remote-control device.~~

~~230.206 Overcurrent Devices as Disconnecting Means.~~

~~Where the circuit breaker or alternative for it, as specified in 230.208 for service overcurrent devices, meets the requirements specified in 230.205, it shall constitute the service disconnecting means.~~

~~230.208 Protection Requirements.~~

~~A short-circuit protective device shall be provided on the load side of, or as an integral part of, the service disconnect, and shall protect all ungrounded conductors that it supplies. The protective device shall be capable of detecting and interrupting all values of current, in excess of its trip setting or melting point, that can occur at its location. A fuse rated in continuous amperes not to exceed three times the ampacity of the conductor, or a circuit breaker with a trip setting of not more than six times the ampacity of the conductors, shall be considered as providing the required short-circuit protection.~~

~~Informational Note: See Table 315.60(C)(1) through Table 315.60(C)(20) for ampacities of conductors rated 2001 volts to 35,000 volts.~~

~~Overcurrent devices shall conform to 230.208(A) and (B).~~

~~(A) Equipment Type.~~

~~Equipment used to protect service-entrance conductors shall meet the requirements of Article 490, Part II.~~

~~(B) Enclosed Overcurrent Devices.~~

~~The restriction to 80 percent of the rating for an enclosed overcurrent device for continuous loads shall not apply to overcurrent devices installed in systems operating at over 1000 volts.~~

~~230.209 Surge Arresters.~~

~~Surge arresters installed in accordance with the requirements of Parts II and III of Article 242 shall be permitted on each ungrounded overhead service conductor.~~

~~Informational Note: Surge arresters may be referred to as lightning arresters in older documents.~~

~~230.210 Service Equipment—General.~~

~~Service equipment, including instrument transformers, shall conform to Part I of Article 490.~~

~~230.211 Switchgear.~~

~~Switchgear shall consist of a substantial metal structure and a sheet metal enclosure. Where installed over a combustible floor, suitable protection thereto shall be provided.~~

~~230.212 Over 35,000 Volts.~~

~~Where the voltage exceeds 35,000 volts between conductors that enter a building, they shall terminate in a switchgear compartment or a vault conforming to the requirements of 450.41 through 450.48.~~

Proposed Article 235 (Changes to Article 235 with migration of MV sections from 215, 225, and 230)

235.1 Scope.

This Article covers requirements for installations for branch circuits, feeders, and services over 1,000 volts ac or 1500 volts dc, nominal. (Note – this is modified from PC 285 to expand the scope of Article 235)

Informational Note: See ANSI/IEEE C2-2017, *National Electrical Safety Code*, for additional information on wiring over 1000 volts, nominal.

REFER TO PC 285, noting that it only includes requirements for "Branch Circuits"; therefore, the work from PC 285 should be augmented by making the "Scope" "Part I" and "Branch Circuits" "Part II".

Part III Feeders

235.201 General.

Part III covers the installation requirements, overcurrent protection requirements, minimum size, and ampacity of conductors for feeders over 1000 volts ac or 1500 volts dc, nominal.

235.202 Minimum Rating and Size.

The ampacity of conductors shall be in accordance with 310.14 and 315.60 as applicable. Where installed, the size of the feeder-circuit grounded conductor shall not be smaller than that required by 250.122, except that 250.122(F) shall not apply where grounded conductors are run in parallel. Feeder conductors over 1000 volts shall be sized in accordance with 235.202(B)(1), (B)(2), or (B)(3).

(1) Feeders Supplying Transformers.

The ampacity of feeder conductors shall not be less than the sum of the nameplate ratings of the transformers supplied when only transformers are supplied.

(2) Feeders Supplying Transformers and Utilization Equipment.

The ampacity of feeders supplying a combination of transformers and utilization equipment shall not be less than the sum of the nameplate ratings of the transformers and 125 percent of the designed potential load of the utilization equipment that will be operated simultaneously.

(3) Supervised Installations.

For supervised installations, feeder conductor sizing shall be permitted to be determined by qualified persons under engineering supervision in accordance with 310.14(B) or 315.60(B). Supervised installations are defined as those portions of a facility where all of the following conditions are met:

- (1) Conditions of design and installation are provided under engineering supervision.
- (2) Qualified persons with documented training and experience in over 1000-volt systems provide maintenance, monitoring, and servicing of the system.

235.203 Overcurrent Protection.

Feeders shall be protected against overcurrent in accordance with Part IX of Article 240.

235.205 Diagrams of Feeders.

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

235.206 Feeder Equipment Grounding Conductor.

Where a feeder supplies branch circuits in which equipment grounding conductors are required, the feeder shall include or provide an equipment grounding conductor, to which the equipment grounding conductors of the branch circuits shall be connected. Where the feeder supplies a separate building or structure, the requirements of 250.32 shall apply.

235.212 Identification for Feeders.

(A) Grounded Conductor.

The grounded conductor of a feeder, if insulated, shall be identified in accordance with 200.6.

(B) Equipment Grounding Conductor.

The equipment grounding conductor shall be identified in accordance with 250.119.

(C) Identification of Ungrounded Conductors.

Ungrounded conductors shall be identified in accordance with 235.212(C)(1) or (C)(2), as applicable.

(1) Feeders Supplied from More Than One Nominal Voltage System.

Where the premises wiring system has feeders supplied from more than one nominal voltage system, each ungrounded conductor of a feeder shall be identified by phase or line and system at all termination, connection, and splice points in compliance with 235.212(C)(1)(a) and (b).

- (a) Means of Identification. The means of identification shall be permitted to be by separate color coding, marking tape, tagging, or other approved means.
- (b) Posting of Identification Means. The method utilized for conductors originating within each feeder panelboard or similar feeder distribution equipment shall be documented in a manner that is readily available or shall be permanently posted at each feeder panelboard or similar feeder distribution equipment.

(2) Feeders Supplied from Direct-Current Systems.

Where a feeder is supplied from a dc system operating at more than 1500 volts, each ungrounded conductor of 4 AWG or larger shall be identified by polarity at all termination, connection, and splice points by marking tape, tagging, or other approved means; each ungrounded conductor of 6 AWG or smaller shall be identified by polarity at all termination, connection, and splice points in compliance with 235.212(C)(2)(a) and (b). The identification methods utilized for conductors originating within each feeder panelboard or similar feeder distribution equipment shall be documented in a manner that is readily available or shall be permanently posted at each feeder panelboard or similar feeder distribution equipment.

- (a) Positive Polarity, Sizes 6 AWG or Smaller. Where the positive polarity of a dc system does not serve as the connection for the grounded conductor, each positive ungrounded conductor shall be identified by one of the following means:
 - (1) A continuous red outer finish
 - (2) A continuous red stripe durably marked along the conductor's entire length on insulation of a color other than green, white, gray, or black
 - (3) Imprinted plus signs (+) or the word POSITIVE or POS durably marked on insulation of a color other than green, white, gray, or black, and repeated at intervals not exceeding 610 mm (24 in.) in accordance with 310.8(B)
 - (4) An approved permanent marking means such as sleeving or shrink-tubing that is suitable for the conductor size, at all termination, connection, and splice points, with imprinted plus signs (+) or the word POSITIVE or POS durably marked on insulation of a color other than green, white, gray, or black
- (b) Negative Polarity, Sizes 6 AWG or Smaller. Where the negative polarity of a dc system does not serve as the connection for the grounded conductor, each negative ungrounded conductor shall be identified by one of the following means:
 - (1) A continuous black outer finish
 - (2) A continuous black stripe durably marked along the conductor's entire length on insulation of a color other than green, white, gray, or red
 - (3) Imprinted minus signs (-) or the word NEGATIVE or NEG durably marked on insulation of a color other than green, white, gray, or red, and repeated at intervals not exceeding 610 mm (24 in.) in accordance with 310.8(B)
 - (4) An approved permanent marking means such as sleeving or shrink-tubing that is suitable for the conductor size, at all termination, connection, and splice points, with imprinted minus signs (-) or the word NEGATIVE or NEG durably marked on insulation of a color other than green, white, gray, or red

Part IV. Outside Branch Circuits and Feeders

235.301 General.

Part IV covers requirements for outside branch circuits and feeders over 1000 volts ac or 1500 volts dc, nominal, that are run on or between buildings, structures, or poles on the premises; and electrical equipment and wiring for the supply of utilization equipment that is located on or attached to the outside of buildings, structures, or poles. Outside branch circuits and feeders over 1000 volts ac or 1500 volts dc, nominal, shall comply with the applicable requirements in Parts I and II of article 225, and with Part IV of this article which supplements or modifies those requirements.

235.306 Conductor Size and Support.

For overhead spans open individual conductors shall not be smaller than 6 AWG copper or 4 AWG aluminum where open individual conductors, and 8 AWG copper or 6 AWG aluminum where in cable

235.310 Wiring on Buildings (or Other Structures).

The installation of outside wiring on surfaces of buildings (or other structures) shall be installed as provided in 300.37.

235.314 Open-Conductor Spacings.

Conductors shall comply with the spacings provided in 110.36 and 495.24.

235.339 Rating of Disconnect.

The feeder or branch-circuit disconnecting means shall have a rating of not less than the calculated load to be supplied, determined in accordance with Parts I and II of Article 220 for branch circuits, Part III or IV of Article 220 for feeders, or Part V of Article 220 for farm loads. Where the branch circuit or feeder disconnecting means consists

235.350 Sizing of Conductors.

The sizing of conductors over 1000 volts shall be in accordance with 235.19(A) for branch circuits and 235.202(B) for feeders.

235.351 Isolating Switches.

Where oil switches or air, oil, vacuum, or sulfur hexafluoride circuit breakers constitute a building disconnecting means, an isolating switch with visible break contacts and meeting the requirements of 235.404(B), (C), and (D) shall be installed on the supply side of the disconnecting means and all associated equipment.

Exception: The isolating switch shall not be required where the disconnecting means is mounted on removable truck panels or switchgear units that cannot be opened unless the circuit is disconnected and that, when removed from the normal operating position, automatically disconnect the circuit breaker or switch from all energized parts.

235.352 Disconnecting Means.

(A) Location.

A building or structure disconnecting means shall be located in accordance with 225.31(B), or, if not readily accessible, it shall be operable by mechanical linkage from a readily accessible point. For multibuilding industrial installations under single management, it shall be permitted to be electrically operated by a readily accessible, remote-control device in a separate building or structure.

(B) Type.

Each building or structure disconnect shall simultaneously disconnect all ungrounded supply conductors it controls and shall have a fault-closing rating not less than the available fault current at its supply terminals.

Exception: Where the individual disconnecting means consists of fused cutouts, the simultaneous disconnection of all ungrounded supply conductors shall not be required if there is a means to disconnect the load before opening the cutouts. A permanent legible sign shall be installed adjacent to the fused cutouts and shall read DISCONNECT LOAD BEFORE OPENING CUTOUTS.

Where fused switches or separately mounted fuses are installed, the fuse characteristics shall be permitted to contribute to the fault-closing rating of the disconnecting means.

(C) Locking.

Disconnecting means shall be lockable open in accordance with 110.25.

Exception: Where an individual disconnecting means consists of fused cutouts, a suitable enclosure capable of being locked and sized to contain all cutout fuse holders shall be installed at a convenient location to the fused cutouts.

(D) Indicating.

Disconnecting means shall clearly indicate whether they are in the open "off" or closed "on" position.

(E) Uniform Position.

Where disconnecting means handles are operated vertically, the "up" position of the handle shall be the "on" position.

Exception: A switching device having more than one "on" position, such as a double throw switch, shall not be required to comply with this requirement.

(F) Identification.

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

235.356 Inspections and Tests.

(A) Pre-Energization and Operating Tests.

The complete electrical system design, including settings for protective, switching, and control circuits, shall be prepared in advance and made available on request to the authority having jurisdiction and shall be performance tested when first installed on-site. Each protective, switching, and control circuit shall be adjusted in accordance

with the system design and tested by actual operation using current injection or equivalent methods as necessary to ensure that each and every such circuit operates correctly to the satisfaction of the authority having jurisdiction.

(1) Instrument Transformers.

All instrument transformers shall be tested to verify correct polarity and burden.

(2) Protective Relays.

Each protective relay shall be demonstrated to operate by injecting current or voltage, or both, at the associated instrument transformer output terminal and observing that the associated switching and signaling functions occur correctly and in proper time and sequence to accomplish the protective function intended.

(3) Switching Circuits.

Each switching circuit shall be observed to operate the associated equipment being switched.

(4) Control and Signal Circuits.

Each control or signal circuit shall be observed to perform its proper control function or produce a correct signal output.

(5) Metering Circuits.

All metering circuits shall be verified to operate correctly from voltage and current sources in a similar manner to protective relay circuits.

(6) Acceptance Tests.

Complete acceptance tests shall be performed, after the substation installation is completed, on all assemblies, equipment, conductors, and control and protective systems, as applicable, to verify the integrity of all the systems.

(7) Relays and Metering Utilizing Phase Differences.

All relays and metering that use phase differences for operation shall be verified by measuring phase angles at the relay under actual load conditions after operation commences.

(B) Test Report.

A test report covering the results of the tests required in 235.356(A) shall be delivered to the authority having jurisdiction prior to energization.

Informational Note: See ANSI/NETA ATS-2013, *Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems*, for an example of acceptance specifications.

235.360 Clearances over Roadways, Walkways, Rail, Water, and Open Land.

(A) 22 kV or Less to Ground.

The clearances over roadways, walkways, rail, water, and open land for conductors and live parts up to 22 kV or less to ground shall be not less than the values shown in Table 235.360(A).

Table 235.360(A) Clearances over Roadways, Walkways, Rail, Water, and Open Land

	<u>Location</u>	<u>Clearance</u>	
		<u>m</u>	<u>ft</u>
-	Open land subject to vehicles, cultivation, or grazing	5.6	18.5
	Roadways, driveways, parking lots, and alleys	5.6	18.5
	Walkways	4.1	13.5
	Rails	8.1	26.5
	Spaces and ways for pedestrians and restricted traffic	4.4	14.5
	Water areas not suitable for boating	5.2	17.0

(B) More Than 22 kV to Ground.

Clearances for the categories shown in Table 235.360(A) shall be increased by 10 mm (0.4 in.) per kV, or major fraction thereof, more than 22 kV.

(C) Special Cases.

For special cases, such as where crossings will be made over lakes, rivers, or areas using large vehicles such as mining operations, specific designs shall be engineered considering the special circumstances and shall be approved by the authority having jurisdiction.

Informational Note: See ANSI/IEEE C2-2017, *National Electrical Safety Code*, for additional information.

235.361 Clearances over Buildings and Other Structures.

(A) 22 kV or Less to Ground.

The clearances over buildings and other structures for conductors and live parts up to 22 kV or less to ground shall be not less than the values shown in Table 235.361(A).

Table 235.361(A) Clearances over Buildings and Other Structures

<u>Clearance from Conductors or Live Parts from:</u>	<u>Horizontal</u>		<u>-</u>	<u>Vertical</u>	
	<u>m</u>	<u>ft</u>		<u>m</u>	<u>ft</u>
Building walls, projections, and windows	2.3	7.5	-	=	=
Balconies, catwalks, and similar areas accessible to people	2.3	7.5	-	4.1	13.5
Over or under roofs or projections not readily accessible to people	=	=	-	3.8	12.5

<u>Clearance from Conductors or Live Parts from:</u>	<u>Horizontal</u>		<u>-</u>	<u>Vertical</u>	
	<u>m</u>	<u>ft</u>		<u>m</u>	<u>ft</u>
<u>Over roofs accessible to vehicles but not trucks</u>	<u>=</u>	<u>=</u>	<u>-</u>	<u>4.1</u>	<u>13.5</u>
<u>Over roofs accessible to trucks</u>	<u>=</u>	<u>=</u>	<u>-</u>	<u>5.6</u>	<u>18.5</u>
<u>Other structures</u>	<u>2.3</u>	<u>7.5</u>	<u>-</u>	<u>=</u>	<u>=</u>

(B) More Than 22 kV to Ground.

Clearances for the categories shown in Table 235.613(A) shall be increased by 10 mm (0.4 in.) per kV , or major fraction thereof, more than 22 kV.

Informational Note: See ANSI/IEEE C2-2017, *National Electrical Safety Code*, for additional information.

Part V. Services

235.401 General.

Part V covers requirements for service conductors and equipment used on circuits over 1000 volts ac and 1500 volts dc, nominal, shall comply with all of the applicable requirements in Parts I – VII of article 230, and with Part V of this article which supplements or modifies those requirements. In no case shall the provisions of Part V apply to equipment on the supply side of the service point.

235.402 Service-Entrance Conductors.

Service-entrance conductors to buildings or enclosures shall be installed to conform to 430.202(A) and (B).

(A) Conductor Size.

Service-entrance conductors shall not be smaller than 6 AWG unless in multiconductor cable. Multiconductor cable shall not be smaller than 8 AWG.

(B) Wiring Methods.

Service-entrance conductors shall be installed by one of the wiring methods covered in 300.37 and 305.15.

235.404 Isolating Switches.

(A) Where Required.

Where oil switches or air, oil, vacuum, or sulfur hexafluoride circuit breakers constitute the service disconnecting means, an isolating switch with visible break contacts shall be installed on the supply side of the disconnecting means and all associated service equipment.

Exception: An isolating switch shall not be required where the circuit breaker or switch is mounted on removable truck panels or switchgear units where both of the following conditions apply:

- (1) Cannot be opened unless the circuit is disconnected*
- (2) Where all energized parts are automatically disconnected when the circuit breaker or switch is removed from the normal operating position*

(B) Fuses as Isolating Switch.

Where fuses are of the type that can be operated as a disconnecting switch, a set of such fuses shall be permitted as the isolating switch.

(C) Accessible to Qualified Persons Only.

The isolating switch shall be accessible to qualified persons only.

(D) Connection to Ground.

Isolating switches shall be provided with a means for readily connecting the load side conductors to a grounding electrode system, equipment ground busbar, or grounded steel structure when disconnected from the source of supply.

A means for grounding the load side conductors to a grounding electrode system, equipment grounding busbar, or grounded structural steel shall not be required for any duplicate isolating switch installed and maintained by the electric supply company.

235.405 Disconnecting Means.

(A) Location.

The service disconnecting means shall be located in accordance with 230.70.

For either overhead or underground primary distribution systems on private property, the service disconnect shall be permitted to be located in a location that is not readily accessible, if the disconnecting means can be operated by mechanical linkage from a readily accessible point, or electronically in accordance with 234.405(C), where applicable.

(B) Type.

Each service disconnect shall simultaneously disconnect all ungrounded service conductors that it controls and shall have a fault-closing rating that is not less than the available fault current at its supply terminals.

Where fused switches or separately mounted fuses are installed, the fuse characteristics shall be permitted to contribute to the fault-closing rating of the disconnecting means.

(C) Remote Control.

For multibuilding, industrial installations under single management, the service disconnecting means shall be permitted to be located at a separate building or structure. In such cases, the service disconnecting means shall be permitted to be electrically operated by a readily accessible, remote-control device.

235.406 Overcurrent Devices as Disconnecting Means.

Where the circuit breaker or alternative for it, as specified in 235.408 for service overcurrent devices, meets the requirements specified in 235.405, it shall constitute the service disconnecting means.

235.408 Protection Requirements.

A short-circuit protective device shall be provided on the load side of, or as an integral part of, the service disconnect, and shall protect all ungrounded conductors that it supplies. The protective device shall be capable of detecting and interrupting all values of current, in excess of its trip setting or melting point, that can occur at its location. A fuse rated in continuous amperes not to exceed three times the ampacity of the conductor, or a circuit breaker with a trip setting of not more than six times the ampacity of the conductors, shall be considered as providing the required short-circuit protection.

Informational Note: See Table 315.60(C)(1) through Table 315.60(C)(20) for ampacities of conductors rated 2001 volts to 35,000 volts.

Overcurrent devices shall conform to 235.408(A) and (B).

(A) Equipment Type.

Equipment used to protect service-entrance conductors shall meet the requirements of Article 495, Part II.

(B) Enclosed Overcurrent Devices.

The restriction to 80 percent of the rating for an enclosed overcurrent device for continuous loads shall not apply to overcurrent devices installed in systems operating at over 1000 volts.

235.409 Surge Arresters.

Surge arresters installed in accordance with the requirements of Parts II and III of Article 242 shall be permitted on each ungrounded overhead service conductor.

Informational Note: Surge arresters may be referred to as lightning arresters in older documents.

235.410 Service Equipment — General.

Service equipment, including instrument transformers, shall conform to Part I of Article 495.

235.411 Switchgear.

Switchgear shall consist of a substantial metal structure and a sheet metal enclosure. Where installed over a combustible floor, suitable protection thereto shall be provided.

235.412 Over 35,000 Volts.

Where the voltage exceeds 35,000 volts between conductors that enter a building, they shall terminate in a switchgear compartment or a vault conforming to the requirements of 450.41 through 450.48.

**Public Comment No. 877-NFPA 70-2021 [Global Input]**

The Correlating Committee directs CMP 10 to reconsider the creation of a new Article 231. The content of the proposed article contains requirements that are redundant with existing requirements within Article 230 and Article 705. A task group has been established consisting of members from CMPs 4, 5, and 10 to review all current and proposed requirements related to the connection of power sources to a service. The task group shall develop public comments based on the following division of CMP responsibilities.

The connection of power source(s) to a service consists of service conductors connected to an additional service or to a connection ahead of the service disconnect(s). The service conductors for the power interconnection must follow the rules in Article 230 for service conductors and terminate in one or more service disconnects. The sizing of the service conductors and the rating of service disconnect(s) based on the number of power sources and calculation of maximum current shall be the responsibility of CMP 4. The remaining responsibilities for service conductor installation remain with CMP 10. Grounding and bonding requirements should remain with CMP 5.

The Correlating Committee also directs CMP 4 to reconsider why the conductors from the service disconnect(s) to one or more power sources should be called power source output circuit conductors instead of feeders. To maintain consistency in the Code and improve its ease of use it is desirable for these conductors to simply follow the rules in Article 215 and Article 225 except as amended by Article 705. The responsibility for modification or amendment of the feeder rules within Article 705 for power sources remains with CMP 4.

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_313_Global.pdf	70_CN313

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 313 appeared in the First Draft Report on First Revision No. 7974.

The Correlating Committee directs CMP 10 to reconsider the creation of a new Article 231. The content of the proposed article contains requirements that are redundant with existing requirements within Article 230 and Article 705. A task group has been established consisting of members from CMPs 4, 5, and 10 to review all current and proposed requirements related to the connection of power sources to a service. The task group shall develop public comments based on the following division of CMP responsibilities.

The connection of power source(s) to a service consists of service conductors connected to an additional service or to a connection ahead of the service disconnect(s). The service conductors for the power interconnection must follow the rules in Article 230 for service conductors and terminate in one or more service disconnects. The sizing of the service conductors and the rating of service disconnect(s) based on the number of power sources and calculation of maximum current shall be the responsibility of CMP 4. The remaining responsibilities for service conductor installation remain with CMP 10. Grounding and bonding requirements should remain with CMP 5.

The Correlating Committee also directs CMP 4 to reconsider why the conductors from the service disconnect(s) to one or more power sources should be called power source output circuit conductors instead of feeders. To maintain consistency in the Code and improve its ease of use it is desirable for these conductors to simply follow the rules in Article 215 and Article 225 except as amended by Article 705. The responsibility for modification or amendment of the feeder rules within Article 705 for power sources remains with CMP 4.

Related Item

- First Revision No. 7974

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 04 15:28:43 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: [SR-8272-NFPA 70-2021](#)
Statement: New Article 231 is deleted in support of the revision provided in PC 1098. The provision of Article 231 will be redundant if PC 1098 is accepted.

PC-321 & 325: These public comments were resolved by the deletion of Article 231.



Correlating Committee Note No. 313-NFPA 70-2021 [Global Input]

Submitter Information Verification

Committee: NEC-P10

Submission Date: Thu May 06 15:14:41 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs CMP 10 to reconsider the creation of a new Article 231. The content of the proposed article contains requirements that are redundant with existing requirements within Article 230 and Article 705. A task group has been established consisting of members from CMPs 4, 5, and 10 to review all current and proposed requirements related to the connection of power sources to a service. The task group shall develop public comments based on the following division of CMP responsibilities.

The connection of power source(s) to a service consists of service conductors connected to an additional service or to a connection ahead of the service disconnect(s). The service conductors for the power interconnection must follow the rules in Article 230 for service conductors and terminate in one or more service disconnects. The sizing of the service conductors and the rating of service disconnect(s) based on the number of power sources and calculation of maximum current shall be the responsibility of CMP 4. The remaining responsibilities for service conductor installation remain with CMP 10. Grounding and bonding requirements should remain with CMP 5.

The Correlating Committee also directs CMP 4 to reconsider why the conductors from the service disconnect(s) to one or more power sources should be called power source output circuit conductors instead of feeders. To maintain consistency in the Code and improve its ease of use it is desirable for these conductors to simply follow the rules in Article 215 and Article 225 except as amended by Article 705. The responsibility for modification or amendment of the feeder rules within Article 705 for power sources remains with CMP 4.

First Revision No. 7974-NFPA 70-2020 [Global Input]

Ballot Results

✓ **This item has passed ballot**

12 Eligible Voters

0 Not Returned

11 Affirmative All

1 Affirmative with Comments

0 Negative with Comments

0 Abstention

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Johnston, Michael J.

Kendall, David H.

Kovacik, John R.

Manche, Alan

McDaniel, Roger D.

Porter, Christine T.

Williams, David A.

Affirmative with Comment

Hunter, Dean C.

At present, 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 my opinion, there is concern that failure to look at a long-term solution to systems over 1000 volts may create a vacuum in which other standards look to fill that void.

**Public Comment No. 885-NFPA 70-2021 [Global Input]**

The Correlating Committee directs the Chair of CMP-10 to assign a task group to review all the definitions under their purview for compliance with the NEC Style Manual and to review definitions identified by the Correlating Committee that may contain correlation issues. The attachment includes a list of those definitions identified that need to be reviewed.

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_359_Global.pdf	70_CN359

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 359 appeared in the First Draft Report on First Revision No. 7857.

The Correlating Committee directs the Chair of CMP-10 to assign a task group to review all the definitions under their purview for compliance with the NEC Style Manual and to review definitions identified by the Correlating Committee that may contain correlation issues. The attachment includes a list of those definitions identified that need to be reviewed.

Related Item

- First Revision No. 7857

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 04 15:37:39 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: [SR-8449-NFPA 70-2021](#)
Statement: The definitions of Service-entrance Conductor, Overhead and Service-conductor, Underground are combined and simplified for clarity and usability.

**Correlating Committee Note No. 359-NFPA 70-2021 [Global Input]****Supplemental Information**

<u>File Name</u>	<u>Description Approved</u>
NEC_P10_Definitions_TG_Attachment_CN359.docx	

Submitter Information Verification**Committee:** NEC-P10**Submittal Date:** Thu May 06 22:41:14 EDT 2021**Committee Statement**

Committee Statement: The Correlating Committee directs the Chair of CMP-10 to assign a task group to review all the definitions under their purview for compliance with the NEC Style Manual and to review definitions identified by the Correlating Committee that may contain correlation issues. The attachment includes a list of those definitions identified that need to be reviewed.

First Revision No. 7857-NFPA 70-2020 [Global Input]

Ballot Results

✓ **This item has passed ballot**

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

Affirmative All

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

Correlating Committee Definitions Task Group

CMP-10 - Definitions

CMP-10 Definitions	Correlating Committee Comments
	The Correlating Committee directs the Chair of CMP-10 to assign a task group to review all the definitions under their purview for compliance with the NEC Style Manual and to review definitions identified by the Correlating Committee that may contain correlation issues. The attachment includes a list of those definitions identified that need to be reviewed.
Overcurrent Protective Device, Branch-Circuit. (Branch-Circuit Overcurrent Protective Device). A device capable of providing protection for service, feeder, and branch circuits and equipment over the full range of overcurrents between its rated current and its interrupting rating. Such devices are provided with interrupting ratings appropriate for the intended use but no less than 5000 amperes. (CMP-10)	2.2.2.2 Requirement in Definition The Correlating Committee directs that this first revision be rewritten to comply with the NEC Style Manual, Section 2.2.2.2, regarding requirements within a definition. The second sentence includes a requirement. The term Branch Circuit in the definition title does not match the defined term.
Reconditioned. Electromechanical systems, equipment, apparatus, or components that are restored to operating conditions. This process differs from normal servicing of equipment that remains within a facility, or replacement of listed equipment on a one-to-one basis. (CMP-10) Informational Note: The term reconditioned is frequently referred to as rebuilt, refurbished, or remanufactured.	The Correlating Committee assigns the definition of “Reconditioned” to CMP-1.
Supervised Industrial Installation. For the purposes of Part VIII of Article 240, the industrial portions of a facility where all of the following conditions are met: (1) Conditions of maintenance and engineering supervision ensure that only qualified persons monitor and service the system. (2) The premises wiring system has 2500 kVA or greater of load used in industrial process(es), manufacturing activities, or both, as calculated in accordance with Article 220. (3) The premises has at least one service or feeder that is more than 150 volts to ground and more than 300 volts phase-to-phase. This definition excludes installations in buildings used by the industrial facility for offices, warehouses, garages, machine shops, and recreational facilities that are not an integral part of the industrial plant, substation, or control center. (240) (CMP-10)	"Task Group 12 Industrial Establishment - Supervised Industrial Installation" 2.2.2.3.2 Article Number (1st line"

Service Conductors, Underground. (Underground Service Conductors). The underground conductors between the service point and the first point of connection to the service-entrance conductors in a terminal box, meter, or other enclosure, inside or outside the building wall. (CMP-10) Informational Note: Where there is no terminal box, meter, or other enclosure, the point of connection is considered to be the point of entrance of the service conductors into the building.	3.1.3 Informational Note Interpretation.
Service-Entrance Conductors, Overhead System. The service conductors between the terminals of the service equipment and a point usually outside the building, clear of building walls, where joined by tap or splice to the service drop or overhead service conductors. (CMP-10)	2.2.2 Term is not used. 2.2.2.3.1 Searchable Title
Service-Entrance Conductors, Underground System. The service conductors between the terminals of the service equipment and the point of connection to the service lateral or underground service conductors. (CMP-10) Informational Note: Where service equipment is located outside the building walls, there may be no service-entrance conductors or they may be entirely outside the building.	2.2.2 Term is not used. 2.2.2.3.1 Searchable Title

**Public Comment No. 830-NFPA 70-2021 [Definition: Feeder.]****Feeder.**

All circuit conductors between the service equipment, the source of a separately derived system, or other power supply source other than a inverter output circuit and the final branch-circuit overcurrent device. (CMP-10)

Statement of Problem and Substantiation for Public Comment

. Inverter output circuit are NOT feeders and do NOT follow any feeder rules. For clarification this should be clear in this definition. see Articles 690 and 705. In PI 3140 the CMP statement of ceasing to be feeders is incorrect they were never feeder or branch circuits to begin with, so even the CMP members are confused.

Related Item

- 3140

Submitter Information Verification

Submitter Full Name: Alfio Torrisi

Organization: Master Electrician

Street Address:

City:

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Zip:

Submittal Date: Wed Aug 04 13:21:29 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The added text does not add clarity as the inverter output circuit conductors are power-source output conductors.

**Public Comment No. 1496-NFPA 70-2021 [Definition: Overcurrent Protective Device, Branch-Circuit. ...]****Overcurrent Protective Device, ~~Branch-Circuit.~~ (~~Branch-Circuit Overcurrent Protective Device~~)**

A device capable of providing protection for service, feeder, and branch circuits and equipment over the full range of overcurrents between its rated current and its interrupting rating. Such devices are provided with interrupting ratings appropriate for the intended use but no less than 5000 amperes. (CMP-10)

Statement of Problem and Substantiation for Public Comment

The term "overcurrent protective device" appears over 200 times in the NEC. The term "branch circuit overcurrent protective device" appears only 10 times, each time it implies a location in the circuit or system. In fact the words "branch circuit" are not necessary in most instances of the use of the term branch circuit overcurrent protective device. The title of the current definition appears to be exclusive to just branch circuits, but the definition applies to overcurrent protective devices for other than just branch circuits. Clearly in the definition, overcurrent devices are provided for and intended for services and feeders too. The revision is an effort to broaden the terminology to improve accuracy, reduce confusion, and enhance clarity. The defined term Overcurrent Device, Supplementary already provides the needed differentiation between an overcurrent device used for a branch circuit, feeder, or service equipment.

Related Item

- FR 8289

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz

Organization: NECA

Street Address:

City:

State:

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Submittal Date: Sun Aug 15 16:16:04 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8442-NFPA 70-2021](#)

Statement: The term branch-circuit is not removed in the title to correlate with product standards. The second sentence is removed because it contained a requirement.

CMP-10 is requesting that the correlating committee review the use of the term "Branch-Circuit Overcurrent Protective Device" and the use of the term "overcurrent protection device" and "supplemental overcurrent device".

See SR-8440 relocating the requirement to 240.16.

**Public Comment No. 891-NFPA 70-2021 [Definition: Overcurrent Protective Device, Branch-Circuit. ...]****Overcurrent Protective Device, Branch-Circuit. (Branch-Circuit Overcurrent Protective Device)**

A device capable of providing protection for service, feeder, and branch circuits and equipment over the full range of overcurrents between its rated current and its interrupting rating. Such devices are provided with interrupting ratings appropriate for the intended use but no less than 5000 amperes. (CMP-10)

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_428.pdf	70_CN428

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 428 appeared in the First Draft Report on First Revision No. 8289.

The Correlating Committee directs that this first revision be rewritten to comply with the NEC Style Manual, Section 2.2.2.2, regarding requirements within a definition. The second sentence includes a requirement. The term Branch Circuit in the definition title does not match the defined term.

Related Item

- First Revision No. 8289

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 04 15:40:58 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: [SR-8442-NFPA 70-2021](#)
Statement: The term branch-circuit is not removed in the title to correlate with product standards. The second sentence is removed because it contained a requirement.

CMP-10 is requesting that the correlating committee review the use of the term "Branch-Circuit Overcurrent Protective Device" and the use of the term "overcurrent protection device" and "supplemental overcurrent device".

See SR-8440 relocating the requirement to 240.16.



Correlating Committee Note No. 428-NFPA 70-2021 [Definition: Overcurrent Protective Device, Branch-Circuit.]

Submitter Information Verification

Committee: NEC-P10

Submittal Date: Sun May 09 22:16:59 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs that this first revision be rewritten to comply with the NEC Style Manual, Section 2.2.2.2, regarding requirements within a definition. The second sentence includes a requirement. The term Branch Circuit in the definition title does not match the defined term.

First Revision No. 8289-NFPA 70-2020 [Definition: Overcurrent Protective Device, Branch-Circuit.]

Ballot Results

✓ **This item has passed ballot**

12 Eligible Voters

0 Not Returned

12 Affirmative All

0 Affirmative with Comments

0 Negative with Comments

0 Abstention

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Johnston, Michael J.

Kendall, David H.

Kovacik, John R.

Manche, Alan

McDaniel, Roger D.

Porter, Christine T.

Williams, David A.

**Public Comment No. 1524-NFPA 70-2021 [Definition: Supervised Industrial Installation.]****Industrial Installation, Supervised (Supervised Industrial Installation) .**

~~For the purposes of Part VIII of Article 240, the~~ The industrial portions of a facility where all of the following conditions are met:

- (1) Conditions of maintenance and engineering supervision ensure that only qualified persons monitor and service the system.
- (2) The premises wiring system has 2500 kVA or greater of load used in industrial process(es), manufacturing activities, or both, as calculated in accordance with Article 220.
- (3) The premises has at least one service or feeder that is more than 150 volts to ground and more than 300 volts phase-to-phase.

This definition excludes installations in buildings used by the industrial facility for offices, warehouses, garages, machine shops, and recreational facilities that are not an integral part of the industrial plant, substation, or control center. (240) (CMP-10)

Statement of Problem and Substantiation for Public Comment

At the request of the correlating committee, a task group was formed from members Kevin Arnold (CMP-10), Mike Stone (CMP-1) and Don Ankele (CMP-14) to review definitions related to Industrial Installation and Industrial Establishment. The purpose of the task group was to review the definitions for accuracy, correlation, and style manual compliance. The changes were made to accomplish the purpose of the task group such as the definition title structure as defined in section 2.2.2.3.1 of the Style Manual.

Related Item

- FR-7857

Submitter Information Verification

Submitter Full Name: Kevin Arnold

Organization: Eaton's Bussmann Business

Street Address:

City:

State:

Zip:

Submittal Date: Mon Aug 16 10:22:26 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Accepted

Resolution: SR-8447-NFPA 70-2021

Statement: The first sentence was revised to comply with the NEC Style Manual. The title was changed to enhance usability of the Code.

CMP-10 requests editorial to relocate this term so it appears alphabetically.

**Public Comment No. 844-NFPA 70-2021 [Section No. 215.1]****215.1 Scope.**

This article covers the installation requirements, overcurrent protection requirements, minimum size, and ampacity of conductors for feeders.

Exception: This article does not apply to feeders for electrolytic cells as covered in 668.3(C)(1) and (C)(4).

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_146.pdf	70_CN146

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 146 appeared in the First Draft Report on First Revision No. 7894.

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and the Correlating Committee rejects the panel action. The Correlating Committee directs the Panel to consider revising the scope to convert the excepted language into positive language to comply with the NEC Style Manual, Section 3.1.4.

Related Item

- First Revision No. 7894

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 04 14:21:03 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: [SR-8215-NFPA 70-2021](#)
Statement: The Exception is not necessary based on 90.3 and the Manual of style in paragraph 4.1.1.

**Correlating Committee Note No. 146-NFPA 70-2021 [Section No. 215.1]****Submitter Information Verification**

Committee: NEC-P10

Submittal Date: Tue May 04 17:28:01 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and the Correlating Committee rejects the panel action. The Correlating Committee directs the Panel to consider revising the scope to convert the excepted language into positive language to comply with the NEC Style Manual, Section 3.1.4.

First Revision No. 7894-NFPA 70-2020 [Section No. 215.1]

Ballot Results

✓ **This item has passed ballot**

12 Eligible Voters

0 Not Returned

12 Affirmative All

0 Affirmative with Comments

0 Negative with Comments

0 Abstention

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Johnston, Michael J.

Kendall, David H.

Kovacik, John R.

Manche, Alan

McDaniel, Roger D.

Porter, Christine T.

Williams, David A.

**Public Comment No. 962-NFPA 70-2021 [Section No. 215.1]****215.1 Scope.**

This article covers the installation requirements, overcurrent protection requirements, minimum size, and ampacity of conductors for feeders.

Exception: This article does not apply to feeders for electrolytic cells as covered in 668.3(C)(1) and (C)(4).

I.N. See 225.31 for restrictions on multiple feeders to a building or structure.

Statement of Problem and Substantiation for Public Comment

While Article 225 clearly applies to feeders run between buildings, it could enhance safety to remind people reading 215 of the exceptions in 225.31.

Related Item

- PI 1185

Submitter Information Verification

Submitter Full Name: David Shapiro

Organization: Safety First Electrical

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 05 12:15:08 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The informational note is not necessary based on the Style Manual in paragraph 3.1.3.



Public Comment No. 1481-NFPA 70-2021 [Section No. 215.2(A)(1)]

(1) General.

~~Feeder conductors~~ Feeders shall have ~~an ampacity not a minimum conductor size not~~ less than the larger of 215.2(A)(1)(a) or (A)(1)(b) and shall comply with 110.14(C).

(a) ~~Where a feeder supplies continuous loads or any combination of continuous and noncontinuous loads, the minimum feeder conductor size shall have an ampacity~~ A conductor size based on its table ampacity not less than the noncontinuous load plus 125 percent of the continuous load in accordance with 310.14.

Exception No. 1: If the assembly, including the overcurrent devices protecting the feeder(s), is listed for operation at 100 percent of its rating, the ampacity of the feeder conductors shall be permitted to be not less than the sum of the continuous load plus the noncontinuous load.

Exception No. 2: Where a portion of a feeder is connected at both its supply and load ends to separately installed pressure connections as covered in 110.14(C)(2), it shall be permitted to have an ampacity not less than the sum of the continuous load plus the noncontinuous load. No portion of a feeder installed under this exception shall extend into an enclosure containing either the feeder supply or the feeder load terminations, as covered in 110.14(C)(1).

Exception No. 3: Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the continuous and noncontinuous load.

(b) ~~The minimum feeder conductor size shall have an ampacity~~ A conductor size based on its modified ampacity not less than the maximum load to be served after the application of any adjustment or correction factors in accordance with 310.14 15.

Informational Note No. 1: See Examples D1 through D11 in Informative Annex D.

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

Informational Note No. 3: See 210.19(B), Informational Note No. 3, for voltage drop for branch circuits.

Statement of Problem and Substantiation for Public Comment

The way the rule is currently written is not clear. The intent of this rule is understood to be about the minimum size of a feeder conductor, yet it conflates the meaning of the physical size of a conductor with its ampacity. The proposed change attempts to clarify the following:

1. Affirms the requirement is primarily about the minimum conductor size (namely the minimum AWG or kcmil),
2. Establishes a difference between the allowable ampacity (which is only a table ampacity) and the modified ampacity (which reflects any correction/adjustment factors based on the conditions of use),
3. Maintains the original intent in a clear concise manner while doing away with ambiguous language and improving readability,
4. Supports consistency with the verbiage and intent of Section 210.19(A)

Related Public Comments for This Document

Related Comment

[Public Comment No. 1482-NFPA 70-2021 \[Section No. 210.19\(A\)\]](#)

[Public Comment No. 1482-NFPA 70-2021 \[Section No. 210.19\(A\)\]](#)

Relationship

Similar Requirement

Related Item

- Public Input No. 91-NFPA 70-2019

Submitter Information Verification

Submitter Full Name: Octavio L. Gonzalez

Organization: IPE & Technical Services, LLC

Affiliation: IPE & Technical Services, LLC

Street Address:

City:

State:

Zip:

Submittal Date: Sat Aug 14 15:03:24 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The definition of ampacity is already addressed in Article 100 and the ampacity tables under specific conditions of use. The adjustment and correction factors are required to adjust the ampacity when those conditions of use are not met.



Public Comment No. 59-NFPA 70-2021 [Section No. 215.2(A)(1)]

(1) General.

Feeder conductors shall have an ampacity not less than the larger of 215.2(A)(1)(a) or (A)(1)(b) and shall comply with 110.14(C).

(a) Where a feeder supplies continuous loads or any combination of continuous and noncontinuous loads, the minimum feeder conductor size shall have an ~~ampacity not less than the noncontinuous load plus 125 percent of the continuous load, before the application of any adjustment or correction factors in accordance with 310.15(B) or (C).~~

Exception No. 1: If the assembly, including the overcurrent devices protecting the feeder(s), is listed for operation at 100 percent of its rating, the ampacity of the feeder conductors shall be permitted to be not less than the sum of the continuous load plus the noncontinuous load, before the application of any adjustment or correction factors in accordance with 310.15(B) or (C).

Exception No. 2: Where a portion of a feeder is connected at both its supply and load ends to separately installed pressure connections as covered in 110.14(C)(2), it shall be permitted to have an ampacity not less than the sum of the continuous load plus the noncontinuous load, before the application of any adjustment or correction factors in accordance with 310.15(B) or (C). No portion of a feeder installed under this exception shall extend into an enclosure containing either the feeder supply or the feeder load terminations, as covered in 110.14(C)(1).

Exception No. 3: Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the continuous and noncontinuous load.

(b) The minimum feeder conductor size shall have an ampacity not less than the maximum load to be served ~~after the application of any adjustment or correction factors in accordance with 310.14.~~

Informational Note No. 1: See Examples D1 through D11 in Informative Annex D.

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

Informational Note No. 3: See 210.19(B), Informational Note No. 3, for voltage drop for branch circuits.

Statement of Problem and Substantiation for Public Comment

As currently written, the 215.2(A)(1) phrases "ampacity" in part (a) and "ampacity . . . after the application of any adjustment or correction factors in accordance with 310.14" in part (b) have the identical meaning and value. The article 100 definition of "ampacity" refers to the "conditions of use". That means whenever the word "ampacity" is used in the NEC without any modifiers, it refers to a value that includes the "adjustment or correction factors in accordance with 310.14." The result is that logically, as currently written, part (b) is moot; the value in part (a) will always be larger.

My understanding is that this is not the intention, that the computation in part (a) is meant to be based not on the final "ampacity", but rather the ampacity before the application of any adjustment or correction factors. That is the value directly from the tables in 310.16 through 310.21. But if the CMP's preference is not to directly reference those tables as suggested in my PI, the language I proposed for this Public Comment would be a good alternative.

Regardless, 215.2(A)(1)(a) must be amended to refer to something other than simply "ampacity," as the current text's meaning does not match the intended meaning.

Related Public Comments for This Document

Related Comment

Public Comment No. 60-NFPA 70-2021 [Section No. 210.19(A)]

Relationship

Related Item

• Public Input No. 91-NFPA 70-2019 • Public Input No. 2018-NFPA 70-2020

Submitter Information Verification

Submitter Full Name: Wayne Whitney

Organization: [Not Specified]

Street Address:

City:

State:

Zip:

Submittal Date: Thu Jul 01 11:40:21 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The definition of ampacity is already addressed in Article 100 and the ampacity tables under specific conditions of use. The adjustment and correction factors are required to adjust the ampacity when those conditions of use are not met.

**Public Comment No. 323-NFPA 70-2021 [Section No. 215.10]****215.10 Ground-Fault Protection of Equipment.**

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

Informational Note: See 517.17 for buildings that contain health care occupancies.

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

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

Exception No. 3: If temporary feeder conductors are used to connect a generator to a facility for repair, maintenance, or emergencies, ground-fault protection of equipment shall not be required. Temporary feeders without ground-fault protection shall be permitted for the time period necessary but shall not exceed 90 days.

Exception No. 4: For fused disconnects, where the available fault current is 10,000 amperes or greater, the ground-fault protection provisions of this section shall not apply if the fuses have a clearing time of 0.07 seconds or less at the lower of the calculated minimum available arcing current or 38% of the available fault current or if the disconnect switch complies with Section 240.67(B)(1), 240.67(B)(3), or 240.67(B)(4), and is set to operate at the lower of the calculated minimum arcing current or 38% of the available fault current.

Exception No. 5: For circuit breakers, where the available fault current is 10,000 amperes or greater, the ground-fault protection provisions of this section shall not apply if the circuit breaker complies with Section 240.87(B)(2), 240.87(B)(4), 240.87(B)(5), or 240.87(B)(6), and is set to operate at the lower of the calculated minimum arcing current or 38% of the available fault current.

Statement of Problem and Substantiation for Public Comment

A sincere "Thank You" goes to Code Making Panels 2 and 10 for discovering the flaw with Public Inputs 693, 694, 695, and 696. The Panels stated: "Substantiation was not provided to support the equivalency of alternate technologies. As an example, it is possible that alternate systems could be set such that they might provide arc energy reduction, but not operate during a lower level ground fault where traditional GFPE will provide protection." To rectify this flaw, this Public Comment has added the requirement that the methods to reduce clearing time operate at the lower of the calculated minimum arcing current or 38% of the available fault current. While an arcing fault from phase to ground is almost certainly going to escalate into a three phase arcing fault, it is possible that the arcing fault could remain as a phase to ground arcing fault. When this occurs, it has been shown, in numerous IEEE papers, that the minimum phase to ground arcing fault, on a 480/277 volt, solidly grounded system, must be at least 38% of the available fault current in order to sustain the arc. With this requirement added in, it is assured that the method to reduce clearing time will function to clear the circuit.

In addition to this requirement, and to add even more conservatism, this Public Comment has added a minimum available fault current of 10,000 amperes to the proposed requirement. Based on a 32mm spacing, 480 volts, and HCB configuration, IEEE 1584-2018 calculates the minimum arcing current to be 6.09 kA for an available (bolted) fault current of 10,000 amperes. The minimum arcing current of 6.09 KA is 5 times the maximum 1200 ampere setting and 2 times the 3000 ampere value used with the one second maximum delay. (NEC 230.95(A) allows for a maximum setting of 1200 amperes and a maximum time delay of 1 second at 3000 amperes or greater.) The 6.09 KA current for 60 cycles produces an expected equipment damage level of 36,540 KW-Cycles (6.09KA X 100 arcing volts X 60 cycles). In contrast, this Public Comment would provide a worst case, expected equipment damage level of only 4,263 KW-Cycles. Yes, that is correct, the proposed exception would allow less than 12% of the damage level allowed by the existing 230.95(A) requirements.

The following paragraphs provide a detailed comparison of expected equipment damage levels allowed by 230.95(A), proposed exceptions for fusible switches (240.67), and proposed exceptions for circuit breakers (240.87).

Expected Equipment Damage from 230.95(A)

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 10kA, the IEEE 1584-2018 arcing current is 7.07kA with a minimum arcing current of 6.09kA. Using the maximum 230.95(A) opening time of 60 cycles, the expected equipment damage is 36,540 kW-cycles.

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 25kA, the IEEE 1584-2018 arcing current is 17.64kA with a minimum arcing current of 15.21kA. Using the maximum 230.95(A) opening time of 60 cycles, the expected equipment damage is 91,260 kW-cycles.

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 50kA, the IEEE 1584-2018 arcing current is 30.14kA with a minimum arcing current of 25.98kA. Using the maximum 230.95(A) opening time of 60 cycles, the expected equipment damage is 155,880 kW-cycles.

Expected Equipment Damage from Proposed Exceptions for Fusible Switches (240.67)

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 10kA, the IEEE 1584-2018 arcing current is 7.07kA with a minimum arcing current of 6.09kA. Assuming an opening time of 4 cycles for 240.67(B), the expected equipment damage is 2,436 kW-cycles. Assuming an opening time of 7 cycles for 240.67(B)(1) or (B)(3), the expected equipment damage is 4,263 kW-cycles. Assuming an opening time of 1/2 cycle for 240.67(B)(4), the expected equipment damage is 305 kW-cycles. Worst case damage (4,263 kW-cycles) is less than 12% of the damage allowed by 230.95(A) (36,540 kW-cycles).

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 25kA, the IEEE 1584-2018 arcing current is 17.64kA with a minimum arcing current of 15.21kA. Assuming an opening time of 4 cycles for 240.67(B), the expected equipment damage is 6,084 kW-cycles. Assuming an opening time of 7 cycles for 240.67(B)(1) or (B)(3), the expected equipment damage is 10,647 kW-cycles. Assuming an opening time of 1/2 cycle for 240.67(B)(4), the expected equipment damage is 761 kW-cycles. Worst case damage (10,647 kW-cycles) is less than 12% of the damage allowed by 230.95(A) (91,260 kW-cycles).

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 50kA, the IEEE 1584-2018 arcing current is 30.14kA with a minimum arcing current of 25.98kA. Assuming an opening time of 4 cycles for 240.67(B), the expected equipment damage is 10,392 kW-cycles. Assuming an opening time of 7 cycles for 240.67(B)(1) or (B)(3), the expected equipment damage is 18,186 kW-cycles. Assuming an opening time of 1/2 cycle for 240.67(B)(4), the expected equipment damage is 1,299 kW-cycles. Worst case damage (18,186 kW-cycles) is less than 12% of the damage allowed by 230.95(A) (155,880 kW-cycles).

Expected Equipment Damage from Proposed Exceptions for Circuit Breakers (240.87)

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 10kA, the IEEE 1584-2018 arcing current is 7.07kA with a minimum arcing current of 6.09kA. Assuming an opening time of 4 cycles for 240.87(B)(1), (B)(2), or (B)(4), the expected equipment damage is 2,436 kW-cycles. Assuming an opening time of 3 cycles for 240.87(B)(5) or (B)(6), the expected equipment damage is 1,827 kW-cycles. Worst case damage (2,426 KW-Cycles) is less than 7% of the damage allowed by 230.95(A) (36,540 kW-cycles).

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 25kA, the IEEE 1584-2018 arcing current is 17.64kA with a minimum arcing current of 15.21kA. Assuming an opening time of 4 cycles for 240.87(B)(1), (B)(2), or (B)(4), the expected equipment damage is 6,084 kW-cycles. Assuming an opening time of 3 cycles for 240.87(B)(5) or (B)(6), the expected equipment damage is 4,563 kW-cycles. Worst case damage (6,084 kW-Cycles) is less than 7% of the damage allowed by 230.95(A) (91,260 kW-cycles).

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 50kA, the IEEE 1584-2018 arcing current is 30.14kA with a minimum arcing current of 25.98kA. Assuming an opening time of 4 cycles for 240.87(B)(1), (B)(2), or (B)(4), the expected equipment damage is 10,392 kW-cycles. Assuming an opening time of 3 cycles for 240.87(B)(5) or (B)(6), the expected equipment damage is 7,794 kW-cycles. Worst case damage (10,392 KW-Cycles) is less than 7% of the damage allowed by 230.95(A) (155,880 kW-cycles).

Other Change from Public Input Stage

The other change that is made from the original Public Input is that the text lists the methods that can be used rather than the methods that cannot be used.
Background from Public Input Stage

A requirement (230.95) for ground fault protection of equipment (GFPE) was added to the 1971 NEC® because 480/277 volt, solidly grounded wye services, protected by 1000 ampere and larger overcurrent protective devices, were burning down due to arcing faults. 208/120 volt services and those services protected by smaller overcurrent protective devices were not burning down, so they weren't included in the new requirement. Over many Code cycles, GFPE requirements were also added for branch circuits (210.13), feeders (215.10), and equipment (240.13). In all cases, the intent was to limit damage to the switchboard, switchgear, panelboard or equipment, not the downstream conductors or busway.

The electrical industry has evolved considerably since those early GFPE requirements were introduced. IEEE 1584 now predicts the magnitude of the arcing current along with the incident energy to which a worker could be exposed while working on energized equipment. It has become clearly evident that the level of protection necessary to protect an employee is orders of magnitude greater than that required to protect equipment.

Energy reducing maintenance switches (240.67(B)(2) and 240.87(B)(3)) are excluded because energy-reducing maintenance switches are typically turned off when a worker is not working on energized equipment, whereas ground fault protection is constantly protecting the equipment, whether or not a worker is working on the energized equipment.

The Approved Equivalent Means (240.67(B)(5) and 240.87(B)(7)) are excluded because the opening times for these methods are unknown at this time.

Key Benefit

One very key benefit of this Public Comment is that when these alternate methods are utilized, it provides the consulting engineer with significantly more design options to meet the selective coordination requirements of 700.32, 701.32, and 708.54. This becomes especially important now, because it appears that GFPE will be required at 800 amperes and above, rather than 1000 amperes and above, making selective coordination even more challenging for the consulting engineer.

Conclusion

This Public Comment takes advantage of the arc-energy reduction requirements found in 240.67 and 240.87. It provides an exception for GFPE requirements whenever specific 240.67 and 240.87 methods to reduce clearing time are utilized. The methods to reduce clearing time will limit the arcing fault damage to the equipment to a level that is considerably less than currently allowed by the requirements found in 230.95(A).

Related Item

- PI 695

Submitter Information Verification

Submitter Full Name: Vincent Saporita
Organization: Saporita Consulting
Affiliation: Saporita Consulting
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jul 21 21:21:38 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected
Resolution: Arc flash protection is primarily for the protection of personnel and, secondarily, for the protection of equipment. Arc flash protection may or may not open under a ground fault condition depending on the protection scheme design. Ground fault protection is not considered in incident energy calculations as provided in NFPA 70E and IEEE 1584. Additional protection means to reduce arc flash hazards are considered in 240.67 or 240.87 and should not impact the use of ground fault protection identified in 230.95.

**Public Comment No. 1270-NFPA 70-2021 [Section No. 215.15]****215.15 Barriers.**

Barriers shall be placed in panelboards, switchboards, switchgear, and motor control centers such that no uninsulated, ungrounded busbar or

supply terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations in panelboards, switchboards, switchgear, or motor control centers

, This requirement shall be applied to the supply terminals of equipment supplied by feeder taps as covered in 240.21(B) or by transformer secondary conductors as covered in 240.21(C)

with

, in all instances where the

disconnecting device, to which the tap conductors are terminated, in the open position

equipment disconnecting means is located within the same enclosure, or is located remotely but controls no other load .

Statement of Problem and Substantiation for Public Comment

This mangled rewrite is brought to us by TerraView. It is a complete rewrite, intended entirely as an editorial improvement that attempts to completely cover the intent of the FR. It uses two sentences for clarity. The first sentence covers the intent of the rule and the equipment it applies to. The second sentence covers the supply instances where tap rules in 240.21 raise issues. It also excludes instances where the disconnecting means, although unique to the equipment in question, is remote from the enclosure. This responds fully to the correct substantiation that a supply source controlling multiple loads is less likely to be opened to provide the maintenance described. Any qualified person, and most unqualified persons as well, will turn the disconnect off if no collateral inconvenience is occasioned as a result. What follows is the suggested text in the English language:

"Barriers shall be placed in panelboards, switchboards, switchgear, and motor control centers such that no uninsulated, ungrounded supply terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations. This requirement shall be applied to the supply terminals of equipment supplied by feeder taps as covered in 240.21(B) or by transformer secondary conductors as covered in 240.21(C), in all instances where the equipment disconnecting means is located within the same enclosure, or is located remotely but controls no other load."

Related Item

- FR-7688

Submitter Information Verification

Submitter Full Name: Frederic Hartwell

Organization: Hartwell Electrical Services, Inc.

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 11 14:51:12 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8216-NFPA 70-2021](#)

Statement: Editorial changes are made to improve clarity and useability.

**Public Comment No. 919-NFPA 70-2021 [Section No. 215.15]****215 New section 408 .15– 57** Barriers.

~~Barriers- Where panelboards, switchboards, or switchgear, are equipped at the equipment with a means to disconnect the main supply, barriers shall be placed such that no uninsulated, ungrounded busbar or terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations in panelboards, switchboards, switchgear, or motor control centers supplied by feeder taps in 240.21(B) or transformer secondary conductors in 240.21(C) with the disconnecting device, to which the tap conductors are terminated, in the open position, terminations while the disconnecting device is in the open position. The barriers shall be listed or identified for use with the equipment.~~

New section 409.107 Barriers.

Where an industrial control panel is equipped at the equipment with a means to disconnect the main supply, barriers shall be placed such that no uninsulated, ungrounded busbar or terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations while the disconnecting device is in the open position. The barriers shall be listed or identified for use with the equipment.

Statement of Problem and Substantiation for Public Comment**Substantiation:**

A user-friendly NEC results in more code compliant installations. In the current text, as long as someone doesn't de-rate per the tap rules, they don't have to use the barriers. In some installations, such as perhaps 2 200 amp panelboards connected right next to a 400 amp enclosed circuit breaker service disconnect, it would be relatively inexpensive for someone who forgot to order the components to circumvent the rule by simply not downsizing the feeder wire per the tap rules. Thus, I think rather than using the tap rules as a trigger to require this, we should just require it across the board.

Aside from the substantiation, this proposed revision would have the following additional benefits:

Moving this to the construction specifications would reduce the chance of equipment not coming to jobsites without these barriers. It would increase the likelihood that even in states that won't be adopting the 2023 NEC for years, that equipment with these barriers would still end up on jobsites in those states. And it would decrease the chance of someone not being aware of the rule and not ordering proper equipment. These barriers are quite inexpensive, and as such it wouldn't seem there would be a good reason to resist every panelboard equipped with a main breaker to have them.

The moving of this rule to articles 408 and 409 will make it apply to all industrial control centers (including motor control centers), as well as panelboards, switchgear, switchboards. It would enhance the safety of installations even more, while doing so for little cost. It would also make achieving code compliance easier on the installation community, which actually tends to result in more code compliant installations.

Related Item

- Public Input No. 2878-NFPA 70-2020 [New Section after 215.12] • First Revision No. 7688-NFPA 70-2020 [New Section after 215.12]

Submitter Information Verification

Submitter Full Name: Josh Weaver

Organization:

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 04 20:12:27 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The barrier requirements for specific equipment should be located in the equipment Articles in 408 and 409.

**Public Comment No. 1717-NFPA 70-2021 [Section No. 215.18]****215.18** Surge Protection.**(A)** Surge-Protective Device.

Where a feeder supplies any of the following, a surge-protective device (SPD) shall be installed:

- (1) Dwelling units
- (2) Dormitory units
- (3) Guest rooms and guest suites of hotels and motels
- (4) Areas of nursing homes and limited-care facilities used exclusively as patient sleeping rooms

(B) Location.

An SPD shall be installed in or adjacent to the distribution equipment containing branch circuit overcurrent protective device(s) that supply the location specified in 215.18(A).

Exception: An SPD shall not be required in distribution equipment that is supplied by a feeder originating in the distribution equipment containing an SPD as required in 215.18(A) and (B).

Informational Note: Surge protection is most effective when closest to the branch circuit. Surges can be generated from multiple sources including, but not limited to, lightning, the electric utility, or utilization equipment.

(C) Type.

The SPD shall be a Type 1 or Type 2 SPD.

(D) Replacement.

Where the distribution equipment supplied by the feeder is replaced, all of the requirements of this section shall apply.

(E) Ratings.

SPDs shall have a nominal discharge current rating (In) of not less than 10kA.

Informational Note: Lead lengths of conductors to the SPD should be kept as short as possible to reduce let-through voltages.

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_147.pdf	10 CN147

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 147 appeared in the First Draft Report on First Revision No. 7689

The Correlating Committee directs the Panel to reconsider the Informational Note to 215.18(E), as it is covered by 242.24. It is directed that this action be reviewed for compliance with 4.1.1 of the NEC Style Manual. It is not necessary to repeat requirements in Chapters 1-4. If the Informational Note is retained, the Correlating Committee directs that the panel reconsider the text to remove any recommendations in an Informational Note for compliance with the NEC Style Manual, Section 3.1.3.

Related Item

- First Revision No. 7689

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC

Organization: NEC Correlating Committee

Street Address:

City:

State:

Zip:

Submittal Date: Tue Aug 17 13:58:32 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8218-NFPA 70-2021](#)

Statement: The informational note is deleted because it repeats information already covered in 242.24.

**Correlating Committee Note No. 147-NFPA 70-2021 [New Section after 215.12]****Submitter Information Verification**

Committee: NEC-P10

Submittal Date: Tue May 04 17:35:24 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs the Panel to reconsider the Informational Note to 215.18(E), as it is covered by 242.24. It is directed that this action be reviewed for compliance with 4.1.1 of the NEC Style Manual. It is not necessary to repeat requirements in Chapters 1-4. If the Informational Note is retained, the Correlating Committee directs that the panel reconsider the text to remove any recommendations in an Informational Note for compliance with the NEC Style Manual, Section 3.1.3.

First Revision No. 7689-NFPA 70-2020 [New Section after 215.12]

Ballot Results

✓ **This item has passed ballot**

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

Affirmative All

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

**Public Comment No. 1868-NFPA 70-2021 [Section No. 215.18]****215.18 Surge Protection.**

Surge protective devices shall be installed in accordance with the general requirements in Parts I and II of Article 242. In addition, surge protective devices shall be installed in feeders as required in (A), through (E).

(A) Surge-Protective Device.

Where a feeder supplies any of the following, a surge-protective device (SPD) shall be installed:

- (1) Dwelling units
- (2) Dormitory units
- (3) Guest rooms and guest suites of hotels and motels
- (4) Areas of nursing homes and limited-care facilities used exclusively as patient sleeping rooms

(B) Location.

An SPD shall be installed in or adjacent to the distribution equipment containing branch circuit overcurrent protective device(s) that supply the location specified in 215.18(A).

Exception: An SPD shall not be required in distribution equipment that is supplied by a feeder originating in the distribution equipment containing an SPD as required in 215.18(A) and (B).

Informational Note: Surge protection is most effective when closest to the branch circuit. Surges can be generated from multiple sources including, but not limited to, lightning, the electric utility, or utilization equipment.

(C) Type.

The SPD shall be a Type 1 or Type 2 SPD.

(D) Replacement.

Where the distribution equipment supplied by the feeder is replaced, all of the requirements of this section shall apply.

(E) Ratings.

SPDs shall have a nominal discharge current rating (In) of not less than 10kA.

Informational Note: ~~- Lead lengths of conductors to the SPD should be kept as short as possible to reduce let-through voltages. See 242.24 regarding limiting lengths of leads connecting SPDs~~

Statement of Problem and Substantiation for Public Comment

This comment seeks to add driving text in the beginning of the section and provide direct correlation to other installation requirements from Article 242 that are or could be applicable. It is suggested that the term listed be added to subdivision (C), however this may be redundant to existing requirements in 242.6. The last informational note seemed to be a requirement. To remove that perception, the informational note is revised to refer to 242.24.

Related Item

- FR 7689

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz

Organization: NECA

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 18 12:43:49 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: It is not necessary to state compliance with Article 242 is required based on the structure of this Code as established in 90.3. The informational note is deleted in SR-8218 (PC 1717) because it repeats information already covered in 242.24.

**Public Comment No. 1901-NFPA 70-2021 [Section No. 215.18]****215.18 Surge Protection._**

Feeder Conductors are protected by the Line Arrestors. SPDs are inappropriate for this section.

Remove entire section for 215.18

This places an inappropriate barrier to trade for contractors, espically a 10 kA requiremet.

(A) Surge-Protective Device.

Where a feeder supplies any of the following, a surge-protective device (SPD) shall be installed:

- (1) Dwelling units
- (2) Dormitory units
- (3) Guest rooms and guest suites of hotels and motels
- (4) Areas of nursing homes and limited-care facilities used exclusively as patient sleeping rooms

(B) Location._

Feeder Conductors are protected by the Line Arrestors. SPDs are inappropriate for this section.

Remove entire section for 215.18

This places an inappropriate barrier to trade for contractors, espically a 10 kA requiremet.

An SPD shall be installed in or adjacent to the distribution equipment containing branch circuit overcurrent protective device(s) that supply the location specified in 215.18(A).

Exception: An SPD shall not be required in distribution equipment that is supplied by a feeder originating in the distribution equipment containing an SPD as required in 215.18(A) and (B).

Informational Note: Surge protection is most effective when closest to the branch circuit. Surges can be generated from multiple sources including, but not limited to, lightning, the electric utility, or utilization equipment.

(C) Type.

The SPD shall be a Type 1 or Type 2 SPD.

(D) Replacement.

Where the distribution equipment supplied by the feeder is replaced, all of the requirements of this section shall apply.

(E) Ratings.

SPDs shall have a nominal discharge current rating (In) of not less than 10kA.

Informational Note: Lead lengths of conductors to the SPD should be kept as short as possible to reduce let-through voltages.

Feeder Conductors are protected by the Line Arrestors. SPDs are inappropriate for this section.

Remove entire section for 215.18

This places an inappropriate barrier to trade for contractors, espically a 10 kA requiremet.

Statement of Problem and Substantiation for Public Comment

Feeder conductors do Not require SPDs, especially a 10 kA rating for discharge current.

Remove section 215.18

Related Item

- FR 8299

Submitter Information Verification

Submitter Full Name: john gibson

Organization: Lee County Electric

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 18 15:07:03 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: No changes to the text are provided in accordance with Regulations Governing the development of NFPA Standards 4.4.4.1.

**Public Comment No. 1918-NFPA 70-2021 [Section No. 215.18(E)]**

Informational Note: Lead lengths of conductors to the SPD should be kept as short as possible to reduce let-through voltages.

FR 8299 as 215.18 (E)

– Ratings:

SPDs shall have a nominal discharge current rating (In) of not less than 10kA.

should **not** be included in the Code. This proposal does not prevent fire or promote safety.

The existing requirements of 215.18- A to D should be left as is. As drafted, the language will create confusion for the safe use of Surge Protective Devices (SPDs) also known as Transient Voltage Surge Suppressors (TVSS). This proposal will cost manufacturers millions of dollars unnecessarily as it supersedes the exciting requirements by more than 3 times the value of 3kA. This is the value accepted by ANSI/UL 1449. Voltage suppressors follow industry standards. There is nothing in the UL or IEEE standards stating a surge current value of 10kA reduces the risk of fire to equipment or premises wiring systems.

It is not feasible for the NEC to exceed the recommendations that have been well established in ANSI/UL 1449 for over 25 years. I(n) levels used in products today range from 5 amps to 3000 amps. They are serving the NEC well with no reports of insufficient I(n) levels.

This proposal does nothing to promote the safe use of voltage suppression nor conductor safety. Remove mandatory 215.18 (E) requirement.

Statement of Problem and Substantiation for Public Comment

FR 8299 as 215.18(E) should not be included in the Code. This proposal does not prevent fire or promote safety.

It is not feasible for the NEC to exceed the recommendations that have been well established in ANSI/UL 1449 for over 25 years. I(n) levels used in products today range from 5 amps to 3000 amps. They are serving the NEC well with no reports of insufficient I(n) levels.

This proposal does nothing to promote the safe use of voltage suppression nor conductor safety. Remove mandatory 215.18 (E) requirement.

Related Item

- FR 8299

Submitter Information Verification

Submitter Full Name: james moellmann

Organization: Maxivolt

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 18 16:12:18 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Rejected

Action:

Resolution: No changes to the text are provided in accordance with Regulations Governing the development of NFPA Standards 4.4.4.1. The panel does not agree with the submitter's substantiation because it is important that the surge device be installed on a circuit such that it will not be expected to discharge a surge greater than its nominal discharge rating. IEEE Std C62.41.2 characterizes the service or exterior entrance as being typically exposed to surges up to 10kA. The requirement is clear that this is a nominal discharge rating and not a short circuit current rating.



Public Comment No. 2097-NFPA 70-2021 [Section No. 215.18(E)]

(E) Ratings.

SPDs shall have a nominal discharge current rating (In) of not less than 10kA.

Informational Note: Lead lengths of conductors to the SPD should be kept as short as possible to reduce let-through voltages.

Personal Background

I have over 35 years of experience in the design, manufacture, and application of Surge Protective Devices in high voltage and low voltage applications. In addition, I have 10 years of electric utility experience in all isokeraunic locations.

At this time I am semi-retired and represent no SPD manufacturer or seller.

Surge Protective Device (SPD) Function

An SPD is a device that is designed to "shunt" high transient currents to earth (or other common bus) and while doing so limit the voltage across the SPD to an acceptable level.

The act of "limiting" the transient voltage across the SPD to an acceptable level is the ONLY function that the SPD is expected to perform.

As such, the minimum acceptable rating I(n) of 10 kA has no basis in the desired function of an SPD and is of no particular functional value for the specifying engineer and is clearly a secondary or tertiary rating.

What an SPD will NOT perform the following functions:

1) Voltage Regulation – The SPD is a transient voltage device only.

2) Survive a prolonged over-voltage surge

3) Survive a prolonged Temporary Over-Voltage (TOV)

The Electric Utility Perspective

Consider the primary electrical distribution system. The overhead lines that we see in our community all have SPDs attached to the conductors and the "normal" I(n) for overhead conductors is 5kA. An I(n) of 10kA is considered "Heavy Duty" is only needed in high isokeraunic regions, in the U.S. that is typically only in the state of Florida.

As a curious side note, the value of an I(n) of 10 kA was specifically designed, by request, for a southern Florida utility by request.

If we consider the secondary voltage of the distribution system, the service entrance voltage, we see that the electric utility industry uses a 5 kA surge arrester on the transformer. See EATON's Cooper Power Systems "Storm Trapper"™ H.E. (high energy) low-voltage distribution-class MOV surge arrester".

When an arrester fails, that is a good thing, it has given it's "life" for the protection of apparatus.

What the Industry Experiences in Real Life

In my 45 years of SPD experience, I have had the privilege of examining hundreds of failed SPDs for both product design feedback and forensic analysis for liability. The reasons for SPD failure have been TOV, loss of ground, improper voltage application, and direct lightning exposure.

I have NEVER seen an SPD fail due to a lack of a sufficient I(n).

Loss of ground or phase is the most common failure mode and an I(n) rating of 300 kA will not save that SPD from failure. This often occurs at the service entrance or service transformer.

High Voltage Systems (>1000V) – The characteristics of both surge arresters and system apparatus are well known and surge arresters are successfully applied using an I(n) of 1.5 kA to 100 kA. This is historically proven.

Low Voltage Systems (<1000V) – SPD characteristics are fairly well known but the transient response of low voltage attached equipment is completely unknown or not well defined. Surge arresters are beneficial because they do provide a level of transient protection but this has led to extreme over- or under-design resulting in wasted money or poorly performing devices. The so-called marketing "horsepower races".

Summary

1) I(n) is not a suitable rating for surge arresters in and of itself.

2) SPDs fail for reasons of sustained over-voltages at power frequency. I(n) will not help this failure mode.

3) The regional isokeraunic level MUST be considered when specifying an SPD.

4) The electric utility considers an I(n) of 5 kA sufficient for lightning protection, and has so for over 75 years.

5) At this time there is no guidance for the engineered application of surge arresters in low voltage systems. The proper specifications for surge arrester application do not yet exist.

6) A certification by one of the NRTLs is necessary and sufficient for safe application of an SPD. The application of the appropriate Type will provide safe protection at this time.

Proposed Action

Delete section 230.67(E) - Ratings.

This section will not have the intended impact on the durability of the SPD and is a premature requirement that will result in potentially costly over-design and ineffective designs.

Future Action

Open a technical discussion the Surge and TOV capabilities of connected equipment. When these values are determined, it is then appropriate to specify protective levels for the TOV limits on the voltage system topology in question. These ratings will also be based on the isokeraunic level for the installation. Then safe and effective application of an SPD can be assured. Please reference the CBEMA or ITIC curve.

A bit of Deserved Sarcasm

Another proposal would be to suggest that the minimum fuse or circuit breaker size should be 50 amperes to prevent nuisance fuse tripping and leaving people in the dark.

Statement of Problem and Substantiation for Public Comment

At this time there is not enough information to determine what ratings are required for SPDs.
The suggested minimum I(n) will only serve to frustrate the manufactures and consumers.
A certification by one of the NRTLs is necessary and sufficient for safe application of and SPD.

A review of the substantiation:

- 1) I(n) is not a suitable rating for surge arresters in and of itself.
- 2) SPDs fail for reasons of sustained over-voltages at power frequency. I(n) will not help this failure mode.
- 3) The regional isokeraunic level MUST be considered when specifying an SPD.
- 4) The electric utility considers an I(n) of 5 kA sufficient for lightning protection, and has so for over 75 years.
- 5) At this time there is no guidance for the engineered application of surge arresters in low voltage systems. The proper specifications for surge arrester application do not yet exist.

Related Item

- FR 8299

Submitter Information Verification

Submitter Full Name: Thomas Hartman

Organization: None

Affiliation: None

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 19 11:58:31 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Rejected

Action:

Resolution: The public comment does not comply with the Regulations Governing the Development of Standards in Section 4.4.4.3. The panel does not agree with the submitter's substantiation because it is important that the surge device be installed on a circuit such that it will not be expected to discharge a surge greater than its nominal discharge rating. IEEE Std C62.41.2 characterizes the service or exterior entrance as being typically exposed to surges up to 10kA. There is no substantiated direct conflict with the UL safety standard identified by the submitter.

**Public Comment No. 2197-NFPA 70-2021 [Section No. 215.18(E)]****(E) Ratings.**

SPDs shall have a nominal discharge current rating (In) of not less than 10kA.

Informational Note: Lead lengths of conductors to the SPD should be kept as short as possible to reduce let-through voltages.

Requiring such a high current rating implies this is exclusively for lightning protection. The NEC does not address lightning protection directly, only offering a cross reference to Article 242 for overvoltage protection, which is a component of a good lightning protection system. Good overvoltage protection is a trade off with high current protection as the components in surge protection devices have a linear relationship between current and let through voltage. This requirement for such a high current rating will arbitrarily exclude the use of many listed Type 2 devices whose purpose is good overvoltage protection. This requirement will actually degrade the performance of the overvoltage protection. There is no technical reason for this requirement, only a commercial one.

Statement of Problem and Substantiation for Public Comment

The NEC arbitrarily setting performance specifications for equipment at all locations does not improve safety and may actually degrade performance.

Related Public Comments for This Document

<u>Related Comment</u>	<u>Relationship</u>
Public Comment No. 2178-NFPA 70-2021 [Section No. 230.67(E)]	
<u>Related Item</u>	
• FR 8299	

Submitter Information Verification

Submitter Full Name: Brett Board
Organization: Blue Line Logic
Street Address:
City:
State:
Zip:
Submittal Date: Thu Aug 19 16:22:45 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected
Resolution: The public comment does not comply with the Regulations Governing the Development of Standards in Section 4.4.4.3. The panel does not agree with the submitter's substantiation because it is important that the surge device be installed on a circuit such that it will not be expected to discharge a surge greater than its nominal discharge rating. IEEE Std C62.41.2 characterizes the service or exterior entrance as being typically exposed to surges up to 10kA. There is no substantiated direct conflict with the UL safety standard identified by the submitter.

**Public Comment No. 2211-NFPA 70-2021 [Section No. 215.18(E)]****(E) Ratings.**

SPDs shall have a nominal discharge current rating (In) of not less than 10kA.

Informational Note: Lead lengths of conductors to the SPD should be kept as short as possible to reduce let-through voltages.

[This conflict with UL standards.](#)

Statement of Problem and Substantiation for Public Comment

This section is in conflict with UL standards.

Related Public Comments for This Document

<u>Related Comment</u>	<u>Relationship</u>
<u>Public Comment No. 2206-NFPA 70-2021 [Section No. 215.18 (E)]</u>	FR8299

Related Item

- Frist Draft

Submitter Information Verification

Submitter Full Name: John Gauthier

Organization: [Not Specified]

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 19 16:54:17 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The public comment does not comply with the Regulations Governing the Development of Standards in Section 4.4.4.3. The panel does not agree with the submitter's substantiation because it is important that the surge device be installed on a circuit such that it will not be expected to discharge a surge greater than its nominal discharge rating. IEEE Std C62.41.2 characterizes the service or exterior entrance as being typically exposed to surges up to 10kA. There is no substantiated direct conflict with the UL safety standard identified by the submitter.

**Public Comment No. 582-NFPA 70-2021 [Section No. 215.18(E)]**

~~(E)– Ratings.~~

~~SPDs shall have a nominal discharge current rating (In) of not less than 10kA.~~

~~Informational Note: Lead lengths of conductors to the SPD should be kept as short as possible to reduce let-through voltages.~~

Statement of Problem and Substantiation for Public Comment

An interrupting rating indicates the short-circuit current that an overcurrent protective device can safely interrupt under standard test conditions. (An overcurrent protective device is not necessarily functional after the test.)

A short-circuit current rating indicates how much short-circuit current a component, such as a motor starter, can carry while an overcurrent protective device clears a short-circuit, under standard test conditions. (The component is not necessarily functional after the test.)

A Nominal Discharge Current is the amount of short-circuit current that the test circuit can deliver to the SPD during 15 tests that are 20 microseconds each, under standard test conditions. (The SPD must still function properly after the 15th test.)

To make this even more confusing, the SPD also has an I_{max} rating, which is based upon just one 20 microsecond surge test. (The SPD is allowed to be degraded in this test and can only withstand a limited number of these surges before it needs to be replaced.)

As written, this First Revision will confuse users, specifiers, and inspectors who are familiar with interrupting ratings and short-circuit current ratings. It will encourage users, specifiers, and inspectors to call out for a Nominal Discharge Current that is equal to or greater than the available short-circuit current, thinking that doing so will assure compliance with 110.3(B). Unfortunately, as can be seen in the practical descriptions above, it is comparing apples and oranges. The CMP is encouraged to remove this First Revision requirement that will certainly mislead users, specifiers, and inspectors.

Related Item

• FR 7689 • FR 7739 • FR 8299 • FR 7707 • PC 522 • PC 583

Submitter Information Verification

Submitter Full Name: Vincent Saporita

Organization: Saporita Consulting

Affiliation: Saporita Consulting

Street Address:

City:

State:

Zip:

Submittal Date: Sun Aug 01 12:11:30 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: While the nominal discharge rating is not directly related to available fault current, it is important that the surge device be installed on a circuit such that it will not be expected to discharge a surge greater than its nominal discharge rating. IEEE Std C62.41.2 characterizes the service entrance as being typically exposed to surges up to 10kA.

**Public Comment No. 848-NFPA 70-2021 [Section No. 225.1]****225.1 Scope.**

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

Informational Note: See ANSI/IEEE C2-2017, *National Electrical Safety Code*, for additional information on wiring over 1000 volts.

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_148.pdf	70_CN148

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 148 appeared in the First Draft Report on First Revision No. 7899.

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and the Correlating Committee accepts the panel action. The Panel should reconsider the wording of the Informational Note with regard to the use of the term "wiring" vs. "installation" since the referenced document covers more than simply wiring.

Related Item

- First Revision No. 7899

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 04 14:31:42 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8472-NFPA 70-2021](#)

Statement: This action will combine all the requirements under the purview of CMP-10 for feeders, outside branch circuits and feeders, and services over 1000 Vac or 1500 Vdc into the new Article 235. This action is to correlate with the actions taken by CMP-2 on PC-285 which created the new Article 235.

The corresponding sections from Articles 215, 225, and 230 will be deleted as the requirements have been relocated to the new Article 235.

The edition year ANSI/NETA ATS was removed so that it is automatically the latest edition as outlined in 90.1(C) pursuant to PC-853.

CMP-10 is requesting the correlating committee review the changes in scope of Articles 225 and 230. The scope change to Article 215 is addressed by SR-8369.

**Correlating Committee Note No. 148-NFPA 70-2021 [Section No. 225.1]****Submitter Information Verification**

Committee: NEC-P10

Submittal Date: Tue May 04 17:40:15 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and the Correlating Committee accepts the panel action. The Panel should reconsider the wording of the Informational Note with regard to the use of the term "wiring" vs. "installation" since the referenced document covers more than simply wiring.

First Revision No. 7899-NFPA 70-2020 [Section No. 225.1]

Ballot Results

✓ **This item has passed ballot**

12 Eligible Voters

0 Not Returned

12 Affirmative All

0 Affirmative with Comments

0 Negative with Comments

0 Abstention

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Johnston, Michael J.

Kendall, David H.

Kovacik, John R.

Manche, Alan

McDaniel, Roger D.

Porter, Christine T.

Williams, David A.

**Public Comment No. 1807-NFPA 70-2021 [Section No. 225.3]****225.3 Other Articles.**

Application of other articles, including additional requirements to specific cases of equipment and conductors, is shown in Table 225.3.

Table 225.3 Other Articles

<u>Equipment/Conductors</u>	<u>Article</u>
Branch circuits	210
Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits	725
-	-
-	-
Conductors for general wiring	310
Electrically driven or controlled irrigation machines	675
Electric signs and outline lighting	600
Feeders	215
Fire alarm systems	760
Fixed outdoor electric deicing and snow-melting equipment	426
- <u>Flexible bus systems</u>	- <u>371</u>
Grounding and bonding	250
Hazardous (classified) locations	500
Hazardous (classified) locations — specific	510
Marinas and boatyards	555
Medium-voltage conductors and cable	311
Messenger-supported wiring	396
Mobile homes, manufactured homes, and mobile home parks	550
Open wiring on insulators	398
Over 1000 volts, general	490
Overcurrent protection	240
-	-
Services	230
Solar photovoltaic systems	690
Swimming pools, fountains, and similar installations	680
Use and identification of grounded conductors	200

Additional Proposed Changes

<u>File Name</u>	<u>Description</u>	<u>Approved</u>
PC_for_225.3_Draft_3.docx	text in Word file	

Statement of Problem and Substantiation for Public Comment

This public comment provides a correlating addition to recognize Flexible Bus Systems as one of the available wiring methods listed in 225.3 for outside feeders. The only change being made is to include Flexible Bus System in the list for 225.3. No other changes are intended. Attached to this PC is a clean file to show the intended changes.

Flexible Bus Systems are included in a new Article 371 which was accepted by CMP-8 as FR 7621 in the first draft stage. The accepted article text requires the Flexible Bus System to be listed as a system. There are two UL Outlines of Investigation in process to provide the listing for the Flexible Insulated Bus and the Flexible Bus System. Section 371.10(1) in the article permits the Flexible Bus System to be used as a wiring method for services, feeders and branch circuits. Section 225.3 is a list of other articles that may be used as outside feeder wiring methods as detailed in the referenced wiring method articles and this addition is to ensure the list is complete.

Related Item

- PI 3786

Submitter Information Verification

Submitter Full Name: Ward Judson
Organization: nVent Electric
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 17 21:50:06 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected
Resolution: Adding wiring methods to the table does not improve useability of the NEC. If one wiring method is added, then all would have to be added.

PC Code Text:

225.3 Other Articles. Application of other articles, including additional requirements to specific cases of equipment and conductors, is shown in Table 225.3.

Table 225.3 Other Articles

<u>Equipment/Conductors</u>	<u>Article</u>
Branch circuits	210
Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits	725
Communications circuits	805
Community antenna television and radio distribution systems	820
Conductors for general wiring	310
Electrically driven or controlled irrigation machines	675
Electric signs and outline lighting	600
Feeders	215
Fire alarm systems	760
Fixed outdoor electric deicing and snow-melting equipment	426
<u>Flexible bus systems</u>	<u>371</u>
Grounding and bonding	250
Hazardous (classified) locations	500
Hazardous (classified) locations — specific	510
Marinas and boatyards	555
Medium-voltage conductors and cable	311
Messenger-supported wiring	396
Mobile homes, manufactured homes, and mobile home parks	550
Open wiring on insulators	398
Over 1000 volts, general	490
Overcurrent protection	240
Radio and television equipment	810
Services	230
Solar photovoltaic systems	690
Swimming pools, fountains, and similar installations	680
Use and identification of grounded conductors	200

Substantiation:

PC Substantiation

This public comment provides a correlating addition to recognize Flexible Bus Systems as one of the available wiring methods listed in 225.3 for outside feeders. The only change being made is to include Flexible Bus System in the list for 225.3. No other changes are intended. Attached to this PC is a clean file to show the intended changes.

Flexible Bus Systems are included in a new Article 371 which was accepted by CMP-8 as FR 7621 in the first draft stage. The accepted article text requires the Flexible Bus System to be listed as a system. There are two UL Outlines of Investigation in process to provide the listing for the Flexible Insulated Bus and the Flexible Bus System. Section 371.10(1) in the article permits the Flexible Bus System to be used as a wiring method for services, feeders and branch circuits. Section 225.3 is a list of other articles that may be used as outside feeder wiring methods as detailed in the referenced wiring method articles and this addition is to ensure the list is complete.

**Public Comment No. 851-NFPA 70-2021 [Section No. 225.3]****225.3 Other Articles.**

Application of other articles, including additional requirements to specific cases of equipment and conductors, is shown in Table 225.3.

Table 225.3 Other Articles

<u>Equipment/Conductors</u>	<u>Article</u>
Branch circuits	210
Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits	725
Conductors for general wiring	310
Electrically driven or controlled irrigation machines	675
Electric signs and outline lighting	600
Feeders	215
Fire alarm systems	760
Fixed outdoor electric deicing and snow-melting equipment	426
Grounding and bonding	250
Hazardous (classified) locations	500
Hazardous (classified) locations — specific	510
Marinas and boatyards	555
Medium-voltage conductors and cable	311
Messenger-supported wiring	396
Mobile homes, manufactured homes, and mobile home parks	550
Open wiring on insulators	398
Over 1000 volts, general	490
Overcurrent protection	240
Services	230
Solar photovoltaic systems	690
Swimming pools, fountains, and similar installations	680
Use and identification of grounded conductors	200

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_149.pdf	70_CN149

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 149 appeared in the First Draft Report on First Revision No. 7691.

The Correlating Committee acknowledges the Panel's request to delete Table 225.3 and the decision to retain or delete the Table is within the purview of the Panel. If the Panel decides to keep the table then it shall be reviewed for compliance with 4.1.1 and 4.1.4 of the NEC Style Manual. Panels shall always be mindful of the structure of the document as specified in 90.3 when contemplating the inclusion of a reference to other requirements.

Related Item

- First Revision No. 7691

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 04 14:36:46 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected
Resolution: Table 225.3 is retained because it adds useability to the NEC by providing helpful cross references.

**Correlating Committee Note No. 149-NFPA 70-2021 [Section No. 225.3]****Submitter Information Verification**

Committee: NEC-P10

Submittal Date: Tue May 04 17:43:16 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee acknowledges the Panel's request to delete Table 225.3 and the decision to retain or delete the Table is within the purview of the Panel. If the Panel decides to keep the table then it shall be reviewed for compliance with 4.1.1 and 4.1.4 of the NEC Style Manual. Panels shall always be mindful of the structure of the document as specified in 90.3 when contemplating the inclusion of a reference to other requirements.

First Revision No. 7691-NFPA 70-2020 [Section No. 225.3]

Ballot Results

✓ **This item has passed ballot**

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

Affirmative All

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

**Public Comment No. 963-NFPA 70-2021 [Section No. 225.22]****225.22 Raceways on Exterior Surfaces of Buildings or Other Structures.**

Raceways on exteriors of buildings or other structures shall be arranged to drain and shall be listed or approved for use in wet locations. One or more weep holes created in the bottom of exterior or wet location raceways, shall be permitted to serve as a drain method in other than classified locations, in lieu of fittings, enclosures, routing, etc.

Statement of Problem and Substantiation for Public Comment

Not all Code users understand that raceways can be drilled to provide weep holes. Yet raceways should not drain into enclosures, per 314.15, "314.15 Damp or Wet Locations. In damp or wet locations, boxes, conduit bodies, outlet box hoods, and fittings shall be placed or equipped so as to prevent moisture from entering" so mentioning enclosures provided with weep holes intended primarily to remove condensation does not address Inspector Feck's concern as represented by his observation. The testimony in PI 1455 underscores the need to arrange for raceways themselves to drain--but not into enclosures.

Related Public Comments for This Document**Related Comment****Relationship**

Public Comment No. 1012-NFPA 70-2021 [Section No. 230.53]

Related Item

• PI 999 • PI1455 • PI 1012

Submitter Information Verification

Submitter Full Name: David Shapiro

Organization: Safety First Electrical

Affiliation: myself; Pat Bahn of Washington, D.C.; and Ken Lederman of Conway, Mass.

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 05 12:19:02 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: Where water is potentially an issue, an enclosure with weep holes must be installed. This is a design issue and should not be addressed in this code.

**Public Comment No. 263-NFPA 70-2021 [Section No. 225.27]****225.27 Raceway Seal.**

Where a raceway enters a building or structure from outside, it shall be sealed in accordance with 300.5(G) ~~and or~~ 300.7(A), as applicable . Spare or unused raceways shall also be sealed. Sealants shall be identified for use with cable insulation, conductor insulation, bare conductor, shield, or other components.

Statement of Problem and Substantiation for Public Comment

300.5G and 300.7A are applicable to 2 different things. One is for condensation due to temperature change and the other is more concerned with actual water buildup in conduits that can occur in underground installations. Whether to seal per 300.5G or 300.7A depends on the specifics of the circumstance. Thus, OR seems to be more appropriate than AND.

Related Item

- First Revision No. 7696-NFPA 70-2020 [Section No. 225.27]

Submitter Information Verification

Submitter Full Name: Josh Weaver

Organization: Josh Weaver

Street Address:

City:

State:

Zip:

Submittal Date: Sun Jul 18 17:03:42 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: One or both of the conditions described in 300.5(G) and 300.7(A) can occur so compliance with both is required.

**Public Comment No. 1308-NFPA 70-2021 [Section No. 225.31]****225.31** Disconnecting Means.**(A)** General.

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

(B) Location.

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

Exception No. 1: For installations under single management, where documented safe switching procedures are established and maintained, and where the installation is monitored by qualified individuals, the disconnecting means shall be permitted to be located elsewhere on the premises.

Exception No. 2: For buildings or other structures qualifying under 685.1, the disconnecting means shall be permitted to be located elsewhere on the premises.

Exception No. 3: For towers or poles used as lighting standards, the disconnecting means shall be permitted to be located elsewhere on the premises.

Exception No. 4: For poles or similar structures used only for support of signs installed in accordance with 600.1, the disconnecting means shall be permitted to be located elsewhere on the premises.

Statement of Problem and Substantiation for Public Comment

The first draft shows 225.32 being deleted. Please say it ain't so.

Related Item

- FR 7703

Submitter Information Verification

Submitter Full Name: Ryan Jackson

Organization: Ryan Jackson

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 11 17:14:56 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: No changes to the text are provided in accordance with Regulations Governing the development of NFPA Standards 4.4.4.1.

**Public Comment No. 965-NFPA 70-2021 [Section No. 225.39(D)]**

(D) All Others.

For all other installations, the feeder or branch-circuit disconnecting means shall have a rating of not less than 60 amperes.

Statement of Problem and Substantiation for Public Comment

I urge retention of the present language even if a Comment to exempt 3-phase installations is put into adoptable language. Three-phase power typically is selected because the loads are larger, and single-phase installation would be less efficient. AHJs have the authority to make exceptions in cases that warrant doing so.

Related Item

• PI 1201

Submitter Information Verification

Submitter Full Name: David Shapiro

Organization: Safety First Electrical

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 05 13:05:35 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: No changes to the text are provided in accordance with Regulations Governing the Development of NFPA Standards 4.4.4.1.



Public Comment No. 1548-NFPA 70-2021 [Section No. 225.41]

225.41– Emergency Disconnects.

For one- and two-family dwelling units, an emergency disconnecting means shall be installed.

(A)– General.

(1)– Location.

The disconnecting means shall be installed in a readily accessible outdoor location on or within sight of the dwelling unit.

(2)– Rating.

The disconnecting means shall have a short-circuit current rating equal to or greater than the available fault current.

(3)– Grouping.

If more than one disconnecting means is provided, they shall be grouped.

(B)– Identification of Other Emergency Disconnects.

Where emergency disconnects are installed for other systems that are not located adjacent to the emergency disconnect required by this section, a plaque or directory identifying the location of all emergency disconnects shall be located adjacent to the disconnecting means required by this section.

(C)– Marking.

The disconnecting means shall be marked as EMERGENCY-DISCONNECT.

Markings shall comply with 110.21(B) and all of the following:

(1) The marking or labels shall be located on the outside front of the disconnect enclosure with red background and white text.

(2) The letters shall be least 13 mm ($\frac{1}{2}$ in.) high.

Statement of Problem and Substantiation for Public Comment

This proposed section for an dwelling unit emergency disconnect for a feeder is excessive and unnecessary. The proposed revisions of 230.85 call for the emergency disconnect to be "installed in a readily accessible outdoor location on or within sight of the dwelling unit." The emergency disconnect for the service would be required to be on the exterior of the dwelling unit or within 50 ft of the dwelling unit and visible from the dwelling unit. This excessive requirement would call for and emergency disconnect meeting the requirements of 230.85 or an emergency disconnect on a pole or structure within 50 ft (and visible) of the dwelling unit and ANOTHER emergency disconnect at the dwelling unit (both visible of each other). How many emergency disconnects does the firefighting community need?

Related Item

• PI 2913 • FR 7706

Submitter Information Verification

Submitter Full Name: L. Keith Lofland

Organization: IAEI

Affiliation: None

Street Address:

City:

State:

Zip:

Submittal Date: Mon Aug 16 13:10:20 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: FR 7770 revised 230.85 and added an exception to (A)(1) that addresses the submitter's concern.

**Public Comment No. 1841-NFPA 70-2021 [Section No. 225.41(A)(1)]**

(1) Location.

The disconnecting means shall be installed in a readily accessible outdoor location- ~~on or within sight of the dwelling unit~~ .

Statement of Problem and Substantiation for Public Comment

Remove "on or within sight of the dwelling unit"

Basically, FR-7706 item (A)(1) negates section 225.32 Location for dwelling units.

When a remote service or single distribution point is installed on the property and feeder is run under the slab into an equipment room inside the dwelling meeting section 230.6, or a feeder using a conduit body and nipple in the back of a panelboard inside the nearest the point of entrance of the conductors into a dwelling unit, this is no longer allowed because of FR-7706 item (A)(1).

Now a disconnect will be installed either within 50 feet and within sight or mounted directly on the dwelling.

It seems likely and possible a first respond could, even in an emergency situation, find a single service point on the property which is already required by 230.85.

In removing 230.85(A)(1), a service disconnect is still proved for the first responder.

Considering there is no clear panel statement as to why the emergency disconnect needs to be visible and not more than 50 ft distant from the dwelling, why is there is a problem with using section 225.32 scenarios described in the first paragraph.

PI-2019 "MAY BE difficult for first responders"

Is there a fact-finding report, recognized technical validation, or other actual documentation to corroborate "MAY BE difficult for first responders?"

FR-7706 item (A)(1) appears that this may also be modifying 90.1 Purpose. (B) Adequacy.
"but not necessarily convenient"

At a minimum this portion of the first revision FR-7706 item (A)(1) should be put on hold for further contemplation (unintended consequences.) Such as NEC section 210.8(F)

Related Item

- FR-7706 PI-2019

Submitter Information Verification

Submitter Full Name: Gary Jones

Organization: Self

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 18 10:37:51 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The location is established to ensure a first responder can easily disconnect power.

**Public Comment No. 878-NFPA 70-2021 [Section No. 225.41(A)(1)]****(1) Location.**

The disconnecting means shall be installed in a readily accessible outdoor location on or within sight of the dwelling unit. The disconnecting means shall be lockable in the closed position.

Statement of Problem and Substantiation for Public Comment

There are many locations where it may not be safe, or wise, to install an unprotected disconnecting means at the service entrance, outside the house. In the winter, especially, an inadvertent prank of shutting off this disconnect could result in significant property damage. If this requirement remains, then I think at a minimum we should require it be lockable in the closed position. The first responders can always cut a lock without any significant problem or delay in response time and that should help assure the reliability of the connection otherwise.

Related Item

- First Revision No. 7706

Submitter Information Verification

Submitter Full Name: Richard Holub

Organization: The DuPont Company, Inc.

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 04 15:28:48 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: Locking in the closed (on) position is not currently prohibited. Introducing a mandatory requirement is not substantiated.



Public Comment No. 1903-NFPA 70-2021 [Section No. 225.42]

225.42 Surge Protection._

Feeder Conductors are protected by the Line Arrestors. SPDs are inappropriate for this section.

Remove entire section for 225.42

This places an inappropriate barrier to trade for contractors, espically a 10 kA requiremet.

(A) Surge-Protective Device.

Where a feeder supplies any of the following, a surge-protective device (SPD) shall be installed:

- (1) Dwelling units
- (2) Dormitory units
- (3) Guest rooms and guest suites of hotels and motels
- (4) Areas of nursing homes and limited-care facilities used exclusively as patient sleeping rooms

(B) Location.

An SPD shall be installed in or adjacent to the distribution equipment containing branch circuit overcurrent protective device(s) that supply the location specified in 225.42(A).

Exception: An SPD shall not be required in distribution equipment that is supplied by a feeder originating in the distribution equipment containing an SPD as required in 225.42(A) and (B).

Informational Note: Surge protection is most effective when closest to the branch circuit. Surges can be generated from multiple sources including, but not limited to, lightning, the electric utility, or utilization equipment.

(C) Type._

Feeder Conductors are protected by the Line Arrestors. SPDs are inappropriate for this section.

Remove entire section for 225.42

This places an inappropriate barrier to trade for contractors, espically a 10 kA requiremet.

The SPD shall be a Type 1 or Type 2 SPD.

(D) Replacement.

Where the distribution equipment supplied by the feeder is replaced, all of the requirements of this section shall apply.

(E) Ratings.

Feeder Conductors are protected by the Line Arrestors. SPDs are inappropriate for this section.

Remove entire section for 225.42

This places an inappropriate barrier to trade for contractors, espically a 10 kA requiremet.

SPDs shall have a nominal discharge current rating (I_n) of not less than 10kA.

Informational Note: Lead lengths of conductors to the SPD should be kept as short as possible to reduce let-through voltages.

Statement of Problem and Substantiation for Public Comment

Feeder Conductors are protected by the Line Arrestors. SPDs are inappropriate for this section.

Remove entire section for 215.18

This places an inappropriate barrier to trade for contractors, espically a 10 kA requiremet,

Related Item

- FR8299

Submitter Information Verification

Submitter Full Name: john gibson

Organization: Lee County Electric

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 18 15:19:36 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: No changes to the text are provided in accordance with Regulations Governing the development of NFPA Standards 4.4.4.1.



Public Comment No. 1916-NFPA 70-2021 [Section No. 225.42]

225.42 Surge Protection.

225.42 (E) should not be included in the Code. This proposal does not prevent fire or promote safety. The existing requirements of 225.42- A to D should be left as is. As drafted, the language will create confusion for the safe use of Surge Protective Devices (SPDs), also known as Transient Voltage Surge Suppressors (TVSS). This proposal will cost manufacturers millions of dollars unnecessarily as it supersedes the exciting requirements by more than 3 times the value of 3kA. This is the value accepted by ANSI/UL 1449. Voltage suppressors follow industry standards. There is nothing in the UL or IEEE standards stating a surge current value of 10kA reduces the risk of fire to equipment or premises wiring systems.

(A) Surge-Protective Device.

Where a feeder supplies any of the following, a surge-protective device (SPD) shall be installed:

- (1) Dwelling units
- (2) Dormitory units
- (3) Guest rooms and guest suites of hotels and motels
- (4) Areas of nursing homes and limited-care facilities used exclusively as patient sleeping rooms

(B) Location.

An SPD shall be installed in or adjacent to the distribution equipment containing branch circuit overcurrent protective device(s) that supply the location specified in 225.42(A).

Exception: An SPD shall not be required in distribution equipment that is supplied by a feeder originating in the distribution equipment containing an SPD as required in 225.42(A) and (B).

Informational Note: Surge protection is most effective when closest to the branch circuit. Surges can be generated from multiple sources including, but not limited to, lightning, the electric utility, or utilization equipment.

(C) Type.

The SPD shall be a Type 1 or Type 2 SPD.

(D) Replacement.

Where the distribution equipment supplied by the feeder is replaced, all of the requirements of this section shall apply.

(E) Ratings.

SPDs shall have a nominal discharge current rating (I_n) of not less than 10kA.

Informational Note: Lead lengths of conductors to the SPD should be kept as short as possible to reduce let-through voltages.

(E) Ratings.

SPDs shall have a nominal discharge current rating (I_n) of not less than 10kA.

225.42(E) should not be included in the Code. This proposal does not prevent fire or promote safety.

The existing requirements of 225.42- A to D should be left as is. As drafted, the language will create confusion for the safe use of Surge Protective Devices (SPDs) also known as Transient Voltage Surge Suppressors (TVSS). This proposal will cost manufacturers millions of dollars unnecessarily as it supersedes the exciting requirements by more than 3 times the value of 3kA. This is the value accepted by ANSI/UL 1449. Voltage suppressors follow industry standards. There is nothing in the UL or IEEE standards stating a surge current value of 10kA reduces the risk of fire to equipment or premises wiring systems.

It is not feasible for the NEC to exceed the recommendations that have been well established in ANSI/UL 1449 for over 25 years. $I(n)$ levels used in products today range from 5 amps to 3000 amps. They are serving the NEC well with no reports of insufficient $I(n)$ levels. A 10,000 amp level is not justified as product testing is only done up to the 3kA value. There have been no reports of inappropriate kA levels presented in this proposal. Voltage suppression devices are successfully used and installed at the existing levels of $I(n)$. To introduce this new requirement will be a misstep.

This proposal does nothing to promote the safe use of voltage suppression.

The requirement for 225.42 (E) should be removed.

Statement of Problem and Substantiation for Public Comment

225.42 (E) should not be included in the Code. This proposal does not prevent fire or promote safety. The existing requirements of 225.42- A to D should be left as is.

It is not feasible for the NEC to exceed the recommendations that have been well established in ANSI/UL 1449 for over 25 years. The requirement in 225.42 (E) should be removed.

Related Item

- FR 8299

Submitter Information Verification

Submitter Full Name: james moellmann

Organization: Maxivolt

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 18 16:01:15 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution:

No changes to the text are provided in accordance with Regulations Governing the development of NFPA Standards 4.4.4.1.

**Public Comment No. 1560-NFPA 70-2021 [Section No. 225.42(A)]****(A) Surge-Protective Device.**

Where a feeder supplies any of the following, a surge-protective device (SPD) shall be installed:

- (1) ~~Dwelling units.~~ Feeders for dwelling units meeting the requirements of 310.12(B)
- (2) Dormitory units
- (3) Guest rooms and guest suites of hotels and motels
- (4) Areas of nursing homes and limited-care facilities used exclusively as patient sleeping rooms

Statement of Problem and Substantiation for Public Comment

Would a dwelling unit feeder supplying two or three AC units need surge protection under this proposed rule? It would seem to be feeders that supply several branch circuit loads of a dwelling unit that is being targeted here. If that be the case, a feeder that supplies the entire load of a dwelling unit [as described at 310.12(B)] would need to be identified here. As proposed in the First Draft, surge protection would be required for any and all dwelling unit feeders [regardless of the load(s) served].

Related Item

- FR 7707

Submitter Information Verification

Submitter Full Name: L. Keith Lofland

Organization: IAEI

Affiliation: None

Street Address:

City:

State:

Zip:

Submittal Date: Mon Aug 16 14:06:09 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The language establishes that an outside feeder supplying a dwelling unit is required to have surge protection.

**Public Comment No. 1346-NFPA 70-2021 [Section No. 225.42(B)]****(B) Location.**

An SPD shall be installed in or adjacent to the distribution equipment containing branch circuit overcurrent protective device(s) that supply the location specified in 225.42(A).

Exception: An additional SPD shall not be required in ~~distribution equipment that is supplied by a feeder originating in the distribution equipment containing an SPD as required in~~ where all feeders serving the locations in 225.42(A) are protected on their supply side by an SPD meeting the requirements of 225.42(A C) and (B E).

Informational Note: Surge protection is most effective when closest to the branch circuit. Surges can be generated from multiple sources including, but not limited to, lightning, the electric utility, or utilization equipment.

Statement of Problem and Substantiation for Public Comment

This is an entirely editorial comment directed at removing what is effectively a circular reference to 225.42(A) and (B). It also addresses instances where the feeders and/or disconnects are plural.

Related Item

- FR-7707

Submitter Information Verification

Submitter Full Name: Frederic Hartwell

Organization: Hartwell Electrical Services, Inc.

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 12 10:39:10 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8379-NFPA 70-2021](#)

Statement: The text is revised to indicate that the SPD is intended to protect the branch circuits and should not be installed remotely from the distribution equipment supplying branch circuits in the locations specified in 225.42(A). The current exception in 230.67 achieves the goals of this exception by not requiring the SPD at the service when surge protection is provided at each next level distribution equipment downstream towards the load. The requirements of 225.42(A) require SPD for distribution panels that serve the locations in 225.42(A), and subpanels within these spaces would not require additional SPD.

**Public Comment No. 1459-NFPA 70-2021 [Section No. 225.42(B)]****(B) Location.**

An SPD shall be installed in or adjacent to the distribution equipment containing branch circuit overcurrent protective device(s) that supply the location specified in 225.42(A).

Exception: An SPD shall not be required in distribution equipment that is supplied by a feeder originating in the distribution equipment containing an SPD as required in 225.42(A) and (B).

Informational Note: Surge protection is most effective when closest to the branch circuit. Surges can be generated from multiple sources including, but not limited to, lightning, the electric utility, or utilization equipment.

Statement of Problem and Substantiation for Public Comment

Remove the exception. The exception defeats the purpose of the new requirement.

The committee statement says in part: "The addition of surge protection to 225.42 addresses the proper protection of areas served by outdoor feeders that are extended distances away from services that can result in limited surge protection."

Any of the area's in 225.42(A) may be served by a feeder from distribution equipment other than service equipment.

This exception also contradicts the requirement in 230.67(B) exception, that an SPD be installed at each next level of distribution downstream towards the load if not installed at the service equipment.

The information note states that: "Surge protection is most effective when closest to the branch circuit."

Related Item

- FR No. 7707

Submitter Information Verification

Submitter Full Name: Peter Diamond

Organization: Town of Norfolk Massachusetts

Affiliation: Massachusetts Wire Inspector Association

Street Address:

City:

State:

Zip:

Submittal Date: Fri Aug 13 15:59:50 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8379-NFPA 70-2021

Statement: The text is revised to indicate that the SPD is intended to protect the branch circuits and should not be installed remotely from the distribution equipment supplying branch circuits in the locations specified in 225.42(A). The current exception in 230.67 achieves the goals of this exception by not requiring the SPD at the service when surge protection is provided at each next level distribution equipment downstream towards the load. The requirements of 225.42(A) require SPD for distribution panels that serve the locations in 225.42(A), and subpanels within these spaces would not require additional SPD.



Public Comment No. 2104-NFPA 70-2021 [Section No. 225.42(E)]

(E) Ratings.

SPDs shall have a nominal discharge current rating (I_n) of not less than 10kA.

Informational Note: Lead lengths of conductors to the SPD should be kept as short as possible to reduce let-through voltages.

Personal Background

I have over 35 years of experience in the design, manufacture, and application of Surge Protective Devices in high voltage and low voltage applications. In addition, I have 10 years of electric utility experience in all isokeraunic locations.

At this time I am semi-retired and represent no SPD manufacturer or seller.

Surge Protective Device (SPD) Function

An SPD is a device that is designed to "shunt" high transient currents to earth (or other common bus) and while doing so limit the voltage across the SPD to an acceptable level.

The act of "limiting" the transient voltage across the SPD to an acceptable level" is the ONLY function that the SPD is expected to perform.

As such, the minimum acceptable rating $I(n)$ of 10 kA has no basis in the desired function of an SPD and is of no particular functional value for the specifying engineer and is clearly a secondary or tertiary rating.

What an SPD will NOT perform the following functions:

1) Voltage Regulation – The SPD is a transient voltage device only.

2) Survive a prolonged over-voltage surge

3) Survive a prolonged Temporary Over-Voltage (TOV)

The Electric Utility Perspective

Consider the primary electrical distribution system. The overhead lines that we see in our community all have SPDs attached to the conductors and the "normal" $I(n)$ for overhead conductors is 5kA. An $I(n)$ of 10kA is considered "Heavy Duty" is only needed in high isokeraunic regions, in the U.S. that is typically only in the state of Florida.

As a curious side note, the value of an $I(n)$ of 10 kA was specifically designed, by request, for a southern Florida utility by request.

If we consider the secondary voltage of the distribution system, the service entrance voltage, we see that the electric utility industry uses a 5 kA surge arrester on the transformer. See EATON's Cooper Power Systems "Storm Trapper"™ H.E. (high energy) low-voltage distribution-class MOV surge arrester.

When an arrester fails, that is a good thing, it has given it's "life" for the protection of apparatus.

What the Industry Experiences in Real Life

In my 45 years of SPD experience, I have had the privilege of examining hundreds of failed SPDs for both product design feedback and forensic analysis for liability. The reasons for SPD failure have been TOV, loss of ground, improper voltage application, and direct lightning exposure.

I have NEVER seen an SPD fail due to a lack of a sufficient $I(n)$.

Loss of ground or phase is the most common failure mode and an $I(n)$ rating of 300 kA will not save that SPD from failure. This often occurs at the service entrance or service transformer.

High Voltage Systems (>1000V) – The characteristics of both surge arresters and system apparatus are well known and surge arresters are successfully applied using an $I(n)$ of 1.5 kA to 100 kA. This is historically proven.

Low Voltage Systems (<1000V) – SPD characteristics are fairly well known but the transient response of low voltage attached equipment is completely unknown or not well defined. Surge arresters are beneficial because they do provide a level of transient protection but this has led to extreme over- or under-design resulting in wasted money or poorly performing devices. The so-called marketing "horsepower races".

Summary

1) $I(n)$ is not a suitable rating for surge arresters in and of itself.

2) SPDs fail for reasons of sustained over-voltages at power frequency. $I(n)$ will not help this failure mode.

3) The regional isokeraunic level MUST be considered when specifying an SPD.

4) The electric utility considers an $I(n)$ of 5 kA sufficient for lightning protection, and has so for over 75 years.

5) At this time there is no guidance for the engineered application of surge arresters in low voltage systems. The proper specifications for surge arrester application do not yet exist.

6) A certification by one of the NRTLs is necessary and sufficient for safe application of an SPD. The application of the appropriate Type will provide safe protection at this time.

Proposed Action

Delete section 230.67(E) - Ratings.

This section will not have the intended impact on the durability of the SPD and is a premature requirement that will result in potentially costly over-design and ineffective designs.

Future Action

Open a technical discussion the Surge and TOV capabilities of connected equipment. When these values are determined, it is then appropriate to specify protective levels for the TOV limits on the voltage system topology in question. These ratings will also be based on the isokeraunic level for the installation. Then safe and effective application of an SPD can be assured. Please reference the CBEMA or ITIC curve.

A bit of Deserved Sarcasm

Another proposal would be to suggest that the minimum fuse or circuit breaker size should be 50 amperes to prevent nuisance fuse tripping and leaving people in the dark.

At this time there is not enough information to determine what ratings are required for SPDs.
The suggested minimum $I(n)$ will only serve to frustrate the manufactures and consumers.
A certification by one of the NRTLs is necessary and sufficient for safe application of and SPD.

A review of the substantiation:

- 1) $I(n)$ is not a suitable rating for surge arresters in and of itself.
- 2) SPDs fail for reasons of sustained over-voltages at power frequency. $I(n)$ will not help this failure mode.
- 3) The regional isokeraunic level MUST be considered when specifying an SPD.
- 4) The electric utility considers an $I(n)$ of 5 kA sufficient for lightning protection, and has so for over 75 years.
- 5) At this time there is no guidance for the engineered application of surge arresters in low voltage systems. The proper specifications for surge arrester application do not yet exist.

Related Item

- FR 8299

Submitter Information Verification

Submitter Full Name: Thomas Hartman

Organization: None

Affiliation: None

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 19 12:02:09 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The public comment does not comply with the Regulations Governing the Development of Standards in Section 4.4.4.3. The proposed action stated relates to Section 230.67(E). The panel does not agree with the submitter's technical substantiation because it is important that the surge device be installed on a circuit such that it will not be expected to discharge a surge greater than its nominal discharge rating. IEEE Std C62.41.2 characterizes the service entrance as being typically exposed to surges up to 10kA.

**Public Comment No. 2194-NFPA 70-2021 [Section No. 225.42(E)]****(E) Ratings.**

SPDs shall have a nominal discharge current rating (I_n) of not less than 10kA.

Informational Note: Lead lengths of conductors to the SPD should be kept as short as possible to reduce let-through voltages.

Requiring such a high current rating implies this is exclusively for lightning protection. The NEC does not address lightning protection directly, only offering a cross reference to Article 242 for overvoltage protection, which is a component of a good lightning protection system. Good overvoltage protection is a trade off with high current protection as the components in surge protection devices have a linear relationship between current and let through voltage. This requirement for such a high current rating will arbitrarily exclude the use of many listed Type 2 devices whose purpose is good overvoltage protection. This requirement will actually degrade the performance of the overvoltage protection. There is no technical reason for this requirement, only a commercial one.

Statement of Problem and Substantiation for Public Comment

NEC arbitrarily dictating performance specifications for equipment for all systems does not improved safety and many degrade performance.

Related Public Comments for This Document**Related Comment****Relationship**

[Public Comment No. 2178-NFPA 70-2021 \[Section No. 230.67\(E\)\]](#)

Related Item

- FR 8299

Submitter Information Verification

Submitter Full Name: Brett Board

Organization: Blue Line Logic

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 19 16:20:06 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The public comment does not comply with the Regulations Governing the Development of Standards in Section 4.4.4.3. The panel does not agree with the submitter's technical substantiation because it is important that the surge device be installed on a circuit such that it will not be expected to discharge a surge greater than it nominal discharge rating. IEEE Std C62.41.2 characterizes the service entrance as being typically exposed to surges up to 10kA.

**Public Comment No. 2215-NFPA 70-2021 [Section No. 225.42(E)]**

(E) Ratings.

SPDs shall have a nominal discharge current rating (I_n) of not less than 10kA.

Informational Note: Lead lengths of conductors to the SPD should be kept as short as possible to reduce let-through voltages. [This is in conflict with UL safety Standard.](#)

Statement of Problem and Substantiation for Public Comment

It would eliminate conflict with UL safety standards.

Related Public Comments for This Document

<u>Related Comment</u>	<u>Relationship</u>
Public Comment No. 2206-NFPA 70-2021 [Section No. 225.42 (E)]	FR 8299
<u>Related Item</u>	
• FR8299	

Submitter Information Verification

Submitter Full Name: John Gauthier

Organization: [Not Specified]

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 19 17:00:52 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The public comment does not comply with the Regulations Governing the Development of Standards in Section 4.4.4.3. There is no substantiated direct conflict with the UL safety standard provided by the submitter.

**Public Comment No. 583-NFPA 70-2021 [Section No. 225.42(E)]**

(E)– Ratings.

~~SPDs shall have a nominal discharge current rating (I_n) of not less than 10kA.~~

Informational Note: Lead lengths of conductors to the SPD should be kept as short as possible to reduce let-through voltages.

Statement of Problem and Substantiation for Public Comment

An interrupting rating indicates the short-circuit current that an overcurrent protective device can safely interrupt under standard test conditions. (An overcurrent protective device is not necessarily functional after the test.)

A short-circuit current rating indicates how much short-circuit current a component, such as a motor starter, can carry while an overcurrent protective device clears a short-circuit, under standard test conditions. (The component is not necessarily functional after the test.)

A Nominal Discharge Current is the amount of short-circuit current that the test circuit can deliver to the SPD during 15 tests that are 20 microseconds each, under standard test conditions. (The SPD must still function properly after the 15th test.)

To make this even more confusing, the SPD also has an I_{max} rating, which is based upon just one 20 microsecond surge test. (The SPD is allowed to be degraded in this test and can only withstand a limited number of these surges before it needs to be replaced.)

As written, this First Revision will confuse users, specifiers, and inspectors who are familiar with interrupting ratings and short-circuit current ratings. It will encourage users, specifiers, and inspectors to call out for a Nominal Discharge Current that is equal to or greater than the available short-circuit current, thinking that doing so will assure compliance with 110.3(B). Unfortunately, as can be seen in the practical descriptions above, it is comparing apples and oranges. The CMP is encouraged to remove this First Revision requirement that will certainly mislead users, specifiers, and inspectors.

Related Item

• FR 7707 • FR 7739 • FR 8299 • PC 522 • FR 7689 • PC 582

Submitter Information Verification

Submitter Full Name: Vincent Saporita

Organization: Saporita Consulting

Affiliation: Saporita Consulting

Street Address:

City:

State:

Zip:

Submittal Date: Sun Aug 01 12:16:18 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: While the nominal discharge rating is not directly related to available fault current, it is important that the surge device be installed on a circuit such that it will not be expected to discharge a surge greater than its nominal discharge rating. IEEE Std C62.41.2 characterizes the service entrance as being typically exposed to surges rated up to 10kA.

**Public Comment No. 853-NFPA 70-2021 [Section No. 225.56(B)]****(B) Test Report.**

A test report covering the results of the tests required in 225.56(A) shall be delivered to the authority having jurisdiction prior to energization.

Informational Note: See ANSI/NETA ATS-2013, *Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems*, for an example of acceptance specifications.

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_150.pdf	70_CN150

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 150 appeared in the First Draft Report on First Revision No. 7906.

The Correlating Committee requests the Panel to reconsider the date of the referenced standard based on the information contained in the panel statement.

Related Item

- First Revision No. 7906

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 04 14:40:21 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8472-NFPA 70-2021](#)

Statement: This action will combine all the requirements under the purview of CMP-10 for feeders, outside branch circuits and feeders, and services over 1000 Vac or 1500 Vdc into the new Article 235. This action is to correlate with the actions taken by CMP-2 on PC-285 which created the new Article 235.

The corresponding sections from Articles 215, 225, and 230 will be deleted as the requirements have been relocated to the new Article 235.

The edition year ANSI/NETA ATS was removed so that it is automatically the latest edition as outlined in 90.1(C) pursuant to PC-853.

CMP-10 is requesting the correlating committee review the changes in scope of Articles 225 and 230. The scope change to Article 215 is addressed by SR-8369.

**Correlating Committee Note No. 150-NFPA 70-2021 [Section No. 225.56(B)]****Submitter Information Verification**

Committee: NEC-P10

Submittal Date: Tue May 04 18:02:48 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee requests the Panel to reconsider the date of the referenced standard based on the information contained in the panel statement.

First Revision No. 7906-NFPA 70-2020 [Section No. 225.56(B)]

Ballot Results

✓ **This item has passed ballot**

12 Eligible Voters

0 Not Returned

12 Affirmative All

0 Affirmative with Comments

0 Negative with Comments

0 Abstention

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Johnston, Michael J.

Kendall, David H.

Kovacik, John R.

Manche, Alan

McDaniel, Roger D.

Porter, Christine T.

Williams, David A.

**Public Comment No. 968-NFPA 70-2021 [Section No. 230.2(E)]****(E) Identification.**

Where a building or structure is supplied by more than one service, or any combination of branch circuits, feeders, and services, a readily visible permanent plaque or directory shall be installed ~~at~~ as near as practicable to each service disconnect location and each emergency disconnect location denoting all other services, feeders, and branch circuits supplying that building or structure and the area served by each. See 225.37.

Statement of Problem and Substantiation for Public Comment

Ready visibility can be important, but visibility from every location that could be taken as the service disconnect is essential, in line with 230.85. This could be at least an element of what the task group sought. This wording seeks to balance the need to have the directory by the equipment and to ensure that the directory is noticed.

Related Item

• PI 2982 • FR8302

Submitter Information Verification

Submitter Full Name: David Shapiro

Organization: Safety First Electrical

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 05 13:12:58 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: "Readily visible" is not defined and does not add clarity or usability. In addition, the submitter's concern about denoting all emergency disconnects on site is already addressed in 230.85(D) and 225.41(B).

**Public Comment No. 1009-NFPA 70-2021 [Section No. 230.2 [Excluding any Sub-Sections]]**

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

I.N. See 225.30 for restrictions on the type and number of non-service conductors permitted to serve or pass through a building or structure.

Statement of Problem and Substantiation for Public Comment

I don't believe Inspector Sasso's PI, or the text proposed in this P.C., enhances the usability of 230, but rather the usability of the NEC overall. Due to layout issues, offering users a heads-up at this location regarding other types of conductors is a good idea. If a user reads 230.2 and says, "does a similar restriction apply to feeders?" and look at the equivalent location, 215.2, they won't find their answer. They won't find an answer at 215.anything, or even at 225.2. It seems worthwhile to direct them to 225.30 to avert avoidable errors.

Related Item

- PI 1184

Submitter Information Verification

Submitter Full Name: David Shapiro

Organization: Safety First Electrical

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 05 15:26:11 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The NEC Style Manual section 4.1.4 discourages restating requirements found elsewhere in the code.

**Public Comment No. 1309-NFPA 70-2021 [Section No. 230.7]****230.7 Other Conductors.**

~~Conductors. Circuit conductors~~ other than service conductors shall not be installed in the same ~~service~~ raceway, ~~service~~ cable, ~~handholes~~ handhole enclosure , or underground ~~boxes in which box as~~ the service conductors ~~are installed~~ .

~~Exception No. 1: Grounding electrode conductors or supply side bonding jumpers or conductors shall be permitted within service raceways.~~

~~Exception No. 2: Exception: Load management control conductors having overcurrent protection shall be permitted within service raceways.~~

Statement of Problem and Substantiation for Public Comment

These edits should be viewed as editorial. In the first draft text, half of the items are singular and half plural. We also refer to handholes instead of handhole enclosures. A handhole can be something found in the pole supporting a luminaire, a handhole enclosure is the thing in the ground that acts like a box. By adding the word "circuit" in front of "conductors" we can remove the first exception.

Related Item

- FR 7721

Submitter Information Verification

Submitter Full Name: Ryan Jackson

Organization: Ryan Jackson

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 11 17:18:58 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8236-NFPA 70-2021

Statement: It is important to clarify that grounding electrode conductors and supply side bonding jumpers are permitted in the same raceway or enclosure as service conductors. Revisions are made to enhance clarity and consistency in code language.

**Public Comment No. 320-NFPA 70-2021 [Section No. 230.8]****230.8 Raceway Seal.**

Where a service raceway enters a building or structure, it shall be sealed in accordance with 300.5(G) ~~and or~~ 300.7(A), as applicable. Spare or unused raceways shall also be sealed. Sealants shall be identified for use with the cable insulation, conductor insulation, bare conductor, shield, or other components.

Statement of Problem and Substantiation for Public Comment

The change in the current first draft seems to be a way to simplify and/or clarify the rules for sealing raceways by referencing the applicable section in article 300. The AND, as in requiring sealing all raceways per 300.5G AND 300.7A might communicate something different than the intent of the code. 300.5G deals with concerns about water ingress into equipment caused by underground installations. In these, the water ingress could be severe, and the mitigation may in some cases require a pressure rated sealant. 300.7A deals with circumstances where there's a chance of condensation. It would seem more appropriate to require sealing per ONE of these 2 rules, not both.

Related Item

• First Revision No. 7722-NFPA 70-2020 [Section No. 230.8] •

Submitter Information Verification

Submitter Full Name: Josh Weaver

Organization: Josh Weaver

Street Address:

City:

State:

Zip:

Submittal Date: Wed Jul 21 20:34:27 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: One or both of the conditions described in 300.5(G) and 300.7(A) can occur with compliance with both is required. "As applicable" is implied and adding these words does not improve clarity or useability.

**Public Comment No. 267-NFPA 70-2021 [Section No. 230.31(C)]**

(C) Grounded Conductors.

The grounded conductor shall not be ~~less than~~ smaller than the minimum size required by 250.24(D).

Statement of Problem and Substantiation for Public Comment

The use of the word "smaller" is correct and aligns with 230.23(B) where "smaller" is used to indicate a wire size. Typically (but not always) "less" is used to designate a quantity such as less or more.

Related Item

- FR-7728

Submitter Information Verification

Submitter Full Name: Phil Simmons

Organization: Simmons Electrical Services

Street Address:

City:

State:

Zip:

Submittal Date: Sun Jul 18 21:21:21 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8238-NFPA 70-2021](#)

Statement: Editorial changes are made to improve clarity and useability.



Public Comment No. 1808-NFPA 70-2021 [Section No. 230.43]

230.43 Wiring Methods for 1000 Volts, Nominal, or Less.

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

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

Additional Proposed Changes

<u>File Name</u>	<u>Description</u>	<u>Approved</u>
PC_for_230.43_Draft_3.docx	230.43 text in Word file	

Statement of Problem and Substantiation for Public Comment

This public comment provides a correlating addition to recognize Flexible Bus Systems as one of the available wiring methods listed in 230.43 for services. The only change being made is to include Flexible Bus System in the list for 230.43. No other changes are intended. Attached to this PC is a clean file to show the intended changes.

Flexible Bus Systems are included in a new Article 371 which was accepted by CMP-8 as FR 7621 in the first draft stage. The accepted article text requires the Flexible Bus System to be listed as a system. There are two UL Outlines of Investigation in process to provide the listing for the Flexible Insulated Bus and the Flexible Bus System. Section 371.10(1) in the article permits the Flexible Bus System to be used as a wiring method for services, feeders and branch circuits. Section 230.43 is a list of wiring methods that may be used for services and this addition is to ensure the list is complete.

Related Item

- PI 3789

Submitter Information Verification

Submitter Full Name: Ward Judson
Organization: nVent Electric
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 17 22:03:05 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: SR-8241-NFPA 70-2021
Statement: The addition of Flexible Bus Systems recognizes the wiring method for use in services as found in permitted uses in NEC 371.10 and listed in accordance with 371.6. The panel recommends that the correlating committee confirm that the ballot passes for the new Article 371.

PC Code Text:

230.43 Wiring Methods for 1000 Volts, Nominal, or Less.

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

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

Substantiation

PC Substantiation:

This public comment provides a correlating addition to recognize Flexible Bus Systems as one of the available wiring methods listed in 230.43 for services. The only change being made is to include Flexible Bus System in the list for 230.43. No other changes are intended. Attached to this PC is a clean file to show the intended changes.

Flexible Bus Systems are included in a new Article 371 which was accepted by CMP-8 as FR 7621 in the first draft stage. The accepted article text requires the Flexible Bus System to be listed as a system. There are two UL Outlines of Investigation in process to provide the listing for the Flexible Insulated Bus and the Flexible Bus System. Section 371.10(1) in the article permits the Flexible Bus System to be used as a wiring method for services, feeders and branch circuits. Section 230.43 is a list of wiring methods that may be used for services and this addition is to ensure the list is complete.

**Public Comment No. 1012-NFPA 70-2021 [Section No. 230.53]****230.53 Raceways to Drain.**

Where exposed to the weather, raceways enclosing service-entrance conductors shall be listed or approved for use in wet locations and arranged to drain. Where embedded in masonry, raceways shall be arranged to drain. One or more field-created weep holes shall be permitted in the bottom of raceways exposed to the weather or other wet locations in lieu of fittings, enclosures weep holes, or routing

Statement of Problem and Substantiation for Public Comment

Not all Code users understand that raceways can be drilled to provide weep holes. Yet raceways should not drain into enclosures, per 314.15, "314.15 Damp or Wet Locations. In damp or wet locations, boxes, conduit bodies, outlet box hoods, and fittings shall be placed or equipped so as to prevent moisture from entering" so mentioning enclosures provided with weep holes does not address Mr. Feck's concern as represented by his observation. The testimony in PI 1455 underscores the need to arrange for raceways themselves to drain (but not into enclosures).

Related Public Comments for This Document**Related Comment****Relationship**

Public Comment No. 963-NFPA 70-2021 [Section No. 225.22]

Related Item

- PI 1012

Submitter Information Verification

Submitter Full Name: David Shapiro
Organization: Safety First Electrical
Affiliation: Myself; Pat Bahn of Washington, D.C.; and Ken Lederman of Conway, Mass.
Street Address:
City:
State:
Zip:
Submittal Date: Thu Aug 05 16:52:26 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected
Resolution: Where water is potentially an issue, an enclosure with weep holes must be installed. This is a design issue and should not be addressed in this code.

**Public Comment No. 319-NFPA 70-2021 [Section No. 230.67]****230.67** Surge Protection.**(A)** Surge-Protective Device.

All services supplying the following occupancies shall be provided with a surge-protective device (SPD):

- (1) Dwelling units
- (2) Dormitory units
- (3) Guest rooms and guest suites of hotels and motels
- (4) Areas of nursing homes and limited-care facilities used exclusively as patient sleeping rooms

Informational Note: See 517.10(B)(2).

(B) Location.

The SPD shall be an integral part of the service equipment or shall be located immediately adjacent thereto.

Exception: The SPD shall not be required to be located in the service equipment as required in 230.67(B) if located at each next level distribution equipment downstream toward the load.

(C) Type.

The SPD shall be a Type 1 SPD, or ~~Type 2 SPD~~, a type 2 SPD with a nominal discharge current rating of not less than 10KA

(D) Replacement.

Where service equipment is replaced, all of the requirements of this section shall apply.

(E) Ratings.

~~SPDs shall have a nominal discharge current rating (In) of not less than 10kA.~~

Statement of Problem and Substantiation for Public Comment

It is thought that the revision submitted would communicate the same requirement in a manner that may be more reader friendly. It takes up less lines and/or text, while at the same time educating the the user the need to use caution when using a type 2 SPD. This might be better retained than if it is in the format of just one more rule. According to the PI that generated this proposed change, amongst the UL listed SPD's, it is just the type 2 SPD's that could be selected and have a low discharge current rating. For the type 1 SPD's, the code requires they be listed, so they should come with the desired 10KA minimum rating.

Secondly, it might be wise for the committee to consider if the specific rules on location and type of SPD would be better located in article 242. Article 242 already has special requirements for SPD's at services. It may make for a more user friendly standard to have this there, and maybe since SPD's are somewhat new requirement, to have a Informational Note to inform the user that article 242 has rules for SPD's.

Related Item

• Public Input No. 3722-NFPA 70-2020 [New Section after 230.67] • First Revision No. 8299-NFPA 70-2020 [Detail]

Submitter Information Verification

Submitter Full Name: Josh Weaver

Organization: Josh Weaver

Street Address:

City:

State:

Zip:

Submittal Date: Wed Jul 21 19:46:34 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The proposed changes do not improve useability of the code. The nominal discharge current rating should be highlighted in a separate section. Reorganizing this section into Article 242 may be an appropriate suggestion for the next development cycle.

**Public Comment No. 1363-NFPA 70-2021 [Section No. 230.67(B)]****(B) Location.**

The SPD shall be an integral part of the service equipment or shall be located immediately adjacent thereto.

Exception: The SPD shall not be required to be located ~~in-with~~ the service equipment as required in ~~230.67(B)~~ - if ~~located at~~ each next level distribution equipment downstream toward the load is provided with surge protection in accordance with 230.67(C) and 230.67(E).

Statement of Problem and Substantiation for Public Comment

This is an editorial comment that removes what is effectively a circular reference to 230.67(B).

Related Item

- FR-7739

Submitter Information Verification

Submitter Full Name: Frederic Hartwell

Organization: Hartwell Electrical Services, Inc.

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 12 12:35:20 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8244-NFPA 70-2021](#)

Statement: Editorial change was made to improve clarity and useability.

**Public Comment No. 1900-NFPA 70-2021 [Section No. 230.67(E)]****(E) Ratings.**

SPDs shall have a nominal discharge current rating (In) of not less than 10kA.

FR 8299 is not justified and should be withdrawn. The 10 kA value is not an NEC concern for installation safety.

An SPD is intended to react to over voltage, not an over current condition. FR 8299 is not valid.

This proposal seeks to impose a mandatory current rating for nominal discharge current. Nominal discharge current values are only tested and evaluated for less than 20 millionths of a second (20 / 1,000,000). The testing process is to impulse a product at the selected nominal discharge current levels for 20 millionths of a second and does not provide an RMS or AIC fault current value and is not appropriate for a mandatory NEC rating. The nominal discharge current value does nothing but cause confusion for installers.

Statement of Problem and Substantiation for Public Comment

Remove 230.67 E. Remove all text. Inappropriate rating.

"Ratings

SPDs shall have a nominal discharge current (In) rating of not less than 10kA"

Related Item

- FR 8299

Submitter Information Verification

Submitter Full Name: john gibson

Organization: Lee County Electric

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 18 14:49:33 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: No changes to the text are provided in accordance with Regulations Governing the development of NFPA Standards 4.4.4.1. The panel does not agree with the submitter's technical substantiation because it is important that the surge device be installed on a circuit such that it will not be expected to discharge a surge greater than its nominal discharge rating. IEEE Std C62.41.2 characterizes the service entrance as being typically exposed to surges rated up to 10kA. The requirement is clear that this is a nominal discharge rating and not a short circuit current rating.

**Public Comment No. 1914-NFPA 70-2021 [Section No. 230.67(E)]**

(E) Ratings.

SPDs shall have a nominal discharge current rating (In) of not less than 10kA.

FR 8299 as 230.67(E) should NOT be included in the Code.

This proposal does not prevent fire or promote safety.

The existing requirements of 236.67- A to D should be left as is. As drafted, the language will create confusion for the safe use of Surge Protective Devices (SPDs) also known as Transient Voltage Surge Suppressors (TVSS). This proposal will cost manufacturers millions of dollars unnecessarily as it supersedes the existing requirements by more than 3 times the value of 3kA. This would mandate a minimum level of 10kA for a UL listing. Three (3) kA is the value accepted by ANSI/UL 1449. Voltage suppressors follow industry standards. There is nothing in the ANSI/UL 1449 or IEEE C 62 series standards stating a surge current value of 10kA reduces the risk of fire to equipment or premises wiring systems.

FR 8299 was created in response to PI 3722. The substantiation of PI 3722 was based on a Lightning Protection System (LPS) which has many components, one of which may be a voltage surge suppressor. The vast majority of NEC installations do not require the use of a Lightning Protection System. The mandatory inclusion of an LPS requirement into article 230.67 (E) is a gross misrepresentation for the use of voltage suppression.

It is not feasible for the NEC to exceed the recommendations that have been well established in ANSI/UL 1449 for over 25 years.

I(n) levels used in products today range from 5 amps to 3000 amps. They are serving the NEC well with no reports of insufficient I(n) levels. A 10,000 amp level is not justified as product testing is only done up to the 3kA value. There have been no reports of inappropriate kA levels presented in this proposal.

Voltage suppression devices are successfully used and installed at the existing levels of I(n). To introduce this new requirement will be a misstep. This proposal does nothing to promote the safe use of voltage suppression.

Article 230.67 is for overvoltage, it is not addressing overcurrent requirements.

The requirement for 230.67 (E) should be removed.

Statement of Problem and Substantiation for Public Comment

230.67(E) should not be included in the Code. This proposal does not prevent fire or promote safety.

It is not feasible for the NEC to exceed the recommendations that have been well established in ANSI/UL 1449 for over 25 years. I(n) levels used in products today range from 5 amps to 3000 amps. They are serving the NEC well with no reports of insufficient I(n) levels. A 10,000 amp level is not justified as product testing is only done up to the 3kA value. There have been no reports of inappropriate kA levels presented in this proposal. Voltage suppression devices are successfully used and installed at the existing levels of I(n). To introduce this new requirement will be a misstep. This proposal does nothing to promote the safe use of voltage suppression. Article 230.67 is for overvoltage, it is not addressing overcurrent requirements. The requirement for 230.67 (E) should be removed.

Related Item

- FR 8299

Submitter Information Verification

Submitter Full Name: james moellmann

Organization: Maxivolt

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 18 15:54:00 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Rejected

Action:

Resolution: No changes to the text are provided in accordance with Regulations Governing the development of NFPA Standards 4.4.4.1. The panel does not agree with the submitter's technical substantiation because it is important that the surge device be installed on a circuit such that it will not be expected to discharge a surge greater than its nominal discharge rating. IEEE Std C62.41.2 characterizes the service entrance as being typically exposed to surges rated up to 10kA. The requirement is clear that this is a nominal discharge rating and not a short circuit current rating.



Public Comment No. 2091-NFPA 70-2021 [Section No. 230.67(E)]

(E) Ratings.

SPDs shall have a nominal discharge current rating (In) of not less than 10kA.

Personal Background

I have over 35 years of experience in the design, manufacture, and application of Surge Protective Devices in high voltage and low voltage applications. In addition, I have 10 years of electric utility experience in all isokeraunic locations.

At this time I am semi-retired and represent no SPD manufacturer or seller.

Surge Protective Device (SPD) Function

An SPD is a device that is designed to "shunt" high transient currents to earth (or other common bus) and while doing so limit the voltage across the SPD to an acceptable level.

The act of "limiting" the transient voltage across the SPD to an acceptable level" is the ONLY function that the SPD is expected to perform.

As such, the minimum acceptable rating I(n) of 10 kA has no basis in the desired function of an SPD and is of no particular functional value for the specifying engineer and is clearly a secondary or tertiary rating.

What an SPD will NOT perform the following functions:

- 1) Voltage Regulation – The SPD is a transient voltage device only.
- 2) Survive a prolonged over-voltage surge
- 3) Survive a prolonged Temporary Over-Voltage (TOV)

The Electric Utility Perspective

Consider the primary electrical distribution system. The overhead lines that we see in our community all have SPDs attached to the conductors and the "normal" I(n) for overhead conductors is 5kA. An I(n) of 10kA is considered "Heavy Duty" is only needed in high isokeraunic regions, in the U.S. that is typically only in the state of Florida.

As a curious side note, the value of an I(n) of 10 kA was specifically designed, by request, for a southern Florida utility by request.

If we consider the secondary voltage of the distribution system, the service entrance voltage, we see that the electric utility industry uses a 5 kA surge arrester on the transformer. See EATON's Cooper Power Systems "Storm Trapper™ H.E. (high energy) low-voltage distribution-class MOV surge arrester".

When an arrester fails, that is a good thing, it has given it's "life" for the protection of apparatus.

What the Industry Experiences in Real Life

In my 45 years of SPD experience, I have had the privilege of examining hundreds of failed SPDs for both product design feedback and forensic analysis for liability. The reasons for SPD failure have been TOV, loss of ground, improper voltage application, and direct lightning exposure.

I have NEVER seen an SPD fail due to a lack of a sufficient I(n).

Loss of ground or phase is the most common failure mode and an I(n) rating of 300 kA will not save that SPD from failure. This often occurs at the service entrance or service transformer.

High Voltage Systems (>1000V) – The characteristics of both surge arresters and system apparatus are well known and surge arresters are successfully applied using an I(n) of 1.5 kA to 100 kA. This is historically proven.

Low Voltage Systems (<1000V) – SPD characteristics are fairly well known but the transient response of low voltage attached equipment is completely unknown or not well defined. Surge arresters are beneficial because they do provide a level of transient protection but this has led to extreme over- or under-design resulting in wasted money or poorly performing devices. The so-called marketing "horsepower races".

Summary

- 1) I(n) is not a suitable rating for surge arresters in and of itself.
- 2) SPDs fail for reasons of sustained over-voltages at power frequency. I(n) will not help this failure mode.
- 3) The regional isokeraunic level MUST be considered when specifying an SPD.
- 4) The electric utility considers an I(n) of 5 kA sufficient for lightning protection, and has so for over 75 years.
- 5) At this time there is no guidance for the engineered application of surge arresters in low voltage systems. The proper specifications for surge arrester application do not yet exist.
- 6) A certification by one of the NRTLs is necessary and sufficient for safe application of an SPD. The application of the appropriate Type will provide safe protection at this time.

Proposed Action

Delete section 230.67(E) - Ratings.

This section will not have the intended impact on the durability of the SPD and is a premature requirement that will result in potentially costly over-design and ineffective designs.

Future Action

Open a technical discussion the Surge and TOV capabilities of connected equipment. When these values are determined, it is then appropriate to specify protective levels for the TOV limits on the voltage system topology in question. These ratings will also be based on the isokeraunic level for the installation. Then safe and effective application of an SPD can be assured. Please reference the CBEMA or ITIC curve.

A bit of Deserved Sarcasm

Another proposal would be to suggest that the minimum fuse or circuit breaker size should be 50 amperes to prevent nuisance fuse tripping and leaving people in the dark.

At this time there is not enough information to determine what ratings are required for SPDs.
The suggested minimum I(n) will only serve to frustrate the manufactures and consumers.
A certification by one of the NRTLs is necessary and sufficient for safe application of and SPD.

A review of the substantiation:

- 1) I(n) is not a suitable rating for surge arresters in and of itself.
- 2) SPDs fail for reasons of sustained over-voltages at power frequency. I(n) will not help this failure mode.
- 3) The regional isokeraunic level MUST be considered when specifying an SPD.
- 4) The electric utility considers an I(n) of 5 kA sufficient for lightning protection, and has so for over 75 years.
- 5) At this time there is no guidance for the engineered application of surge arresters in low voltage systems. The proper specifications for surge arrester application do not yet exist.

Related Item

- FR 8299

Submitter Information Verification

Submitter Full Name: Thomas Hartman

Organization: None

Affiliation: None

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 19 11:32:24 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: No changes to the text are provided in accordance with Regulations Governing the development of NFPA Standards 4.4.4.1. The panel does not agree with the submitter's technical substantiation because it is important that the surge device be installed on a circuit such that it will not be expected to discharge a surge greater than its nominal discharge rating. IEEE Std C62.41.2 characterizes the service entrance as being typically exposed to surges rated up to 10kA. The requirement is clear that this is a nominal discharge rating and not a short circuit current rating.

**Public Comment No. 2161-NFPA 70-2021 [Section No. 230.67(E)]**

~~(E)– Ratings.~~

~~SPDs shall have a nominal discharge current rating (In) of not less than 10kA.~~

Statement of Problem and Substantiation for Public Comment

The new list item (E) for ratings under 230.67 should be deleted. As 230.67(C) permits Type 1 and Type 2 SPDs, then the new 230.67(E) that excludes Type 2 SPDs that would have an In of 3kA or 5kA conflicts with what is permitted in 230.67(C). To confirm:

UL 1449 allows for Type 1 SPDs to have an In of 10 or 20kA and Type 2 SPDs to have an In of 3, 5, 10, or 20kA.

This addition of a minimum 10kA rating by selected industry participants represents an exclusion of products offered by many OTHER industry providers and stakeholders (i.e. – those firms providing Type 2 SPDs that have an In of 3kA or 5kA) that can be and are marketed today as "meeting Code" no longer being permitted to do so. This addition conflicts with 230.67(C), as products that currently meet Type 2 SPD requirements as defined by UL 1449 (therefore in compliance with 230.67(C)) would be unduly excluded without evidence-based data because of this ratings requirement.

There is no appropriate cause, basis, or justification to negatively impact other marketplace participants by working to "box out" certain Type 2 SPDs that have an In of 3kA or 5kA from being able to continue to "meet Code". 230.67(E) should not have been introduced without accounting for the inclusion of Type 2 SPDs that have an In of 3kA or 5kA as being able to meet the NEC, as it is currently and still permitted by 230.67(C). It is inappropriate to introduce a conflict into the NEC of this nature, which on the surface unduly reduces installation choice and resulting market competition.

There is nothing in the UL or IEEE standards stating a surge current value of 10kA reduces the risk of fire to equipment or premises wiring systems. As there was no defined rationale for a value of 10 kA, the NEC should not mandate this objective requirement based upon subjective speculation.

[Related
Item](#)

• This proposal is in opposition to the new 230.67(E) resulting from FR 8299 arising from PI 3722. This addition conflicts with 230.67(C), as products that currently meet Type 2 SPD requirements as defined by UL 1449 (therefore in compliance with 230.67(C)) would be unduly excluded without evidence-based data because of this ratings requirement.

Submitter Information Verification

Submitter Full Name: Stephen Rood

Organization: Legrand North America

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 19 14:57:26 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: It is important that the surge device be installed on a circuit such that it will not be expected to discharge a surge greater than its nominal discharge rating. IEEE Std C62.41.2 characterizes the service entrance as being typically exposed to surges rated up to 10kA. The requirement is clear that this is a nominal discharge rating and not a short circuit current rating.

**Public Comment No. 2178-NFPA 70-2021 [Section No. 230.67(E)]****(E) Ratings.**

SPDs shall have a nominal discharge current rating (In) of not less than 10kA.

Requiring such a high current rating implies this is exclusively for lightning protection. The NEC does not address lightning protection directly, only offering a cross reference to Article 242 for overvoltage protection, which is a component of a good lightning protection system. Good overvoltage protection is a trade off with high current protection as the components in surge protection devices have a linear relationship between current and let through voltage. This requirement for such a high current rating will arbitrarily exclude the use of many listed Type 2 devices whose purpose is good overvoltage protection. This requirement will actually degrade the performance of the overvoltage protection. There is no technical reason for this requirement, only a commercial one.

Statement of Problem and Substantiation for Public Comment

The NEC requiring arbitrary performance specs for all installations does not improve safety and actually degrade system performance.

Related Public Comments for This Document**Related Comment****Relationship**

[Public Comment No. 2194-NFPA 70-2021 \[Section No. 225.42\(E\)\]](#)

[Public Comment No. 2197-NFPA 70-2021 \[Section No. 215.18\(E\)\]](#)

Related Item

- FR 8299

Submitter Information Verification

Submitter Full Name: Brett Board

Organization: Blue Line Logic

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 19 15:55:36 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: No changes to the text are provided in accordance with Regulations Governing the development of NFPA Standards 4.4.4.1. The panel does not agree with the submitter's technical substantiation because it is important that the surge device be installed on a circuit such that it will not be expected to discharge a surge greater than its nominal discharge rating. IEEE Std C62.41.2 characterizes the service entrance as being typically exposed to surges rated up to 10kA. The requirement is clear that this is a nominal discharge rating and not a short circuit current rating.

**Public Comment No. 2206-NFPA 70-2021 [Section No. 230.67(E)]**

(E) Ratings.

SPDs shall have a nominal discharge current rating (In) of not less than 10kA.

Statement of Problem and Substantiation for Public Comment

item e, 230.67 should be withdrawn. This proposal is in conflict with UL requirements.

Related Public Comments for This Document**Related Comment****Relationship**

Public Comment No. 2211-NFPA 70-2021 [Section No. 215.18(E)]

Public Comment No. 2215-NFPA 70-2021 [Section No. 225.42(E)]

Related Item

- FR 8299

Submitter Information Verification

Submitter Full Name: John Gauthier

Organization: [Not Specified]

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 19 16:40:58 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: No changes to the text are provided in accordance with Regulations Governing the development of NFPA Standards 4.4.4.1. The panel does not agree with the submitter's technical substantiation because it is important that the surge device be installed on a circuit such that it will not be expected to discharge a surge greater than its nominal discharge rating. IEEE Std C62.41.2 characterizes the service entrance as being typically exposed to surges rated up to 10kA. The requirement is clear that this is a nominal discharge rating and not a short circuit current rating.

**Public Comment No. 522-NFPA 70-2021 [Section No. 230.67(E)]**

~~(E)– Ratings.~~

~~SPDs shall have a nominal discharge current rating (In) of not less than 10kA.~~

Statement of Problem and Substantiation for Public Comment

An interrupting rating indicates the short-circuit current that an overcurrent protective device can safely interrupt under standard test conditions. (An overcurrent protective device is not necessarily functional after the test.)

A short-circuit current rating indicates how much short-circuit current a component, such as a motor starter, can carry while an overcurrent protective device clears a short-circuit, under standard test conditions. (The component is not necessarily functional after the test.)

A Nominal Discharge Current is the amount of short-circuit current that the test circuit can deliver to the SPD during 15 tests that are 20 microseconds each, under standard test conditions. (The SPD must still function properly after the 15th test.)

To make this even more confusing, the SPD also has an I_{max} rating, which is based upon just one 20 microsecond surge test. (The SPD is allowed to be degraded in this test and can only withstand a limited number of these surges before it needs to be replaced.)

As written, this First Revision will confuse users, specifiers, and inspectors who are familiar with interrupting ratings and short-circuit current ratings. It will encourage users, specifiers, and inspectors to call out for a Nominal Discharge Current that is equal to or greater than the available short-circuit current, thinking that doing so will assure compliance with 110.3(B). Unfortunately, as can be seen in the practical descriptions above, it is comparing apples and oranges. The CMP is encouraged to remove this First Revision requirement that will certainly mislead users, specifiers, and inspectors.

Related Item

• FR 7739 • FR 8299 • FR 7689 • FR 7707 • PC 582 • PC 583

Submitter Information Verification

Submitter Full Name: Vincent Saporita

Organization: Saporita Consulting

Affiliation: Saporita Consulting

Street Address:

City:

State:

Zip:

Submittal Date: Wed Jul 28 18:49:01 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: It is important that the surge device be installed on a circuit such that it will not be expected to discharge a surge greater than its nominal discharge rating. IEEE Std C62.41.2 characterizes the service entrance as being typically exposed to surges rated up to 10kA. The requirement is clear that this is a nominal discharge rating and not a short circuit current rating.

**Public Comment No. 1013-NFPA 70-2021 [Section No. 230.70(A)(1)]****(1) Readily Accessible Location.**

The service disconnecting means shall be installed at a readily accessible location either outside of a building or structure or inside ~~nearest~~ as close as practicable to the point of entrance of the service conductors.

Statement of Problem and Substantiation for Public Comment

NECA's language creates no confusion that is evident. In other instances, a CMP has offered examples of how a P.I. could confuse or be misinterpreted. Here, they have not. Lacking insight into what about this clearer and more evenly enforceable term troubled them, I can only urge that they reconsider this in light of the Style Manual's direction. Sure, after decades in the trade, i know what it means. Unfortunately, another person might also know what it means but have something else in mind.

Related Item

- PI 1166

Submitter Information Verification

Submitter Full Name: David Shapiro

Organization: Safety First Electrical

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 05 17:26:24 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: Replacing the word "nearest" with "as near close as practicable" does not clarify the language and may create further confusion. The existing language has been in the NEC for years with practices and enforcement based on the existing language.

**Public Comment No. 1820-NFPA 70-2021 [Section No. 230.71(B)]****(B) Two to Six Service Disconnecting Means.**

Two to six service disconnects shall be permitted for each service permitted by 230.2 or for each set of service-entrance conductors permitted by 230.40, Exception No. 1, 3, 4, or 5. The two to six service disconnecting means shall be permitted to consist of a combination of any of the following:

- (1) Separate enclosures with a main service disconnecting means in each enclosure.
- (2) Panelboards with a main service disconnecting means in each panelboard enclosure.
- (3) Switchboard(s) where there is only one service disconnect in each separate vertical section. Barriers shall be provided between each vertical section to maintain the inadvertent contact protection required in 230.62 based on access from the adjacent section(s).
- (4) Service disconnects in switchgear, transfer switches, or metering centers where each disconnect is located in a separate compartment.
- (5) Metering centers with a main service disconnecting means in each metering center.
- (6) Motor control center(s) where there is only one service disconnect in a motor control center unit and a maximum of two service disconnects provided in a single motor control center. Barriers shall be provided between each motor control center unit or compartment containing a service disconnect to maintain the inadvertent contact protection required in 230.62 based on access from adjacent motor control center unit(s) or compartment(s).

~~Exception to (2), (3), (4), (5), and (6): Existing service equipment, installed in compliance with previous editions of this Code that permitted multiple service disconnecting means in a single enclosure, section, or compartment, shall be permitted to contain a maximum of six service disconnecting means.~~

Informational Note No. 1: See UL 67, Standard for Panelboards, for information on metering centers.

Informational Note No. 2: Examples of separate enclosures with a main service disconnecting means in each enclosure include but are not limited to motor control centers, fused disconnects, and circuit breaker enclosures.

Informational Note No. 3: Transfer switches may have one service disconnect or may have multiple service disconnects for multiple services. Transfer switches with multiple disconnects will have a separate compartment for each service disconnect.

Statement of Problem and Substantiation for Public Comment

The new exception permits existing equipment to remain if existing unused switch positions are now put into service or modified. This exception conflicts with the intent of this rule to provide safety to persons working on such equipment.

Related Item

• PI No. 298 • PI No. 4590 • PI No. 894 • FR-7916

Submitter Information Verification

Submitter Full Name: Peter Diamond

Organization: Town of Norfolk Massachusetts

Affiliation: Massachusetts Wire Inspector Association

Street Address:

City:

State:

Zip:

Submission Date: Wed Aug 18 07:14:29 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: No substantiation has been provided to support the rework of an existing service.



Public Comment No. 1938-NFPA 70-2021 [Section No. 230.71(B)]

(B) Two to Six Service Disconnecting Means.

Two to six service disconnects shall be permitted for each service permitted by 230.2 or for each set of service-entrance conductors permitted by 230.40, Exception No. 1, 3, 4, or 5. The two to six service disconnecting means shall be permitted to consist of a combination of any of the following:

- (1) Separate enclosures with a main service disconnecting means in each enclosure.
- (2) Panelboards with a main service disconnecting means in each panelboard enclosure.
- (3) Switchboard(s) where there is only one service disconnect in each separate vertical section. Barriers shall be provided between each vertical section to maintain the inadvertent contact protection required in 230.62 based on access from the adjacent section(s).
- (4) Service disconnects in switchgear, transfer switches, or metering centers where each disconnect is located in a separate compartment.
- (5) Metering centers with a main service disconnecting means in each metering center.
- (6) Motor control center(s) where there is only one service disconnect in a motor control center unit and a maximum of two service disconnects provided in a single motor control center. Barriers shall be provided between each motor control center unit or compartment containing a service disconnect to maintain the inadvertent contact protection required in 230.62 based on access from adjacent motor control center unit(s) or compartment(s).

Exception to (2), (3), (4), (5), and (6): Existing service equipment, installed in compliance with previous editions of this Code that permitted multiple service disconnecting means in a single enclosure, section, or compartment, shall be permitted to contain a maximum of six service disconnecting means.

Informational Note No. 1: See UL 67, *Standard for Panelboards*, for information on metering centers.

Informational Note No. 2: Examples of separate enclosures with a main service disconnecting means in each enclosure include but are not limited to motor control centers, fused disconnects, and circuit breaker enclosures.

Informational Note No. 3: Transfer switches may have one service disconnect or may have multiple service disconnects for multiple services. Transfer switches with multiple disconnects will have a separate compartment for each service disconnect.

Additional Proposed Changes

File Name	Description Approved
CN_311.pdf	70_CN311

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 311 appeared in the First Draft Report.

The Correlating Committee directs the panel to review the format of the list items in this section. Section 3.3.5.3 of the NEC Style Manual requires that list items be written using phrases or sentences but not a mix. Lists containing phrases should not include ending periods.

The Correlating Committee directs the panel to reconsider the text of Informational Note 3. Informational notes can be informative, but are not permitted to contain requirements or recommendations. The use of the words "may" and "will" introduce permissive language and future tense into the Code and should be removed.

Related Item

- Correlating Note No. 311

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 18 17:11:12 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: SR-8249-NFPA 70-2021
Statement: Text revisions have been completed to comply with the style manual of Section 3.3.5.3. The informational note has also been modified to comply with the style manual.

**Correlating Committee Note No. 311-NFPA 70-2021 [Section No. 230.71(B)]****Submitter Information Verification**

Committee: NEC-AAC

Submittal Date: Thu May 06 15:08:39 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs the panel to review the format of the list items in this section. Section 3.3.5.3 of the NEC Style Manual requires that list items be written using phrases or sentences but not a mix. Lists containing phrases should not include ending periods.

The Correlating Committee directs the panel to reconsider the text of Informational Note 3. Informational notes can be informative, but are not permitted to contain requirements or recommendations. The use of the words “may” and “will” introduce permissive language and future tense into the Code and should be removed.

FR-7916-NFPA 70-2020

Ballot Results

✓ **This item has passed ballot**

12 Eligible Voters

0 Not Returned

12 Affirmative All

0 Affirmative with Comments

0 Negative with Comments

0 Abstention

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Johnston, Michael J.

Kendall, David H.

Kovacik, John R.

Manche, Alan

McDaniel, Roger D.

Porter, Christine T.

Williams, David A.



Public Comment No. 1406-NFPA 70-2021 [Section No. 230.82]

230.82 Equipment Connected to the Supply Side of Service Disconnect.

Only the following equipment shall be permitted to be connected to the supply side of the service disconnecting means:

- (1) Cable limiters.
- (2) Meters and meter sockets nominally rated not in excess of 1000 volts, if all metal housings and service enclosures are grounded in accordance with Part VII and bonded in accordance with Part V of Article 250.
- (3) Meter disconnect switches nominally rated not in excess of 1000 volts that have a short-circuit current rating equal to or greater than the available fault current, if all metal housings and service enclosures are grounded in accordance with Part VII and bonded in accordance with Part V of Article 250. A meter disconnect switch shall be capable of interrupting the load served. A meter disconnect shall be legibly field marked on its exterior in a manner suitable for the environment as follows:

METER DISCONNECT

NOT SERVICE EQUIPMENT

- (4) Instrument transformers (current and voltage), impedance shunts, load management devices, surge arresters, and Type 1 surge-protective devices.
- (5) Conductors used to ~~supply load~~ supply energy, management ~~devices~~ systems, circuits for standby power systems, fire pump equipment, and fire and sprinkler alarms, if provided with service equipment and installed in accordance with requirements for service-entrance conductors.
- (6) Solar photovoltaic systems, fuel cell systems, wind electric systems, energy storage systems, or interconnected electric power production sources, if provided with a disconnecting means listed as suitable for use as service equipment, and overcurrent protection as specified in Part VII of Article 230.
- (7) Control circuits for power-operable service disconnecting means, if suitable overcurrent protection and disconnecting means are provided.
- (8) Ground-fault protection systems or Type 2 surge-protective devices, where installed as part of listed equipment, if suitable overcurrent protection and disconnecting means are provided.
- (9) Connections used only to supply listed communications equipment under the exclusive control of the serving electric utility, if suitable overcurrent protection and disconnecting means are provided. For installations of equipment by the serving electric utility, a disconnecting means is not required if the supply is installed as part of a meter socket, such that access can only be gained with the meter removed.
- (10) Emergency disconnects in accordance with 230.85(B)(2) and (B)(3), if all metal housings and enclosures are grounded in accordance with Part VII and bonded in accordance with Part V of Article 250.
- (11) Meter-mounted transfer switches nominally rated not in excess of 1000 volts that have a short-circuit current rating equal to or greater than the available fault current. A meter-mounted transfer switch shall be listed and be capable of transferring the load served. A meter-mounted transfer switch shall be marked on its exterior with both of the following:
 - (12) Meter-mounted transfer switch
 - (13) Not service equipment
- (14) Control power circuits for protective relays where installed as part of listed equipment, if overcurrent protection and disconnecting means are provided.

Statement of Problem and Substantiation for Public Comment

This public comment is submitted on behalf of the Energy Management Task Group formed under the direction of the Correlating Committee to review all current and proposed definitions and requirements related to load management, load management system, power control system, energy management system and related terms to ensure a coordinated approach throughout the Code. See CN-279.

The task group members are; Chad Kennedy (Chair), Tim Zgonena, Rebekah Hren, Greg Ball, Jason Fisher, Doug Burkett, Robert Jordan, Matthew Grover, Tim Windey, Karl Reighard, and Brian Baughman. This task group of balanced interests provided the expertise to develop these public comments covering energy management across the NEC.

The term "Load Management Devices" is replaced with "Energy Management Systems" to align with the requirements in Article 750 and public comment PC-1034 which removes the definition of Load Management System.

This public comment is part of a series of actions recommended by the task group. See the related public comments which complete this action.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 36-NFPA 70-2021 [Definition: Energy Management System.]	
Public Comment No. 1034-NFPA 70-2021 [Definition: Load Management System.]	
Public Comment No. 1036-NFPA 70-2021 [Definition: Load Management.]	
Public Comment No. 1037-NFPA 70-2021 [Section No. 750.30]	
Public Comment No. 1039-NFPA 70-2021 [Section No. 220.70]	
Public Comment No. 1041-NFPA 70-2021 [Section No. 625.42(A)]	
Public Comment No. 1042-NFPA 70-2021 [Section No. 625.42(B)]	
Public Comment No. 1043-NFPA 70-2021 [Section No. 705.13]	
Public Comment No. 1044-NFPA 70-2021 [Section No. 705.46]	
Public Comment No. 1045-NFPA 70-2021 [Section No. 700.4(C)]	
Public Comment No. 1046-NFPA 70-2021 [Section No. 701.4(C)]	
Public Comment No. 1047-NFPA 70-2021 [Section No. 702.4(B)]	

[Public Comment No. 1048-NFPA 70-2021 \[Section No. 708.22\(B\)\]](#)
[Public Comment No. 1049-NFPA 70-2021 \[Section No. 705.80\]](#)
[Public Comment No. 1050-NFPA 70-2021 \[Section No. 705.28\(A\)\]](#)
[Public Comment No. 1052-NFPA 70-2021 \[Section No. 705.11\(A\)\(1\)\]](#)
[Public Comment No. 1053-NFPA 70-2021 \[Section No. 705.12 \[Excluding any Sub-Sections\]\]](#)
[Public Comment No. 36-NFPA 70-2021 \[Definition: Energy Management System.\]](#)
[Public Comment No. 1034-NFPA 70-2021 \[Definition: Load Management System.\]](#)
[Public Comment No. 1036-NFPA 70-2021 \[Definition: Load Management.\]](#)
[Public Comment No. 1037-NFPA 70-2021 \[Section No. 750.30\]](#)
[Public Comment No. 1039-NFPA 70-2021 \[Section No. 220.70\]](#)
[Public Comment No. 1041-NFPA 70-2021 \[Section No. 625.42\(A\)\]](#)
[Public Comment No. 1042-NFPA 70-2021 \[Section No. 625.42\(B\)\]](#)
[Public Comment No. 1043-NFPA 70-2021 \[Section No. 705.13\]](#)
[Public Comment No. 1044-NFPA 70-2021 \[Section No. 705.46\]](#)
[Public Comment No. 1045-NFPA 70-2021 \[Section No. 700.4\(C\)\]](#)
[Public Comment No. 1046-NFPA 70-2021 \[Section No. 701.4\(C\)\]](#)
[Public Comment No. 1047-NFPA 70-2021 \[Section No. 702.4\(B\)\]](#)
[Public Comment No. 1048-NFPA 70-2021 \[Section No. 708.22\(B\)\]](#)
[Public Comment No. 1049-NFPA 70-2021 \[Section No. 705.80\]](#)
[Public Comment No. 1050-NFPA 70-2021 \[Section No. 705.28\(A\)\]](#)
[Public Comment No. 1052-NFPA 70-2021 \[Section No. 705.11\(A\)\(1\)\]](#)
[Public Comment No. 1053-NFPA 70-2021 \[Section No. 705.12 \[Excluding any Sub-Sections\]\]](#)

Related Item

- [CN-279](#)

Submitter Information Verification

Submitter Full Name: Chad Kennedy
Organization: Schneider Electric
Street Address:
City:
State:
Zip:
Submittal Date: Thu Aug 12 15:07:56 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: [SR-8253-NFPA 70-2021](#)
Statement: The term energy management system is used to maintain consistency and clarity throughout the code.

**Public Comment No. 163-NFPA 70-2021 [Section No. 230.82]****230.82 Equipment Connected to the Supply Side of Service Disconnect.**

Only the following equipment shall be permitted to be connected to the supply side of the service disconnecting means:

- (1) Cable limiters.
- (2) Meters and meter sockets nominally rated not in excess of 1000 volts, if all metal housings and service enclosures are grounded in accordance with Part VII and bonded in accordance with Part V of Article 250.
- (3) Meter disconnect switches nominally rated not in excess of 1000 volts that have a short-circuit current rating equal to or greater than the available fault current, if all metal housings and service enclosures are grounded in accordance with Part VII and bonded in accordance with Part V of Article 250. A meter disconnect switch shall be capable of interrupting the load served. A meter disconnect shall be legibly field marked on its exterior in a manner suitable for the environment as follows:

METER DISCONNECT**NOT SERVICE EQUIPMENT**

- (4) Instrument transformers (current and voltage), impedance shunts, load management devices, surge arresters, and Type 1 surge-protective devices.
- (5) Conductors used to supply load management devices, circuits for standby power systems, fire pump equipment, and fire and sprinkler alarms, if provided with service equipment and installed in accordance with requirements for service-entrance conductors.
- (6) Solar photovoltaic systems, fuel cell systems, wind electric systems, energy storage systems, or interconnected electric power production sources, if provided with a disconnecting means listed as suitable for use as service equipment, installed in accordance with the requirements for service entrance conductors, and overcurrent protection as specified in Part VII of Article 230.
- (7) Control circuits for power-operable service disconnecting means, if suitable overcurrent protection and disconnecting means are provided.
- (8) Ground-fault protection systems or Type 2 surge-protective devices, where installed as part of listed equipment, if suitable overcurrent protection and disconnecting means are provided.
- (9) Connections used only to supply listed communications equipment under the exclusive control of the serving electric utility, if suitable overcurrent protection and disconnecting means are provided. For installations of equipment by the serving electric utility, a disconnecting means is not required if the supply is installed as part of a meter socket, such that access can only be gained with the meter removed.
- (10) Emergency disconnects in accordance with 230.85(B)(2) and (B)(3), if all metal housings and enclosures are grounded in accordance with Part VII and bonded in accordance with Part V of Article 250.
- (11) Meter-mounted transfer switches nominally rated not in excess of 1000 volts that have a short-circuit current rating equal to or greater than the available fault current. A meter-mounted transfer switch shall be listed and be capable of transferring the load served. A meter-mounted transfer switch shall be marked on its exterior with both of the following:
 - (12) Meter-mounted transfer switch
 - (13) Not service equipment
- (14) Control power circuits for protective relays where installed as part of listed equipment, if overcurrent protection and disconnecting means are provided.

Statement of Problem and Substantiation for Public Comment

The revision to (6) in 230.82 will provide needed clarity that the conductors for the supply side connection of Article 705 power production sources have to meet the requirements for service entrance conductors, as these conductors are an extension of the electrical service to a service rated disconnect. The proposed text copies the same requirement for standby systems and fire pumps in (5) and applies it to supply side connection power production sources.

Related Item

- CN 278

Submitter Information Verification

Submitter Full Name: Brian Baughman
Organization: Generac Power Systems Inc.
Street Address:
City:
State:
Zip:
Submission Date: Thu Jul 08 10:05:41 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected
Resolution: The proposed language creates further confusion and does not enhance clarity. The Correlating Committee created a TG of members from CMP-4, -5 and -10 that submitted PC 1098 to make changes to 705.11 that includes clarifying the concerns of the submitter.

**Public Comment No. 1388-NFPA 70-2021 [Section No. 230.85]****230.85 Emergency Disconnects.**

For one- and two-family dwelling units, an emergency disconnecting means shall be installed.

(A) General.**(1) Location.**

The disconnecting means shall be installed in a readily accessible outdoor location on or within sight of the dwelling unit.

Exception: Where the requirements of 225.41 are met, this section shall not apply.

(2) Rating.

The disconnecting means shall have a short-circuit current rating equal to or greater than the available fault current.

(3) Grouping.

If more than one disconnecting means is provided, they shall be grouped.

(B) Disconnects.

Each disconnect shall be one of the following:

(1) Service disconnect

(2) A meter disconnect, ~~integral to the meter mounting equipment~~, not marked as suitable only for use as service equipment, and installed in accordance with 230.82(3)

(3) Other listed disconnect switch or enclosed circuit breaker that is marked suitable for use as service equipment, but not marked as suitable only for use as service equipment, and is installed on the supply side of each service disconnect

Informational Note 1: Conductors between the emergency disconnect and the service disconnect in 230.85(2) and 230.85(3) are service conductors.

Informational Note 2: Equipment marked "Suitable only for use as service equipment" is not appropriate for use as the emergency disconnect in 230.85(B)(3), because it would require the equipment to be modified after leaving the factory, by removing the factory marking "Service Disconnect," and perhaps removing the factory installed bonding jumper, which may be nonremovable.

Exception to (B): A building supplied by a service lateral or by underground service conductors shall be permitted to be capable of disconnection by using a method of providing remote control of the service disconnecting means. The control operator shall be installed at a readily accessible location outside of the dwelling, and be marked "EMERGENCY ELECTRICAL DISCONNECT and NOT SERVICE EQUIPMENT."

(C) Replacement.

Where service equipment is replaced, all of the requirements of this section shall apply.

Exception to (C): Where only meter sockets or service entrance conductors are replaced, the requirements of this section shall not apply.

(D) Identification of Other Emergency Disconnects.

Where emergency disconnects are installed for other systems that are not located adjacent to the emergency disconnect required by this section, a plaque or directory identifying the location of all emergency disconnects shall be located adjacent to the disconnecting means required by this section.

(E) Marking.

The disconnecting means shall marked as follows:

(1) Service disconnect

EMERGENCY DISCONNECT,

SERVICE DISCONNECT

(2) Meter disconnects installed in accordance with 230.82(3) and marked as follows:

EMERGENCY DISCONNECT,

METER DISCONNECT,

NOT SERVICE EQUIPMENT

(3) Other listed disconnect switches or circuit breakers on the supply side of each service disconnect that are marked suitable for use as service equipment and marked as follows:

EMERGENCY DISCONNECT,

NOT SERVICE EQUIPMENT

Markings shall comply with 110.21(B) and both of the following:

(1) The marking or labels shall be located on the outside front of the disconnect enclosure with red background and white text.

(2) The letters shall be at least 13 mm (1/2 in.) high.

Statement of Problem and Substantiation for Public Comment

The requirement in (B)(2) for the disconnect to be an integral part of the meter socket is unsubstantiated and completely unworkable. These switches have always been separate. Note that this commenter was the author of the referred provision of 250.83, as based on extensive usage throughout Massachusetts by state rule for many cycles prior to its final inclusion in the NEC. The editorial work in (B)(3) is based on the fact that the circuit breaker will never carry the marking, only its enclosure. The exception to (B) admittedly introduces an instance where remote control is to be relied upon, and this will be controversial. However, some relief is appropriate in cases where the entire service path is below grade, entering a disconnect in a basement. Remember that the 2023 NEC, courtesy of 230.85(C), will impose the disconnect requirement in conjunction with service changes. This wording avoids routing such service conductors from below grade to above and then back down again in such cases, and allows for a shunt trip as an alternative, but only under the relatively unusual circumstance where the literal building entry is underground. There is precedent for this sort of trade-off; see 230.205(C) which allows for remote control of medium voltage service disconnects in some cases.

Related Item

- FR-7770

Submitter Information Verification

Submitter Full Name: Frederic Hartwell

Organization: Hartwell Electrical Services, Inc.

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 12 13:47:48 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: Informational Note 2 is revised to remove requirements, see SR-8262. The note provides explanatory material related to the mandatory requirement in 230.85(B)(3). All equipment listed and marked "suitable only for service" is marked "Service Disconnect." The equipment could not be applied in accordance with 110.3(b).

**Public Comment No. 883-NFPA 70-2021 [Section No. 230.85]****230.85** Emergency Disconnects.

For one- and two-family dwelling units, an emergency disconnecting means shall be installed.

(A) General.**(1)** Location.

The disconnecting means shall be installed in a readily accessible outdoor location on or within sight of the dwelling unit.

Exception: Where the requirements of 225.41 are met, this section shall not apply.

(2) Rating.

The disconnecting means shall have a short-circuit current rating equal to or greater than the available fault current.

(3) Grouping.

If more than one disconnecting means is provided, they shall be grouped.

(B) Disconnects.

Each disconnect shall be one of the following:

(1) Service disconnect**(2)** A meter disconnect integral to the meter mounting equipment not marked as suitable only for use as service equipment installed in accordance with 230.82(3)**(3)** Other listed disconnect switch or circuit breaker that is marked suitable for use as service equipment, but not marked as suitable only for use as service equipment, installed on the supply side of each service disconnect

Informational Note 1: Conductors between the emergency disconnect and the service disconnect in 230.85(2) and 230.85(3) are service conductors.

Informational Note 2: Equipment marked "Suitable only for use as service equipment" is not appropriate for use as the emergency disconnect in 230.85(B)(3), because it would require the equipment to be modified after leaving the factory, by removing the factory marking "Service Disconnect," and perhaps removing the factory installed bonding jumper, which may be nonremovable.

(C) Replacement.

Where service equipment is replaced, all of the requirements of this section shall apply.

Exception to (C): Where only meter sockets or service entrance conductors are replaced, the requirements of this section shall not apply.

(D) Identification of Other Emergency Disconnects.

Where emergency disconnects are installed for other systems that are not located adjacent to the emergency disconnect required by this section, a plaque or directory identifying the location of all emergency disconnects shall be located adjacent to the disconnecting means required by this section.

(E) Marking.

The disconnecting means shall marked as follows:

(1) Service disconnect

EMERGENCY DISCONNECT,
SERVICE DISCONNECT

(2) Meter disconnects installed in accordance with 230.82(3) and marked as follows:

EMERGENCY DISCONNECT,
METER DISCONNECT,
NOT SERVICE EQUIPMENT

(3) Other listed disconnect switches or circuit breakers on the supply side of each service disconnect that are marked suitable for use as service equipment and marked as follows:

EMERGENCY DISCONNECT,
NOT SERVICE EQUIPMENT

Markings shall comply with 110.21(B) and both of the following:

(1) The marking or labels shall be located on the outside front of the disconnect enclosure with red background and white text.**(2)** The letters shall be at least 13 mm (1/2 in.) high.**Additional Proposed Changes**

<u>File Name</u>	<u>Description Approved</u>
10_CN_312_Detail.pdf	70_CN312

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 312 appeared in the First Draft Report on First Revision No. 8300.

The Correlating Committee directs the panel to review Informational Note No. 2 and consider revising the text into a mandatory requirement.

Related Item

- First Revision No. 8300

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC

Organization: NEC Correlating Committee

Street Address:

City:

State:
Zip:
Submittal Date: Wed Aug 04 15:35:17 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: [SR-8262-NFPA 70-2021](#)
Statement: Informational Note 2 is revised to remove requirements. The note provides explanatory material related to the mandatory requirement is in 230.85(B)(3). All equipment listed and marked "suitable only for service" is marked "Service Disconnect." The equipment could not be applied in accordance with 110.3(b).



Correlating Committee Note No. 312-NFPA 70-2021 [Detail]

Submitter Information Verification

Committee: NEC-P10

Submittal Date: Thu May 06 15:12:47 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs the panel to review Informational Note No. 2 and consider revising the text into a mandatory requirement.

[First Revision No. 8300-NFPA 70-2020 \[Detail\]](#)

Ballot Results

✓ **This item has passed ballot**

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

Affirmative All

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

**Public Comment No. 4-NFPA 70-2021 [New Section after 230.85(A)(1)]****Informational Note**

Some overcurrent protective devices have temperature limitations that restrict their use in low temperature applicaitons.

Statement of Problem and Substantiation for Public Comment

This was PI 2021 that was resolved by the panel at the first draft stage. The panel statement indicated that this information is found in the installation instructions and compliance is required by 110.3(B). I agree with that, but in cases where such instructions are not well know or complied with this code has taken action to ensure compliance. In at least two cases that action has been to make the manufacturer's instructions actual code rules. Those two are the termination torque rules in 110.14(D) and the rule for grounded conductor panelboard terminations in 408.41. In both cases these were long standing listing and labeling instructions that were not being followed in the field because many don't read those instructions. Also in both cases failure to comply with those rules could result in a safety issue. That is also the case with the installation of overcurrent devices in low ambient temperatures. The low temperature shifts the trip point of thermal OCPDs. In my are the shift point would be at least 25% higher than the rated trip point of the device for a bit over 5 months of the year based on the average high temperature being less than 50°F for that time. The instructions for some devices say they are not for use in an ambient below 14°F. A outdoor temperature that is common in many areas. This is a case where the listing and labeling instructions are not well known, and we need to draw attention to them.

Related Item

- PI-2021

Submitter Information Verification

Submitter Full Name: Don Ganiere

Organization: [Not Specified]

Street Address:

City:

State:

Zip:

Submittal Date: Tue Jun 29 10:49:06 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: Numerous environmental considerations must be given to all electrical components in a service entrance installation. The installation instructions must be consulted for all necessary environmental considerations in accordance with NEC 110.3(B). The NEC style manual requires the committee to consider the need for informational notes in accordance with paragraph 3.1.3.

**Public Comment No. 1859-NFPA 70-2021 [Section No. 230.85(A)(1)]****(1) Location.**

The disconnecting means shall be installed in a readily accessible outdoor location- ~~on or within sight of the dwelling unit~~ .

Exception:

~~Where~~

Where the requirements of 225.41 are met, this section shall not apply.

Statement of Problem and Substantiation for Public Comment

Remove "on or within sight of the dwelling unit"

Basically, FR-7770 item (A)(1) negates section 225.32 Location for dwelling units.

When a remote service or single distribution point is installed on the property and feeder is run under the slab into an equipment room inside the dwelling meeting section 230.6, or a feeder using a conduit body and nipple in the back of a panelboard inside the nearest the point of entrance of the conductors into a dwelling unit, this is no longer allowed because of FR-7770 item (A)(1).

Now a disconnect will be installed either within 50 feet and within sight or mounted directly on the dwelling.

It seems likely and possible a first responder could, even in an emergency situation, find a single service point on the property which is already required by 230.85.

In removing 230.85(A)(1), a service disconnect is still proved for the first responder.

Considering there is no clear panel statement as to why the emergency disconnect needs to be visible and not more than 50 ft distant from the dwelling, why is there is a problem with using section 225.32 scenarios described in the first paragraph.

PI-1973 and PI-2019 "MAY NOT be aware" and "MAY BE difficult for first responders"

Is there a fact-finding report, recognized technical validation, or other actual documentation to corroborate "MAY BE difficult for first responders?"

FR-7770 item (A)(1) appears that this may also be modifying 90.1 Purpose. (B) Adequacy.
"but not necessarily convenient"

At a minimum this portion of the first revision FR-7770 item (A)(1) should be put on hold for further contemplation (unintended consequences.) Such as NEC section 210.8(F)

Related Item

- PC-1841

Submitter Information Verification

Submitter Full Name: Gary Jones

Organization: Self

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 18 11:45:50 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The location is established to ensure a first responder can easily disconnect power.

**Public Comment No. 1075-NFPA 70-2021 [Section No. 230.85(B)]****(B) Disconnects.**

Each disconnect shall be one of the following:

- (1) Service disconnect
- (2) A meter disconnect integral to the meter mounting equipment not marked as suitable only for use as service equipment installed in accordance with 230.82(3)
- (3) Other listed disconnect switch or circuit breaker with an ampere rating meeting or exceeding the service disconnect that is marked "suitable for use as service equipment", but not or marked as "suitable only for use as service equipment, installed on the supply side of each service disconnect " when the "Service Disconnect" label has been adequately covered by the appropriate "Emergency Disconnect, Not Service Disconnect" label.

Informational Note 1: Conductors between the emergency disconnect and the service disconnect in 230.85(2) and 230.85(3) are service conductors.

Informational Note 2: ~~Equipment marked "Suitable only for use as service equipment" is not appropriate for use as the emergency disconnect in 230.85(B)(3), because it would require the equipment to be modified after leaving the factory, by removing the factory marking "Service Disconnect," and perhaps removing the factory installed bonding jumper, which may be nonremovable.~~

Statement of Problem and Substantiation for Public Comment

The bond screw should be installed at this location, informational note confuses the issue by implying that the bond screw should not be installed here. A minor labelling change should be allowed by the NEC to allow for equipment that is likely to become more common, and more financially prudent. Where a circuit breaker is used it logically must be as big or bigger than the service disconnecting means.

Related Item

- Public Input No. 3366-NFPA 70-2020 [Section No. 230.85]

Submitter Information Verification

Submitter Full Name: Timothy Kunkel

Organization: Tim Kunkel Electric

Street Address:

City:

State:

Zip:

Submittal Date: Mon Aug 09 00:24:08 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: Placing a label over another label can expose the potential for the new information label being readily removed or coming off over time establishing potential confusion. The ampere rating of the disconnect is addressed in 404.14.

**Public Comment No. 1485-NFPA 70-2021 [Section No. 230.85(B)]****(B) Disconnects.**

Each disconnect shall be one of the following:

- (1) Service disconnect
- (2) A meter ~~disconnect integral to the meter mounting equipment not~~ disconnect not marked as suitable only for use as service equipment installed in accordance with 230.82(3)
- (3) Other listed disconnect switch or circuit breaker that is marked suitable for use as service equipment, but not marked as suitable only for use as service equipment, installed on the supply side of each service disconnect

Informational Note 1: Conductors between the emergency disconnect and the service disconnect in 230.85(2) and 230.85(3) are service conductors.

Informational Note 2: Equipment marked "Suitable only for use as service equipment" is not appropriate for use as the emergency disconnect in 230.85(B)(3), because it would require the equipment to be modified after leaving the factory, by removing the factory marking "Service Disconnect," and perhaps removing the factory installed bonding jumper, which may be nonremovable.

Statement of Problem and Substantiation for Public Comment

This comment seeks to remove the First Draft text related to internal devices.

Meter disconnect switches are usually installed to meet the serving utility's requirements. They are normally installed ahead of the meter enclosure so the metering equipment can be deenergized while utility company employees are inserting or removing meters, etc. Occasionally they are installed after the meter enclosure so meters are not removed under load. Therefore, this section should not specify a location. The internal devices are generally meter bypass devices and are not intended to be used as a disconnecting means or in this case as the meter disconnect recognized in 230.82. Even if the internal device is a disconnecting means, having to open the enclosure while it is energized to access it defeats the main purpose of installing a meter disconnect.

Related Item

- FR 7770

Submitter Information Verification

Submitter Full Name: Mark Hilbert

Organization: MR Hilbert Electrical Inspections and Training

Street Address:

City:

State:

Zip:

Submittal Date: Sun Aug 15 11:03:09 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: Informational Note 2 is revised to remove requirements, see SR-8262. The note provides explanatory material related to the mandatory requirement is in 230.85(B)(3). All equipment listed and marked "suitable only for service" is marked "Service Disconnect." The equipment could not be applied in accordance with 110.3(b).

**Public Comment No. 1227-NFPA 70-2021 [Section No. 230.85(C)]****(C) Replacement.**

Where service equipment is replaced, all of the requirements of this section shall apply.

Exception to (C): Where only ~~meter-sockets or service-entrance conductors are replaced~~ items on the line side of the service disconnect are repaired or replaced, the requirements of this section shall not apply.

Statement of Problem and Substantiation for Public Comment

The text as existing does not allow for replacement of items like conduit, weatherheads, connectors etc... If a meter socket is replaced other associated items will or should be replaced, and if not allowed for will lead to the reuse of material that is compromised.

Related Item

- First Revision No. 8301-NFPA 70-2020 [Detail]

Submitter Information Verification

Submitter Full Name: Timothy Kunkel

Organization: Tim Kunkel Electric

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 11 00:01:07 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8265-NFPA 70-2021](#)

Statement: Maintenance or repair such as replacing storm damaged service entrance conductors or raceways or fittings should not trigger the requirement for the addition of an emergency disconnect.

**Public Comment No. 1137-NFPA 70-2021 [Section No. 230.85(D)]****(D) Identification of Other Emergency Disconnects, Shutdown Devices, and Remote-Control Devices .**

Where emergency disconnects- ~~are~~ , shutdown devices, or remote-control devices are installed for other systems that are not located adjacent to the emergency disconnect required by this section, a plaque or directory identifying the location of all emergency disconnects- ~~shall~~ , shutdown devices, or remote-control devices shall be located adjacent to the disconnecting means required by this section.

Statement of Problem and Substantiation for Public Comment

The inclusion of shutdown devices and remote control devices in 230.85(D) is for correlation purposes with 445.19 for generator prime mover shutdown devices, 480.7(B) for standby batteries, and 706.15 for remote control shutdown devices for an ESS. The FR as currently written could be interpreted as only requiring the system disconnecting means to meet the requirement of 230.85(D), which I do not believe was the intent of the FR.

Related Item

• FR 8302 • FR 9028 • FR 9086

Submitter Information Verification

Submitter Full Name: Brian Baughman

Organization: Generac Power Systems Inc.

Street Address:

City:

State:

Zip:

Submittal Date: Tue Aug 10 10:11:33 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8268-NFPA 70-2021](#)

Statement: The language has been revised to address the identification for isolation means of other energy sources. An information note is also added to provide guidance of energy source isolation requirements.

**Public Comment No. 1556-NFPA 70-2021 [Section No. 230.85(E)]****(E) Marking.**

The equipment containing the disconnecting means shall be marked as follows:

(1) Service disconnect

EMERGENCY DISCONNECT,

SERVICE DISCONNECT

(2) Meter disconnects installed in accordance with 230.82(3) ~~and marked as follows:~~

EMERGENCY DISCONNECT,

METER DISCONNECT,

NOT SERVICE EQUIPMENT

(3) Other listed disconnect switches or circuit breakers on the supply side of each service disconnect that are marked suitable for use as service equipment ~~and marked as follows :~~

EMERGENCY DISCONNECT,

NOT SERVICE EQUIPMENT

Markings shall comply with 110.21(B) and both of the following:

- (1) The marking ~~or labels~~ specified in this section shall be located on the outside front of the disconnect enclosure with red background and white text.
- (2) The letters shall be at least 13 mm (1/2 in.) high.

Informational Note: See 230.70(B) for information on marking service disconnects.

Statement of Problem and Substantiation for Public Comment

The requirements in this section should be revised for clarity and alignment with other code sections. In item (1) the marking of "SERVICE DISCONNECT" is redundant with the requirements in 230.70(B). Similarly, for item (2), the marking "METER DISCONNECT" and "NOT SERVICE EQUIPMENT" is redundant with 230.82(3). The location of the marking should also align with 230.82(3), 230.70(B) and existing product standards. The marking of service disconnects has traditionally meant to identify each service disconnect individually with a label next to the handle. Providing a marking on the outside of the enclosure creates confusion and a potential to mistakenly operate a breaker other than the service disconnect.

Related Item

- FR 7770

Submitter Information Verification

Submitter Full Name: Megan Hayes

Organization: Nema

Street Address:

City:

State:

Zip:

Submittal Date: Mon Aug 16 13:56:41 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Rejected

Action:

Resolution: The proposed language does not add clarity to 230.85(E). The existing language is necessary to clarify to the NEC user what language for signage can be used for different types of disconnects being used as emergency disconnects.

**Public Comment No. 1555-NFPA 70-2021 [Section No. 230.91]****230.91** Location.**(A)** General.

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

(B) ~~Separate Enclosure.~~

~~Services over 150 volts to ground and not over 1000 volts phase-to-phase that include fuses rated 1600 amperes or higher, or circuit breakers where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated or can be adjusted is 1600 amperes or higher, the service disconnecting means and overcurrent device shall be located in a separate enclosure from feeder or branch circuit overcurrent devices.~~

Statement of Problem and Substantiation for Public Comment

The new requirements added by FR 7778 as a new 230.91(B) should not be included in the Code at this time. As drafted, the language will not only result in an increase in the number of conductor terminations, but will also present difficulties in achieving common equipment configurations such as Main-Tie-Main line-ups.

FR 7778 was created in response to PI 4261. The focus of PI 4261 was an arc energy protection method for the line side of the service disconnect which is currently not addressed within the NEC. The inclusion of separate enclosure requirements as shown in 230.91(B) does not address the line side arc energy exposure at the service disconnect.

The industry needs additional time to determine the line side arc energy reduction protection level and evaluation criteria before including any requirements within the NEC. 230.62(C) already requires barriers in service equipment so that no uninsulated, ungrounded service conductors are exposed to inadvertent contact while servicing load terminations with the service disconnect is in the open position. Further expansion of this requirement as drafted in 230.91(B) is not necessary at this time as it introduces complexities in common system configurations and does not alter the line side arc energy exposure at the service disconnect.

Related Item

- FR 7778

Submitter Information Verification

Submitter Full Name: Megan Hayes

Organization: Nema

Street Address:

City:

State:

Zip:

Submittal Date: Mon Aug 16 13:52:23 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8453-NFPA 70-2021

Statement: The requirements in 230.91(B) are removed to align with the existing requirement for line side barriers in 230.62(C) and the lack of substantiation that the line side arc flash hazard is reduced. The line side barriers reduce the likelihood of an event initiating on the line side.

The heading to 230.91(A) was removed to comply with the NFPA Manual of Style.

**Public Comment No. 1681-NFPA 70-2021 [Section No. 230.91(B)]**

~~(B)– Separate Enclosure.~~

~~Services over 150 volts to ground and not over 1000 volts phase-to-phase that include fuses rated 1600 amperes or higher, or circuit breakers where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated or can be adjusted is 1600 amperes or higher, the service disconnecting means and overcurrent device shall be located in a separate enclosure from feeder or branch circuit overcurrent devices.~~

Statement of Problem and Substantiation for Public Comment

The revisions made in FR-7778 do not address the line side safety exposure from arc flash and arc blast events. The expelled materials during an arc flash event are electrically conductive and the pressure generated within enclosures during these events can push these in unexpected ways. There are safety concerns for personnel within the arc flash boundary as well as pathways for arc propagation due to deformation of equipment enclosures and barriers from internal pressure. Equipment testing has demonstrated the need for evaluating for performance under internal arcing conditions. Enclosures and barriers for standard equipment do not provide protection from arc flash events.

Arc resistant equipment requires special construction to force the arc energy into known paths and contain the energy away from the worker.

This revision would suggest that standard equipment can provide this level of protection but testing has demonstrated this is not the case. The requirements included in FR-7778 should be removed to allow the industry to focus on the development of protection levels and evaluation criteria for the line side in service equipment.

Related Item

- FR-7778

Submitter Information Verification

Submitter Full Name: Chad Kennedy

Organization: Schneider Electric

Street Address:

City:

State:

Zip:

Submittal Date: Tue Aug 17 11:09:07 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8453-NFPA 70-2021](#)

Statement: The requirements in 230.91(B) are removed to align with the existing requirement for line side barriers in 230.62(C) and the lack of substantiation that the line side arc flash hazard is reduced. The line side barriers reduce the likelihood of an event initiating on the line side.

The heading to 230.91(A) was removed to comply with the NFPA Manual of Style.

**Public Comment No. 1870-NFPA 70-2021 [Section No. 230.91(B)]****(B)– Separate Enclosure.**

Services over 150 volts to ground and not over 1000 volts phase-to-phase that include fuses rated 1600 amperes or higher, or circuit breakers where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated or can be adjusted is 1600 amperes or higher, the service disconnecting means and overcurrent device shall be located in a separate enclosure from feeder or branch circuit overcurrent devices.

Statement of Problem and Substantiation for Public Comment

No substantiation was provided to require the main disconnecting means to be in a separate enclosure. Providing a 1600 A service disconnect in a separate enclosure is not just an additional cost concern, often the electrical room/real estate does not have space for an additional disconnect of this size. No field evidence of problems was provided.

Related Item

- FR 7778

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz

Organization: NECA

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 18 13:11:41 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8453-NFPA 70-2021

Statement: The requirements in 230.91(B) are removed to align with the existing requirement for line side barriers in 230.62(C) and the lack of substantiation that the line side arc flash hazard is reduced. The line side barriers reduce the likelihood of an event initiating on the line side.

The heading to 230.91(A) was removed to comply with the NFPA Manual of Style.

**Public Comment No. 373-NFPA 70-2021 [Section No. 230.91(B)]****(B) Separate Enclosure.**

Services over 150 volts to ground and not over 1000 volts phase-to-phase that include fuses rated 1600 amperes or higher, or circuit breakers where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated or can be adjusted is 1600 amperes or higher, the service disconnecting means and overcurrent device shall be located in a separate enclosure from feeder or branch circuit overcurrent devices.

Exception No. 1: Switchboards or metal enclosed switchgear which has fully barriered main terminals or sheet-metal enclosed sections shall not be required to further separate the main from the branch circuit overcurrent devices.

Exception No. 2: Switchboards or switchgear employing arc energy reduction methods in accordance with 240.67 or 240.87 shall not be required to comply with this requirement.

Statement of Problem and Substantiation for Public Comment

This highly prescriptive text, today, does not acknowledge the different constructions of switchboards or switchgear which have fully barriered main terminals/lugs where an arc flash in an adjacent section of the switchgear is prevented by the enclosure design from propagating to the line side terminals. Furthermore, 240.67 and 240.87 allow many arc energy reduction methods to reduce the arc energy present at the equipment and no consideration is given to these, which could include an energy-reducing active arc flash mitigation system. There are numerous methods which can be employed here and the undefined term "separate enclosure" is problematic and overly prescriptive.

Related Item

- FR-7778

Submitter Information Verification

Submitter Full Name: Richard Holub

Organization: The DuPont Company, Inc.

Street Address:

City:

State:

Zip:

Submittal Date: Mon Jul 26 09:47:19 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The public comments were adding exceptions to 230.91(B) which was deleted by SR-8453.

**Public Comment No. 418-NFPA 70-2021 [Section No. 230.91(B)]****(B) Separate Enclosure.**

Services over 150 volts to ground and not over 1000 volts phase-to-phase that include fuses rated 1600 amperes or higher, or circuit breakers where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated or can be adjusted is 1600 amperes or higher, the service disconnecting means and overcurrent device shall be located in a separate enclosure from feeder or branch circuit overcurrent devices.

Exception: Where all sections of the service equipment are marked as "No Energized Work Permitted, Service Must be Deenergized Before Work is Permitted" shall not require the service disconnecting means and overcurrent device to be located in a separate enclosure from feeder or branch circuit overcurrent devices.

Statement of Problem and Substantiation for Public Comment

If the service entrance is deenergized then providing an isolated section for the the service disconnecting means and overcurrent device provides no additional safety when working on the equipment and a significant increase in the space required for the service entrance installation. While this will usually require a utility shutdown to isolate the service entrance equipment it is a valid alternative that provides the same level of safety. Where energized work is required a separate sections will be required.

Related Item

• PI 4261-NFPA 70-2020 • FR 7778-NFPA 70-2020

Submitter Information Verification

Submitter Full Name: Marvin Hamon

Organization: [Not Specified]

Street Address:

City:

State:

Zip:

Submittal Date: Tue Jul 27 11:22:13 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The public comment was adding exceptions to 230.91(B) which was deleted by SR-8453.

**Public Comment No. 1871-NFPA 70-2021 [Section No. 230.95]****230.95** Ground-Fault Protection of Equipment.

Ground-fault protection of equipment shall be provided for solidly grounded wye electric services of more than 150 volts to ground but not exceeding 1000 volts phase-to-phase for each service disconnect rated ~~800 amperes~~ 1000 amperes or more. The grounded conductor for the solidly grounded wye system shall be connected directly to ground through a grounding electrode system, as specified in 250.50, without inserting any resistor or impedance device.

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

Exception: The ground-fault protection provisions of this section shall not apply to a service disconnect for a continuous industrial process where a nonorderly shutdown will introduce additional or increased hazards.

(A) Setting.

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

(B) Fuses.

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

(C) Performance Testing.

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

Informational Note No. 1: Ground-fault protection that functions to open the service disconnect affords no protection from faults on the line side of the protective element. It serves only to limit damage to conductors and equipment on the load side in the event of an arcing ground fault on the load side of the protective element.

Informational Note No. 2: This added protective equipment at the service equipment may make it necessary to review the overall wiring system for proper selective overcurrent protection coordination. Additional installations of ground-fault protective equipment may be needed on feeders and branch circuits where maximum continuity of electric service is necessary.

Informational Note No. 3: Where ground-fault protection is provided for the service disconnect and interconnection is made with another supply system by a transfer device, means or devices may be needed to ensure proper ground-fault sensing by the ground-fault protection equipment.

Informational Note No. 4: See 517.17(A) for information on where an additional step of ground-fault protection is required for hospitals and other buildings with critical areas or life support equipment.

Statement of Problem and Substantiation for Public Comment

No technical substantiation was provided to reduce the threshold for the requirement for GFPE on solidly grounded wye services of more than 150 volts to ground. No field evidence was provided.

Related Item

• FR 8196

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz

Organization: NECA

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 18 13:14:09 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Accepted

Resolution: SR-8703-NFPA 70-2021

Statement: No technical substantiation was provided to reduce the threshold for the requirement for GFPE on solidly grounded wye services of more than 150 volts to ground. No field evidence was provided.



Public Comment No. 326-NFPA 70-2021 [Section No. 230.95 [Excluding any Sub-Sections]]

Ground-fault protection of equipment shall be provided for solidly grounded wye electric services of more than 150 volts to ground but not exceeding 1000 volts phase-to-phase for each service disconnect rated 800 amperes or more. The grounded conductor for the solidly grounded wye system shall be connected directly to ground through a grounding electrode system, as specified in 250.50, without inserting any resistor or impedance device.

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

Exception No. 1: The ground-fault protection provisions of this section shall not apply to a service disconnect for a continuous industrial process where a nonorderly shutdown will introduce additional or increased hazards.

Exception No. 2: For fused disconnects, where the available fault current is 10,000 amperes or greater, the ground-fault protection provisions of this section shall not apply if the fuses have a clearing time of 0.07 seconds or less at the lower of the calculated minimum available arcing current or 38% of the available fault current, or if the disconnect switch complies with Section 240.67(B)(1), 240.67(B)(3), or 240.67(B)(4), and is set to operate at the lower of the calculated minimum arcing current or 38% of the available fault current.

Exception No. 3: For circuit breakers, where the available fault current is 10,000 amperes or greater, the ground-fault protection provisions of this section shall not apply if the circuit breaker complies with Section 240.87(B)(2), 240.87(B)(4), 240.87(B)(5), or 240.87(B)(6), and is set to operate at the lower of the calculated minimum arcing current or 38% of the available fault current.

Statement of Problem and Substantiation for Public Comment

A sincere "Thank You" goes to Code Making Panels 2 and 10 for discovering the flaw with Public Inputs 693, 694, 695, and 696. The Panels stated: "Substantiation was not provided to support the equivalency of alternate technologies. As an example, it is possible that alternate systems could be set such that they might provide arc energy reduction, but not operate during a lower level ground fault where traditional GFPE will provide protection." To rectify this flaw, this Public Comment has added the requirement that the methods to reduce clearing time operate at the lower of the calculated minimum arcing current or 38% of the available fault current. While an arcing fault from phase to ground is almost certainly going to escalate into a three phase arcing fault, it is possible that the arcing fault could remain as a phase to ground arcing fault. When this occurs, it has been shown, in numerous IEEE papers, that the minimum phase to ground arcing fault, on a 480/277 volt, solidly grounded system, must be at least 38% of the available fault current in order to sustain the arc. With this requirement added in, it is assured that the method to reduce clearing time will function to clear the circuit.

In addition to this requirement, and to add even more conservatism, this Public Comment has added a minimum available fault current of 10,000 amperes to the proposed requirement. Based on a 32mm spacing, 480 volts, and HCB configuration, IEEE 1584-2018 calculates the minimum arcing current to be 6.09 kA for an available (bolted) fault current of 10,000 amperes. The minimum arcing current of 6.09 KA is 5 times the maximum 1200 ampere setting and 2 times the 3000 ampere value used with the one second maximum delay. (NEC 230.95(A) allows for a maximum setting of 1200 amperes and a maximum time delay of 1 second at 3000 amperes or greater.) The 6.09 KA current for 60 cycles produces an expected equipment damage level of 36,540 KW-Cycles (6.09KA X 100 arcing volts X 60 cycles). In contrast, this Public Comment would provide a worst case, expected equipment damage level of only 4,263 KW-Cycles. Yes, that is correct, the proposed exception would allow less than 12% of the damage level allowed by the existing 230.95(A) requirements.

The following paragraphs provide a detailed comparison of expected equipment damage levels allowed by 230.95(A), proposed exceptions for fusible switches (240.67), and proposed exceptions for circuit breakers (240.87).

Expected Equipment Damage from 230.95(A)

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 10kA, the IEEE 1584-2018 arcing current is 7.07kA with a minimum arcing current of 6.09kA. Using the maximum 230.95(A) opening time of 60 cycles, the expected equipment damage is 36,540 kW-cycles.

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 25kA, the IEEE 1584-2018 arcing current is 17.64kA with a minimum arcing current of 15.21kA. Using the maximum 230.95(A) opening time of 60 cycles, the expected equipment damage is 91,260 kW-cycles.

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 50kA, the IEEE 1584-2018 arcing current is 30.14kA with a minimum arcing current of 25.98kA. Using the maximum 230.95(A) opening time of 60 cycles, the expected equipment damage is 155,880 kW-cycles.

Expected Equipment Damage from Proposed Exceptions for Fusible Switches (240.67)

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 10kA, the IEEE 1584-2018 arcing current is 7.07kA with a minimum arcing current of 6.09kA. Assuming an opening time of 4 cycles for 240.67(B), the expected equipment damage is 2,436 kW-cycles. Assuming an opening time of 7 cycles for 240.67(B)(1) or (B)(3), the expected equipment damage is 4,263 kW-cycles. Assuming an opening time of 1/2 cycle for 240.67(B)(4), the expected equipment damage is 305 kW-cycles. Worst case damage (4,263 kW-cycles) is less than 12% of the damage allowed by 230.95(A) (36,540 kW-cycles).

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 25kA, the IEEE 1584-2018 arcing current is 17.64kA with a minimum arcing current of 15.21kA. Assuming an opening time of 4 cycles for 240.67(B), the expected equipment damage is 6,084 kW-cycles. Assuming an opening time of 7 cycles for 240.67(B)(1) or (B)(3), the expected equipment damage is 10,647 kW-cycles. Assuming an opening time of 1/2 cycle for 240.67(B)(4), the expected equipment damage is 761 kW-cycles. Worst case damage (10,647 kW-cycles) is less than 12% of the damage allowed by 230.95(A) (91,260 kW-cycles).

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 50kA, the IEEE 1584-2018 arcing current is 30.14kA with a minimum arcing current of 25.98kA. Assuming an opening time of 4 cycles for 240.67(B), the expected equipment damage is 10,392 kW-cycles. Assuming an opening time of 7 cycles for 240.67(B)(1) or (B)(3), the expected equipment damage is 18,186 kW-cycles. Assuming an opening time of 1/2 cycle for 240.67(B)(4), the expected equipment damage is 1,299 kW-cycles. Worst case damage (18,186 kW-cycles) is less than 12% of the damage allowed by 230.95(A) (155,880 kW-cycles).

Expected Equipment Damage from Proposed Exceptions for Circuit Breakers (240.87)

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 10kA, the IEEE 1584-2018 arcing current is 7.07kA with a minimum arcing current of 6.09kA. Assuming an opening time of 4 cycles for 240.87(B)(1), (B)(2), or (B)(4), the expected equipment damage is 2,436 kW-cycles. Assuming an opening time of 3 cycles for 240.87(B)(5) or (B)(6), the expected equipment damage is 1,827 kW-cycles. Worst case damage (2,426 KW-Cycles) is less than 7% of the damage allowed by 230.95(A) (36,540 kW-cycles).

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 25kA, the IEEE 1584-2018 arcing current is 17.64kA with a minimum arcing current of 15.21kA. Assuming an opening time of 4 cycles for 240.87(B)(1), (B)(2), or (B)(4), the expected equipment damage is 6,084 kW-cycles. Assuming an opening time of 3 cycles for 240.87(B)(5) or (B)(6), the expected equipment damage is 4,563 kW-cycles. Worst case damage (6,084 KW-Cycles) is less than 7% of the damage allowed by 230.95(A) (91,260 kW-cycles).

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 50kA, the IEEE 1584-2018 arcing current is 30.14kA with a minimum arcing current of 25.98kA. Assuming an opening time of 4 cycles for 240.87(B)(1), (B)(2), or (B)(4), the expected equipment damage is 10,392 kW-cycles. Assuming an opening time of 3 cycles for 240.87(B)(5) or (B)(6), the expected equipment damage is 7,794 kW-cycles. Worst case damage (10,392 KW-Cycles) is less than 7% of the damage allowed by 230.95(A) (155,880 kW-cycles).

Other Change from Public Input Stage

The other change that is made from the original Public Input is that the text lists the methods that can be used rather than the methods that cannot be used.

Background from Public Input Stage

A requirement (230.95) for ground fault protection of equipment (GFPE) was added to the 1971 NEC® because 480/277 volt, solidly grounded wye services, protected by 1000 ampere and larger overcurrent protective devices, were burning down due to arcing faults. 208/120 volt services and those services protected by smaller overcurrent protective devices were not burning down, so they weren't included in the new requirement. Over many Code cycles, GFPE requirements were also added for branch circuits (210.13), feeders (215.10), and equipment (240.13). In all cases, the intent was to limit damage to the switchboard, switchgear, panelboard or equipment, not the downstream conductors or busway.

The electrical industry has evolved considerably since those early GFPE requirements were introduced. IEEE 1584 now predicts the magnitude of the arcing current along with the incident energy to which a worker could be exposed while working on energized equipment. It has become clearly evident that the level of protection necessary to protect an employee is orders of magnitude greater than that required to protect equipment.

Energy reducing maintenance switches (240.67(B)(2) and 240.87(B)(3)) are excluded because energy-reducing maintenance switches are typically turned off when a worker is not working on energized equipment, whereas ground fault protection is constantly protecting the equipment, whether or not a worker is working on the energized equipment.

The Approved Equivalent Means (240.67(B)(5) and 240.87(B)(7)) are excluded because the opening times for these methods are unknown at this time.

Key Benefit

One very key benefit of this Public Comment is that when these alternate methods are utilized, it provides the consulting engineer with significantly more design options to meet the selective coordination requirements of 700.32, 701.32, and 708.54. This becomes especially important now, because it appears that GFPE will be required at 800 amperes and above, rather than 1000 amperes and above, making selective coordination even more challenging for the consulting engineer.

Conclusion

This Public Comment takes advantage of the arc-energy reduction requirements found in 240.67 and 240.87. It provides an exception for GFPE requirements whenever specific 240.67 and 240.87 methods to reduce clearing time are utilized. The methods to reduce clearing time will limit the arcing fault damage to the equipment to a level that is considerably less than currently allowed by the requirements found in 230.95(A).

Related Item

- PI 693

Submitter Information Verification

Submitter Full Name: Vincent Saporita
Organization: Saporita Consulting
Affiliation: Saporita Consulting
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jul 21 21:33:09 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected
Resolution: Arc flash protection is primarily for the protection of personnel and, secondarily, for the protection of equipment. Arc flash protection may or may not open under a ground fault condition depending on the protection scheme design. Ground fault protection is not considered in incident energy calculations as provided in NFPA70E and IEEE1584. Additional protection means to reduce arc flash hazards are considered in 240.67 or 240.87 and should not impact the use of ground fault protection identified in 230.95.



Public Comment No. 1244-NFPA 70-2021 [Article 231]

Article 231— Electric Power Sources Interconnected with an Electric Utility

Part I.— General

231.1— Scope.

This article covers installation of one or more power production equipment or energy storage systems operating in parallel with a utility source. This article does not include on-site electrical power source(s) that do not operate in parallel with the electric utility.

Informational Note: For further information, see IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power System Interfaces*.

231.6— Equipment Approval.

All equipment shall be identified for the intended use. Power production equipment and energy storage systems intended to operate in parallel with electric power production sources shall be listed for interactive function or be evaluated for interactive function and have a field label applied, or both.

Informational Note: Examples of power production sources include interactive inverters, engine generators, and wind turbines.

231.8— System Installation.

Installation of one or more power production equipment or energy storage systems operating in parallel with the electric utility shall be performed only by qualified persons.

231.10— Identification of Power Sources.

A permanent plaque or directory shall be installed at each service equipment location or at an approved readily visible location. The plaque or directory shall denote the location of each power production equipment or energy storage system disconnecting means for the building or structure and be grouped with other plaques or directories for other on-site sources. The plaque or directory shall be marked with the wording CAUTION: MULTIPLE SOURCES OF POWER. Any posted diagrams shall be correctly oriented with respect to the diagram's location. The marking shall comply with 110.21(B).

Exception: Installations with multiple co-located power production sources shall be permitted to be identified as a group(s). The plaque or directory shall not be required to identify each power source individually.

231.11— Supply-Side Service Connections.

Power production equipment and energy storage systems shall be permitted to be connected to the supply side of the service disconnecting means in accordance with 230.82(6) and shall comply with 231.11(A) through (G).

(A)— Minimum Size and Ampacity.

The sum of the connected power production equipment and energy storage systems maximum continuous output current, other than those controlled in accordance with 231.14, shall not exceed the ampacity of the service conductors connecting the service equipment to the service point.

(B)— Calculation of Maximum Circuit Current.

Where not elsewhere required or permitted in this Code, the maximum current from the power production equipment or energy storage system shall be the sum of the continuous output current ratings of the connected power production equipment and energy storage system.

(C)— Conductors.

The service conductors connecting the power production equipment or energy storage system from the point of connection to the first overcurrent protection device shall be sized in accordance with 231.11(C)(1) and (C)(2) and in no case sized smaller than 6 AWG copper or 4 AWG aluminum.

Service conductor wiring methods shall comply with Parts II, III, and IV of Article 230.

Service entrance conductors shall have an ampacity of not less than the maximum output current calculated in 231.11(B). Conductors shall be sized not less than the largest of 231.11(C)(1) or (C)(2). Ampacity shall be determined from 310.14 and shall comply with 110.14(C). The maximum current of busways shall be that value for which the busway has been listed or labeled.

(1)— Supplied From Continuous Power Production Equipment or Energy Storage System.

Where the service entrance conductors are supplied from continuous power production equipment or energy storage system or any combination of noncontinuous and continuous power production equipment or energy storage system source currents, the minimum service entrance conductor size shall have an ampacity not less than the sum of the noncontinuous source currents plus 125 percent of continuous source currents.

Exception No. 1: Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the sum of the continuous and noncontinuous source current.

Exception No. 2: The sum of the noncontinuous source currents and the continuous source currents if the service entrance conductors terminate in an overcurrent device where both the overcurrent device and its assembly are listed for operation at 100 percent of their rating shall be permitted.

(2)— Minimum Service Entrance Conductor Ampacity.

The minimum service entrance conductor size shall have an ampacity not less than the maximum calculated sum of all connected power production equipment or energy storage system source currents after the application of any adjustment or correction factors.

(D)— Overcurrent Protection.

Overcurrent protection shall be provided in accordance with Part VII of Article 230.

(E)— Connections.

(1)— Spliced and Tapped Conductors.

The connection of service conductors connecting the electric power production sources to the service conductors shall be made in accordance with 230.46.

(2)— Modifications.

Any modifications to existing equipment shall be made in accordance with the manufacturer's instructions, or the modification shall be required to be evaluated for the application and have a field label applied.

(3)— Meter Socket Connections.

For meter socket enclosures or other equipment under the exclusive control of the electric utility, only connections approved by the electric utility shall be permitted.

(F)— Neutral Conductors.

Neutral conductors shall be permitted to be sized in accordance with either 231.11(F)(1) or (F)(2).

(1)— Single-Phase Line-to-Neutral Power Sources.

Where not elsewhere required or permitted in this Code, the ampacity of a neutral conductor to which a single-phase line-to-neutral power source is connected shall not be smaller than the ampacity in 231.11(C).

(2)– Neutral Conductor Used Solely for Instrumentation, Voltage, Detection, or Phase Detection.

A power production equipment neutral conductor used solely for instrumentation, voltage detection, or phase detection shall be permitted to be sized in accordance with 250.102.

(G)– Equipment.

The first disconnecting means for the conductors connected to the supply side of a service disconnect, where in a separate enclosure other than the service equipment, shall be in accordance with Parts V and VI of Article 230.

231.12– Load-Side Source Connections.

Feeder conductors connecting the output of power production equipment or energy storage systems shall be permitted to be connected to the load side of the service disconnecting means at any distribution equipment on the premises. Where distribution equipment or feeders are fed simultaneously by an electric utility source and one or more other power sources the interconnected equipment shall comply with 231.12(A) through (F). Where a power control system (PCS) is installed in accordance with 231.14, the setting of the PCS controller shall be considered the power production equipment or energy storage system output current in relation to 231.12(A) through (F).

(A)– Dedicated Overcurrent and Disconnect.

Each interconnection of one or more power production equipment or energy storage system installed in one system shall be made at a dedicated circuit breaker or fusible disconnecting means.

(B)– Bus Rating.

The power production equipment or energy storage system output circuit current multiplied by 125 percent shall be used in determining the ratings of busbars in accordance with 231.12(B)(1) through (B)(5).

(1)– Output Current Plus Rating of Overcurrent Protective Device.

The sum of 125 percent of the power production equipment and energy storage system output current, and the rating of the overcurrent device protecting the busbar shall not exceed the ampacity of the busbar.

Informational Note: This general rule assumes no limitation in the number of the loads or sources applied to busbars or their locations.

(2)– Sources Connected at Opposite Ends of Busbar.

Where two sources, one a primary power source and the other from power production equipment or energy storage system, are located at opposite ends of a busbar that contains loads, the sum of 125 percent of the power production equipment or energy storage system output current and the rating of the overcurrent device protecting the busbar shall not exceed 120 percent of the ampacity of the busbar. The busbar shall be sized for the loads connected in accordance with Parts I, III, or IV of Article 220. A permanent warning label shall be applied to the distribution equipment adjacent to the back-fed breaker from the power source that displays the following or equivalent wording:

WARNING: POWER SOURCE OUTPUT CONNECTION — DO NOT RELOCATE THIS OVERCURRENT DEVICE. THIS EQUIPMENT FED BY MULTIPLE SOURCES.

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

(3)– Sum of Overcurrent Device Ratings.

The sum of the ampere ratings of all overcurrent devices on panelboards, both load and supply devices, excluding the rating of the overcurrent device protecting the busbar, shall not exceed the ampacity of the busbar. The rating of the overcurrent device protecting the busbar shall not exceed the rating of the busbar. Permanent warning labels shall be applied to distribution equipment displaying the following or equivalent wording:

WARNING:

THIS EQUIPMENT FED BY MULTIPLE SOURCES.

TOTAL RATING OF ALL OVERCURRENT DEVICES

EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE

SHALL NOT EXCEED AMPACITY OF BUSBAR.

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

(4)– Center-Fed Panelboards.

A connection at either end of a center-fed panelboard in dwellings shall be permitted where the sum of 125 percent of the power production equipment and energy storage system output current and the rating of the overcurrent device protecting the busbar does not exceed 120 percent of the current rating of the busbar.

(5)– Engineering Supervision.

Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 231.12(B)(1) through (B)(4) where designed under engineering supervision that includes available fault current and busbar load calculations.

(6)– Feed-Through Connections.

Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors. The feed-through conductors shall be protected in accordance with 231.12(C)(2). Where an overcurrent device is installed at the supply end of the feed-through conductors, the busbar in the supplying panelboard shall be permitted to be sized in accordance with 231.12(B)(1) through (B)(5).

(C)– Feeder Connections.

(1)– Connection From Power Production Equipment or Energy Storage System.

Where the power production equipment or energy storage system connection is made to a feeder, the conductors from the power production equipment or energy storage system to the point of connection shall be sized based on the larger of 125 percent of all power production and energy storage system source(s) output circuit current(s) or as sized in accordance with 240.21(B).

(2)– Connection at Other Than Opposite End of Primary Source Overcurrent Device.

Where the connection is made to a feeder at a location other than the opposite end of the feeder from the primary source overcurrent device, that portion of the feeder from the point of connection to the load shall be protected by one of the following:

- (1) The feeder ampacity shall be not less than the sum of the primary source overcurrent device and 125 percent of the power production equipment or energy storage system output circuit current.
- (2) An overcurrent protective device at the load side of the power source connection point rated not greater than the ampacity of that portion of the feeder.

(D)– Marking.

Equipment containing overcurrent devices in circuits supplying power to a busbar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources.

(E)– Suitable for Backfeed.

Fused disconnects, unless otherwise marked, shall be considered suitable for backfeed. Circuit breakers not marked *line* and *load* shall be considered suitable for backfeed. Circuit breakers marked *line* and *load* shall not be considered suitable for backfeed.

(F)– Fastening.

Listed plug-in-type circuit breakers back-fed from electric power production equipment or energy storage system that are listed and identified as interactive shall be permitted to omit the additional fastener required by 408.36(D) for such applications.

231.14– Power Control Systems.

A PCS shall be listed and evaluated to control the output of one or more power production sources, energy storage systems (ESS), and other equipment. The PCS shall limit current and loading on the busbars and conductors supplied by the PCS.

For the circuits connected to a PCS, the PCS shall limit the current to the ampacity of the conductors or the ratings of the busbars to which it is connected in accordance with 231.14(A) through (E).

(A)– Monitoring.

The PCS controller shall monitor all currents within the PCS. Any busbar or conductor on the load side of the service disconnecting means that is not monitored by the PCS shall comply with 231.12. Where the PCS is connected in accordance with 231.11, the PCS shall monitor the service conductors and prevent overload of these conductors.

(B)– Settings.

The sum of all PCS-controlled currents plus all monitored currents from other sources of supply shall not exceed the ampacity of any busbar or conductor supplied by the power production sources. Where the PCS is connected to an overcurrent device protecting any busbar or conductor not monitored by the PCS, the setting of the PCS controller shall be set within the ratings of that overcurrent device.

(C)– Overcurrent Protection.

The PCS shall provide overcurrent protection either by overcurrent devices or by the PCS including the functionality as an overcurrent device in the product listing.

Informational Note: Some PCS are listed to provide overcurrent protection.

(D)– Single Power Source Rating.

The rating of the overcurrent device for any single power source controlled by the PCS shall not exceed the rating of the busbar or the ampacity of the conductors to which it is connected.

(E)– Access to Settings.

The access to settings of the PCS shall be restricted to qualified personnel in accordance with the requirements of 240.6(C).

231.15– Output Characteristics.

The output of power production equipment or energy storage systems operating in parallel with an electrical supply system shall be compatible with the voltage, wave shape, and frequency of the system to which it is connected. Synchronous generators operating in parallel with an electrical supply system shall be provided with the necessary equipment to establish and maintain a synchronous condition.

Informational Note No.1: The term *compatible* does not necessarily mean matching the primary source wave shape.

Informational Note No.2: Information on the performance of power production equipment when interconnecting with a utility can be found in Chapter 7 of IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*.

231.16– Interrupting and Short-Circuit Current Rating.

Consideration shall be given to the contribution of fault currents from all interconnected power sources for the interrupting and short-circuit current ratings of equipment on interactive systems.

231.20– Disconnecting Means, Source.

The disconnecting means shall comply with the following:

- (1) Be one of the following types:
 - (2) A manually operable switch or circuit breaker
 - (3) A load-break rated pull-out switch
 - (4) A power operated or remote-controlled switch or circuit breaker that is manually operable locally and opens automatically when control power is interrupted
 - (5) A device listed or approved for the intended application
- (6) Simultaneously disconnect all ungrounded conductors of the circuit
- (7) Be located where readily accessible
- (8) Be externally operable without exposed live parts
- (9) Enclosures with doors or hinged covers with exposed live parts when open that require a tool to open or are lockable where readily accessible to unqualified persons
- (10) Plainly indicate whether in the open (off) or closed (on) position
- (11) Have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals
- (12) Be marked in accordance with the warning in 690.13(B), where the line and load terminals are capable of being energized in the open position

Informational Note: See 404.6(C) Exception for interconnected power sources where equipment, including switches and fuses, could be energized from both directions.

231.32– Ground-Fault Protection.

Where protection is installed in accordance with 230.95, the output of connected power production equipment or energy storage systems shall be connected to the supply side of the ground-fault protection.

Exception: Connection shall be permitted to be made to the load side of ground-fault protection, if there is ground-fault protection for equipment from all ground-fault current sources.

231.40– Loss of Primary Source. The output of electric power production equipment and energy storage systems shall be automatically disconnected from all ungrounded conductors of the interconnected systems when one or more of the phases to which it is connected opens. The electric power production equipment or energy storage system shall not be reconnected until all the phases of the interconnected system to which it is connected are restored. This requirement shall not be applicable to electric power production equipment or energy storage system providing power to an emergency or legally required standby system. <i>Exception: A listed interactive inverter shall trip or shall be permitted to automatically cease exporting power when one or more of the phases of the interconnected system opens and shall not be required to automatically disconnect all ungrounded conductors from the primary source. A listed interactive inverter shall be permitted to automatically or manually resume exporting power to the interconnected system once all phases of the source to which it is connected are restored.</i> Interactive power production equipment shall be permitted to operate in island mode to supply loads that have been disconnected from the electric power production and distribution network. Informational Note No. 1: Risks to personnel and equipment associated with the primary source could occur if an interactive electric power production source can operate as an intentional island. Special detection methods are required to determine that a primary source supply system outage has occurred and whether there should be automatic disconnection. When the primary source supply system is restored, special detection methods are typically required to limit exposure of power production sources to out-of-phase reconnection. Reference Chapter 6, "Response to EPS Abnormal Conditions," of IEEE 1547-2018, <i>IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces</i>. Informational Note No. 2: Induction-generating equipment connected on systems with significant capacitance can become self-excited upon loss of the primary source and experience severe overvoltage as a result. 231.45– Unbalanced Interconnections. (A)– Single Phase Equipment Connected to Three-Phase Systems. Where single-phase power production equipment or energy storage system sources are connected to three-phase systems in parallel with the utility, unbalanced voltages at the point of interconnection to shall not exceed more than 3 percent. Informational Note: For interactive power sources, unbalanced voltages can be minimized by the same methods that are used for single-phase loads on a 3-phase power system. See ANSI/C84.1-2020, <i>Electric Power Systems and Equipment — Voltage Ratings (60 Hertz)</i>. (B)– Three Phase. Three-phase power production equipment and energy storage systems in interactive systems shall have all phases automatically de-energized upon loss of, or unbalance of, voltage in one or more phases unless the interconnected system is designed so that significant unbalanced voltages will not result. Part II.– AC Microgrid Systems 231.50– System Operation. AC microgrid systems shall be permitted to disconnect from the primary source of power or other interconnected electric power production sources and operate in island mode. 231.60– Primary Power Source Connection. AC microgrid connections to a utility source shall comply with 231.11 or 231.12. 231.65– Reconnection to Primary Power Source. AC microgrid systems that reconnect to a utility source shall be provided with the necessary equipment to establish a synchronous transition. 231.70– Microgrid Interconnect Devices (MID). AC microgrid interconnect devices shall comply with the following: (1) Be required for any connection between an AC microgrid system and a utility (2) Be evaluated for the application and have a field label applied or be listed for the application (3) Have a sufficient number of overcurrent protective devices located to provide overcurrent protection from all sources Informational Note: MID functionality is often incorporated in an interactive or multimode inverter, energy storage system, or similar device identified for interactive operation.
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Statement of Problem and Substantiation for Public Comment

This Public Comment is submitted on behalf of the task group formed by the Correlating Committee to identify correlation issues between Article 705 and new Article 231 as a result of the work done in the first draft of the 2023 NEC. The public comment includes revisions to 705.11 and the elimination of new Article 231. The revisions in 705.11 eliminate the need for new Article 231.

The task group included members of CMPs 4, 5, and 10 including: G. Scott Harding (Chair), Derrick Atkins, Randy Dollar, Steven Emert, Brian Mehalic, Nathan Philips, Jim Rogers, Christopher Vance, Doug Smith and Danish Zia.

The summary of the changes are as follows:

- 1. The power production source disconnecting means located between the service point and the power production source are service disconnects. New Part (A) is intended to describe the service connections.
- 2. 705.11(B) and 705.11 (C) (formerly parts (A) and (B)) have been modified to clarify that the conductors on the line side of the power source service disconnecting means are service conductors.
- 3. 705.11 (D) and 705.11 (E) (formerly parts (C) and (D)) have been modified to comply with the Correlating Committee direction to eliminate redundancy within the code. In this instance users are directed to Articles 230 and 250.
- 4. 705.11(F) (formerly part (E)) has been modified to clarify how a code user is to determine the rating to be used to determine if 230.95 applies.

The Task Group recognizes that the term power source is used throughout Article 705 and suggests CMP 4 to review the use of the term power production source for clarity and consistency.

The Task Group suggests that new 705.11(E) (formerly part (D)) be reviewed by CMP 5 for correlation of terms on Grounding and Bonding.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 1098-NFPA 70-2021 [Section No. 705.11]	
Public Comment No. 1098-NFPA 70-2021 [Section No. 705.11]	
Related Item	
• CN 278	

Submitter Information Verification

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Submittal Date: Wed Aug 11 11:35:43 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8272-NFPA 70-2021](#)

Statement: New Article 231 is deleted in support of the revision provided in PC 1098. The provision of Article 231 will be redundant if PC 1098 is accepted.

PC-321 & 325: These public comments were resolved by the deletion of Article 231.



Public Comment No. 1416-NFPA 70-2021 [Article 231]

Article 231— Electric Power Sources Interconnected with an Electric Utility

Part I.— General

231.1— Scope.

This article covers installation of one or more power production equipment or energy storage systems operating in parallel with a utility source. This article does not include on-site electrical power source(s) that do not operate in parallel with the electric utility.

Informational Note: For further information, see IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power System Interfaces*.

231.6— Equipment Approval.

All equipment shall be identified for the intended use. Power production equipment and energy storage systems intended to operate in parallel with electric power production sources shall be listed for interactive function or be evaluated for interactive function and have a field label applied, or both.

Informational Note: Examples of power production sources include interactive inverters, engine generators, and wind turbines.

231.8— System Installation.

Installation of one or more power production equipment or energy storage systems operating in parallel with the electric utility shall be performed only by qualified persons.

231.10— Identification of Power Sources.

A permanent plaque or directory shall be installed at each service equipment location or at an approved readily visible location. The plaque or directory shall denote the location of each power production equipment or energy storage system disconnecting means for the building or structure and be grouped with other plaques or directories for other on-site sources. The plaque or directory shall be marked with the wording CAUTION: MULTIPLE SOURCES OF POWER. Any posted diagrams shall be correctly oriented with respect to the diagram's location. The marking shall comply with 110.24(B).

Exception: Installations with multiple co-located power production sources shall be permitted to be identified as a group(s). The plaque or directory shall not be required to identify each power source individually.

231.11— Supply-Side Service Connections.

Power production equipment and energy storage systems shall be permitted to be connected to the supply side of the service disconnecting means in accordance with 230.82(6) and shall comply with 231.11(A) through (G).

(A)— Minimum Size and Ampacity.

The sum of the connected power production equipment and energy storage systems maximum continuous output current, other than those controlled in accordance with 231.14, shall not exceed the ampacity of the service conductors connecting the service equipment to the service point.

(B)— Calculation of Maximum Circuit Current.

Where not elsewhere required or permitted in this Code, the maximum current from the power production equipment or energy storage system shall be the sum of the continuous output current ratings of the connected power production equipment and energy storage system.

(C)— Conductors.

The service conductors connecting the power production equipment or energy storage system from the point of connection to the first overcurrent protection device shall be sized in accordance with 231.11(C)(1) and (C)(2) and in no case sized smaller than 6 AWG copper or 4 AWG aluminum.

Service conductor wiring methods shall comply with Parts II, III, and IV of Article 230.

Service entrance conductors shall have an ampacity of not less than the maximum output current calculated in 231.11(B). Conductors shall be sized not less than the largest of 231.11(C)(1) or (C)(2). Ampacity shall be determined from 310.14 and shall comply with 110.14(C). The maximum current of busways shall be that value for which the busway has been listed or labeled.

(1)— Supplied From Continuous Power Production Equipment or Energy Storage System.

Where the service entrance conductors are supplied from continuous power production equipment or energy storage system or any combination of noncontinuous and continuous power production equipment or energy storage system source currents, the minimum service entrance conductor size shall have an ampacity not less than the sum of the noncontinuous source currents plus 125 percent of continuous source currents.

Exception No. 1: Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the sum of the continuous and noncontinuous source current.

Exception No. 2: The sum of the noncontinuous source currents and the continuous source currents if the service entrance conductors terminate in an overcurrent device where both the overcurrent device and its assembly are listed for operation at 100 percent of their rating shall be permitted.

(2)— Minimum Service Entrance Conductor Ampacity.

The minimum service entrance conductor size shall have an ampacity not less than the maximum calculated sum of all connected power production equipment or energy storage system source currents after the application of any adjustment or correction factors.

(D)— Overcurrent Protection.

Overcurrent protection shall be provided in accordance with Part VII of Article 230.

(E)— Connections.

(1)— Spliced and Tapped Conductors.

The connection of service conductors connecting the electric power production sources to the service conductors shall be made in accordance with 230.46.

(2)— Modifications.

Any modifications to existing equipment shall be made in accordance with the manufacturer's instructions, or the modification shall be required to be evaluated for the application and have a field label applied.

(3)— Meter Socket Connections.

For meter socket enclosures or other equipment under the exclusive control of the electric utility, only connections approved by the electric utility shall be permitted.

(F)— Neutral Conductors.

Neutral conductors shall be permitted to be sized in accordance with either 231.11(F)(1) or (F)(2).

(1)— Single-Phase Line-to-Neutral Power Sources.

Where not elsewhere required or permitted in this Code, the ampacity of a neutral conductor to which a single-phase line-to-neutral power source is connected shall not be smaller than the ampacity in 231.11(C).

(2)– Neutral Conductor Used Solely for Instrumentation, Voltage, Detection, or Phase Detection.

A power production equipment neutral conductor used solely for instrumentation, voltage detection, or phase detection shall be permitted to be sized in accordance with 250.102.

(G)– Equipment.

The first disconnecting means for the conductors connected to the supply side of a service disconnect, where in a separate enclosure other than the service equipment, shall be in accordance with Parts V and VI of Article 230.

231.12– Load-Side Source Connections.

Feeder conductors connecting the output of power production equipment or energy storage systems shall be permitted to be connected to the load side of the service disconnecting means at any distribution equipment on the premises. Where distribution equipment or feeders are fed simultaneously by an electric utility source and one or more other power sources the interconnected equipment shall comply with 231.12(A) through (F). Where a power control system (PCS) is installed in accordance with 231.14, the setting of the PCS controller shall be considered the power production equipment or energy storage system output current in relation to 231.12(A) through (F).

(A)– Dedicated Overcurrent and Disconnect.

Each interconnection of one or more power production equipment or energy storage system installed in one system shall be made at a dedicated circuit breaker or fusible disconnecting means.

(B)– Bus Rating.

The power production equipment or energy storage system output circuit current multiplied by 125 percent shall be used in determining the ratings of busbars in accordance with 231.12(B)(1) through (B)(5).

(1)– Output Current Plus Rating of Overcurrent Protective Device.

The sum of 125 percent of the power production equipment and energy storage system output current, and the rating of the overcurrent device protecting the busbar shall not exceed the ampacity of the busbar.

Informational Note: This general rule assumes no limitation in the number of the loads or sources applied to busbars or their locations.

(2)– Sources Connected at Opposite Ends of Busbar.

Where two sources, one a primary power source and the other from power production equipment or energy storage system, are located at opposite ends of a busbar that contains loads, the sum of 125 percent of the power production equipment or energy storage system output current and the rating of the overcurrent device protecting the busbar shall not exceed 120 percent of the ampacity of the busbar. The busbar shall be sized for the loads connected in accordance with Parts I, III, or IV of Article 220. A permanent warning label shall be applied to the distribution equipment adjacent to the back-fed breaker from the power source that displays the following or equivalent wording:

WARNING: POWER SOURCE OUTPUT CONNECTION — DO NOT RELOCATE THIS OVERCURRENT DEVICE. THIS EQUIPMENT FED BY MULTIPLE SOURCES.

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

(3)– Sum of Overcurrent Device Ratings.

The sum of the ampere ratings of all overcurrent devices on panelboards, both load and supply devices, excluding the rating of the overcurrent device protecting the busbar, shall not exceed the ampacity of the busbar. The rating of the overcurrent device protecting the busbar shall not exceed the rating of the busbar. Permanent warning labels shall be applied to distribution equipment displaying the following or equivalent wording:

WARNING:

THIS EQUIPMENT FED BY MULTIPLE SOURCES.

TOTAL RATING OF ALL OVERCURRENT DEVICES

EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE

SHALL NOT EXCEED AMPACITY OF BUSBAR.

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

(4)– Center-Fed Panelboards.

A connection at either end of a center-fed panelboard in dwellings shall be permitted where the sum of 125 percent of the power production equipment and energy storage system output current and the rating of the overcurrent device protecting the busbar does not exceed 120 percent of the current rating of the busbar.

(5)– Engineering Supervision.

Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 231.12(B)(1) through (B)(4) where designed under engineering supervision that includes available fault current and busbar load calculations.

(6)– Feed-Through Connections.

Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors. The feed-through conductors shall be protected in accordance with 231.12(C)(2). Where an overcurrent device is installed at the supply end of the feed-through conductors, the busbar in the supplying panelboard shall be permitted to be sized in accordance with 231.12(B)(1) through (B)(5).

(C)– Feeder Connections.

(1)– Connection From Power Production Equipment or Energy Storage System.

Where the power production equipment or energy storage system connection is made to a feeder, the conductors from the power production equipment or energy storage system to the point of connection shall be sized based on the larger of 125 percent of all power production and energy storage system source(s) output circuit current(s) or as sized in accordance with 240.21(B).

(2)– Connection at Other Than Opposite End of Primary Source Overcurrent Device.

Where the connection is made to a feeder at a location other than the opposite end of the feeder from the primary source overcurrent device, that portion of the feeder from the point of connection to the load shall be protected by one of the following:

- (1) The feeder ampacity shall be not less than the sum of the primary source overcurrent device and 125 percent of the power production equipment or energy storage system output circuit current.
- (2) An overcurrent protective device at the load side of the power source connection point rated not greater than the ampacity of that portion of the feeder.

(D)– Marking.

Equipment containing overcurrent devices in circuits supplying power to a busbar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources.

(E)– Suitable for Backfeed.

Fused disconnects, unless otherwise marked, shall be considered suitable for backfeed. Circuit breakers not marked *line* and *load* shall be considered suitable for backfeed. Circuit breakers marked *line* and *load* shall not be considered suitable for backfeed.

(F)– Fastening.

Listed plug-in-type circuit breakers back-fed from electric power production equipment or energy storage system that are listed and identified as interactive shall be permitted to omit the additional fastener required by 408.36(D) for such applications.

231.14– Power Control Systems.

A PCS shall be listed and evaluated to control the output of one or more power production sources, energy storage systems (ESS), and other equipment. The PCS shall limit current and loading on the busbars and conductors supplied by the PCS.

For the circuits connected to a PCS, the PCS shall limit the current to the ampacity of the conductors or the ratings of the busbars to which it is connected in accordance with 231.14(A) through (E).

(A)– Monitoring.

The PCS controller shall monitor all currents within the PCS. Any busbar or conductor on the load side of the service disconnecting means that is not monitored by the PCS shall comply with 231.12. Where the PCS is connected in accordance with 231.11, the PCS shall monitor the service conductors and prevent overload of these conductors.

(B)– Settings.

The sum of all PCS-controlled currents plus all monitored currents from other sources of supply shall not exceed the ampacity of any busbar or conductor supplied by the power production sources. Where the PCS is connected to an overcurrent device protecting any busbar or conductor not monitored by the PCS, the setting of the PCS controller shall be set within the ratings of that overcurrent device.

(C)– Overcurrent Protection.

The PCS shall provide overcurrent protection either by overcurrent devices or by the PCS including the functionality as an overcurrent device in the product listing.

Informational Note: Some PCS are listed to provide overcurrent protection.

(D)– Single Power Source Rating.

The rating of the overcurrent device for any single power source controlled by the PCS shall not exceed the rating of the busbar or the ampacity of the conductors to which it is connected.

(E)– Access to Settings.

The access to settings of the PCS shall be restricted to qualified personnel in accordance with the requirements of 240.6(C).

231.15– Output Characteristics.

The output of power production equipment or energy storage systems operating in parallel with an electrical supply system shall be compatible with the voltage, wave shape, and frequency of the system to which it is connected. Synchronous generators operating in parallel with an electrical supply system shall be provided with the necessary equipment to establish and maintain a synchronous condition.

Informational Note No.1: The term *compatible* does not necessarily mean matching the primary source wave shape.

Informational Note No.2: Information on the performance of power production equipment when interconnecting with a utility can be found in Chapter 7 of IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*.

231.16– Interrupting and Short-Circuit Current Rating.

Consideration shall be given to the contribution of fault currents from all interconnected power sources for the interrupting and short-circuit current ratings of equipment on interactive systems.

231.20– Disconnecting Means, Source.

The disconnecting means shall comply with the following:

- (1) Be one of the following types:
 - (2) A manually operable switch or circuit breaker
 - (3) A load-break rated pull-out switch
 - (4) A power operated or remote-controlled switch or circuit breaker that is manually operable locally and opens automatically when control power is interrupted
 - (5) A device listed or approved for the intended application
- (6) Simultaneously disconnect all ungrounded conductors of the circuit
- (7) Be located where readily accessible
- (8) Be externally operable without exposed live parts
- (9) Enclosures with doors or hinged covers with exposed live parts when open that require a tool to open or are lockable where readily accessible to unqualified persons
- (10) Plainly indicate whether in the open (off) or closed (on) position
- (11) Have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals
- (12) Be marked in accordance with the warning in 690.13(B), where the line and load terminals are capable of being energized in the open position

Informational Note: See 404.6(C) Exception for interconnected power sources where equipment, including switches and fuses, could be energized from both directions.

231.32– Ground-Fault Protection.

Where protection is installed in accordance with 230.95, the output of connected power production equipment or energy storage systems shall be connected to the supply side of the ground-fault protection.

Exception: Connection shall be permitted to be made to the load side of ground-fault protection, if there is ground-fault protection for equipment from all ground-fault current sources.

231.40 – Loss of Primary Source.

The output of electric power production equipment and energy storage systems shall be automatically disconnected from all ungrounded conductors of the interconnected systems when one or more of the phases to which it is connected opens. The electric power production equipment or energy storage system shall not be reconnected until all the phases of the interconnected system to which it is connected are restored. This requirement shall not be applicable to electric power production equipment or energy storage system providing power to an emergency or legally required standby system.

Exception: A listed interactive inverter shall trip or shall be permitted to automatically cease exporting power when one or more of the phases of the interconnected system opens and shall not be required to automatically disconnect all ungrounded conductors from the primary source. A listed interactive inverter shall be permitted to automatically or manually resume exporting power to the interconnected system once all phases of the source to which it is connected are restored.

Interactive power production equipment shall be permitted to operate in island mode to supply loads that have been disconnected from the electric power production and distribution network.

Informational Note No. 1: Risks to personnel and equipment associated with the primary source could occur if an interactive electric power production source can operate as an intentional island. Special detection methods are required to determine that a primary source supply system outage has occurred and whether there should be automatic disconnection. When the primary source supply system is restored, special detection methods are typically required to limit exposure of power production sources to out-of-phase reconnection. Reference Chapter 6, "Response to EPS Abnormal Conditions," of IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*.

Informational Note No. 2: Induction-generating equipment connected on systems with significant capacitance can become self-excited upon loss of the primary source and experience severe overvoltage as a result.

231.45 – Unbalanced Interconnections.

(A) – Single Phase Equipment Connected to Three Phase Systems.

Where single-phase power production equipment or energy storage system sources are connected to three-phase systems in parallel with the utility, unbalanced voltages at the point of interconnection to shall not exceed more than 3 percent.

Informational Note: For interactive power sources, unbalanced voltages can be minimized by the same methods that are used for single-phase loads on a 3-phase power system. See ANSI/C84.1-2020, *Electric Power Systems and Equipment — Voltage Ratings (60 Hertz)*.

(B) – Three Phase.

Three-phase power production equipment and energy storage systems in interactive systems shall have all phases automatically de-energized upon loss of, or unbalance of, voltage in one or more phases unless the interconnected system is designed so that significant unbalanced voltages will not result.

Part II. – AC Microgrid Systems

231.50 – System Operation.

AC microgrid systems shall be permitted to disconnect from the primary source of power or other interconnected electric power production sources and operate in island mode.

231.60 – Primary Power Source Connection.

AC microgrid connections to a utility source shall comply with 231.11 or 231.12.

231.65 – Reconnection to Primary Power Source.

AC microgrid systems that reconnect to a utility source shall be provided with the necessary equipment to establish a synchronous transition.

231.70 – Microgrid Interconnect Devices (MID).

AC microgrid interconnect devices shall comply with the following:

- (1) ~~Be required for any connection between an AC microgrid system and a utility~~
- (2) ~~Be evaluated for the application and have a field label applied or be listed for the application~~
- (3) ~~Have a sufficient number of overcurrent protective devices located to provide overcurrent protection from all sources~~

Informational Note: MID functionality is often incorporated in an interactive or multimode inverter, energy storage system, or similar device identified for interactive operation.

Statement of Problem and Substantiation for Public Comment

This article should not go forward. It amounts to an end run around 90.3. By long precedent, going back to the 1987 NEC, the Chapter 7 Article 705 has had the ability to amend the general chapters of the NEC, including Article 230 in Chapter 2. This process, as mediated by the Correlating Committee, has worked well and should be respected. If there is disagreement with how CMP 4 is addressing an issue, there are ample avenues for public comment and the Annual Meeting, both of which have been successfully used to modify results in Article 705. This article is a dangerous and unfortunate precedent. I have genuine and enduring respect for those involved in this, but I simply cannot support this. This cycle has seen a number of attempts to effectively emasculate 90.3, including the attempt to put numerous articles at the end of Chapter 6 and beginning of Chapter 7 into a blender. I attended that meeting and I am pleased to say I was instrumental in stopping that attempt without any FRs issuing. I was unaware of this one until it was too late, hence this comment. This must stop.

The Correlating Committee, in its Note 278, has done an exemplary job in sorting out which panels are responsible for which material, and is recommending that this effort be reconsidered. Their efforts should be enthusiastically and comprehensively supported, for the good of the document.

Related Item

• Global FR-7974 • CC Note 278

Submitter Information Verification

Submitter Full Name: Frederic Hartwell
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Submittal Date: Thu Aug 12 16:18:23 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8272-NFPA 70-2021](#)

Statement: New Article 231 is deleted in support of the revision provided in PC 1098. The provision of Article 231 will be redundant if PC 1098 is accepted.

PC-321 & 325: These public comments were resolved by the deletion of Article 231.



Public Comment No. 1473-NFPA 70-2021 [Article 231]

Article 231— Electric Power Sources Interconnected with an Electric Utility

Part I.— General

231.1— Scope.

This article covers installation of one or more power production equipment or energy storage systems operating in parallel with a utility source. This article does not include on-site electrical power source(s) that do not operate in parallel with the electric utility.

Informational Note: For further information, see IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power System Interfaces*.

231.6— Equipment Approval.

All equipment shall be identified for the intended use. Power production equipment and energy storage systems intended to operate in parallel with electric power production sources shall be listed for interactive function or be evaluated for interactive function and have a field label applied, or both.

Informational Note: Examples of power production sources include interactive inverters, engine generators, and wind turbines.

231.8— System Installation.

Installation of one or more power production equipment or energy storage systems operating in parallel with the electric utility shall be performed only by qualified persons.

231.10— Identification of Power Sources.

A permanent plaque or directory shall be installed at each service equipment location or at an approved readily visible location. The plaque or directory shall denote the location of each power production equipment or energy storage system disconnecting means for the building or structure and be grouped with other plaques or directories for other on-site sources. The plaque or directory shall be marked with the wording CAUTION: MULTIPLE SOURCES OF POWER. Any posted diagrams shall be correctly oriented with respect to the diagram's location. The marking shall comply with 110.21(B).

Exception: Installations with multiple co-located power production sources shall be permitted to be identified as a group(s). The plaque or directory shall not be required to identify each power source individually.

231.11— Supply-Side Service Connections.

Power production equipment and energy storage systems shall be permitted to be connected to the supply side of the service disconnecting means in accordance with 230.82(6) and shall comply with 231.11(A) through (G).

(A)— Minimum Size and Ampacity.

The sum of the connected power production equipment and energy storage systems maximum continuous output current, other than those controlled in accordance with 231.14, shall not exceed the ampacity of the service conductors connecting the service equipment to the service point.

(B)— Calculation of Maximum Circuit Current.

Where not elsewhere required or permitted in this Code, the maximum current from the power production equipment or energy storage system shall be the sum of the continuous output current ratings of the connected power production equipment and energy storage system.

(C)— Conductors.

The service conductors connecting the power production equipment or energy storage system from the point of connection to the first overcurrent protection device shall be sized in accordance with 231.11(C)(1) and (C)(2) and in no case sized smaller than 6 AWG copper or 4 AWG aluminum.

Service conductor wiring methods shall comply with Parts II, III, and IV of Article 230.

Service entrance conductors shall have an ampacity of not less than the maximum output current calculated in 231.11(B). Conductors shall be sized not less than the largest of 231.11(C)(1) or (C)(2). Ampacity shall be determined from 310.14 and shall comply with 110.14(C). The maximum current of busways shall be that value for which the busway has been listed or labeled.

(1)— Supplied From Continuous Power Production Equipment or Energy Storage System.

Where the service entrance conductors are supplied from continuous power production equipment or energy storage system or any combination of noncontinuous and continuous power production equipment or energy storage system source currents, the minimum service entrance conductor size shall have an ampacity not less than the sum of the noncontinuous source currents plus 125 percent of continuous source currents.

Exception No. 1: Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the sum of the continuous and noncontinuous source current.

Exception No. 2: The sum of the noncontinuous source currents and the continuous source currents if the service entrance conductors terminate in an overcurrent device where both the overcurrent device and its assembly are listed for operation at 100 percent of their rating shall be permitted.

(2)— Minimum Service Entrance Conductor Ampacity.

The minimum service entrance conductor size shall have an ampacity not less than the maximum calculated sum of all connected power production equipment or energy storage system source currents after the application of any adjustment or correction factors.

(D)— Overcurrent Protection.

Overcurrent protection shall be provided in accordance with Part VII of Article 230.

(E)— Connections.

(1)— Spliced and Tapped Conductors.

The connection of service conductors connecting the electric power production sources to the service conductors shall be made in accordance with 230.46.

(2)— Modifications.

Any modifications to existing equipment shall be made in accordance with the manufacturer's instructions, or the modification shall be required to be evaluated for the application and have a field label applied.

(3)— Meter Socket Connections.

For meter socket enclosures or other equipment under the exclusive control of the electric utility, only connections approved by the electric utility shall be permitted.

(F)— Neutral Conductors.

Neutral conductors shall be permitted to be sized in accordance with either 231.11(F)(1) or (F)(2).

(1)— Single-Phase Line-to-Neutral Power Sources.

Where not elsewhere required or permitted in this Code, the ampacity of a neutral conductor to which a single-phase line-to-neutral power source is connected shall not be smaller than the ampacity in 231.11(C).

(2)– Neutral Conductor Used Solely for Instrumentation, Voltage, Detection, or Phase Detection.

A power production equipment neutral conductor used solely for instrumentation, voltage detection, or phase detection shall be permitted to be sized in accordance with 250.102.

(G)– Equipment.

The first disconnecting means for the conductors connected to the supply side of a service disconnect, where in a separate enclosure other than the service equipment, shall be in accordance with Parts V and VI of Article 230.

231.12– Load-Side Source Connections.

Feeder conductors connecting the output of power production equipment or energy storage systems shall be permitted to be connected to the load side of the service disconnecting means at any distribution equipment on the premises. Where distribution equipment or feeders are fed simultaneously by an electric utility source and one or more other power sources the interconnected equipment shall comply with 231.12(A) through (F). Where a power control system (PCS) is installed in accordance with 231.14, the setting of the PCS controller shall be considered the power production equipment or energy storage system output current in relation to 231.12(A) through (F).

(A)– Dedicated Overcurrent and Disconnect.

Each interconnection of one or more power production equipment or energy storage system installed in one system shall be made at a dedicated circuit breaker or fusible disconnecting means.

(B)– Bus Rating.

The power production equipment or energy storage system output circuit current multiplied by 125 percent shall be used in determining the ratings of busbars in accordance with 231.12(B)(1) through (B)(5).

(1)– Output Current Plus Rating of Overcurrent Protective Device.

The sum of 125 percent of the power production equipment and energy storage system output current, and the rating of the overcurrent device protecting the busbar shall not exceed the ampacity of the busbar.

Informational Note: This general rule assumes no limitation in the number of the loads or sources applied to busbars or their locations.

(2)– Sources Connected at Opposite Ends of Busbar.

Where two sources, one a primary power source and the other from power production equipment or energy storage system, are located at opposite ends of a busbar that contains loads, the sum of 125 percent of the power production equipment or energy storage system output current and the rating of the overcurrent device protecting the busbar shall not exceed 120 percent of the ampacity of the busbar. The busbar shall be sized for the loads connected in accordance with Parts I, III, or IV of Article 220. A permanent warning label shall be applied to the distribution equipment adjacent to the back-fed breaker from the power source that displays the following or equivalent wording:

WARNING: POWER SOURCE OUTPUT CONNECTION — DO NOT RELOCATE THIS OVERCURRENT DEVICE. THIS EQUIPMENT FED BY MULTIPLE SOURCES.

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

(3)– Sum of Overcurrent Device Ratings.

The sum of the ampere ratings of all overcurrent devices on panelboards, both load and supply devices, excluding the rating of the overcurrent device protecting the busbar, shall not exceed the ampacity of the busbar. The rating of the overcurrent device protecting the busbar shall not exceed the rating of the busbar. Permanent warning labels shall be applied to distribution equipment displaying the following or equivalent wording:

WARNING:

THIS EQUIPMENT FED BY MULTIPLE SOURCES.

TOTAL RATING OF ALL OVERCURRENT DEVICES

EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE

SHALL NOT EXCEED AMPACITY OF BUSBAR.

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

(4)– Center-Fed Panelboards.

A connection at either end of a center-fed panelboard in dwellings shall be permitted where the sum of 125 percent of the power production equipment and energy storage system output current and the rating of the overcurrent device protecting the busbar does not exceed 120 percent of the current rating of the busbar.

(5)– Engineering Supervision.

Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 231.12(B)(1) through (B)(4) where designed under engineering supervision that includes available fault current and busbar load calculations.

(6)– Feed-Through Connections.

Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors. The feed-through conductors shall be protected in accordance with 231.12(C)(2). Where an overcurrent device is installed at the supply end of the feed-through conductors, the busbar in the supplying panelboard shall be permitted to be sized in accordance with 231.12(B)(1) through (B)(5).

(C)– Feeder Connections.

(1)– Connection From Power Production Equipment or Energy Storage System.

Where the power production equipment or energy storage system connection is made to a feeder, the conductors from the power production equipment or energy storage system to the point of connection shall be sized based on the larger of 125 percent of all power production and energy storage system source(s) output circuit current(s) or as sized in accordance with 240.21(B).

(2)– Connection at Other Than Opposite End of Primary Source Overcurrent Device.

Where the connection is made to a feeder at a location other than the opposite end of the feeder from the primary source overcurrent device, that portion of the feeder from the point of connection to the load shall be protected by one of the following:

- (1) The feeder ampacity shall be not less than the sum of the primary source overcurrent device and 125 percent of the power production equipment or energy storage system output circuit current.
- (2) An overcurrent protective device at the load side of the power source connection point rated not greater than the ampacity of that portion of the feeder.

(D)– Marking.

Equipment containing overcurrent devices in circuits supplying power to a busbar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources.

(E)– Suitable for Backfeed.

Fused disconnects, unless otherwise marked, shall be considered suitable for backfeed. Circuit breakers not marked *line* and *load* shall be considered suitable for backfeed. Circuit breakers marked *line* and *load* shall not be considered suitable for backfeed.

(F)– Fastening.

Listed plug-in-type circuit breakers back-fed from electric power production equipment or energy storage system that are listed and identified as interactive shall be permitted to omit the additional fastener required by 408.36(D) for such applications.

231.14– Power Control Systems.

A PCS shall be listed and evaluated to control the output of one or more power production sources, energy storage systems (ESS), and other equipment. The PCS shall limit current and loading on the busbars and conductors supplied by the PCS.

For the circuits connected to a PCS, the PCS shall limit the current to the ampacity of the conductors or the ratings of the busbars to which it is connected in accordance with 231.14(A) through (E).

(A)– Monitoring.

The PCS controller shall monitor all currents within the PCS. Any busbar or conductor on the load side of the service disconnecting means that is not monitored by the PCS shall comply with 231.12. Where the PCS is connected in accordance with 231.11, the PCS shall monitor the service conductors and prevent overload of these conductors.

(B)– Settings.

The sum of all PCS-controlled currents plus all monitored currents from other sources of supply shall not exceed the ampacity of any busbar or conductor supplied by the power production sources. Where the PCS is connected to an overcurrent device protecting any busbar or conductor not monitored by the PCS, the setting of the PCS controller shall be set within the ratings of that overcurrent device.

(C)– Overcurrent Protection.

The PCS shall provide overcurrent protection either by overcurrent devices or by the PCS including the functionality as an overcurrent device in the product listing.

Informational Note: Some PCS are listed to provide overcurrent protection.

(D)– Single Power Source Rating.

The rating of the overcurrent device for any single power source controlled by the PCS shall not exceed the rating of the busbar or the ampacity of the conductors to which it is connected.

(E)– Access to Settings.

The access to settings of the PCS shall be restricted to qualified personnel in accordance with the requirements of 240.6(C).

231.15– Output Characteristics.

The output of power production equipment or energy storage systems operating in parallel with an electrical supply system shall be compatible with the voltage, wave shape, and frequency of the system to which it is connected. Synchronous generators operating in parallel with an electrical supply system shall be provided with the necessary equipment to establish and maintain a synchronous condition.

Informational Note No.1: The term *compatible* does not necessarily mean matching the primary source wave shape.

Informational Note No.2: Information on the performance of power production equipment when interconnecting with a utility can be found in Chapter 7 of IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*.

231.16– Interrupting and Short-Circuit Current Rating.

Consideration shall be given to the contribution of fault currents from all interconnected power sources for the interrupting and short-circuit current ratings of equipment on interactive systems.

231.20– Disconnecting Means, Source.

The disconnecting means shall comply with the following:

- (1) Be one of the following types:
 - (2) A manually operable switch or circuit breaker
 - (3) A load-break rated pull-out switch
 - (4) A power operated or remote-controlled switch or circuit breaker that is manually operable locally and opens automatically when control power is interrupted
 - (5) A device listed or approved for the intended application
- (6) Simultaneously disconnect all ungrounded conductors of the circuit
- (7) Be located where readily accessible
- (8) Be externally operable without exposed live parts
- (9) Enclosures with doors or hinged covers with exposed live parts when open that require a tool to open or are lockable where readily accessible to unqualified persons
- (10) Plainly indicate whether in the open (off) or closed (on) position
- (11) Have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals
- (12) Be marked in accordance with the warning in 690.13(B), where the line and load terminals are capable of being energized in the open position

Informational Note: See 404.6(C) Exception for interconnected power sources where equipment, including switches and fuses, could be energized from both directions.

231.32– Ground-Fault Protection.

Where protection is installed in accordance with 230.95, the output of connected power production equipment or energy storage systems shall be connected to the supply side of the ground-fault protection.

Exception: Connection shall be permitted to be made to the load side of ground-fault protection, if there is ground-fault protection for equipment from all ground-fault current sources.

231.40 – Loss of Primary Source.

The output of electric power production equipment and energy storage systems shall be automatically disconnected from all ungrounded conductors of the interconnected systems when one or more of the phases to which it is connected opens. The electric power production equipment or energy storage system shall not be reconnected until all the phases of the interconnected system to which it is connected are restored. This requirement shall not be applicable to electric power production equipment or energy storage system providing power to an emergency or legally required standby system.

Exception: A listed interactive inverter shall trip or shall be permitted to automatically cease exporting power when one or more of the phases of the interconnected system opens and shall not be required to automatically disconnect all ungrounded conductors from the primary source. A listed interactive inverter shall be permitted to automatically or manually resume exporting power to the interconnected system once all phases of the source to which it is connected are restored.

Interactive power production equipment shall be permitted to operate in island mode to supply loads that have been disconnected from the electric power production and distribution network.

Informational Note No. 1: Risks to personnel and equipment associated with the primary source could occur if an interactive electric power production source can operate as an intentional island. Special detection methods are required to determine that a primary source supply system outage has occurred and whether there should be automatic disconnection. When the primary source supply system is restored, special detection methods are typically required to limit exposure of power production sources to out-of-phase reconnection. Reference Chapter 6, "Response to EPS Abnormal Conditions," of IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*.

Informational Note No. 2: Induction-generating equipment connected on systems with significant capacitance can become self-excited upon loss of the primary source and experience severe overvoltage as a result.

231.45 – Unbalanced Interconnections.

(A) – Single Phase Equipment Connected to Three-Phase Systems.

Where single-phase power production equipment or energy storage system sources are connected to three-phase systems in parallel with the utility, unbalanced voltages at the point of interconnection to shall not exceed more than 3 percent.

Informational Note: For interactive power sources, unbalanced voltages can be minimized by the same methods that are used for single-phase loads on a 3-phase power system. See ANSI/C84.1-2020, *Electric Power Systems and Equipment — Voltage Ratings (60 Hertz)*.

(B) – Three Phase.

Three-phase power production equipment and energy storage systems in interactive systems shall have all phases automatically de-energized upon loss of, or unbalance of, voltage in one or more phases unless the interconnected system is designed so that significant unbalanced voltages will not result.

Part II. – AC Microgrid Systems

231.50 – System Operation.

AC microgrid systems shall be permitted to disconnect from the primary source of power or other interconnected electric power production sources and operate in island mode.

231.60 – Primary Power Source Connection.

AC microgrid connections to a utility source shall comply with 231.11 or 231.12.

231.65 – Reconnection to Primary Power Source.

AC microgrid systems that reconnect to a utility source shall be provided with the necessary equipment to establish a synchronous transition.

231.70 – Microgrid Interconnect Devices (MID).

AC microgrid interconnect devices shall comply with the following:

- (1) ~~Be required for any connection between an AC microgrid system and a utility~~
- (2) ~~Be evaluated for the application and have a field label applied or be listed for the application~~
- (3) ~~Have a sufficient number of overcurrent protective devices located to provide overcurrent protection from all sources~~

Informational Note: MID functionality is often incorporated in an interactive or multimode inverter, energy storage system, or similar device identified for interactive operation.

Statement of Problem and Substantiation for Public Comment

The members of the Sustainable Energy Action Committee (SEAC) include designers, installers, inspectors and certifiers among other stakeholders. The collective membership includes individuals, groups and jurisdictions that have been integral to the installation of the 2 million rooftop PV systems nationwide and over one million in the State of California. The members of SEAC disagree with Public Input 4318 and the resulting First Revision 7974:

From PI 4318 – This global input is written to address a very serious safety issue that exists abundantly in the NEC.
The problem here is that 90.3 provides committees dealing with alternative energy sources the ability to completely ignore 230.82(6).

From FR 7974 - This First Revision is developed to address issues that have existed for multiple NEC cycles with respect to alternative energy systems and how they connect and interface with service equipment.

All systems connected to the supply-side of the main disconnect have been inspected and approved in accordance with the applicable requirements of both Articles 230 and 705. The majority of the supply-side connections were facilitated through a bus tap ahead of the main disconnect within the existing service equipment. Where the service equipment did not include a provision by the manufacturer for the tap connection, an evaluation by a qualified Field Evaluation Body was required to maintain the equipment certification. The additional conductor protection provided by current-limiters was provided where required by Article 705 (tap conductors in excess of 10' per the 2020 NEC).

The claim that the interconnected systems installed and approved under the current and past NEC Articles 230 and 705 represent a "serious safety issue" is without merit. No documentation of injury or property damage that was a result of the current and past NEC requirements has been provided.

Neither the submitter of PI 4318 nor CMP 10 identified a specific serious safety issue that can only be addressed through creation of a new article. SEAC disagrees with the PI submitter that the code arrangement hierarchy of 90.3 is a "problem". It is also inaccurate to suggest that CMP 4 ignores 230.82(6). NEC 705.11 (2020) specifically references 230.82(6) for supply-side connected systems.

Simply copying the language from the existing Articles 230 and 705 into a new NEC article does not aid in the practical safeguarding of persons and property from electrical hazards. Nor does it remedy any perceived issues of safety in the existing language of those articles. Safety concerns that exist in either Article 230 or Article 705 must be addressed through the proper NFPA process; a public input that identifies a specific technical safety problem with language that addresses the problem.

Related Item

• FR 7974 • PI 4318

Submitter Information Verification

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Submittal Date: Fri Aug 13 18:17:52 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: [SR-8272-NFPA 70-2021](#)
Statement: New Article 231 is deleted in support of the revision provided in PC 1098. The provision of Article 231 will be redundant if PC 1098 is accepted.
PC-321 & 325: These public comments were resolved by the deletion of Article 231.



Public Comment No. 2116-NFPA 70-2021 [Article 231]

Article 231— Electric Power Sources Interconnected with an Electric Utility

Part I.— General

231.1— Scope.

This article covers installation of one or more power production equipment or energy storage systems operating in parallel with a utility source. This article does not include on-site electrical power source(s) that do not operate in parallel with the electric utility.

Informational Note: For further information, see IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power System Interfaces*.

231.6— Equipment Approval.

All equipment shall be identified for the intended use. Power production equipment and energy storage systems intended to operate in parallel with electric power production sources shall be listed for interactive function or be evaluated for interactive function and have a field label applied, or both.

Informational Note: Examples of power production sources include interactive inverters, engine generators, and wind turbines.

231.8— System Installation.

Installation of one or more power production equipment or energy storage systems operating in parallel with the electric utility shall be performed only by qualified persons.

231.10— Identification of Power Sources.

A permanent plaque or directory shall be installed at each service equipment location or at an approved readily visible location. The plaque or directory shall denote the location of each power production equipment or energy storage system disconnecting means for the building or structure and be grouped with other plaques or directories for other on-site sources. The plaque or directory shall be marked with the wording CAUTION: MULTIPLE SOURCES OF POWER. Any posted diagrams shall be correctly oriented with respect to the diagram's location. The marking shall comply with 110.21(B).

Exception: Installations with multiple co-located power production sources shall be permitted to be identified as a group(s). The plaque or directory shall not be required to identify each power source individually.

231.11— Supply-Side Service Connections.

Power production equipment and energy storage systems shall be permitted to be connected to the supply side of the service disconnecting means in accordance with 230.82(6) and shall comply with 231.11(A) through (G).

(A)— Minimum Size and Ampacity.

The sum of the connected power production equipment and energy storage systems maximum continuous output current, other than those controlled in accordance with 231.14, shall not exceed the ampacity of the service conductors connecting the service equipment to the service point.

(B)— Calculation of Maximum Circuit Current.

Where not elsewhere required or permitted in this Code, the maximum current from the power production equipment or energy storage system shall be the sum of the continuous output current ratings of the connected power production equipment and energy storage system.

(C)— Conductors.

The service conductors connecting the power production equipment or energy storage system from the point of connection to the first overcurrent protection device shall be sized in accordance with 231.11(C)(1) and (C)(2) and in no case sized smaller than 6 AWG copper or 4 AWG aluminum.

Service conductor wiring methods shall comply with Parts II, III, and IV of Article 230.

Service entrance conductors shall have an ampacity of not less than the maximum output current calculated in 231.11(B). Conductors shall be sized not less than the largest of 231.11(C)(1) or (C)(2). Ampacity shall be determined from 310.14 and shall comply with 110.14(C). The maximum current of busways shall be that value for which the busway has been listed or labeled.

(1)— Supplied From Continuous Power Production Equipment or Energy Storage System.

Where the service entrance conductors are supplied from continuous power production equipment or energy storage system or any combination of noncontinuous and continuous power production equipment or energy storage system source currents, the minimum service entrance conductor size shall have an ampacity not less than the sum of the noncontinuous source currents plus 125 percent of continuous source currents.

Exception No. 1: Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the sum of the continuous and noncontinuous source current.

Exception No. 2: The sum of the noncontinuous source currents and the continuous source currents if the service entrance conductors terminate in an overcurrent device where both the overcurrent device and its assembly are listed for operation at 100 percent of their rating shall be permitted.

(2)— Minimum Service Entrance Conductor Ampacity.

The minimum service entrance conductor size shall have an ampacity not less than the maximum calculated sum of all connected power production equipment or energy storage system source currents after the application of any adjustment or correction factors.

(D)— Overcurrent Protection.

Overcurrent protection shall be provided in accordance with Part VII of Article 230.

(E)— Connections.

(1)— Spliced and Tapped Conductors.

The connection of service conductors connecting the electric power production sources to the service conductors shall be made in accordance with 230.46.

(2)— Modifications.

Any modifications to existing equipment shall be made in accordance with the manufacturer's instructions, or the modification shall be required to be evaluated for the application and have a field label applied.

(3)— Meter Socket Connections.

For meter socket enclosures or other equipment under the exclusive control of the electric utility, only connections approved by the electric utility shall be permitted.

(F)— Neutral Conductors.

Neutral conductors shall be permitted to be sized in accordance with either 231.11(F)(1) or (F)(2).

(1)— Single-Phase Line-to-Neutral Power Sources.

Where not elsewhere required or permitted in this Code, the ampacity of a neutral conductor to which a single-phase line-to-neutral power source is connected shall not be smaller than the ampacity in 231.11(C).

(2)– Neutral Conductor Used Solely for Instrumentation, Voltage, Detection, or Phase Detection.

A power production equipment neutral conductor used solely for instrumentation, voltage detection, or phase detection shall be permitted to be sized in accordance with 250.102.

(G)– Equipment.

The first disconnecting means for the conductors connected to the supply side of a service disconnect, where in a separate enclosure other than the service equipment, shall be in accordance with Parts V and VI of Article 230.

231.12– Load-Side Source Connections.

Feeder conductors connecting the output of power production equipment or energy storage systems shall be permitted to be connected to the load side of the service disconnecting means at any distribution equipment on the premises. Where distribution equipment or feeders are fed simultaneously by an electric utility source and one or more other power sources the interconnected equipment shall comply with 231.12(A) through (F). Where a power control system (PCS) is installed in accordance with 231.14, the setting of the PCS controller shall be considered the power production equipment or energy storage system output current in relation to 231.12(A) through (F).

(A)– Dedicated Overcurrent and Disconnect.

Each interconnection of one or more power production equipment or energy storage system installed in one system shall be made at a dedicated circuit breaker or fusible disconnecting means.

(B)– Bus Rating.

The power production equipment or energy storage system output circuit current multiplied by 125 percent shall be used in determining the ratings of busbars in accordance with 231.12(B)(1) through (B)(5).

(1)– Output Current Plus Rating of Overcurrent Protective Device.

The sum of 125 percent of the power production equipment and energy storage system output current, and the rating of the overcurrent device protecting the busbar shall not exceed the ampacity of the busbar.

Informational Note: This general rule assumes no limitation in the number of the loads or sources applied to busbars or their locations.

(2)– Sources Connected at Opposite Ends of Busbar.

Where two sources, one a primary power source and the other from power production equipment or energy storage system, are located at opposite ends of a busbar that contains loads, the sum of 125 percent of the power production equipment or energy storage system output current and the rating of the overcurrent device protecting the busbar shall not exceed 120 percent of the ampacity of the busbar. The busbar shall be sized for the loads connected in accordance with Parts I, III, or IV of Article 220. A permanent warning label shall be applied to the distribution equipment adjacent to the back-fed breaker from the power source that displays the following or equivalent wording:

WARNING: POWER SOURCE OUTPUT CONNECTION — DO NOT RELOCATE THIS OVERCURRENT DEVICE. THIS EQUIPMENT FED BY MULTIPLE SOURCES.

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

(3)– Sum of Overcurrent Device Ratings.

The sum of the ampere ratings of all overcurrent devices on panelboards, both load and supply devices, excluding the rating of the overcurrent device protecting the busbar, shall not exceed the ampacity of the busbar. The rating of the overcurrent device protecting the busbar shall not exceed the rating of the busbar. Permanent warning labels shall be applied to distribution equipment displaying the following or equivalent wording:

WARNING:

THIS EQUIPMENT FED BY MULTIPLE SOURCES.

TOTAL RATING OF ALL OVERCURRENT DEVICES

EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE

SHALL NOT EXCEED AMPACITY OF BUSBAR.

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

(4)– Center-Fed Panelboards.

A connection at either end of a center-fed panelboard in dwellings shall be permitted where the sum of 125 percent of the power production equipment and energy storage system output current and the rating of the overcurrent device protecting the busbar does not exceed 120 percent of the current rating of the busbar.

(5)– Engineering Supervision.

Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 231.12(B)(1) through (B)(4) where designed under engineering supervision that includes available fault current and busbar load calculations.

(6)– Feed-Through Connections.

Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors. The feed-through conductors shall be protected in accordance with 231.12(C)(2). Where an overcurrent device is installed at the supply end of the feed-through conductors, the busbar in the supplying panelboard shall be permitted to be sized in accordance with 231.12(B)(1) through (B)(5).

(C)– Feeder Connections.

(1)– Connection From Power Production Equipment or Energy Storage System.

Where the power production equipment or energy storage system connection is made to a feeder, the conductors from the power production equipment or energy storage system to the point of connection shall be sized based on the larger of 125 percent of all power production and energy storage system source(s) output circuit current(s) or as sized in accordance with 240.21(B).

(2)– Connection at Other Than Opposite End of Primary Source Overcurrent Device.

Where the connection is made to a feeder at a location other than the opposite end of the feeder from the primary source overcurrent device, that portion of the feeder from the point of connection to the load shall be protected by one of the following:

- (1) The feeder ampacity shall be not less than the sum of the primary source overcurrent device and 125 percent of the power production equipment or energy storage system output circuit current.
- (2) An overcurrent protective device at the load side of the power source connection point rated not greater than the ampacity of that portion of the feeder.

(D)– Marking.

Equipment containing overcurrent devices in circuits supplying power to a busbar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources.

(E)– Suitable for Backfeed.

Fused disconnects, unless otherwise marked, shall be considered suitable for backfeed. Circuit breakers not marked *line* and *load* shall be considered suitable for backfeed. Circuit breakers marked *line* and *load* shall not be considered suitable for backfeed.

(F)– Fastening.

Listed plug-in-type circuit breakers back-fed from electric power production equipment or energy storage system that are listed and identified as interactive shall be permitted to omit the additional fastener required by 408.36(D) for such applications.

231.14– Power Control Systems.

A PCS shall be listed and evaluated to control the output of one or more power production sources, energy storage systems (ESS), and other equipment. The PCS shall limit current and loading on the busbars and conductors supplied by the PCS.

For the circuits connected to a PCS, the PCS shall limit the current to the ampacity of the conductors or the ratings of the busbars to which it is connected in accordance with 231.14(A) through (E).

(A)– Monitoring.

The PCS controller shall monitor all currents within the PCS. Any busbar or conductor on the load side of the service disconnecting means that is not monitored by the PCS shall comply with 231.12. Where the PCS is connected in accordance with 231.11, the PCS shall monitor the service conductors and prevent overload of these conductors.

(B)– Settings.

The sum of all PCS-controlled currents plus all monitored currents from other sources of supply shall not exceed the ampacity of any busbar or conductor supplied by the power production sources. Where the PCS is connected to an overcurrent device protecting any busbar or conductor not monitored by the PCS, the setting of the PCS controller shall be set within the ratings of that overcurrent device.

(C)– Overcurrent Protection.

The PCS shall provide overcurrent protection either by overcurrent devices or by the PCS including the functionality as an overcurrent device in the product listing.

Informational Note: Some PCS are listed to provide overcurrent protection.

(D)– Single Power Source Rating.

The rating of the overcurrent device for any single power source controlled by the PCS shall not exceed the rating of the busbar or the ampacity of the conductors to which it is connected.

(E)– Access to Settings.

The access to settings of the PCS shall be restricted to qualified personnel in accordance with the requirements of 240.6(C).

231.15– Output Characteristics.

The output of power production equipment or energy storage systems operating in parallel with an electrical supply system shall be compatible with the voltage, wave shape, and frequency of the system to which it is connected. Synchronous generators operating in parallel with an electrical supply system shall be provided with the necessary equipment to establish and maintain a synchronous condition.

Informational Note No.1: The term *compatible* does not necessarily mean matching the primary source wave shape.

Informational Note No.2: Information on the performance of power production equipment when interconnecting with a utility can be found in Chapter 7 of IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*.

231.16– Interrupting and Short-Circuit Current Rating.

Consideration shall be given to the contribution of fault currents from all interconnected power sources for the interrupting and short-circuit current ratings of equipment on interactive systems.

231.20– Disconnecting Means, Source.

The disconnecting means shall comply with the following:

- (1) Be one of the following types:
 - (2) A manually operable switch or circuit breaker
 - (3) A load-break rated pull-out switch
 - (4) A power operated or remote-controlled switch or circuit breaker that is manually operable locally and opens automatically when control power is interrupted
 - (5) A device listed or approved for the intended application
- (6) Simultaneously disconnect all ungrounded conductors of the circuit
- (7) Be located where readily accessible
- (8) Be externally operable without exposed live parts
- (9) Enclosures with doors or hinged covers with exposed live parts when open that require a tool to open or are lockable where readily accessible to unqualified persons
- (10) Plainly indicate whether in the open (off) or closed (on) position
- (11) Have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals
- (12) Be marked in accordance with the warning in 690.13(B), where the line and load terminals are capable of being energized in the open position

Informational Note: See 404.6(C) Exception for interconnected power sources where equipment, including switches and fuses, could be energized from both directions.

231.32– Ground-Fault Protection.

Where protection is installed in accordance with 230.95, the output of connected power production equipment or energy storage systems shall be connected to the supply side of the ground-fault protection.

Exception: Connection shall be permitted to be made to the load side of ground-fault protection, if there is ground-fault protection for equipment from all ground-fault current sources.

231.40 – Loss of Primary Source.

The output of electric power production equipment and energy storage systems shall be automatically disconnected from all ungrounded conductors of the interconnected system when one or more of the phases to which it is connected opens. The electric power production equipment or energy storage system shall not be reconnected until all the phases of the interconnected system to which it is connected are restored. This requirement shall not be applicable to electric power production equipment or energy storage system providing power to an emergency or legally required standby system.

Exception: A listed interactive inverter shall trip or shall be permitted to automatically cease exporting power when one or more of the phases of the interconnected system opens and shall not be required to automatically disconnect all ungrounded conductors from the primary source. A listed interactive inverter shall be permitted to automatically or manually resume exporting power to the interconnected system once all phases of the source to which it is connected are restored.

Interactive power production equipment shall be permitted to operate in island mode to supply loads that have been disconnected from the electric power production and distribution network.

Informational Note No. 1: Risks to personnel and equipment associated with the primary source could occur if an interactive electric power production source can operate as an intentional island. Special detection methods are required to determine that a primary source supply system outage has occurred and whether there should be automatic disconnection. When the primary source supply system is restored, special detection methods are typically required to limit exposure of power production sources to out-of-phase reconnection. Reference Chapter 6, "Response to EPS Abnormal Conditions," of IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*.

Informational Note No. 2: Induction-generating equipment connected on systems with significant capacitance can become self-excited upon loss of the primary source and experience severe overvoltage as a result.

231.45 – Unbalanced Interconnections.**(A) – Single Phase Equipment Connected to Three Phase Systems.**

Where single-phase power production equipment or energy storage system sources are connected to three-phase systems in parallel with the utility, unbalanced voltages at the point of interconnection to shall not exceed more than 3 percent.

Informational Note: For interactive power sources, unbalanced voltages can be minimized by the same methods that are used for single-phase loads on a 3-phase power system. See ANSI/C84.1-2020, *Electric Power Systems and Equipment — Voltage Ratings (60 Hertz)*.

(B) – Three Phase.

Three-phase power production equipment and energy storage systems in interactive systems shall have all phases automatically de-energized upon loss of, or unbalance of, voltage in one or more phases unless the interconnected system is designed so that significant unbalanced voltages will not result.

Part II. – AC Microgrid Systems**231.50 – System Operation.**

AC microgrid systems shall be permitted to disconnect from the primary source of power or other interconnected electric power production sources and operate in island mode.

231.60 – Primary Power Source Connection.

AC microgrid connections to a utility source shall comply with 231.11 or 231.12.

231.65 – Reconnection to Primary Power Source.

AC microgrid systems that reconnect to a utility source shall be provided with the necessary equipment to establish a synchronous transition.

231.70 – Microgrid Interconnect Devices (MID).

AC microgrid interconnect devices shall comply with the following:

- (1) ~~Be required for any connection between an AC microgrid system and a utility~~
- (2) ~~Be evaluated for the application and have a field label applied or be listed for the application~~
- (3) ~~Have a sufficient number of overcurrent protective devices located to provide overcurrent protection from all sources~~

Informational Note: MID functionality is often incorporated in an interactive or multimode inverter, energy storage system, or similar device identified for interactive operation.

Statement of Problem and Substantiation for Public Comment

Delete new Article 231 in its entirety. This Article was created in response to a global Public Input that offered no direct language to be added or revised. As a result a CMP 10 task group created this new Article that is predominately language that was extracted from Article 705. There was a task group created to address the concerns expressed by CMP 10 and make recommended changes in Article 705. Having this new Article would create confusion and be adverse to the general use of the NEC as described in 90.3 where Chapter 7 could amend the requirements in Chapter 2. This would create a great deal of confusion for designers, installers and enforcers when trying to decide which Article to use for these installations.

Related Item

- Global FR7974

Submitter Information Verification

Submitter Full Name: James Rogers

Organization: Towns Of Oak Bluffs, Tisbury,

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 19 12:48:37 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8272-NFPA 70-2021](#)

Statement: New Article 231 is deleted in support of the revision provided in PC 1098. The provision of Article 231 will be redundant if PC 1098 is accepted.

PC-321 & 325: These public comments were resolved by the deletion of Article 231.



Public Comment No. 278-NFPA 70-2021 [Article 231]

Article 231— Electric Power Sources Interconnected with an Electric Utility

Part I— General

231.1— Scope.

This article covers installation of one or more power production equipment or energy storage systems operating in parallel with a utility source. This article does not include on-site electrical power source(s) that do not operate in parallel with the electric utility.

Informational Note: For further information, see IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power System Interfaces*.

231.6— Equipment Approval.

All equipment shall be identified for the intended use. Power production equipment and energy storage systems intended to operate in parallel with electric power production sources shall be listed for interactive function or be evaluated for interactive function and have a field label applied, or both.

Informational Note: Examples of power production sources include interactive inverters, engine generators, and wind turbines.

231.8— System Installation.

Installation of one or more power production equipment or energy storage systems operating in parallel with the electric utility shall be performed only by qualified persons.

231.10— Identification of Power Sources.

A permanent plaque or directory shall be installed at each service equipment location or at an approved readily visible location. The plaque or directory shall denote the location of each power production equipment or energy storage system disconnecting means for the building or structure and be grouped with other plaques or directories for other on-site sources. The plaque or directory shall be marked with the wording CAUTION: MULTIPLE SOURCES OF POWER. Any posted diagrams shall be correctly oriented with respect to the diagram's location. The marking shall comply with 110.24(B).

Exception: Installations with multiple co-located power production sources shall be permitted to be identified as a group(s). The plaque or directory shall not be required to identify each power source individually.

231.11— Supply-Side Service Connections.

Power production equipment and energy storage systems shall be permitted to be connected to the supply side of the service disconnecting means in accordance with 230.82(6) and shall comply with 231.11(A) through (G).

(A)— Minimum Size and Ampacity.

The sum of the connected power production equipment and energy storage systems maximum continuous output current, other than those controlled in accordance with 231.14, shall not exceed the ampacity of the service conductors connecting the service equipment to the service point.

(B)— Calculation of Maximum Circuit Current.

Where not elsewhere required or permitted in this Code, the maximum current from the power production equipment or energy storage system shall be the sum of the continuous output current ratings of the connected power production equipment and energy storage system.

(C)— Conductors.

The service conductors connecting the power production equipment or energy storage system from the point of connection to the first overcurrent protection device shall be sized in accordance with 231.11(C)(1) and (C)(2) and in no case sized smaller than 6 AWG copper or 4 AWG aluminum.

Service conductor wiring methods shall comply with Parts II, III, and IV of Article 230.

Service entrance conductors shall have an ampacity of not less than the maximum output current calculated in 231.11(B). Conductors shall be sized not less than the largest of 231.11(C)(1) or (C)(2). Ampacity shall be determined from 310.14 and shall comply with 110.14(C). The maximum current of busways shall be that value for which the busway has been listed or labeled.

(1)— Supplied From Continuous Power Production Equipment or Energy Storage System.

Where the service entrance conductors are supplied from continuous power production equipment or energy storage system or any combination of noncontinuous and continuous power production equipment or energy storage system source currents, the minimum service entrance conductor size shall have an ampacity not less than the sum of the noncontinuous source currents plus 125 percent of continuous source currents.

Exception No. 1: Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the sum of the continuous and noncontinuous source current.

Exception No. 2: The sum of the noncontinuous source currents and the continuous source currents if the service entrance conductors terminate in an overcurrent device where both the overcurrent device and its assembly are listed for operation at 100 percent of their rating shall be permitted.

(2)— Minimum Service Entrance Conductor Ampacity.

The minimum service entrance conductor size shall have an ampacity not less than the maximum calculated sum of all connected power production equipment or energy storage system source currents after the application of any adjustment or correction factors.

(D)— Overcurrent Protection.

Overcurrent protection shall be provided in accordance with Part VII of Article 230.

(E)— Connections.

(1)— Spliced and Tapped Conductors.

The connection of service conductors connecting the electric power production sources to the service conductors shall be made in accordance with 230.46.

(2)— Modifications.

Any modifications to existing equipment shall be made in accordance with the manufacturer's instructions, or the modification shall be required to be evaluated for the application and have a field label applied.

(3)— Meter Socket Connections.

For meter socket enclosures or other equipment under the exclusive control of the electric utility, only connections approved by the electric utility shall be permitted.

(F)— Neutral Conductors.

Neutral conductors shall be permitted to be sized in accordance with either 231.11(F)(1) or (F)(2).

(1)— Single-Phase Line-to-Neutral Power Sources.

Where not elsewhere required or permitted in this Code, the ampacity of a neutral conductor to which a single-phase line-to-neutral power source is connected shall not be smaller than the ampacity in 231.11(C).

(2)– Neutral Conductor Used Solely for Instrumentation, Voltage, Detection, or Phase Detection.

A power production equipment neutral conductor used solely for instrumentation, voltage detection, or phase detection shall be permitted to be sized in accordance with 250.102.

(G)– Equipment.

The first disconnecting means for the conductors connected to the supply side of a service disconnect, where in a separate enclosure other than the service equipment, shall be in accordance with Parts V and VI of Article 230.

231.12– Load-Side Source Connections.

Feeder conductors connecting the output of power production equipment or energy storage systems shall be permitted to be connected to the load side of the service disconnecting means at any distribution equipment on the premises. Where distribution equipment or feeders are fed simultaneously by an electric utility source and one or more other power sources the interconnected equipment shall comply with 231.12(A) through (F). Where a power control system (PCS) is installed in accordance with 231.14, the setting of the PCS controller shall be considered the power production equipment or energy storage system output current in relation to 231.12(A) through (F).

(A)– Dedicated Overcurrent and Disconnect.

Each interconnection of one or more power production equipment or energy storage system installed in one system shall be made at a dedicated circuit breaker or fusible disconnecting means.

(B)– Bus Rating.

The power production equipment or energy storage system output circuit current multiplied by 125 percent shall be used in determining the ratings of busbars in accordance with 231.12(B)(1) through (B)(5).

(1)– Output Current Plus Rating of Overcurrent Protective Device.

The sum of 125 percent of the power production equipment and energy storage system output current, and the rating of the overcurrent device protecting the busbar shall not exceed the ampacity of the busbar.

Informational Note: This general rule assumes no limitation in the number of the loads or sources applied to busbars or their locations.

(2)– Sources Connected at Opposite Ends of Busbar.

Where two sources, one a primary power source and the other from power production equipment or energy storage system, are located at opposite ends of a busbar that contains loads, the sum of 125 percent of the power production equipment or energy storage system output current and the rating of the overcurrent device protecting the busbar shall not exceed 120 percent of the ampacity of the busbar. The busbar shall be sized for the loads connected in accordance with Parts I, III, or IV of Article 220. A permanent warning label shall be applied to the distribution equipment adjacent to the back-fed breaker from the power source that displays the following or equivalent wording:

WARNING: POWER SOURCE OUTPUT CONNECTION — DO NOT RELOCATE THIS OVERCURRENT DEVICE. THIS EQUIPMENT FED BY MULTIPLE SOURCES.

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

(3)– Sum of Overcurrent Device Ratings.

The sum of the ampere ratings of all overcurrent devices on panelboards, both load and supply devices, excluding the rating of the overcurrent device protecting the busbar, shall not exceed the ampacity of the busbar. The rating of the overcurrent device protecting the busbar shall not exceed the rating of the busbar. Permanent warning labels shall be applied to distribution equipment displaying the following or equivalent wording:

WARNING:

THIS EQUIPMENT FED BY MULTIPLE SOURCES.

TOTAL RATING OF ALL OVERCURRENT DEVICES

EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE

SHALL NOT EXCEED AMPACITY OF BUSBAR.

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

(4)– Center-Fed Panelboards.

A connection at either end of a center-fed panelboard in dwellings shall be permitted where the sum of 125 percent of the power production equipment and energy storage system output current and the rating of the overcurrent device protecting the busbar does not exceed 120 percent of the current rating of the busbar.

(5)– Engineering Supervision.

Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 231.12(B)(1) through (B)(4) where designed under engineering supervision that includes available fault current and busbar load calculations.

(6)– Feed-Through Connections.

Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors. The feed-through conductors shall be protected in accordance with 231.12(C)(2). Where an overcurrent device is installed at the supply end of the feed-through conductors, the busbar in the supplying panelboard shall be permitted to be sized in accordance with 231.12(B)(1) through (B)(5).

(C)– Feeder Connections.

(1)– Connection From Power Production Equipment or Energy Storage System.

Where the power production equipment or energy storage system connection is made to a feeder, the conductors from the power production equipment or energy storage system to the point of connection shall be sized based on the larger of 125 percent of all power production and energy storage system source(s) output circuit current(s) or as sized in accordance with 240.21(B).

(2)– Connection at Other Than Opposite End of Primary Source Overcurrent Device.

Where the connection is made to a feeder at a location other than the opposite end of the feeder from the primary source overcurrent device, that portion of the feeder from the point of connection to the load shall be protected by one of the following:

- (1) The feeder ampacity shall be not less than the sum of the primary source overcurrent device and 125 percent of the power production equipment or energy storage system output circuit current.
- (2) An overcurrent protective device at the load side of the power source connection point rated not greater than the ampacity of that portion of the feeder.

(D)– Marking.

Equipment containing overcurrent devices in circuits supplying power to a busbar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources.

(E)– Suitable for Backfeed.

Fused disconnects, unless otherwise marked, shall be considered suitable for backfeed. Circuit breakers not marked *line* and *load* shall be considered suitable for backfeed. Circuit breakers marked *line* and *load* shall not be considered suitable for backfeed.

(F)– Fastening.

Listed plug-in-type circuit breakers back-fed from electric power production equipment or energy storage system that are listed and identified as interactive shall be permitted to omit the additional fastener required by 408.36(D) for such applications.

231.14– Power Control Systems.

A PCS shall be listed and evaluated to control the output of one or more power production sources, energy storage systems (ESS), and other equipment. The PCS shall limit current and loading on the busbars and conductors supplied by the PCS.

For the circuits connected to a PCS, the PCS shall limit the current to the ampacity of the conductors or the ratings of the busbars to which it is connected in accordance with 231.14(A) through (E).

(A)– Monitoring.

The PCS controller shall monitor all currents within the PCS. Any busbar or conductor on the load side of the service disconnecting means that is not monitored by the PCS shall comply with 231.12. Where the PCS is connected in accordance with 231.11, the PCS shall monitor the service conductors and prevent overload of these conductors.

(B)– Settings.

The sum of all PCS-controlled currents plus all monitored currents from other sources of supply shall not exceed the ampacity of any busbar or conductor supplied by the power production sources. Where the PCS is connected to an overcurrent device protecting any busbar or conductor not monitored by the PCS, the setting of the PCS controller shall be set within the ratings of that overcurrent device.

(C)– Overcurrent Protection.

The PCS shall provide overcurrent protection either by overcurrent devices or by the PCS including the functionality as an overcurrent device in the product listing.

Informational Note: Some PCS are listed to provide overcurrent protection.

(D)– Single Power Source Rating.

The rating of the overcurrent device for any single power source controlled by the PCS shall not exceed the rating of the busbar or the ampacity of the conductors to which it is connected.

(E)– Access to Settings.

The access to settings of the PCS shall be restricted to qualified personnel in accordance with the requirements of 240.6(C).

231.15– Output Characteristics.

The output of power production equipment or energy storage systems operating in parallel with an electrical supply system shall be compatible with the voltage, wave shape, and frequency of the system to which it is connected. Synchronous generators operating in parallel with an electrical supply system shall be provided with the necessary equipment to establish and maintain a synchronous condition.

Informational Note No.1: The term *compatible* does not necessarily mean matching the primary source wave shape.

Informational Note No.2: Information on the performance of power production equipment when interconnecting with a utility can be found in Chapter 7 of IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*.

231.16– Interrupting and Short-Circuit Current Rating.

Consideration shall be given to the contribution of fault currents from all interconnected power sources for the interrupting and short-circuit current ratings of equipment on interactive systems.

231.20– Disconnecting Means, Source.

The disconnecting means shall comply with the following:

- (1) Be one of the following types:
 - (2) A manually operable switch or circuit breaker
 - (3) A load-break rated pull-out switch
 - (4) A power operated or remote-controlled switch or circuit breaker that is manually operable locally and opens automatically when control power is interrupted
 - (5) A device listed or approved for the intended application
- (6) Simultaneously disconnect all ungrounded conductors of the circuit
- (7) Be located where readily accessible
- (8) Be externally operable without exposed live parts
- (9) Enclosures with doors or hinged covers with exposed live parts when open that require a tool to open or are lockable where readily accessible to unqualified persons
- (10) Plainly indicate whether in the open (off) or closed (on) position
- (11) Have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals
- (12) Be marked in accordance with the warning in 690.13(B), where the line and load terminals are capable of being energized in the open position

Informational Note: See 404.6(C) Exception for interconnected power sources where equipment, including switches and fuses, could be energized from both directions.

231.32– Ground-Fault Protection.

Where protection is installed in accordance with 230.95, the output of connected power production equipment or energy storage systems shall be connected to the supply side of the ground-fault protection.

Exception: Connection shall be permitted to be made to the load side of ground-fault protection, if there is ground-fault protection for equipment from all ground-fault current sources.

231.40– Loss of Primary Source.

The output of electric power production equipment and energy storage systems shall be automatically disconnected from all ungrounded conductors of the interconnected systems when one or more of the phases to which it is connected opens. The electric power production equipment or energy storage system shall not be reconnected until all the phases of the interconnected system to which it is connected are restored. This requirement shall not be applicable to electric power production equipment or energy storage system providing power to an emergency or legally required standby system.

Exception: A listed interactive inverter shall trip or shall be permitted to automatically cease exporting power when one or more of the phases of the interconnected system opens and shall not be required to automatically disconnect all ungrounded conductors from the primary source. A listed interactive inverter shall be permitted to automatically or manually resume exporting power to the interconnected system once all phases of the source to which it is connected are restored.

Interactive power production equipment shall be permitted to operate in island mode to supply loads that have been disconnected from the electric power production and distribution network.

Informational Note No. 1: Risks to personnel and equipment associated with the primary source could occur if an interactive electric power production source can operate as an intentional island. Special detection methods are required to determine that a primary source supply system outage has occurred and whether there should be automatic disconnection. When the primary source supply system is restored, special detection methods are typically required to limit exposure of power production sources to out-of-phase reconnection. Reference Chapter 6, "Response to EPS Abnormal Conditions," of IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*.

Informational Note No. 2: Induction-generating equipment connected on systems with significant capacitance can become self-excited upon loss of the primary source and experience severe overvoltage as a result.

231.45– Unbalanced Interconnections.**(A)– Single Phase Equipment Connected to Three Phase Systems.**

Where single-phase power production equipment or energy storage system sources are connected to three-phase systems in parallel with the utility, unbalanced voltages at the point of interconnection to shall not exceed more than 3 percent.

Informational Note: For interactive power sources, unbalanced voltages can be minimized by the same methods that are used for single-phase loads on a 3-phase power system. See ANSI/C84.1-2020, *Electric Power Systems and Equipment — Voltage Ratings (60 Hertz)*.

(B)– Three Phase.

Three-phase power production equipment and energy storage systems in interactive systems shall have all phases automatically de-energized upon loss of, or unbalance of, voltage in one or more phases unless the interconnected system is designed so that significant unbalanced voltages will not result.

Part II.– AC Microgrid Systems**231.50– System Operation.**

AC microgrid systems shall be permitted to disconnect from the primary source of power or other interconnected electric power production sources and operate in island mode.

231.60– Primary Power Source Connection.

AC microgrid connections to a utility source shall comply with 231.11 or 231.12.

231.65– Reconnection to Primary Power Source.

AC microgrid systems that reconnect to a utility source shall be provided with the necessary equipment to establish a synchronous transition.

231.70– Microgrid Interconnect Devices (MID).

AC microgrid interconnect devices shall comply with the following:

- (1) ~~Be required for any connection between an AC microgrid system and a utility~~
- (2) ~~Be evaluated for the application and have a field label applied or be listed for the application~~
- (3) ~~Have a sufficient number of overcurrent protective devices located to provide overcurrent protection from all sources~~

Informational Note: MID functionality is often incorporated in an interactive or multimode inverter, energy storage system, or similar device identified for interactive operation.

Statement of Problem and Substantiation for Public Comment

Included below are excerpts from the committee statement in First Revision No. 7974-NFPA 70-2020 with my responses.

"This First Revision is developed to address issues that have existed for multiple NEC cycles with respect to alternative energy systems and how they connect and interface with service equipment. These issues are well understood by the NEC CC who for cycles attempted to take an approach that would permit individual committees to work out the conflicts. In an effort to provide necessary correlation, CMP-10 has taken the initiative to make the appropriate corrections as seen in this first revision."

While it can be very difficult to work within the consensus based environment of code development used for the NEC it is the system that we have found works best in code development. While I understand CMP-10s frustration in getting changes they feel are important to be incorporated into 705.11, allowing the development of parallel competing code sections by different CMPs will cause no end of problems in the NEC. The proposed article 231 is a parallel article to 705 and will sow confusion among users of the NEC. The corrections that CMP-10 wishes to make need to be made in 705 through the consensus process.

"This new article recognizes that the interconnection of electric power sources that operate in parallel with the electric utility is tightly coupled with the requirements around services and service-related equipment found in Article 230. In response to a public input seeking attention to these connections, a new article located next to Article 230, specifically Article 231, is developed to help the user of the NEC associate the requirements that must be considered when interconnecting and operating in parallel with the utility."

This is a laudable goal on the part of CMP-10, but while it can be frustrating to work with other CMPs to get changes implemented, deciding unilaterally that CMP-10 will develop a parallel article in the chapters of the code they control is not the proper way to address this. Down this path leads to allowing any CMP that feels frustrated in the code making process to just create their own parallel requirements. I can't see how this will do anything but make the NEC less usable and therefore less able to carry out the purpose that the NEC serves.

"This new article clearly identifies those conductors that connect to the line side of the service disconnect as service conductors and the equipment directly connected to these conductors from the power production sources or energy storage systems are considered service equipment and should be treated as such."

Art. 230.82(5) lists equipment that may be connected on the line side of the service disconnecting means. The conductors from the point of connection to the equipment are not specifically identified as service entrance conductors. It does state that the conductors must be provided with service equipment and installed IAW the requirements of service entrance conductors. Specifically identifying the conductors between the point of interconnection and the energy production equipment as "service entrance conductors" is therefore not required and does not increase the safety of the system, they can simply be required to be installed IAW the requirements of service entrance conductors as is done in 230.82(5).

I agree with a number of the changes proposed in this new article but I can't support the path CMP-10 has chosen to make these changes. It will cause unnecessary confusion with the parallel provisions of article 705 and article 705 will take precedence over 231 making any changes incorporated in 231 moot at best. I recommend

deleting article 231 and proposing any changes to article 705. Let's maintain the consensus process and not create silos in the NEC with competing articles on the same or similar subjects.

Related Item

- FR-7974

Submitter Information Verification

Submitter Full Name: Marvin Hamon

Organization: [Not Specified]

Street Address:

City:

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Submittal Date: Mon Jul 19 14:39:32 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8272-NFPA 70-2021](#)

Statement: New Article 231 is deleted in support of the revision provided in PC 1098. The provision of Article 231 will be redundant if PC 1098 is accepted.

PC-321 & 325: These public comments were resolved by the deletion of Article 231.



Public Comment No. 32-NFPA 70-2021 [Article 231]

Article 231— Electric Power Sources Interconnected with an Electric Utility

Part I— General

231.1— Scope.

This article covers installation of one or more power production equipment or energy storage systems operating in parallel with a utility source. This article does not include on-site electrical power source(s) that do not operate in parallel with the electric utility.

Informational Note: For further information, see IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power System Interfaces*.

231.6— Equipment Approval.

All equipment shall be identified for the intended use. Power production equipment and energy storage systems intended to operate in parallel with electric power production sources shall be listed for interactive function or be evaluated for interactive function and have a field label applied, or both.

Informational Note: Examples of power production sources include interactive inverters, engine generators, and wind turbines.

231.8— System Installation.

Installation of one or more power production equipment or energy storage systems operating in parallel with the electric utility shall be performed only by qualified persons.

231.10— Identification of Power Sources.

A permanent plaque or directory shall be installed at each service equipment location or at an approved readily visible location. The plaque or directory shall denote the location of each power production equipment or energy storage system disconnecting means for the building or structure and be grouped with other plaques or directories for other on-site sources. The plaque or directory shall be marked with the wording CAUTION: MULTIPLE SOURCES OF POWER. Any posted diagrams shall be correctly oriented with respect to the diagram's location. The marking shall comply with 110.24(B).

Exception: Installations with multiple co-located power production sources shall be permitted to be identified as a group(s). The plaque or directory shall not be required to identify each power source individually.

231.11— Supply-Side Service Connections.

Power production equipment and energy storage systems shall be permitted to be connected to the supply side of the service disconnecting means in accordance with 230.82(6) and shall comply with 231.11(A) through (G).

(A)— Minimum Size and Ampacity.

The sum of the connected power production equipment and energy storage systems maximum continuous output current, other than those controlled in accordance with 231.14, shall not exceed the ampacity of the service conductors connecting the service equipment to the service point.

(B)— Calculation of Maximum Circuit Current.

Where not elsewhere required or permitted in this Code, the maximum current from the power production equipment or energy storage system shall be the sum of the continuous output current ratings of the connected power production equipment and energy storage system.

(C)— Conductors.

The service conductors connecting the power production equipment or energy storage system from the point of connection to the first overcurrent protection device shall be sized in accordance with 231.11(C)(1) and (C)(2) and in no case sized smaller than 6 AWG copper or 4 AWG aluminum.

Service conductor wiring methods shall comply with Parts II, III, and IV of Article 230.

Service entrance conductors shall have an ampacity of not less than the maximum output current calculated in 231.11(B). Conductors shall be sized not less than the largest of 231.11(C)(1) or (C)(2). Ampacity shall be determined from 310.14 and shall comply with 110.14(C). The maximum current of busways shall be that value for which the busway has been listed or labeled.

(1)— Supplied From Continuous Power Production Equipment or Energy Storage System.

Where the service entrance conductors are supplied from continuous power production equipment or energy storage system or any combination of noncontinuous and continuous power production equipment or energy storage system source currents, the minimum service entrance conductor size shall have an ampacity not less than the sum of the noncontinuous source currents plus 125 percent of continuous source currents.

Exception No. 1: Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the sum of the continuous and noncontinuous source current.

Exception No. 2: The sum of the noncontinuous source currents and the continuous source currents if the service entrance conductors terminate in an overcurrent device where both the overcurrent device and its assembly are listed for operation at 100 percent of their rating shall be permitted.

(2)— Minimum Service Entrance Conductor Ampacity.

The minimum service entrance conductor size shall have an ampacity not less than the maximum calculated sum of all connected power production equipment or energy storage system source currents after the application of any adjustment or correction factors.

(D)— Overcurrent Protection.

Overcurrent protection shall be provided in accordance with Part VII of Article 230.

(E)— Connections.

(1)— Spliced and Tapped Conductors.

The connection of service conductors connecting the electric power production sources to the service conductors shall be made in accordance with 230.46.

(2)— Modifications.

Any modifications to existing equipment shall be made in accordance with the manufacturer's instructions, or the modification shall be required to be evaluated for the application and have a field label applied.

(3)— Meter Socket Connections.

For meter socket enclosures or other equipment under the exclusive control of the electric utility, only connections approved by the electric utility shall be permitted.

(F)— Neutral Conductors.

Neutral conductors shall be permitted to be sized in accordance with either 231.11(F)(1) or (F)(2).

(1)— Single-Phase Line-to-Neutral Power Sources.

Where not elsewhere required or permitted in this Code, the ampacity of a neutral conductor to which a single-phase line-to-neutral power source is connected shall not be smaller than the ampacity in 231.11(C).

(2)– Neutral Conductor Used Solely for Instrumentation, Voltage, Detection, or Phase Detection.

A power production equipment neutral conductor used solely for instrumentation, voltage detection, or phase detection shall be permitted to be sized in accordance with 250.102.

(G)– Equipment.

The first disconnecting means for the conductors connected to the supply side of a service disconnect, where in a separate enclosure other than the service equipment, shall be in accordance with Parts V and VI of Article 230.

231.12– Load-Side Source Connections.

Feeder conductors connecting the output of power production equipment or energy storage systems shall be permitted to be connected to the load side of the service disconnecting means at any distribution equipment on the premises. Where distribution equipment or feeders are fed simultaneously by an electric utility source and one or more other power sources the interconnected equipment shall comply with 231.12(A) through (F). Where a power control system (PCS) is installed in accordance with 231.14, the setting of the PCS controller shall be considered the power production equipment or energy storage system output current in relation to 231.12(A) through (F).

(A)– Dedicated Overcurrent and Disconnect.

Each interconnection of one or more power production equipment or energy storage system installed in one system shall be made at a dedicated circuit breaker or fusible disconnecting means.

(B)– Bus Rating.

The power production equipment or energy storage system output circuit current multiplied by 125 percent shall be used in determining the ratings of busbars in accordance with 231.12(B)(1) through (B)(5).

(1)– Output Current Plus Rating of Overcurrent Protective Device.

The sum of 125 percent of the power production equipment and energy storage system output current, and the rating of the overcurrent device protecting the busbar shall not exceed the ampacity of the busbar.

Informational Note: This general rule assumes no limitation in the number of the loads or sources applied to busbars or their locations.

(2)– Sources Connected at Opposite Ends of Busbar.

Where two sources, one a primary power source and the other from power production equipment or energy storage system, are located at opposite ends of a busbar that contains loads, the sum of 125 percent of the power production equipment or energy storage system output current and the rating of the overcurrent device protecting the busbar shall not exceed 120 percent of the ampacity of the busbar. The busbar shall be sized for the loads connected in accordance with Parts I, III, or IV of Article 220. A permanent warning label shall be applied to the distribution equipment adjacent to the back-fed breaker from the power source that displays the following or equivalent wording:

WARNING: POWER SOURCE OUTPUT CONNECTION — DO NOT RELOCATE THIS OVERCURRENT DEVICE. THIS EQUIPMENT FED BY MULTIPLE SOURCES.

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

(3)– Sum of Overcurrent Device Ratings.

The sum of the ampere ratings of all overcurrent devices on panelboards, both load and supply devices, excluding the rating of the overcurrent device protecting the busbar, shall not exceed the ampacity of the busbar. The rating of the overcurrent device protecting the busbar shall not exceed the rating of the busbar. Permanent warning labels shall be applied to distribution equipment displaying the following or equivalent wording:

WARNING:

THIS EQUIPMENT FED BY MULTIPLE SOURCES.

TOTAL RATING OF ALL OVERCURRENT DEVICES

EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE

SHALL NOT EXCEED AMPACITY OF BUSBAR.

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

(4)– Center-Fed Panelboards.

A connection at either end of a center-fed panelboard in dwellings shall be permitted where the sum of 125 percent of the power production equipment and energy storage system output current and the rating of the overcurrent device protecting the busbar does not exceed 120 percent of the current rating of the busbar.

(5)– Engineering Supervision.

Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 231.12(B)(1) through (B)(4) where designed under engineering supervision that includes available fault current and busbar load calculations.

(6)– Feed-Through Connections.

Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors. The feed-through conductors shall be protected in accordance with 231.12(C)(2). Where an overcurrent device is installed at the supply end of the feed-through conductors, the busbar in the supplying panelboard shall be permitted to be sized in accordance with 231.12(B)(1) through (B)(5).

(C)– Feeder Connections.

(1)– Connection From Power Production Equipment or Energy Storage System.

Where the power production equipment or energy storage system connection is made to a feeder, the conductors from the power production equipment or energy storage system to the point of connection shall be sized based on the larger of 125 percent of all power production and energy storage system source(s) output circuit current(s) or as sized in accordance with 240.21(B).

(2)– Connection at Other Than Opposite End of Primary Source Overcurrent Device.

Where the connection is made to a feeder at a location other than the opposite end of the feeder from the primary source overcurrent device, that portion of the feeder from the point of connection to the load shall be protected by one of the following:

- (1) The feeder ampacity shall be not less than the sum of the primary source overcurrent device and 125 percent of the power production equipment or energy storage system output circuit current.
- (2) An overcurrent protective device at the load side of the power source connection point rated not greater than the ampacity of that portion of the feeder.

(D)– Marking.

Equipment containing overcurrent devices in circuits supplying power to a busbar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources.

(E)– Suitable for Backfeed.

Fused disconnects, unless otherwise marked, shall be considered suitable for backfeed. Circuit breakers not marked *line* and *load* shall be considered suitable for backfeed. Circuit breakers marked *line* and *load* shall not be considered suitable for backfeed.

(F)– Fastening.

Listed plug-in-type circuit breakers back-fed from electric power production equipment or energy storage system that are listed and identified as interactive shall be permitted to omit the additional fastener required by 408.36(D) for such applications.

231.14– Power Control Systems.

A PCS shall be listed and evaluated to control the output of one or more power production sources, energy storage systems (ESS), and other equipment. The PCS shall limit current and loading on the busbars and conductors supplied by the PCS.

For the circuits connected to a PCS, the PCS shall limit the current to the ampacity of the conductors or the ratings of the busbars to which it is connected in accordance with 231.14(A) through (E).

(A)– Monitoring.

The PCS controller shall monitor all currents within the PCS. Any busbar or conductor on the load side of the service disconnecting means that is not monitored by the PCS shall comply with 231.12. Where the PCS is connected in accordance with 231.11, the PCS shall monitor the service conductors and prevent overload of these conductors.

(B)– Settings.

The sum of all PCS-controlled currents plus all monitored currents from other sources of supply shall not exceed the ampacity of any busbar or conductor supplied by the power production sources. Where the PCS is connected to an overcurrent device protecting any busbar or conductor not monitored by the PCS, the setting of the PCS controller shall be set within the ratings of that overcurrent device.

(C)– Overcurrent Protection.

The PCS shall provide overcurrent protection either by overcurrent devices or by the PCS including the functionality as an overcurrent device in the product listing.

Informational Note: Some PCS are listed to provide overcurrent protection.

(D)– Single Power Source Rating.

The rating of the overcurrent device for any single power source controlled by the PCS shall not exceed the rating of the busbar or the ampacity of the conductors to which it is connected.

(E)– Access to Settings.

The access to settings of the PCS shall be restricted to qualified personnel in accordance with the requirements of 240.6(C).

231.15– Output Characteristics.

The output of power production equipment or energy storage systems operating in parallel with an electrical supply system shall be compatible with the voltage, wave shape, and frequency of the system to which it is connected. Synchronous generators operating in parallel with an electrical supply system shall be provided with the necessary equipment to establish and maintain a synchronous condition.

Informational Note No.1: The term *compatible* does not necessarily mean matching the primary source wave shape.

Informational Note No.2: Information on the performance of power production equipment when interconnecting with a utility can be found in Chapter 7 of IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*.

231.16– Interrupting and Short-Circuit Current Rating.

Consideration shall be given to the contribution of fault currents from all interconnected power sources for the interrupting and short-circuit current ratings of equipment on interactive systems.

231.20– Disconnecting Means, Source.

The disconnecting means shall comply with the following:

- (1) Be one of the following types:
 - (2) A manually operable switch or circuit breaker
 - (3) A load-break-rated pull-out switch
 - (4) A power-operated or remote-controlled switch or circuit breaker that is manually operable locally and opens automatically when control power is interrupted
 - (5) A device listed or approved for the intended application
- (6) Simultaneously disconnect all ungrounded conductors of the circuit
- (7) Be located where readily accessible
- (8) Be externally operable without exposed live parts
- (9) Enclosures with doors or hinged covers with exposed live parts when open that require a tool to open or are lockable where readily accessible to unqualified persons
- (10) Plainly indicate whether in the open (off) or closed (on) position
- (11) Have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals
- (12) Be marked in accordance with the warning in 690.13(B), where the line and load terminals are capable of being energized in the open position

Informational Note: See 404.6(C) Exception for interconnected power sources where equipment, including switches and fuses, could be energized from both directions.

231.32– Ground-Fault Protection.

Where protection is installed in accordance with 230.95, the output of connected power production equipment or energy storage systems shall be connected to the supply side of the ground-fault protection.

Exception: Connection shall be permitted to be made to the load side of ground-fault protection, if there is ground-fault protection for equipment from all ground-fault current sources.

231.40 – Loss of Primary Source.

The output of electric power production equipment and energy storage systems shall be automatically disconnected from all ungrounded conductors of the interconnected systems when one or more of the phases to which it is connected opens. The electric power production equipment or energy storage system shall not be reconnected until all the phases of the interconnected system to which it is connected are restored. This requirement shall not be applicable to electric power production equipment or energy storage system providing power to an emergency or legally required standby system.

Exception: A listed interactive inverter shall trip or shall be permitted to automatically cease exporting power when one or more of the phases of the interconnected system opens and shall not be required to automatically disconnect all ungrounded conductors from the primary source. A listed interactive inverter shall be permitted to automatically or manually resume exporting power to the interconnected system once all phases of the source to which it is connected are restored.

Interactive power production equipment shall be permitted to operate in island mode to supply loads that have been disconnected from the electric power production and distribution network.

Informational Note No. 1: Risks to personnel and equipment associated with the primary source could occur if an interactive electric power production source can operate as an intentional island. Special detection methods are required to determine that a primary source supply system outage has occurred and whether there should be automatic disconnection. When the primary source supply system is restored, special detection methods are typically required to limit exposure of power production sources to out-of-phase reconnection. Reference Chapter 6, "Response to EPS Abnormal Conditions," of IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*.

Informational Note No. 2: Induction-generating equipment connected on systems with significant capacitance can become self-excited upon loss of the primary source and experience severe overvoltage as a result.

231.45 – Unbalanced Interconnections.

(A) – Single Phase Equipment Connected to Three Phase Systems.

Where single-phase power production equipment or energy storage system sources are connected to three-phase systems in parallel with the utility, unbalanced voltages at the point of interconnection to shall not exceed more than 3 percent.

Informational Note: For interactive power sources, unbalanced voltages can be minimized by the same methods that are used for single-phase loads on a 3-phase power system. See ANSI/C84.1-2020, *Electric Power Systems and Equipment — Voltage Ratings (60 Hertz)*.

(B) – Three Phase.

Three-phase power production equipment and energy storage systems in interactive systems shall have all phases automatically de-energized upon loss of, or unbalance of, voltage in one or more phases unless the interconnected system is designed so that significant unbalanced voltages will not result.

Part II – AC Microgrid Systems

231.50 – System Operation.

AC microgrid systems shall be permitted to disconnect from the primary source of power or other interconnected electric power production sources and operate in island mode.

231.60 – Primary Power Source Connection.

AC microgrid connections to a utility source shall comply with 231.11 or 231.12.

231.65 – Reconnection to Primary Power Source.

AC microgrid systems that reconnect to a utility source shall be provided with the necessary equipment to establish a synchronous transition.

231.70 – Microgrid Interconnect Devices (MID).

AC microgrid interconnect devices shall comply with the following:

- (1) ~~Be required for any connection between an AC microgrid system and a utility~~
- (2) ~~Be evaluated for the application and have a field label applied or be listed for the application~~
- (3) ~~Have a sufficient number of overcurrent protective devices located to provide overcurrent protection from all sources~~

Informational Note: MID functionality is often incorporated in an interactive or multimode inverter, energy storage system, or similar device identified for interactive operation.

Statement of Problem and Substantiation for Public Comment

Article 231 should be deleted as it is not necessary and contains redundant information that is located elsewhere in the code. This first revision does add any clarity to the code, and creates correlation issues with Article 705. The installation requirements in Article 230 and 705 adequately address the installation requirements for interconnected power production sources that are connected on the supply side of the service disconnect.

Related Item

• FR-7974

Submitter Information Verification

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Submittal Date: Wed Jun 30 08:34:26 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: [SR-8272-NFPA 70-2021](#)
Statement: New Article 231 is deleted in support of the revision provided in PC 1098. The provision of Article 231 will be redundant if PC 1098 is accepted.

PC-321 & 325: These public comments were resolved by the deletion of Article 231.



Public Comment No. 374-NFPA 70-2021 [Article 231]

Article 231— Electric Power Sources Interconnected with an Electric Utility

Part I— General

231.1— Scope.

This article covers installation of one or more power production equipment or energy storage systems operating in parallel with a utility source. This article does not include on-site electrical power source(s) that do not operate in parallel with the electric utility.

Informational Note: For further information, see IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power System Interfaces*.

231.6— Equipment Approval.

All equipment shall be identified for the intended use. Power production equipment and energy storage systems intended to operate in parallel with electric power production sources shall be listed for interactive function or be evaluated for interactive function and have a field label applied, or both.

Informational Note: Examples of power production sources include interactive inverters, engine generators, and wind turbines.

231.8— System Installation.

Installation of one or more power production equipment or energy storage systems operating in parallel with the electric utility shall be performed only by qualified persons.

231.10— Identification of Power Sources.

A permanent plaque or directory shall be installed at each service equipment location or at an approved readily visible location. The plaque or directory shall denote the location of each power production equipment or energy storage system disconnecting means for the building or structure and be grouped with other plaques or directories for other on-site sources. The plaque or directory shall be marked with the wording CAUTION: MULTIPLE SOURCES OF POWER. Any posted diagrams shall be correctly oriented with respect to the diagram's location. The marking shall comply with 110.24(B).

Exception: Installations with multiple co-located power production sources shall be permitted to be identified as a group(s). The plaque or directory shall not be required to identify each power source individually.

231.11— Supply-Side Service Connections.

Power production equipment and energy storage systems shall be permitted to be connected to the supply side of the service disconnecting means in accordance with 230.82(6) and shall comply with 231.11(A) through (G).

(A)— Minimum Size and Ampacity.

The sum of the connected power production equipment and energy storage systems maximum continuous output current, other than those controlled in accordance with 231.14, shall not exceed the ampacity of the service conductors connecting the service equipment to the service point.

(B)— Calculation of Maximum Circuit Current.

Where not elsewhere required or permitted in this Code, the maximum current from the power production equipment or energy storage system shall be the sum of the continuous output current ratings of the connected power production equipment and energy storage system.

(C)— Conductors.

The service conductors connecting the power production equipment or energy storage system from the point of connection to the first overcurrent protection device shall be sized in accordance with 231.11(C)(1) and (C)(2) and in no case sized smaller than 6 AWG copper or 4 AWG aluminum.

Service conductor wiring methods shall comply with Parts II, III, and IV of Article 230.

Service entrance conductors shall have an ampacity of not less than the maximum output current calculated in 231.11(B). Conductors shall be sized not less than the largest of 231.11(C)(1) or (C)(2). Ampacity shall be determined from 310.14 and shall comply with 110.14(C). The maximum current of busways shall be that value for which the busway has been listed or labeled.

(1)— Supplied From Continuous Power Production Equipment or Energy Storage System.

Where the service entrance conductors are supplied from continuous power production equipment or energy storage system or any combination of noncontinuous and continuous power production equipment or energy storage system source currents, the minimum service entrance conductor size shall have an ampacity not less than the sum of the noncontinuous source currents plus 125 percent of continuous source currents.

Exception No. 1: Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the sum of the continuous and noncontinuous source current.

Exception No. 2: The sum of the noncontinuous source currents and the continuous source currents if the service entrance conductors terminate in an overcurrent device where both the overcurrent device and its assembly are listed for operation at 100 percent of their rating shall be permitted.

(2)— Minimum Service Entrance Conductor Ampacity.

The minimum service entrance conductor size shall have an ampacity not less than the maximum calculated sum of all connected power production equipment or energy storage system source currents after the application of any adjustment or correction factors.

(D)— Overcurrent Protection.

Overcurrent protection shall be provided in accordance with Part VII of Article 230.

(E)— Connections.

(1)— Spliced and Tapped Conductors.

The connection of service conductors connecting the electric power production sources to the service conductors shall be made in accordance with 230.46.

(2)— Modifications.

Any modifications to existing equipment shall be made in accordance with the manufacturer's instructions, or the modification shall be required to be evaluated for the application and have a field label applied.

(3)— Meter Socket Connections.

For meter socket enclosures or other equipment under the exclusive control of the electric utility, only connections approved by the electric utility shall be permitted.

(F)— Neutral Conductors.

Neutral conductors shall be permitted to be sized in accordance with either 231.11(F)(1) or (F)(2).

(1)— Single-Phase Line-to-Neutral Power Sources.

Where not elsewhere required or permitted in this Code, the ampacity of a neutral conductor to which a single-phase line-to-neutral power source is connected shall not be smaller than the ampacity in 231.11(C).

(2)– Neutral Conductor Used Solely for Instrumentation, Voltage, Detection, or Phase Detection.

A power production equipment neutral conductor used solely for instrumentation, voltage detection, or phase detection shall be permitted to be sized in accordance with 250.102.

(G)– Equipment.

The first disconnecting means for the conductors connected to the supply side of a service disconnect, where in a separate enclosure other than the service equipment, shall be in accordance with Parts V and VI of Article 230.

231.12– Load-Side Source Connections.

Feeder conductors connecting the output of power production equipment or energy storage systems shall be permitted to be connected to the load side of the service disconnecting means at any distribution equipment on the premises. Where distribution equipment or feeders are fed simultaneously by an electric utility source and one or more other power sources the interconnected equipment shall comply with 231.12(A) through (F). Where a power control system (PCS) is installed in accordance with 231.14, the setting of the PCS controller shall be considered the power production equipment or energy storage system output current in relation to 231.12(A) through (F).

(A)– Dedicated Overcurrent and Disconnect.

Each interconnection of one or more power production equipment or energy storage system installed in one system shall be made at a dedicated circuit breaker or fusible disconnecting means.

(B)– Bus Rating.

The power production equipment or energy storage system output circuit current multiplied by 125 percent shall be used in determining the ratings of busbars in accordance with 231.12(B)(1) through (B)(5).

(1)– Output Current Plus Rating of Overcurrent Protective Device.

The sum of 125 percent of the power production equipment and energy storage system output current, and the rating of the overcurrent device protecting the busbar shall not exceed the ampacity of the busbar.

Informational Note: This general rule assumes no limitation in the number of the loads or sources applied to busbars or their locations.

(2)– Sources Connected at Opposite Ends of Busbar.

Where two sources, one a primary power source and the other from power production equipment or energy storage system, are located at opposite ends of a busbar that contains loads, the sum of 125 percent of the power production equipment or energy storage system output current and the rating of the overcurrent device protecting the busbar shall not exceed 120 percent of the ampacity of the busbar. The busbar shall be sized for the loads connected in accordance with Parts I, III, or IV of Article 220. A permanent warning label shall be applied to the distribution equipment adjacent to the back-fed breaker from the power source that displays the following or equivalent wording:

WARNING: POWER SOURCE OUTPUT CONNECTION — DO NOT RELOCATE THIS OVERCURRENT DEVICE. THIS EQUIPMENT FED BY MULTIPLE SOURCES.

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

(3)– Sum of Overcurrent Device Ratings.

The sum of the ampere ratings of all overcurrent devices on panelboards, both load and supply devices, excluding the rating of the overcurrent device protecting the busbar, shall not exceed the ampacity of the busbar. The rating of the overcurrent device protecting the busbar shall not exceed the rating of the busbar. Permanent warning labels shall be applied to distribution equipment displaying the following or equivalent wording:

WARNING:

THIS EQUIPMENT FED BY MULTIPLE SOURCES.

TOTAL RATING OF ALL OVERCURRENT DEVICES

EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE

SHALL NOT EXCEED AMPACITY OF BUSBAR.

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

(4)– Center-Fed Panelboards.

A connection at either end of a center-fed panelboard in dwellings shall be permitted where the sum of 125 percent of the power production equipment and energy storage system output current and the rating of the overcurrent device protecting the busbar does not exceed 120 percent of the current rating of the busbar.

(5)– Engineering Supervision.

Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 231.12(B)(1) through (B)(4) where designed under engineering supervision that includes available fault current and busbar load calculations.

(6)– Feed-Through Connections.

Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors. The feed-through conductors shall be protected in accordance with 231.12(C)(2). Where an overcurrent device is installed at the supply end of the feed-through conductors, the busbar in the supplying panelboard shall be permitted to be sized in accordance with 231.12(B)(1) through (B)(5).

(C)– Feeder Connections.

(1)– Connection From Power Production Equipment or Energy Storage System.

Where the power production equipment or energy storage system connection is made to a feeder, the conductors from the power production equipment or energy storage system to the point of connection shall be sized based on the larger of 125 percent of all power production and energy storage system source(s) output circuit current(s) or as sized in accordance with 240.21(B).

(2)– Connection at Other Than Opposite End of Primary Source Overcurrent Device.

Where the connection is made to a feeder at a location other than the opposite end of the feeder from the primary source overcurrent device, that portion of the feeder from the point of connection to the load shall be protected by one of the following:

- (1) The feeder ampacity shall be not less than the sum of the primary source overcurrent device and 125 percent of the power production equipment or energy storage system output circuit current.
- (2) An overcurrent protective device at the load side of the power source connection point rated not greater than the ampacity of that portion of the feeder.

(D)– Marking.

Equipment containing overcurrent devices in circuits supplying power to a busbar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources.

(E)– Suitable for Backfeed.

Fused disconnects, unless otherwise marked, shall be considered suitable for backfeed. Circuit breakers not marked *line* and *load* shall be considered suitable for backfeed. Circuit breakers marked *line* and *load* shall not be considered suitable for backfeed.

(F)– Fastening.

Listed plug-in-type circuit breakers back-fed from electric power production equipment or energy storage system that are listed and identified as interactive shall be permitted to omit the additional fastener required by 408.36(D) for such applications.

231.14– Power Control Systems.

A PCS shall be listed and evaluated to control the output of one or more power production sources, energy storage systems (ESS), and other equipment. The PCS shall limit current and loading on the busbars and conductors supplied by the PCS.

For the circuits connected to a PCS, the PCS shall limit the current to the ampacity of the conductors or the ratings of the busbars to which it is connected in accordance with 231.14(A) through (E).

(A)– Monitoring.

The PCS controller shall monitor all currents within the PCS. Any busbar or conductor on the load side of the service disconnecting means that is not monitored by the PCS shall comply with 231.12. Where the PCS is connected in accordance with 231.11, the PCS shall monitor the service conductors and prevent overload of these conductors.

(B)– Settings.

The sum of all PCS-controlled currents plus all monitored currents from other sources of supply shall not exceed the ampacity of any busbar or conductor supplied by the power production sources. Where the PCS is connected to an overcurrent device protecting any busbar or conductor not monitored by the PCS, the setting of the PCS controller shall be set within the ratings of that overcurrent device.

(C)– Overcurrent Protection.

The PCS shall provide overcurrent protection either by overcurrent devices or by the PCS including the functionality as an overcurrent device in the product listing.

Informational Note: Some PCS are listed to provide overcurrent protection.

(D)– Single Power Source Rating.

The rating of the overcurrent device for any single power source controlled by the PCS shall not exceed the rating of the busbar or the ampacity of the conductors to which it is connected.

(E)– Access to Settings.

The access to settings of the PCS shall be restricted to qualified personnel in accordance with the requirements of 240.6(C).

231.15– Output Characteristics.

The output of power production equipment or energy storage systems operating in parallel with an electrical supply system shall be compatible with the voltage, wave shape, and frequency of the system to which it is connected. Synchronous generators operating in parallel with an electrical supply system shall be provided with the necessary equipment to establish and maintain a synchronous condition.

Informational Note No.1: The term *compatible* does not necessarily mean matching the primary source wave shape.

Informational Note No.2: Information on the performance of power production equipment when interconnecting with a utility can be found in Chapter 7 of IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*.

231.16– Interrupting and Short-Circuit Current Rating.

Consideration shall be given to the contribution of fault currents from all interconnected power sources for the interrupting and short-circuit current ratings of equipment on interactive systems.

231.20– Disconnecting Means, Source.

The disconnecting means shall comply with the following:

- (1) Be one of the following types:
 - (2) A manually operable switch or circuit breaker
 - (3) A load-break rated pull-out switch
 - (4) A power operated or remote-controlled switch or circuit breaker that is manually operable locally and opens automatically when control power is interrupted
 - (5) A device listed or approved for the intended application
- (6) Simultaneously disconnect all ungrounded conductors of the circuit
- (7) Be located where readily accessible
- (8) Be externally operable without exposed live parts
- (9) Enclosures with doors or hinged covers with exposed live parts when open that require a tool to open or are lockable where readily accessible to unqualified persons
- (10) Plainly indicate whether in the open (off) or closed (on) position
- (11) Have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals
- (12) Be marked in accordance with the warning in 690.13(B), where the line and load terminals are capable of being energized in the open position

Informational Note: See 404.6(C) Exception for interconnected power sources where equipment, including switches and fuses, could be energized from both directions.

231.32– Ground-Fault Protection.

Where protection is installed in accordance with 230.95, the output of connected power production equipment or energy storage systems shall be connected to the supply side of the ground-fault protection.

Exception: Connection shall be permitted to be made to the load side of ground-fault protection, if there is ground-fault protection for equipment from all ground-fault current sources.

231.40 – Loss of Primary Source.

The output of electric power production equipment and energy storage systems shall be automatically disconnected from all ungrounded conductors of the interconnected systems when one or more of the phases to which it is connected opens. The electric power production equipment or energy storage system shall not be reconnected until all the phases of the interconnected system to which it is connected are restored. This requirement shall not be applicable to electric power production equipment or energy storage system providing power to an emergency or legally required standby system.

Exception: A listed interactive inverter shall trip or shall be permitted to automatically cease exporting power when one or more of the phases of the interconnected system opens and shall not be required to automatically disconnect all ungrounded conductors from the primary source. A listed interactive inverter shall be permitted to automatically or manually resume exporting power to the interconnected system once all phases of the source to which it is connected are restored.

Interactive power production equipment shall be permitted to operate in island mode to supply loads that have been disconnected from the electric power production and distribution network.

Informational Note No. 1: Risks to personnel and equipment associated with the primary source could occur if an interactive electric power production source can operate as an intentional island. Special detection methods are required to determine that a primary source supply system outage has occurred and whether there should be automatic disconnection. When the primary source supply system is restored, special detection methods are typically required to limit exposure of power production sources to out-of-phase reconnection. Reference Chapter 6, "Response to EPS Abnormal Conditions," of IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*.

Informational Note No. 2: Induction-generating equipment connected on systems with significant capacitance can become self-excited upon loss of the primary source and experience severe overvoltage as a result.

231.45 – Unbalanced Interconnections.

(A) – Single Phase Equipment Connected to Three Phase Systems.

Where single-phase power production equipment or energy storage system sources are connected to three-phase systems in parallel with the utility, unbalanced voltages at the point of interconnection to shall not exceed more than 3 percent.

Informational Note: For interactive power sources, unbalanced voltages can be minimized by the same methods that are used for single-phase loads on a 3-phase power system. See ANSI/C84.1-2020, *Electric Power Systems and Equipment — Voltage Ratings (60 Hertz)*.

(B) – Three Phase.

Three-phase power production equipment and energy storage systems in interactive systems shall have all phases automatically de-energized upon loss of, or unbalance of, voltage in one or more phases unless the interconnected system is designed so that significant unbalanced voltages will not result.

Part II. – AC Microgrid Systems

231.50 – System Operation.

AC microgrid systems shall be permitted to disconnect from the primary source of power or other interconnected electric power production sources and operate in island mode.

231.60 – Primary Power Source Connection.

AC microgrid connections to a utility source shall comply with 231.11 or 231.12.

231.65 – Reconnection to Primary Power Source.

AC microgrid systems that reconnect to a utility source shall be provided with the necessary equipment to establish a synchronous transition.

231.70 – Microgrid Interconnect Devices (MID).

AC microgrid interconnect devices shall comply with the following:

- (1) ~~Be required for any connection between an AC microgrid system and a utility~~
- (2) ~~Be evaluated for the application and have a field label applied or be listed for the application~~
- (3) ~~Have a sufficient number of overcurrent protective devices located to provide overcurrent protection from all sources~~

Informational Note: MID functionality is often incorporated in an interactive or multimode inverter, energy storage system, or similar device identified for interactive operation.

Additional Proposed Changes

File Name	Description	Approved
Jaco_Oil_12570556_FR.pdf	UL Field Evaluation	
Article_231_Comment.pdf	Article 231 Comment	

Statement of Problem and Substantiation for Public Comment

From PI 4318 – This global input is written to address a very serious safety issue that exists abundantly in the NEC. The problem here is that 90.3 provides committees dealing with alternative energy sources the ability to completely ignore 230.82(6).

From FR 7974 - This First Revision is developed to address issues that have existed for multiple NEC cycles with respect to alternative energy systems and how they connect and interface with service equipment.

As the Chief Electrical Inspector for the City of Bakersfield, California, I have been responsible for the inspection and approval of approximately 40,000 interconnected PV and energy storage systems to date. An estimated 20% (8,000) of the systems were connected to the supply-side of the main disconnecting means.

All systems connected to the supply-side of the main disconnect were inspected and approved in accordance with the applicable requirements of both Articles 230 and 705. The majority of the supply-side connections were facilitated through a bus tap ahead of the main disconnect within the existing service equipment. Where the service equipment did not include a provision by the manufacturer for the tap connection, an evaluation by a qualified Field Evaluation Body was required to maintain the equipment certification. The additional conductor protection provided by current-limiters was provided where required by Article 705 (tap conductors in excess of 10' per the 2020 NEC). Please see the attached field evaluation report by UL for a typical supply-side connected commercial system.

Can the Article 231 advocates please inform me as to which of those 8,000 systems that I approved contains "serious safety issues"?

Neither the submitter of PI 4318 nor CMP 10 identified a specific serious safety issue that can only be addressed through creation of a new article. As a user of the NEC for over 40 years I must disagree with the PI submitter that the code arrangement hierarchy of 90.3 is a "problem". It is also inaccurate to suggest that CMP 4 ignores 230.82(6). NEC 705.11 (2020) specifically references 230.82(6) for supply-side connected systems.

Simply copying the language from the existing Articles 230 and 705 into a new NEC article does not aid in the practical safeguarding of persons and property from electrical hazards. Nor does it remedy any perceived issues of safety in the existing language of those articles. Safety concerns that exist in either Article 230 or Article 705 must be addressed through the proper NFPA process; a public input that identifies a specific technical safety problem with language that addresses the issue.

Recourse exists for those who feel that a Code Making Panel did not fulfill its responsibilities.

Related Item

• PI 4318 • FR 7974

Submitter Information Verification

Submitter Full Name: Peter D Jackson

Organization: City of Bakersfield, Californi

Street Address:

City:

State:

Zip:

Submittal Date: Mon Jul 26 10:25:01 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8272-NFPA 70-2021](#)

Statement: New Article 231 is deleted in support of the revision provided in PC 1098. The provision of Article 231 will be redundant if PC 1098 is accepted.

PC-321 & 325: These public comments were resolved by the deletion of Article 231.

From PI 4318 – *This global input is written to address a very serious safety issue that exists abundantly in the NEC.*

The problem here is that 90.3 provides committees dealing with alternative energy sources the ability to completely ignore 230.82(6).

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All systems connected to the supply-side of the main disconnect were inspected and approved in accordance with the applicable requirements of both Articles 230 and 705. The majority of the supply-side connections were facilitated through a bus tap ahead of the main disconnect within the existing service equipment. Where the service equipment did not include a provision by the manufacturer for the tap connection, an evaluation by a qualified Field Evaluation Body was required to maintain the equipment certification. The additional conductor protection provided by current-limiters was provided where required by Article 705 (tap conductors in excess of 10' per the 2020 NEC). Please see the attached field evaluation report by UL for a typical supply-side connected commercial system.

Can the Article 231 advocates please inform me as to which of those 8,000 systems that I approved contains “serious safety issues”?

Neither the submitter of PI 4318 nor CMP 10 identified a specific serious safety issue that can only be addressed through creation of a new article. As a user of the NEC for over 40 years I must disagree with the PI submitter that the code arrangement hierarchy of 90.3 is a “problem”. It is also inaccurate to suggest that CMP 4 ignores 230.82(6). NEC 705.11 (2020) specifically references 230.82(6) for supply-side connected systems.

Simply copying the language from the existing Articles 230 and 705 into a new NEC article does not aid in the practical safeguarding of persons and property from electrical hazards. Nor does it remedy any perceived issues of safety in the existing language of those articles. Safety concerns that exist in either Article 230 or Article 705 must be addressed through the proper NFPA process; a public input that identifies a specific technical safety problem with language that addresses the issue. Recourse exists for those who feel that a Code Making Panel did not fulfill its responsibilities.

**Public Comment No. 699-NFPA 70-2021 [Article 231]****Article 231— Electric Power Sources Interconnected with an Electric Utility****Part I— General****231.1— Scope.**

This article covers installation of one or more power production equipment or energy storage systems operating in parallel with a utility source. This article does not include on-site electrical power source(s) that do not operate in parallel with the electric utility.

Informational Note: For further information, see IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power System Interfaces*.

231.6— Equipment Approval.

All equipment shall be identified for the intended use. Power production equipment and energy storage systems intended to operate in parallel with electric power production sources shall be listed for interactive function or be evaluated for interactive function and have a field label applied, or both.

Informational Note: Examples of power production sources include interactive inverters, engine generators, and wind turbines.

231.8— System Installation.

Installation of one or more power production equipment or energy storage systems operating in parallel with the electric utility shall be performed only by qualified persons.

231.10— Identification of Power Sources.

A permanent plaque or directory shall be installed at each service equipment location or at an approved readily visible location. The plaque or directory shall denote the location of each power production equipment or energy storage system disconnecting means for the building or structure and be grouped with other plaques or directories for other on-site sources. The plaque or directory shall be marked with the wording CAUTION: MULTIPLE SOURCES OF POWER. Any posted diagrams shall be correctly oriented with respect to the diagram's location. The marking shall comply with 110.24(B).

Exception: Installations with multiple co-located power production sources shall be permitted to be identified as a group(s). The plaque or directory shall not be required to identify each power source individually.

231.11— Supply-Side Service Connections.

Power production equipment and energy storage systems shall be permitted to be connected to the supply side of the service disconnecting means in accordance with 230.82(6) and shall comply with 231.11(A) through (G).

(A)— Minimum Size and Ampacity.

The sum of the connected power production equipment and energy storage systems maximum continuous output current, other than those controlled in accordance with 231.14, shall not exceed the ampacity of the service conductors connecting the service equipment to the service point.

(B)— Calculation of Maximum Circuit Current.

Where not elsewhere required or permitted in this Code, the maximum current from the power production equipment or energy storage system shall be the sum of the continuous output current ratings of the connected power production equipment and energy storage system.

(C)— Conductors.

The service conductors connecting the power production equipment or energy storage system from the point of connection to the first overcurrent protection device shall be sized in accordance with 231.11(C)(1) and (C)(2) and in no case sized smaller than 6 AWG copper or 4 AWG aluminum.

Service conductor wiring methods shall comply with Parts II, III, and IV of Article 230.

Service entrance conductors shall have an ampacity of not less than the maximum output current calculated in 231.11(B). Conductors shall be sized not less than the largest of 231.11(C)(1) or (C)(2). Ampacity shall be determined from 310.14 and shall comply with 110.14(C). The maximum current of busways shall be that value for which the busway has been listed or labeled.

(1)— Supplied From Continuous Power Production Equipment or Energy Storage System.

Where the service entrance conductors are supplied from continuous power production equipment or energy storage system or any combination of noncontinuous and continuous power production equipment or energy storage system source currents, the minimum service entrance conductor size shall have an ampacity not less than the sum of the noncontinuous source currents plus 125 percent of continuous source currents.

Exception No. 1: Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the sum of the continuous and noncontinuous source current.

Exception No. 2: The sum of the noncontinuous source currents and the continuous source currents if the service entrance conductors terminate in an overcurrent device where both the overcurrent device and its assembly are listed for operation at 100 percent of their rating shall be permitted.

(2)— Minimum Service Entrance Conductor Ampacity.

The minimum service entrance conductor size shall have an ampacity not less than the maximum calculated sum of all connected power production equipment or energy storage system source currents after the application of any adjustment or correction factors.

(D)— Overcurrent Protection.

Overcurrent protection shall be provided in accordance with Part VII of Article 230.

(E)— Connections.**(1)— Spliced and Tapped Conductors.**

The connection of service conductors connecting the electric power production sources to the service conductors shall be made in accordance with 230.46.

(2)— Modifications.

Any modifications to existing equipment shall be made in accordance with the manufacturer's instructions, or the modification shall be required to be evaluated for the application and have a field label applied.

(3)— Meter Socket Connections.

For meter socket enclosures or other equipment under the exclusive control of the electric utility, only connections approved by the electric utility shall be permitted.

(F)— Neutral Conductors.

Neutral conductors shall be permitted to be sized in accordance with either 231.11(F)(1) or (F)(2).

(1)— Single-Phase Line-to-Neutral Power Sources.

Where not elsewhere required or permitted in this Code, the ampacity of a neutral conductor to which a single-phase line-to-neutral power source is connected shall not be smaller than the ampacity in 231.11(C).

(2)– Neutral Conductor Used Solely for Instrumentation, Voltage, Detection, or Phase Detection.

A power production equipment neutral conductor used solely for instrumentation, voltage detection, or phase detection shall be permitted to be sized in accordance with 250.102.

(G)– Equipment.

The first disconnecting means for the conductors connected to the supply side of a service disconnect, where in a separate enclosure other than the service equipment, shall be in accordance with Parts V and VI of Article 230.

231.12– Load-Side Source Connections.

Feeder conductors connecting the output of power production equipment or energy storage systems shall be permitted to be connected to the load side of the service disconnecting means at any distribution equipment on the premises. Where distribution equipment or feeders are fed simultaneously by an electric utility source and one or more other power sources the interconnected equipment shall comply with 231.12(A) through (F). Where a power control system (PCS) is installed in accordance with 231.14, the setting of the PCS controller shall be considered the power production equipment or energy storage system output current in relation to 231.12(A) through (F).

(A)– Dedicated Overcurrent and Disconnect.

Each interconnection of one or more power production equipment or energy storage system installed in one system shall be made at a dedicated circuit breaker or fusible disconnecting means.

(B)– Bus Rating.

The power production equipment or energy storage system output circuit current multiplied by 125 percent shall be used in determining the ratings of busbars in accordance with 231.12(B)(1) through (B)(5).

(1)– Output Current Plus Rating of Overcurrent Protective Device.

The sum of 125 percent of the power production equipment and energy storage system output current, and the rating of the overcurrent device protecting the busbar shall not exceed the ampacity of the busbar.

Informational Note: This general rule assumes no limitation in the number of the loads or sources applied to busbars or their locations.

(2)– Sources Connected at Opposite Ends of Busbar.

Where two sources, one a primary power source and the other from power production equipment or energy storage system, are located at opposite ends of a busbar that contains loads, the sum of 125 percent of the power production equipment or energy storage system output current and the rating of the overcurrent device protecting the busbar shall not exceed 120 percent of the ampacity of the busbar. The busbar shall be sized for the loads connected in accordance with Parts I, III, or IV of Article 220. A permanent warning label shall be applied to the distribution equipment adjacent to the back-fed breaker from the power source that displays the following or equivalent wording:

WARNING: POWER SOURCE OUTPUT CONNECTION — DO NOT RELOCATE THIS OVERCURRENT DEVICE. THIS EQUIPMENT FED BY MULTIPLE SOURCES.

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

(3)– Sum of Overcurrent Device Ratings.

The sum of the ampere ratings of all overcurrent devices on panelboards, both load and supply devices, excluding the rating of the overcurrent device protecting the busbar, shall not exceed the ampacity of the busbar. The rating of the overcurrent device protecting the busbar shall not exceed the rating of the busbar. Permanent warning labels shall be applied to distribution equipment displaying the following or equivalent wording:

WARNING:

THIS EQUIPMENT FED BY MULTIPLE SOURCES.

TOTAL RATING OF ALL OVERCURRENT DEVICES

EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE

SHALL NOT EXCEED AMPACITY OF BUSBAR.

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

(4)– Center-Fed Panelboards.

A connection at either end of a center-fed panelboard in dwellings shall be permitted where the sum of 125 percent of the power production equipment and energy storage system output current and the rating of the overcurrent device protecting the busbar does not exceed 120 percent of the current rating of the busbar.

(5)– Engineering Supervision.

Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 231.12(B)(1) through (B)(4) where designed under engineering supervision that includes available fault current and busbar load calculations.

(6)– Feed-Through Connections.

Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors. The feed-through conductors shall be protected in accordance with 231.12(C)(2). Where an overcurrent device is installed at the supply end of the feed-through conductors, the busbar in the supplying panelboard shall be permitted to be sized in accordance with 231.12(B)(1) through (B)(5).

(C)– Feeder Connections.

(1)– Connection From Power Production Equipment or Energy Storage System.

Where the power production equipment or energy storage system connection is made to a feeder, the conductors from the power production equipment or energy storage system to the point of connection shall be sized based on the larger of 125 percent of all power production and energy storage system source(s) output circuit current(s) or as sized in accordance with 240.21(B).

(2)– Connection at Other Than Opposite End of Primary Source Overcurrent Device.

Where the connection is made to a feeder at a location other than the opposite end of the feeder from the primary source overcurrent device, that portion of the feeder from the point of connection to the load shall be protected by one of the following:

- (1) The feeder ampacity shall be not less than the sum of the primary source overcurrent device and 125 percent of the power production equipment or energy storage system output circuit current.
- (2) An overcurrent protective device at the load side of the power source connection point rated not greater than the ampacity of that portion of the feeder.

(D)– Marking.

Equipment containing overcurrent devices in circuits supplying power to a busbar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources.

(E)– Suitable for Backfeed.

Fused disconnects, unless otherwise marked, shall be considered suitable for backfeed. Circuit breakers not marked *line* and *load* shall be considered suitable for backfeed. Circuit breakers marked *line* and *load* shall not be considered suitable for backfeed.

(F)– Fastening.

Listed plug-in-type circuit breakers back-fed from electric power production equipment or energy storage system that are listed and identified as interactive shall be permitted to omit the additional fastener required by 408.36(D) for such applications.

231.14– Power Control Systems.

A PCS shall be listed and evaluated to control the output of one or more power production sources, energy storage systems (ESS), and other equipment. The PCS shall limit current and loading on the busbars and conductors supplied by the PCS.

For the circuits connected to a PCS, the PCS shall limit the current to the ampacity of the conductors or the ratings of the busbars to which it is connected in accordance with 231.14(A) through (E).

(A)– Monitoring.

The PCS controller shall monitor all currents within the PCS. Any busbar or conductor on the load side of the service disconnecting means that is not monitored by the PCS shall comply with 231.12. Where the PCS is connected in accordance with 231.11, the PCS shall monitor the service conductors and prevent overload of these conductors.

(B)– Settings.

The sum of all PCS-controlled currents plus all monitored currents from other sources of supply shall not exceed the ampacity of any busbar or conductor supplied by the power production sources. Where the PCS is connected to an overcurrent device protecting any busbar or conductor not monitored by the PCS, the setting of the PCS controller shall be set within the ratings of that overcurrent device.

(C)– Overcurrent Protection.

The PCS shall provide overcurrent protection either by overcurrent devices or by the PCS including the functionality as an overcurrent device in the product listing.

Informational Note: Some PCS are listed to provide overcurrent protection.

(D)– Single Power Source Rating.

The rating of the overcurrent device for any single power source controlled by the PCS shall not exceed the rating of the busbar or the ampacity of the conductors to which it is connected.

(E)– Access to Settings.

The access to settings of the PCS shall be restricted to qualified personnel in accordance with the requirements of 240.6(C).

231.15– Output Characteristics.

The output of power production equipment or energy storage systems operating in parallel with an electrical supply system shall be compatible with the voltage, wave shape, and frequency of the system to which it is connected. Synchronous generators operating in parallel with an electrical supply system shall be provided with the necessary equipment to establish and maintain a synchronous condition.

Informational Note No.1: The term *compatible* does not necessarily mean matching the primary source wave shape.

Informational Note No.2: Information on the performance of power production equipment when interconnecting with a utility can be found in Chapter 7 of IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*.

231.16– Interrupting and Short-Circuit Current Rating.

Consideration shall be given to the contribution of fault currents from all interconnected power sources for the interrupting and short-circuit current ratings of equipment on interactive systems.

231.20– Disconnecting Means, Source.

The disconnecting means shall comply with the following:

- (1) Be one of the following types:
 - (2) A manually operable switch or circuit breaker
 - (3) A load-break rated pull-out switch
 - (4) A power operated or remote-controlled switch or circuit breaker that is manually operable locally and opens automatically when control power is interrupted
 - (5) A device listed or approved for the intended application
- (6) Simultaneously disconnect all ungrounded conductors of the circuit
- (7) Be located where readily accessible
- (8) Be externally operable without exposed live parts
- (9) Enclosures with doors or hinged covers with exposed live parts when open that require a tool to open or are lockable where readily accessible to unqualified persons
- (10) Plainly indicate whether in the open (off) or closed (on) position
- (11) Have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals
- (12) Be marked in accordance with the warning in 690.13(B), where the line and load terminals are capable of being energized in the open position

Informational Note: See 404.6(C) Exception for interconnected power sources where equipment, including switches and fuses, could be energized from both directions.

231.32– Ground-Fault Protection.

Where protection is installed in accordance with 230.95, the output of connected power production equipment or energy storage systems shall be connected to the supply side of the ground-fault protection.

Exception: Connection shall be permitted to be made to the load side of ground-fault protection, if there is ground-fault protection for equipment from all ground-fault current sources.

231.40– Loss of Primary Source.

The output of electric power production equipment and energy storage systems shall be automatically disconnected from all ungrounded conductors of the interconnected systems when one or more of the phases to which it is connected opens. The electric power production equipment or energy storage system shall not be reconnected until all the phases of the interconnected system to which it is connected are restored. This requirement shall not be applicable to electric power production equipment or energy storage system providing power to an emergency or legally required standby system.

Exception: A listed interactive inverter shall trip or shall be permitted to automatically cease exporting power when one or more of the phases of the interconnected system opens and shall not be required to automatically disconnect all ungrounded conductors from the primary source. A listed interactive inverter shall be permitted to automatically or manually resume exporting power to the interconnected system once all phases of the source to which it is connected are restored.

Interactive power production equipment shall be permitted to operate in island mode to supply loads that have been disconnected from the electric power production and distribution network.

Informational Note No. 1: Risks to personnel and equipment associated with the primary source could occur if an interactive electric power production source can operate as an intentional island. Special detection methods are required to determine that a primary source supply system outage has occurred and whether there should be automatic disconnection. When the primary source supply system is restored, special detection methods are typically required to limit exposure of power production sources to out-of-phase reconnection. Reference Chapter 6, "Response to EPS Abnormal Conditions," of IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*.

Informational Note No. 2: Induction-generating equipment connected on systems with significant capacitance can become self-excited upon loss of the primary source and experience severe overvoltage as a result.

231.45– Unbalanced Interconnections.

(A)– Single Phase Equipment Connected to Three-Phase Systems.

Where single-phase power production equipment or energy storage system sources are connected to three-phase systems in parallel with the utility, unbalanced voltages at the point of interconnection to shall not exceed more than 3 percent.

Informational Note: For interactive power sources, unbalanced voltages can be minimized by the same methods that are used for single-phase loads on a 3-phase power system. See ANSI/C84.1-2020, *Electric Power Systems and Equipment — Voltage Ratings (60 Hertz)*.

(B)– Three Phase.

Three-phase power production equipment and energy storage systems in interactive systems shall have all phases automatically de-energized upon loss of, or unbalance of, voltage in one or more phases unless the interconnected system is designed so that significant unbalanced voltages will not result.

Part II.– AC Microgrid Systems

231.50– System Operation.

AC microgrid systems shall be permitted to disconnect from the primary source of power or other interconnected electric power production sources and operate in island mode.

231.60– Primary Power Source Connection.

AC microgrid connections to a utility source shall comply with 231.11 or 231.12.

231.65– Reconnection to Primary Power Source.

AC microgrid systems that reconnect to a utility source shall be provided with the necessary equipment to establish a synchronous transition.

231.70– Microgrid Interconnect Devices (MID).

AC microgrid interconnect devices shall comply with the following:

- (1) ~~Be required for any connection between an AC microgrid system and a utility~~
- (2) ~~Be evaluated for the application and have a field label applied or be listed for the application~~
- (3) ~~Have a sufficient number of overcurrent protective devices located to provide overcurrent protection from all sources~~

Informational Note: MID functionality is often incorporated in an interactive or multimode inverter, energy storage system, or similar device identified for interactive operation.

Statement of Problem and Substantiation for Public Comment

The inclusion of this article in this Code would create multiple conflicts and significant confusion on the part of users of this Code. The entirety of this article is redundant with article 705, an article that has existed in this Code with the same Scope since the 1987 edition. The justification for the creation of this article was "to address issues that have existed for multiple NEC cycles with respect to alternative energy systems and how they connect and interface with service equipment." As someone who has been involved in the interconnection of hundreds of megawatts of alternative energy systems to service equipment over more than 2 decades, I can tell you without a doubt that this article does nothing to add clarity for these applications and would in fact, create more confusion potentially resulting in diminished public safety. Furthermore, the premise that was presented to create this article was false. Article 705 has always covered these applications, it has also always referenced specific sections in articles 230 and 250 with regards to the interconnection of onsite power sources to services. As qualified users of this Code understand, unless any section in 705 modified any other section in those articles, the requirements in those articles still apply as written. While the Code can always be improved, this is not an acceptable method to achieve that goal.

Related Item

- First Revision No. 7974

Submitter Information Verification

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Submission Date: Tue Aug 03 11:06:08 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8272-NFPA 70-2021](#)

Statement:

New Article 231 is deleted in support of the revision provided in PC 1098. The provision of Article 231 will be redundant if PC 1098 is accepted.

PC-321 & 325: These public comments were resolved by the deletion of Article 231.



Public Comment No. 916-NFPA 70-2021 [Article 231]

Article 231— Electric Power Sources Interconnected with an Electric Utility

Part I.— General

231.1— Scope.

This article covers installation of one or more power production equipment or energy storage systems operating in parallel with a utility source. This article does not include on-site electrical power source(s) that do not operate in parallel with the electric utility.

Informational Note: For further information, see IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power System Interfaces*.

231.6— Equipment Approval.

All equipment shall be identified for the intended use. Power production equipment and energy storage systems intended to operate in parallel with electric power production sources shall be listed for interactive function or be evaluated for interactive function and have a field label applied, or both.

Informational Note: Examples of power production sources include interactive inverters, engine generators, and wind turbines.

231.8— System Installation.

Installation of one or more power production equipment or energy storage systems operating in parallel with the electric utility shall be performed only by qualified persons.

231.10— Identification of Power Sources.

A permanent plaque or directory shall be installed at each service equipment location or at an approved readily visible location. The plaque or directory shall denote the location of each power production equipment or energy storage system disconnecting means for the building or structure and be grouped with other plaques or directories for other on-site sources. The plaque or directory shall be marked with the wording CAUTION: MULTIPLE SOURCES OF POWER. Any posted diagrams shall be correctly oriented with respect to the diagram's location. The marking shall comply with 110.24(B).

Exception: Installations with multiple co-located power production sources shall be permitted to be identified as a group(s). The plaque or directory shall not be required to identify each power source individually.

231.11— Supply-Side Service Connections.

Power production equipment and energy storage systems shall be permitted to be connected to the supply side of the service disconnecting means in accordance with 230.82(6) and shall comply with 231.11(A) through (G).

(A)— Minimum Size and Ampacity.

The sum of the connected power production equipment and energy storage systems maximum continuous output current, other than those controlled in accordance with 231.14, shall not exceed the ampacity of the service conductors connecting the service equipment to the service point.

(B)— Calculation of Maximum Circuit Current.

Where not elsewhere required or permitted in this Code, the maximum current from the power production equipment or energy storage system shall be the sum of the continuous output current ratings of the connected power production equipment and energy storage system.

(C)— Conductors.

The service conductors connecting the power production equipment or energy storage system from the point of connection to the first overcurrent protection device shall be sized in accordance with 231.11(C)(1) and (C)(2) and in no case sized smaller than 6 AWG copper or 4 AWG aluminum.

Service conductor wiring methods shall comply with Parts II, III, and IV of Article 230.

Service entrance conductors shall have an ampacity of not less than the maximum output current calculated in 231.11(B). Conductors shall be sized not less than the largest of 231.11(C)(1) or (C)(2). Ampacity shall be determined from 310.14 and shall comply with 110.14(C). The maximum current of busways shall be that value for which the busway has been listed or labeled.

(1)— Supplied From Continuous Power Production Equipment or Energy Storage System.

Where the service entrance conductors are supplied from continuous power production equipment or energy storage system or any combination of noncontinuous and continuous power production equipment or energy storage system source currents, the minimum service entrance conductor size shall have an ampacity not less than the sum of the noncontinuous source currents plus 125 percent of continuous source currents.

Exception No. 1: Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the sum of the continuous and noncontinuous source current.

Exception No. 2: The sum of the noncontinuous source currents and the continuous source currents if the service entrance conductors terminate in an overcurrent device where both the overcurrent device and its assembly are listed for operation at 100 percent of their rating shall be permitted.

(2)— Minimum Service Entrance Conductor Ampacity.

The minimum service entrance conductor size shall have an ampacity not less than the maximum calculated sum of all connected power production equipment or energy storage system source currents after the application of any adjustment or correction factors.

(D)— Overcurrent Protection.

Overcurrent protection shall be provided in accordance with Part VII of Article 230.

(E)— Connections.

(1)— Spliced and Tapped Conductors.

The connection of service conductors connecting the electric power production sources to the service conductors shall be made in accordance with 230.46.

(2)— Modifications.

Any modifications to existing equipment shall be made in accordance with the manufacturer's instructions, or the modification shall be required to be evaluated for the application and have a field label applied.

(3)— Meter Socket Connections.

For meter socket enclosures or other equipment under the exclusive control of the electric utility, only connections approved by the electric utility shall be permitted.

(F)— Neutral Conductors.

Neutral conductors shall be permitted to be sized in accordance with either 231.11(F)(1) or (F)(2).

(1)— Single-Phase Line-to-Neutral Power Sources.

Where not elsewhere required or permitted in this Code, the ampacity of a neutral conductor to which a single-phase line-to-neutral power source is connected shall not be smaller than the ampacity in 231.11(C).

(2)– Neutral Conductor Used Solely for Instrumentation, Voltage, Detection, or Phase Detection.

A power production equipment neutral conductor used solely for instrumentation, voltage detection, or phase detection shall be permitted to be sized in accordance with 250.102.

(G)– Equipment.

The first disconnecting means for the conductors connected to the supply side of a service disconnect, where in a separate enclosure other than the service equipment, shall be in accordance with Parts V and VI of Article 230.

231.12– Load-Side Source Connections.

Feeder conductors connecting the output of power production equipment or energy storage systems shall be permitted to be connected to the load side of the service disconnecting means at any distribution equipment on the premises. Where distribution equipment or feeders are fed simultaneously by an electric utility source and one or more other power sources the interconnected equipment shall comply with 231.12(A) through (F). Where a power control system (PCS) is installed in accordance with 231.14, the setting of the PCS controller shall be considered the power production equipment or energy storage system output current in relation to 231.12(A) through (F).

(A)– Dedicated Overcurrent and Disconnect.

Each interconnection of one or more power production equipment or energy storage system installed in one system shall be made at a dedicated circuit breaker or fusible disconnecting means.

(B)– Bus Rating.

The power production equipment or energy storage system output circuit current multiplied by 125 percent shall be used in determining the ratings of busbars in accordance with 231.12(B)(1) through (B)(5).

(1)– Output Current Plus Rating of Overcurrent Protective Device.

The sum of 125 percent of the power production equipment and energy storage system output current, and the rating of the overcurrent device protecting the busbar shall not exceed the ampacity of the busbar.

Informational Note: This general rule assumes no limitation in the number of the loads or sources applied to busbars or their locations.

(2)– Sources Connected at Opposite Ends of Busbar.

Where two sources, one a primary power source and the other from power production equipment or energy storage system, are located at opposite ends of a busbar that contains loads, the sum of 125 percent of the power production equipment or energy storage system output current and the rating of the overcurrent device protecting the busbar shall not exceed 120 percent of the ampacity of the busbar. The busbar shall be sized for the loads connected in accordance with Parts I, III, or IV of Article 220. A permanent warning label shall be applied to the distribution equipment adjacent to the back-fed breaker from the power source that displays the following or equivalent wording:

WARNING: POWER SOURCE OUTPUT CONNECTION — DO NOT RELOCATE THIS OVERCURRENT DEVICE. THIS EQUIPMENT FED BY MULTIPLE SOURCES.

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

(3)– Sum of Overcurrent Device Ratings.

The sum of the ampere ratings of all overcurrent devices on panelboards, both load and supply devices, excluding the rating of the overcurrent device protecting the busbar, shall not exceed the ampacity of the busbar. The rating of the overcurrent device protecting the busbar shall not exceed the rating of the busbar. Permanent warning labels shall be applied to distribution equipment displaying the following or equivalent wording:

WARNING:

THIS EQUIPMENT FED BY MULTIPLE SOURCES.

TOTAL RATING OF ALL OVERCURRENT DEVICES

EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE

SHALL NOT EXCEED AMPACITY OF BUSBAR.

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

(4)– Center-Fed Panelboards.

A connection at either end of a center-fed panelboard in dwellings shall be permitted where the sum of 125 percent of the power production equipment and energy storage system output current and the rating of the overcurrent device protecting the busbar does not exceed 120 percent of the current rating of the busbar.

(5)– Engineering Supervision.

Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 231.12(B)(1) through (B)(4) where designed under engineering supervision that includes available fault current and busbar load calculations.

(6)– Feed-Through Connections.

Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors. The feed-through conductors shall be protected in accordance with 231.12(C)(2). Where an overcurrent device is installed at the supply end of the feed-through conductors, the busbar in the supplying panelboard shall be permitted to be sized in accordance with 231.12(B)(1) through (B)(5).

(C)– Feeder Connections.

(1)– Connection From Power Production Equipment or Energy Storage System.

Where the power production equipment or energy storage system connection is made to a feeder, the conductors from the power production equipment or energy storage system to the point of connection shall be sized based on the larger of 125 percent of all power production and energy storage system source(s) output circuit current(s) or as sized in accordance with 240.21(B).

(2)– Connection at Other Than Opposite End of Primary Source Overcurrent Device.

Where the connection is made to a feeder at a location other than the opposite end of the feeder from the primary source overcurrent device, that portion of the feeder from the point of connection to the load shall be protected by one of the following:

- (1) The feeder ampacity shall be not less than the sum of the primary source overcurrent device and 125 percent of the power production equipment or energy storage system output circuit current.
- (2) An overcurrent protective device at the load side of the power source connection point rated not greater than the ampacity of that portion of the feeder.

(D)– Marking.

Equipment containing overcurrent devices in circuits supplying power to a busbar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources.

(E)– Suitable for Backfeed.

Fused disconnects, unless otherwise marked, shall be considered suitable for backfeed. Circuit breakers not marked *line* and *load* shall be considered suitable for backfeed. Circuit breakers marked *line* and *load* shall not be considered suitable for backfeed.

(F)– Fastening.

Listed plug-in-type circuit breakers back-fed from electric power production equipment or energy storage system that are listed and identified as interactive shall be permitted to omit the additional fastener required by 408.36(D) for such applications.

231.14– Power Control Systems.

A PCS shall be listed and evaluated to control the output of one or more power production sources, energy storage systems (ESS), and other equipment. The PCS shall limit current and loading on the busbars and conductors supplied by the PCS.

For the circuits connected to a PCS, the PCS shall limit the current to the ampacity of the conductors or the ratings of the busbars to which it is connected in accordance with 231.14(A) through (E).

(A)– Monitoring.

The PCS controller shall monitor all currents within the PCS. Any busbar or conductor on the load side of the service disconnecting means that is not monitored by the PCS shall comply with 231.12. Where the PCS is connected in accordance with 231.11, the PCS shall monitor the service conductors and prevent overload of these conductors.

(B)– Settings.

The sum of all PCS-controlled currents plus all monitored currents from other sources of supply shall not exceed the ampacity of any busbar or conductor supplied by the power production sources. Where the PCS is connected to an overcurrent device protecting any busbar or conductor not monitored by the PCS, the setting of the PCS controller shall be set within the ratings of that overcurrent device.

(C)– Overcurrent Protection.

The PCS shall provide overcurrent protection either by overcurrent devices or by the PCS including the functionality as an overcurrent device in the product listing.

Informational Note: Some PCS are listed to provide overcurrent protection.

(D)– Single Power Source Rating.

The rating of the overcurrent device for any single power source controlled by the PCS shall not exceed the rating of the busbar or the ampacity of the conductors to which it is connected.

(E)– Access to Settings.

The access to settings of the PCS shall be restricted to qualified personnel in accordance with the requirements of 240.6(C).

231.15– Output Characteristics.

The output of power production equipment or energy storage systems operating in parallel with an electrical supply system shall be compatible with the voltage, wave shape, and frequency of the system to which it is connected. Synchronous generators operating in parallel with an electrical supply system shall be provided with the necessary equipment to establish and maintain a synchronous condition.

Informational Note No.1: The term *compatible* does not necessarily mean matching the primary source wave shape.

Informational Note No.2: Information on the performance of power production equipment when interconnecting with a utility can be found in Chapter 7 of IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*.

231.16– Interrupting and Short-Circuit Current Rating.

Consideration shall be given to the contribution of fault currents from all interconnected power sources for the interrupting and short-circuit current ratings of equipment on interactive systems.

231.20– Disconnecting Means, Source.

The disconnecting means shall comply with the following:

- (1) Be one of the following types:
 - (2) A manually operable switch or circuit breaker
 - (3) A load-break-rated pull-out switch
 - (4) A power-operated or remote-controlled switch or circuit breaker that is manually operable locally and opens automatically when control power is interrupted
 - (5) A device listed or approved for the intended application
- (6) Simultaneously disconnect all ungrounded conductors of the circuit
- (7) Be located where readily accessible
- (8) Be externally operable without exposed live parts
- (9) Enclosures with doors or hinged covers with exposed live parts when open that require a tool to open or are lockable where readily accessible to unqualified persons
- (10) Plainly indicate whether in the open (off) or closed (on) position
- (11) Have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals
- (12) Be marked in accordance with the warning in 690.13(B), where the line and load terminals are capable of being energized in the open position

Informational Note: See 404.6(C) Exception for interconnected power sources where equipment, including switches and fuses, could be energized from both directions.

231.32– Ground-Fault Protection.

Where protection is installed in accordance with 230.95, the output of connected power production equipment or energy storage systems shall be connected to the supply side of the ground-fault protection.

Exception: Connection shall be permitted to be made to the load side of ground-fault protection, if there is ground-fault protection for equipment from all ground-fault current sources.

231.40 – Loss of Primary Source.

The output of electric power production equipment and energy storage systems shall be automatically disconnected from all ungrounded conductors of the interconnected systems when one or more of the phases to which it is connected opens. The electric power production equipment or energy storage system shall not be reconnected until all the phases of the interconnected system to which it is connected are restored. This requirement shall not be applicable to electric power production equipment or energy storage system providing power to an emergency or legally required standby system.

Exception: A listed interactive inverter shall trip or shall be permitted to automatically cease exporting power when one or more of the phases of the interconnected system opens and shall not be required to automatically disconnect all ungrounded conductors from the primary source. A listed interactive inverter shall be permitted to automatically or manually resume exporting power to the interconnected system once all phases of the source to which it is connected are restored.

Interactive power production equipment shall be permitted to operate in island mode to supply loads that have been disconnected from the electric power production and distribution network.

Informational Note No. 1: Risks to personnel and equipment associated with the primary source could occur if an interactive electric power production source can operate as an intentional island. Special detection methods are required to determine that a primary source supply system outage has occurred and whether there should be automatic disconnection. When the primary source supply system is restored, special detection methods are typically required to limit exposure of power production sources to out-of-phase reconnection. Reference Chapter 6, "Response to EPS Abnormal Conditions," of IEEE 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*.

Informational Note No. 2: Induction-generating equipment connected on systems with significant capacitance can become self-excited upon loss of the primary source and experience severe overvoltage as a result.

231.45 – Unbalanced Interconnections.**(A) – Single Phase Equipment Connected to Three Phase Systems.**

Where single-phase power production equipment or energy storage system sources are connected to three-phase systems in parallel with the utility, unbalanced voltages at the point of interconnection to shall not exceed more than 3 percent.

Informational Note: For interactive power sources, unbalanced voltages can be minimized by the same methods that are used for single-phase loads on a 3-phase power system. See ANSI/C84.1-2020, *Electric Power Systems and Equipment — Voltage Ratings (60 Hertz)*.

(B) – Three Phase.

Three-phase power production equipment and energy storage systems in interactive systems shall have all phases automatically de-energized upon loss of, or unbalance of, voltage in one or more phases unless the interconnected system is designed so that significant unbalanced voltages will not result.

Part II. – AC Microgrid Systems**231.50 – System Operation.**

AC microgrid systems shall be permitted to disconnect from the primary source of power or other interconnected electric power production sources and operate in island mode.

231.60 – Primary Power Source Connection.

AC microgrid connections to a utility source shall comply with 231.11 or 231.12.

231.65 – Reconnection to Primary Power Source.

AC microgrid systems that reconnect to a utility source shall be provided with the necessary equipment to establish a synchronous transition.

231.70 – Microgrid Interconnect Devices (MID).

AC microgrid interconnect devices shall comply with the following:

- (1) ~~Be required for any connection between an AC microgrid system and a utility~~
- (2) ~~Be evaluated for the application and have a field label applied or be listed for the application~~
- (3) ~~Have a sufficient number of overcurrent protective devices located to provide overcurrent protection from all sources~~

Informational Note: MID functionality is often incorporated in an interactive or multimode inverter, energy storage system, or similar device identified for interactive operation.

Statement of Problem and Substantiation for Public Comment

The addition of Article 231 is not necessary as this material is currently present in Article 705.11. Moving Article 705.11 to Article 231 does not improve safety or add clarity to requirements. The changes proposed to Article 705.11 are important to industry as it meets the two objectives stated earlier. For clarity 705 references many subsections in 230 which ensure greater safety and consistency across the Code. The new changes also improve safety by expanding the scope of the requirements by defining a broader set of requirements. The improvements proposed for 705.11 would be lost with the proposal written for 231. In my opinion, it makes no sense to move 705.11 to 231. Please reject this change.

Related Item

• FR-7974

Submitter Information Verification

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Submittal Date: Wed Aug 04 18:49:23 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8272-NFPA 70-2021](#)

Statement: New Article 231 is deleted in support of the revision provided in PC 1098. The provision of Article 231 will be redundant if PC 1098 is accepted.

PC-321 & 325: These public comments were resolved by the deletion of Article 231.

**Public Comment No. 321-NFPA 70-2021 [Section No. 231.11(E)(3)]**

~~(3)– Meter Socket Connections.~~

~~For meter socket enclosures or other equipment under the exclusive control of the electric utility, only connections approved by the electric utility shall be permitted.~~

Statement of Problem and Substantiation for Public Comment

I see no reason for this rule. Utilities are good at prohibiting modifications or access to their exclusively controlled meters. States pass laws prohibiting it. There doesn't seem to be a problem of people removing seals from meters to install parallel generation, and the utility having no remedy for it. The NEC is not a training manual to remind the untrained person to talk to the utility. This ends up just being one more sentence adding to the length of the code book.

Related Item

- First Revision No. 7974-NFPA 70-2020 [Global Input]

Submitter Information Verification

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Submittal Date: Wed Jul 21 21:07:35 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8272-NFPA 70-2021](#)

Statement: New Article 231 is deleted in support of the revision provided in PC 1098. The provision of Article 231 will be redundant if PC 1098 is accepted.

PC-321 & 325: These public comments were resolved by the deletion of Article 231.

**Public Comment No. 325-NFPA 70-2021 [Section No. 231.65]****231.65- Reconnection to Primary Power Source.**

~~AC microgrid systems that reconnect to a utility source shall be provided with the necessary equipment to establish a synchronous transition.~~

Statement of Problem and Substantiation for Public Comment

This rule seems to be unnecessary. And moving it from a special conditions article in 705 to a general article in 231 just adds more rules to general installations that must be kept up with, but that really are empty rules that communicate nothing. Any qualified person installing one of these systems knows full well that the system must be able to synchronize or re-synchronize with the utility. For those who don't know this, putting it in the NEC won't resolve that problem. This rule I guess, requires that a power source synchronize with a utility, but not that a power source sync with another power source? This rule won't reduce any instances of unqualified people doing things they shouldn't be doing, and thus this rule in a general article like 231 won't serve any purpose the NEC intends to serve. It only might help someone use it as a design guide should they choose to do so.

Related Item

- First Revision No. 7974-NFPA 70-2020 [Global Input]

Submitter Information Verification

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Submittal Date: Wed Jul 21 21:32:35 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8272-NFPA 70-2021](#)

Statement: New Article 231 is deleted in support of the revision provided in PC 1098. The provision of Article 231 will be redundant if PC 1098 is accepted.

PC-321 & 325: These public comments were resolved by the deletion of Article 231.

**Public Comment No. 1310-NFPA 70-2021 [Section No. 240.3]****240.3 Other Articles.**

Equipment shall be protected against overcurrent in accordance with the article in this *Code* that covers the type of equipment specified in Table 240.3.

Table 240.3 Other Articles

<u>Equipment</u>	<u>Article</u>
Air-conditioning and refrigerating equipment	440
Appliances	422
Assembly occupancies	518
Audio signal processing, amplification, and reproduction equipment	640
Branch circuits	210
Busways	368
Capacitors	460
Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits	725
Cranes and hoists	610
Electric signs and outline lighting	600
Electric welders	630
Electrolytic cells	668
Elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chairlifts	620
Emergency systems	700
Fire alarm systems	760
Fire pumps	695
Fixed electric heating equipment for pipelines and vessels	427
Fixed electric space-heating equipment	424
Fixed outdoor electric deicing and snow-melting equipment	426
Generators	445
Health care facilities	517
Induction and dielectric heating equipment	665
Industrial machinery	670
Luminaires, lampholders, and lamps	410
Motion picture and television studios and similar locations	530
Motors, motor circuits, and controllers	430
Phase converters	455
Pipe organs	650
Receptacles	406
Services	230
Solar photovoltaic systems	690
Switchboards, <u>Switchgear</u> , and panelboards	408
Theaters, audience areas of motion picture and television studios, and similar locations	520
Transformers and transformer vaults	450
X-ray equipment	660

Statement of Problem and Substantiation for Public Comment

As indicated in the PI's substantiation, if the intent of the table is to include the title or scope of the article then "switchgear" needs to be added. The Panel's statement agrees that this is the intent but did not make the requisite change.

Related Item

- PI 264

Submitter Information Verification

Submitter Full Name: Ryan Jackson

Organization: Ryan Jackson

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 11 17:40:12 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8281-NFPA 70-2021](#)

Statement: "Switchgear" is added to correlate with the scope of Article 408.

**Public Comment No. 1311-NFPA 70-2021 [Section No. 240.4(B)]****(B) Overcurrent Devices Rated 800 Amperes or Less.**

The next higher standard overcurrent device rating or setting (above the ampacity of the conductors being protected) shall be permitted to be used, provided all of the following conditions are met:

- (1) The conductors being protected are not part of a branch circuit supplying more than one receptacle for cord-and-plug-connected portable loads.
- (2) The ampacity of the conductors does not correspond with the standard ampere rating of a fuse or a circuit breaker without overload trip adjustments above its rating (but that shall be permitted to have other trip or rating adjustments).
- (3) The next higher standard rating selected does not exceed 800 amperes.

~~Where the overcurrent protective device is an adjustable trip device, it shall be permitted to be set to a value that does not exceed the next higher standard value above the ampacity of the conductors being protected as shown in Table 240.6(A) where restricted access in accordance with 240.6(C) is provided.~~

Statement of Problem and Substantiation for Public Comment

By adding the words "or setting" the new language is not needed. Furthermore, as written in the first draft the new text appears to apply regardless of whether items (1), (2), and (3) are satisfied.

Related Item

- FR 7802

Submitter Information Verification

Submitter Full Name: Ryan Jackson

Organization: Ryan Jackson

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City:

State:

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Submittal Date: Wed Aug 11 17:43:42 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8283-NFPA 70-2021](#)

Statement: The last sentence is modified for compliance with the NEC style manual and to clarify that all of 240.4(B) applies.

**Public Comment No. 855-NFPA 70-2021 [Section No. 240.4(B)]****(B) Overcurrent Devices Rated 800 Amperes or Less.**

The next higher standard overcurrent device rating (above the ampacity of the conductors being protected) shall be permitted to be used, provided all of the following conditions are met:

- (1) The conductors being protected are not part of a branch circuit supplying more than one receptacle for cord-and-plug-connected portable loads.
- (2) The ampacity of the conductors does not correspond with the standard ampere rating of a fuse or a circuit breaker without overload trip adjustments above its rating (but that shall be permitted to have other trip or rating adjustments).
- (3) The next higher standard rating selected does not exceed 800 amperes.

Where the overcurrent protective device is an adjustable trip device, it shall be permitted to be set to a value that does not exceed the next higher standard value above the ampacity of the conductors being protected as shown in Table 240.6(A) where restricted access in accordance with 240.6(C) is provided.

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_151.pdf	70_CN151

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 151 appeared in the First Draft Report on First Revision No. 7802.

The Correlating Committee directs that FR-7802 be rewritten to comply with the NEC Style Manual, Section 3.3.4 Word Clarity. When stating a condition, the word "where" should be changed to "if".

Related Item

- First Revision No. 7802

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 04 14:43:58 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: [SR-8283-NFPA 70-2021](#)
Statement: The last sentence is modified for compliance with the NEC style manual and to clarify that all of 240.4(B) applies.

**Correlating Committee Note No. 151-NFPA 70-2021 [Section No. 240.4(B)]****Submitter Information Verification**

Committee: NEC-P10

Submittal Date: Tue May 04 18:11:00 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs that FR-7802 be rewritten to comply with the NEC Style Manual, Section 3.3.4 Word Clarity. When stating a condition, the word "where" should be changed to "if".

First Revision No. 7802-NFPA 70-2020 [Section No. 240.4(B)]

Ballot Results

✓ **This item has passed ballot**

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

Affirmative All

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



Public Comment No. 1437-NFPA 70-2021 [Section No. 240.4(D)]

(D) Small Conductors.

Unless specifically permitted in 240.4(E) or (G), the overcurrent protection shall not exceed that required by (D)(1) through (D)(7.8) after any correction factors for ambient temperature and number of conductors have been applied.

(1) 18 AWG Copper.

7 amperes, provided all the following conditions are met:

- (1) Continuous loads do not exceed 5.6 amperes.
- (2) Overcurrent protection is provided by one of the following:
 - (3) Branch-circuit-rated circuit breakers listed and marked for use with 18 AWG copper conductor
 - (4) Branch-circuit-rated fuses listed and marked for use with 18 AWG copper conductor
 - (5) Class CC, Class CF, Class J, or Class T fuses

(2) 16 AWG Copper.

10 amperes, provided all the following conditions are met:

- (1) Continuous loads do not exceed 8 amperes.
- (2) Overcurrent protection is provided by one of the following:
 - (3) Branch-circuit-rated circuit breakers listed and marked for use with 16 AWG copper conductor
 - (4) Branch-circuit-rated fuses listed and marked for use with 16 AWG copper conductor
 - (5) Class CC, Class CF, Class J, or Class T fuses

(3) 14 AWG Copper-Clad Aluminum. 10 amperes provided all the following conditions are met:

- (1) Continuous loads do not exceed 8 amperes
- (2) Overcurrent protection is provided by one of the following:
 - a. Branch circuit-rated circuit breakers are listed and marked for use with 14 AWG copper-clad aluminum conductor.
 - b. Branch circuit-rated fuses are listed and marked for use with 14 AWG copper-clad aluminum conductor.

(4) 14 AWG Copper.

15 amperes

(4.5) 12 AWG Aluminum and Copper-Clad Aluminum.

15 amperes

(5.6) 12 AWG Copper.

20 amperes

(6.7) 10 AWG Aluminum and Copper-Clad Aluminum.

25 amperes

(7.8) 10 AWG Copper.

30 amperes

Additional Proposed Changes

File Name	Description	Approved
Public_Comment_for_240.4_D_Fnl.docx	Text showing correct changes in legislative text due to Terra issues showing changes in lists that are not being changed.	

Statement of Problem and Substantiation for Public Comment

The Correlating Committee Bimetallics Task Group submitted 19 public inputs in a coordinated effort to recognize 14 AWG copper-clad aluminum with a 60°C rating of 10 amps. The results in the first draft by CMP-2, CMP-6, CMP-9, CMP-10 and CMP-18 had general acceptance of these public inputs and the addition of the new conductor size and rating. CMP-10 resolved PI 3238 that sought to include 14 AWG copper-clad aluminum as a new 240.4(D)(3) with a rating of 10-amperes so this conductor was covered along with all the other "small" conductors. The panel's resolve statement to this public input is:

"The circuit breaker standard does not address the use of 14 AWG copper clad aluminum. The proposed text would allow 14 AWG copper clad aluminum for a circuit breaker where the conductor has not been considered in the listing."

This PC is submitted to fill in the gap that now exists so that 14 AWG copper-clad aluminum is included into the 2023 NEC for proper correlation with all the other changes. The parent text is revised to indicate the correct number for the list items. A new 240.4(D)(3) is added for 14 AWG copper-clad aluminum with a 10-ampere rating and conditions for the overcurrent device.

The revised text addresses the concern raised by CMP-10 in their first draft actions. The new requirement establishes 14 AWG Copper-Clad Aluminum with a maximum overcurrent protection rating of 10 Amps, with specific conditions, and aligns with the other small conductors provided in 240.4(D).

Based on the panel's statement further research into the UL standard for molded case circuit breakers found that the minimum conductor used for general application testing was 14 AWG copper. It was also determined that where a copper conductor listing evaluation was found acceptable and the device terminal was rated CU/AL, the next size larger aluminum or copper-clad aluminum conductor was deemed acceptable. The standard has additional evaluation provisions, as denoted in 240.4(D)(1) and 240.4(D)(2), for 18 AWG and 16 AWG copper conductors. Presently, unless the device is marked for smaller conductors the minimum size allowed per the listing is 14 AWG copper or 12 AWG aluminum or copper-clad aluminum.

Proposed changes have been made to UL 489 to include evaluation of 14 AWG copper-clad aluminum with similar requirements as 16 AWG copper. Other proposed changes to the standard address markings and correlation necessary within the standard. The proposed code text for the new 240.4(D)(3) along with the changes in the standard will provide the necessary provisions for proper installations and application of these overcurrent devices.

Related Item

- PI 3238

Submitter Information Verification

Submitter Full Name: Charles Mello
Organization: CdcMello Consulting Llc
Street Address:
City:
State:
Zip:
Submittal Date: Fri Aug 13 12:15:35 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: [SR-8285-NFPA 70-2021](#)
Statement: A new list item (3) is added to address specific requirements for 14 AWG Copper-Clad Aluminum with a maximum overcurrent protection rating of 10 Amps to align with the other small conductors permitted in 240.4(D). The following sections were renumbered accordingly.

The following is provided for the code panel to see the actual changes in the code text due to Terra issues indicating changes in lists that are not changes from the first draft text.

240.4(D) Small Conductors.

Unless specifically permitted in 240.4(E) or (G), the overcurrent protection shall not exceed that required by (D)(1) through (D)(~~78~~) after any correction factors for ambient temperature and number of conductors have been applied.

(1) 18 AWG Copper. 7 amperes, provided all the following conditions are met:

- (1) Continuous loads do not exceed 5.6 amperes.
- (2) Overcurrent protection is provided by one of the following:
 - a. Branch-circuit-rated circuit breakers listed and marked for use with 18 AWG copper wire
 - b. Branch-circuit-rated fuses listed and marked for use with 18 AWG copper wire
 - c. Class CC, Class J, or Class T fuses

(2) 16 AWG Copper. 10 amperes, provided all the following conditions are met:

- (1) Continuous loads do not exceed 8 amperes.
- (2) Overcurrent protection is provided by one of the following:
 - a. Branch-circuit-rated circuit breakers listed and marked for use with 16 AWG copper wire
 - b. Branch-circuit-rated fuses listed and marked for use with 16 AWG copper wire
 - c. Class CC, Class J, or Class T fuses

(3) 14 AWG Copper-Clad Aluminum. 10 amperes provided all the following conditions are met:

- (1) Continuous loads do not exceed 8 amperes.
- (2) Overcurrent protection is provided by one of the following:
 - a. Branch-circuit-rated circuit breakers listed and marked for use with 14 AWG copper-clad aluminum wire
 - b. Branch-circuit-rated fuses listed and marked for use with 14 AWG copper-clad aluminum wire

(~~34~~) 14 AWG Copper. 15 amperes

(~~45~~) 12 AWG Aluminum and Copper-Clad Aluminum. 15 amperes

(~~56~~) 12 AWG Copper. 20 amperes

(~~67~~) 10 AWG Aluminum and Copper-Clad Aluminum. 25 amperes

(~~78~~) 10 AWG Copper. 30 amperes

PC Substantiation:

The Correlating Committee Bimetallics Task Group submitted 19 public inputs in a coordinated effort to recognize 14 AWG copper-clad aluminum with a 60°C rating of 10 amps. The results in the first draft by CMP-2, CMP-6, CMP-9, CMP-10 and CMP-18 had general acceptance of these public inputs and the addition of the new conductor size and rating. CMP-10 resolved PI 3238 that sought to include 14 AWG copper-clad aluminum as a new 240.4(D)(3) with a rating of 10-amperes so this conductor was covered along with all the other “small” conductors. The panel’s resolve statement to this public input is:

“The circuit breaker standard does not address the use of 14 AWG copper clad aluminum. The proposed text would allow 14 AWG copper clad aluminum for a circuit breaker where the conductor has not been considered in the listing.”

This PC is submitted to fill in the gap that now exists so that 14 AWG copper-clad aluminum is included into the 2023 NEC for proper correlation with all the other changes. The parent text is revised to indicate the correct number for the list items. A new 240.4(D)(3) is added for 14 AWG copper-clad aluminum with a 10-ampere rating and conditions for the overcurrent device.

The revised text addresses the concern raised by CMP-10 in their first draft actions. The new requirement establishes 14 AWG Copper-Clad Aluminum with a maximum overcurrent protection rating of 10 Amps, with specific conditions, and aligns with the other small conductors provided in 240.4(D).

Based on the panel’s statement further research into the UL standard for molded case circuit breakers found that the minimum conductor used for general application testing was 14 AWG copper. It was also determined that where a copper conductor listing evaluation was found acceptable and the device terminal was rated CU/AL, the next size larger aluminum or copper-clad aluminum conductor was deemed acceptable. The standard has additional evaluation provisions, as denoted in 240.4(D)(1) and 240.4(D)(2), for 18 AWG and 16 AWG copper conductors. Presently, unless the device is marked for smaller conductors the minimum size allowed per the listing is 14 AWG copper or 12 AWG aluminum or copper-clad aluminum.

Proposed changes have been made to UL 489 to include evaluation of 14 AWG copper-clad aluminum with similar requirements as 16 AWG copper. Other proposed changes to the standard address markings and correlation necessary within the standard. The proposed code text for the new 240.4(D)(3) along with the changes in the standard will provide the necessary provisions for proper installations and application of these overcurrent devices.

**Public Comment No. 2075-NFPA 70-2021 [Section No. 240.4(D)(3)]**

(3) 14 AWG Copper.
15 amperes

Additional Proposed Changes

<u>File Name</u>	<u>Description</u>	<u>Approved</u>
PC_1447_1772_1937_1939_1940_1943_2068_2073_2075_Attachment_C_Dave_Watson.pdf	WO_2021-260_14_AWG_Copper_Clad_Aluminum_Temperature_Study_Initial_Findings.pdf	

Statement of Problem and Substantiation for Public Comment

This Public Comment is submitted in anticipation of Public Comments from other organizations that may be submitted to the code-making panel regarding the addition of 14 AWG copper-clad aluminum conductors. A Public Input (PI 3238) was made during the First Draft to add 14 AWG copper-clad aluminum conductors to this section. While the code-making panel rejected that Public Input during the First Draft, a Public Comment is likely to be submitted to add 14 AWG copper-clad aluminum conductors to this section.

Testing performed by Southwire (at the Southwire Cofer Technology Center, an ISO 17025 accredited test lab by A2LA) indicates that the maximum temperature ratings for products made with 14 AWG Copper-Clad Aluminum conductors are exceeded when using the proposed ampacities (10 Amps at 60°C for NM-B Cable and 20 Amps at 90°C for THHN conductors installed in flexible metal conduit) while the products are installed within insulated walls and ceilings/attics that are typical of residential and commercial installations. A test report is attached, and it is anticipated that more information (including additional test reports) will be available to the code-making panel from further testing conducted by Southwire and other testing facilities. Additional information in support of this position is available for the Code-Making Panels.

Related Public Comments:

PC-1447 - Tables 310.16 and 310.17
PC-1772 - Section 210.24
PC-2075 - Section 240.4(D)
PC-1937 - Section 310.3(A)
PC-2068 - Section 330.104
PC-1939 - Section 334.104
PC-2073 - Section 336.104
PC-1940 - Section 340.104
PC-1943 - Section 406.3(D)

Related Item

• PI-3238

Submitter Information Verification

Submitter Full Name: Dave Watson

Organization: Southwire

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 19 10:38:38 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The public comment was not submitted in accordance with section 4.4.4.3(c) of the Regulations Governing the Development of NFPA Standards. No changes to first draft text were provided.



Southwire®

D.B. Cofer Technology Center

111 Development Drive • Carrollton, GA 30117

Temperature Study of 14 AWG Copper-Clad Aluminum Products -Initial Findings-

Test Performed: August 6th – August 18th, 2021

Report Date: August 19th, 2021

Requested by: Dave Watson

Cofer Center Work Order #: 2021-260

Report by: _____

Steven Powers, PE

Lab Manager, Cofer Technology Center

&

Dave Watson

Principal Engineer, Codes & Standard Engineering

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Disclaimer:

The information is accurate to the best of Southwire Company's knowledge at the time of publication. Southwire Company, LLC and its affiliates disclaim all liability for any errors, omissions, corruption or virus in this message or any attachments. For engineering design information, please contact Southwire Applications Engineering at cabletechsupport@southwire.com.

Introduction

During the First Draft of the 2023 NEC, the smallest size allowed for copper-clad conductors was extended to 14 AWG (from the previous limit of 12 AWG) in several NEC sections, including Table 310.16 and Table 310.17. The proposed Table 310.16 ampacities are 10 Amps at 60 °C, 15 Amps at 75 °C, and 20 Amps at 90 °C. The test data supplied by the American Bimetallic Association in support of this First Draft change addressed performance in open air only. Southwire believes testing in normal residential and commercial installation environments (within insulated walls and ceilings/attics) is also needed to properly assess the safety of 14 AWG copper-clad conductors at these ampacities.

Summary

Testing was performed at Southwire's D.B. Cofer Technology Center (CTC) in a climate-controlled lab. Data was gathered using equipment and processes that are part of the CTC's ISO 17025 Quality Management System. The overall procedure and test apparatus were customer defined and not a part of the CTC's ISO 17015 scope of accreditation.

The test results show that the maximum temperature ratings for products made with 14 AWG copper-clad aluminum conductors are exceeded when using the proposed ampacities (testing was performed using 10 Amps at 60 °C for NM-B Cable and 20 Amps at 90 °C for THHN conductors installed in flexible metallic conduit) while the products are installed within insulated walls and ceilings/attics that are typical of residential and commercial installations. It is anticipated that more information (including possible additions to this test report and additional test reports) will be available to the code-making panel from further testing conducted by Southwire and other testing facilities.

Samples

Southwire obtained 14 AWG copper-clad aluminum bare conductor (using AA-8000 series AL alloy and meeting ASTM B566) and used it to manufacture 14/2 NM-B Cable and 14 AWG THHN/THWN conductors. Since these sizes of copper-clad aluminum are not included within the relevant UL standards at this time (UL 719 and UL 83), we used the same constructions as required for 14 AWG copper products (allowing for the manufacturing variations required due to the lower tensile strength and temperature performance of copper-clad aluminum as compared to copper).

Procedure

Testing was performed on a custom wood and drywall apparatus according to Figure 1. The apparatus was designed to replicate the construction of a traditional wood framed residential wall and ceiling. The apparatus could be flipped 90° from a vertical position (replicating a wall) and a horizontal position

(replicating a ceiling). For the data contained in this report, certified electricians were used to install the samples and make electrical connections.

Complete test setup consisted of the following elements:

1. Wooden apparatus either oriented in the vertical plane (wall) or the horizontal plane (ceiling) constructed using 2"x6" wood boards and ½" sheetrock,
2. Fiberglass insulation (R6.7, R13, R30),
3. Chroma programmable load current supply,
4. Fluke amp probe,
5. Voltage meters,
6. Graphtec temperature datalogger.

Table 1: Equipment Used

Equipment	Cofer Asset #
Graphtec GL 840 Data Logger	948
Fluke 336 Clamp Meter	189
Chroma Model 63803 Programable Load	NA
Fluke 289 Multimeter	267
Fluke 789 Multimeter	679

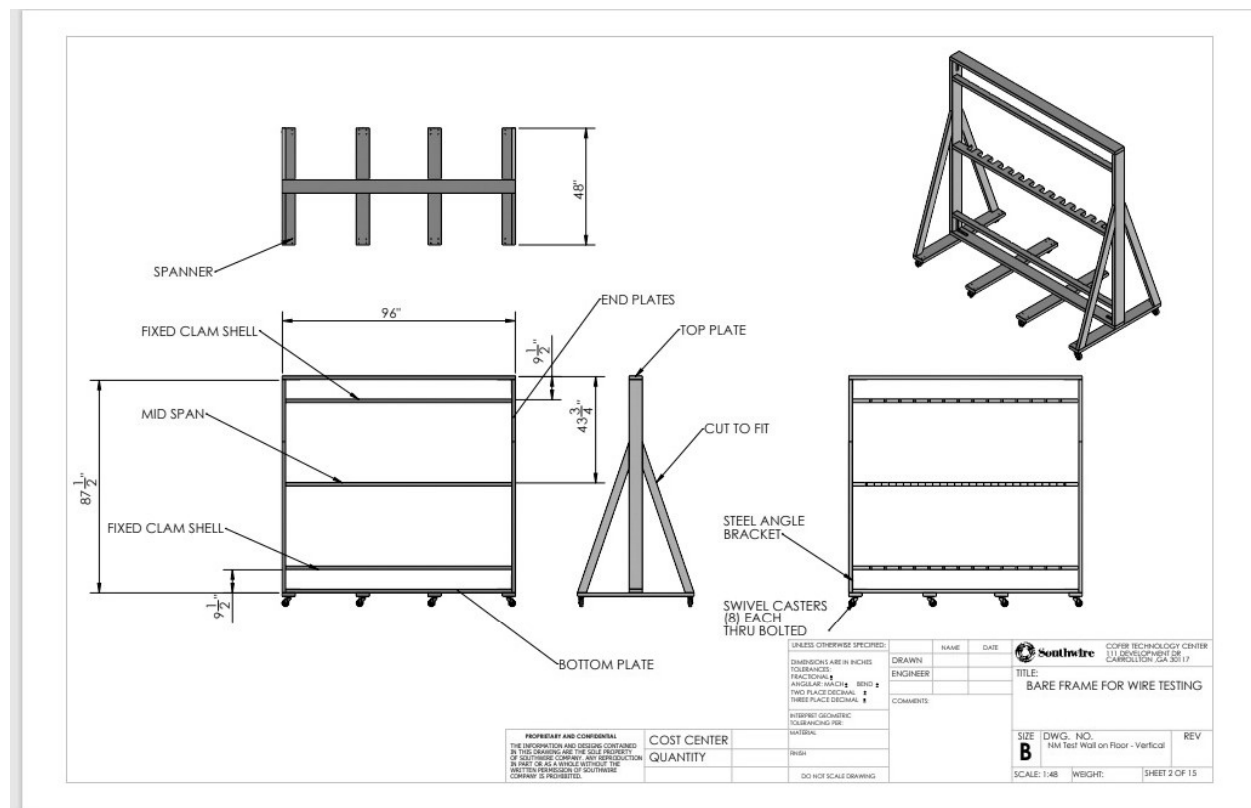


Figure 1: Test Apparatus

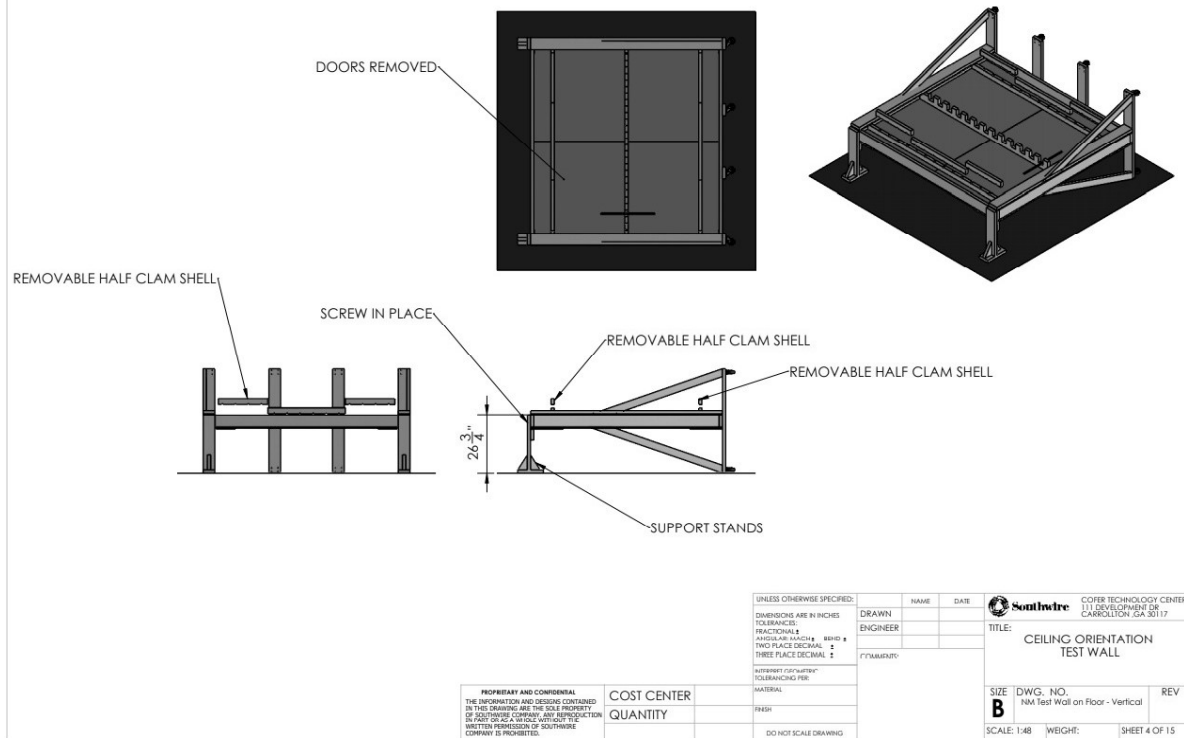


Figure 2: Test Apparatus in Ceiling Configuration

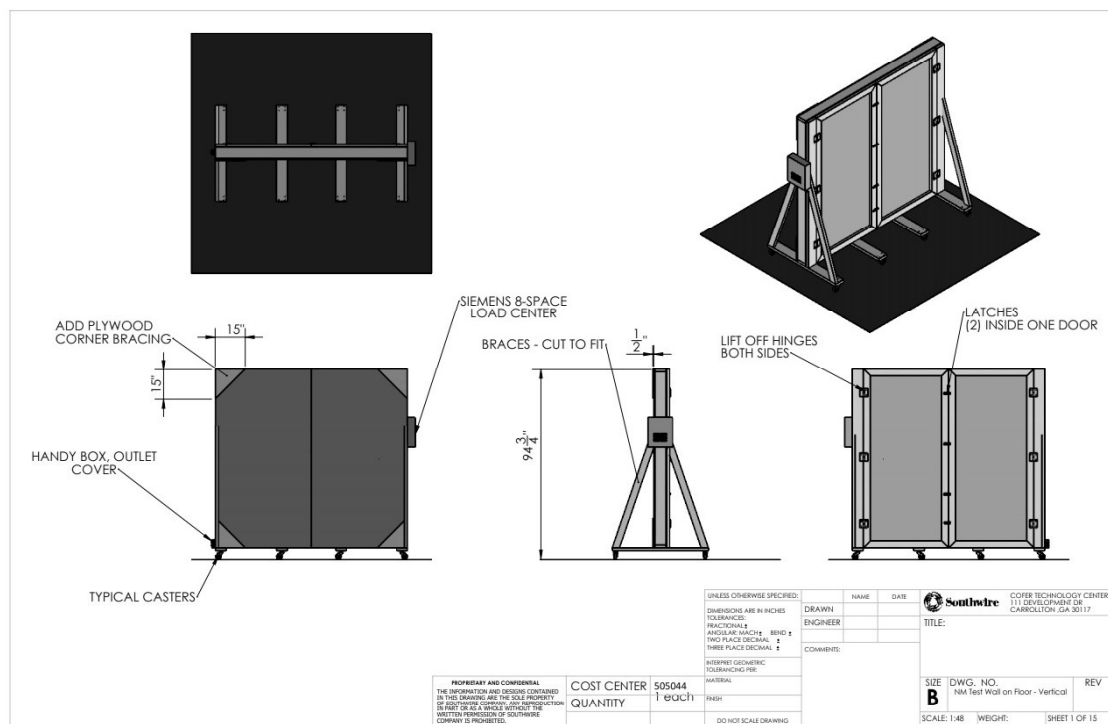


Figure 3: Test Apparatus in Wall Configuration

The following procedure was used for each test.

1. A sufficient length of NM cable or THHN (typically 61 feet) is cut from a coil,
2. While the structure is in the horizontal orientation, one end is terminated in a Siemens EQ 125 Amp 8-Space 16-Circuit Main Lug Flush Mount Indoor Load Center to a Siemens Single-Pole Type QP Circuit Breaker, the amperage based upon the capability of the cable (10, 15, 20 amps typical) or specified by the customer,
3. The sample is secured in the wall at the specified spacing, typically 12" by pulling it through $\frac{3}{4}$ " holes that were drilled through the boards located on either end of the structure,
4. The samples were secured to the apparatus,
 - a. The cable samples are secured to the middle board with nail on staples listed for NM cable (vertical wall and NM-B),
 - b. The THHN samples were pulled through the flexible metal conduit (FMC), and the FMC was terminated in the electrical boxes of both end of the circuit,
5. The other end of the cable is terminated to a duplex outlet on the opposite side of the structure,
6. Thermocouples are installed in the apparatus as follows:
 - a. One ambient (#8),
 - b. One placed inside the cable where it enters the single gang receptacle box (#1) and another one inside the cable where it enters the load center panel (#7),
 - c. Five others placed inside the sample
 - i. The thermocouples in the cable samples are placed approximately 10 feet apart by cutting a small slit in the outer jacket and placing the end of the thermocouple next to the conductors under the paper then two (2) wraps of electrical tape are placed over the slit (#2 through #6),
 - ii. The thermocouples in the FMC were taped to the black conductor using electrical tape every 10 feet,
 - d. One on the black conductor connected to the breaker right at the terminating screw (#9)
7. A specified R-value layer of insulation is placed over the sample and is tucked into the structure to minimize air gaps/heat loss,
8. For wall testing, the sheetrock doors are installed while the structure is horizontal, locked and then the structure is stood to the vertical orientation,
9. For ceiling testing, the sheetrock doors are left off, and the apparatus is left in the horizontal position,
10. The incoming power to the panel is turned ON,
11. The initial incoming voltage and outgoing voltage is recorded,
12. The temperature data logger data collection is launched,
13. The power supply is set to the specified current level (10, 12, 15, 20 amps typical) and is engaged,
14. The current level is verified with the amp probe,
15. The loaded voltages as shown in the corresponding voltage meters are recorded.

Each thermocouple was constructed at the CTC from special-limit-of-error thermocouple wire. After each thermocouple was welded and connected to the data logger, the thermocouple end was placed in an ice bath to verify its functionality and accuracy.

After a specified amount of time or at the point where the cable exceeds the temperature limitation as set forth in the NEC for NM-B Cable (60 °C) or THHN/THWN conductors (90 °C) as indicated on the datalogger screen, the power supply is turned off and the data logger collection is stopped.

Results

Several limits were observed for this study. These limits, coupled with judgement, were considered when determining when to stop a test. Some of these limits include the following:

- Temperature limit of 60°C for NM-B Cable,
- Temperature limit of 90°C for THHN/THWN conductors installed in conduit,
- A temperature rise of 30°C above ambient for NM-B Cable,
- A temperature rise of 60°C above ambient for THHN/THWN conductors installed in conduit,
- An elapsed time of 3 hours (“continuous use” classification).

For the ampacities given in NEC Tables 310.16 and 310.17, the ambient temperature is 30 °C. The total temperature achieved by the cable or conductor is composed of the ambient temperature plus the temperature rise above ambient due to conduction of current. For NM-B Cable (Max Temp = 60 °C), this maximum temperature rise is 30 °C above ambient. For THHN/THWN conductors installed in conduit (Max Temp = 90 °C), this maximum temperature rise is 60 °C above ambient. Normally when installation occurs in an area with a lower ambient temperature, the allowable conductor ampacity is increased per NEC 310.15. However, this testing had to be performed with the appropriate OCPD sizes (10 Amps for NM-B Cable and 20 Amps for THHN/THWN conductors in conduit) to ensure accuracy of the results. Since our testing occurred in an environment with an ambient temperature of less than 30 °C and we were limited in the current we could use for testing by the OCPD, we are using the maximum temperature rise above ambient as the measure of pass/fail results.

The temperature on multiple channels on Figure 2 exceeded the limit of the data logger after approximately 26 minutes. The test lasted for 47 minutes before it was decided to stop testing. The maximum temperature recorded was 102°C above ambient.

See Figures 4 and 5 below for the temperature profile for AWG 14/2 copper-clad aluminum and 14 AWG THHN copper-clad aluminum while the apparatus was in the ceiling orientation. See Figures 6 and 7 for data in the wall orientation.

WO 2021-260 Copper Clad Aluminum Temperature Study 14/2 CCA Spaced 12" in R43 Insulation @ 10 Amps in Ceiling Configuration

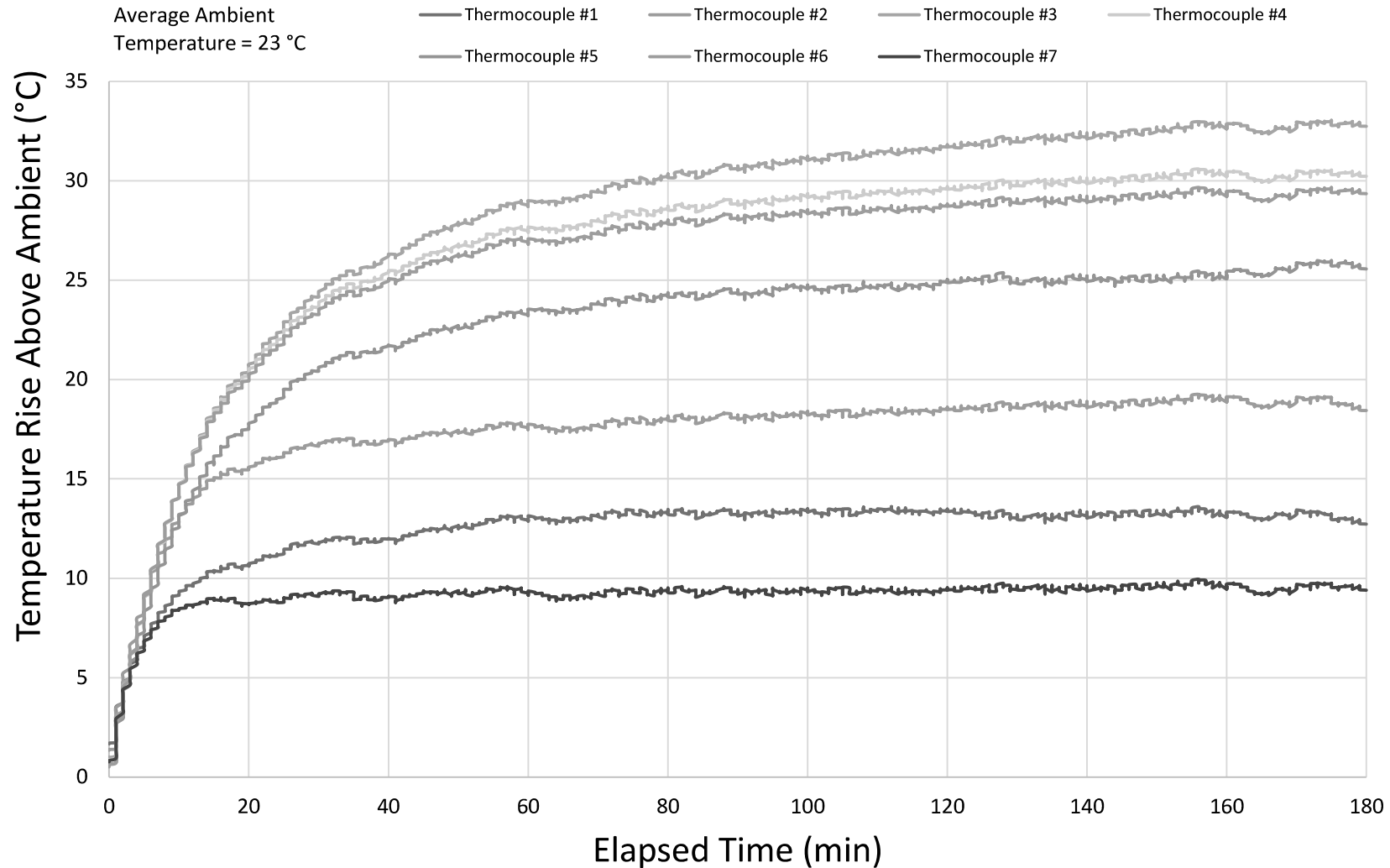


Figure 4: 14/2 CCA Spaced 12" in R43 Insulation at 10 Amps in Ceiling Configuration

WO 2021-260 Copper Clad Aluminum Temperature Study 14 AWG CCA
THHN in 1/2" Flexible Metal Conduit, 12" Spacing in R43 Insulation @ 20
Amps in Ceiling Configuration

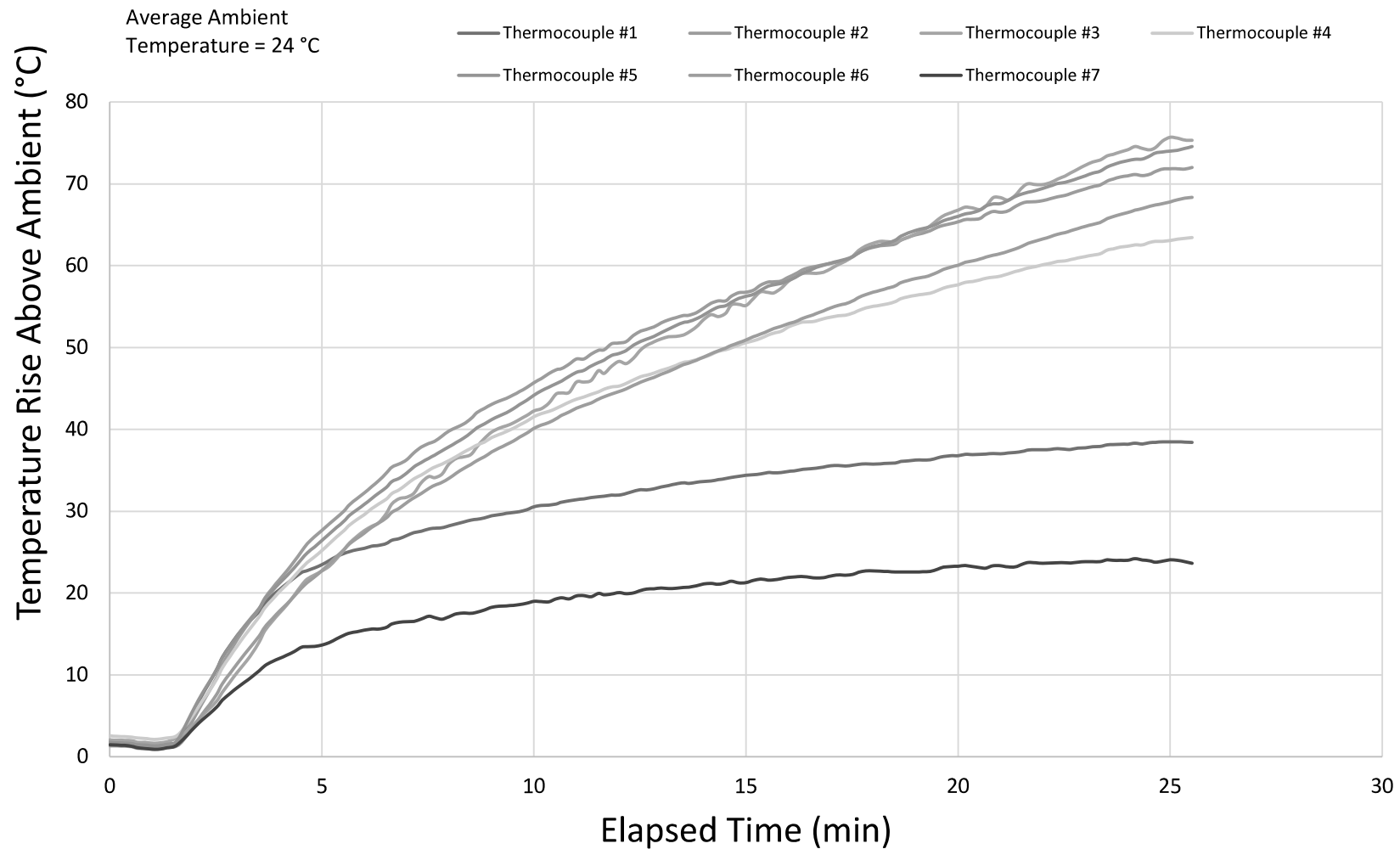


Figure 5: 14 AWG CCA THHN in 1/2" FMC Spaced 12" in R43 Insulation at 20 Amps in Ceiling Configuration

WO 2021-260 Copper Clad Aluminum Temperature Profile Study - 14/2 CCA Spaced 12" in R26 Insulation @ 10 Amps in Wall Configuration

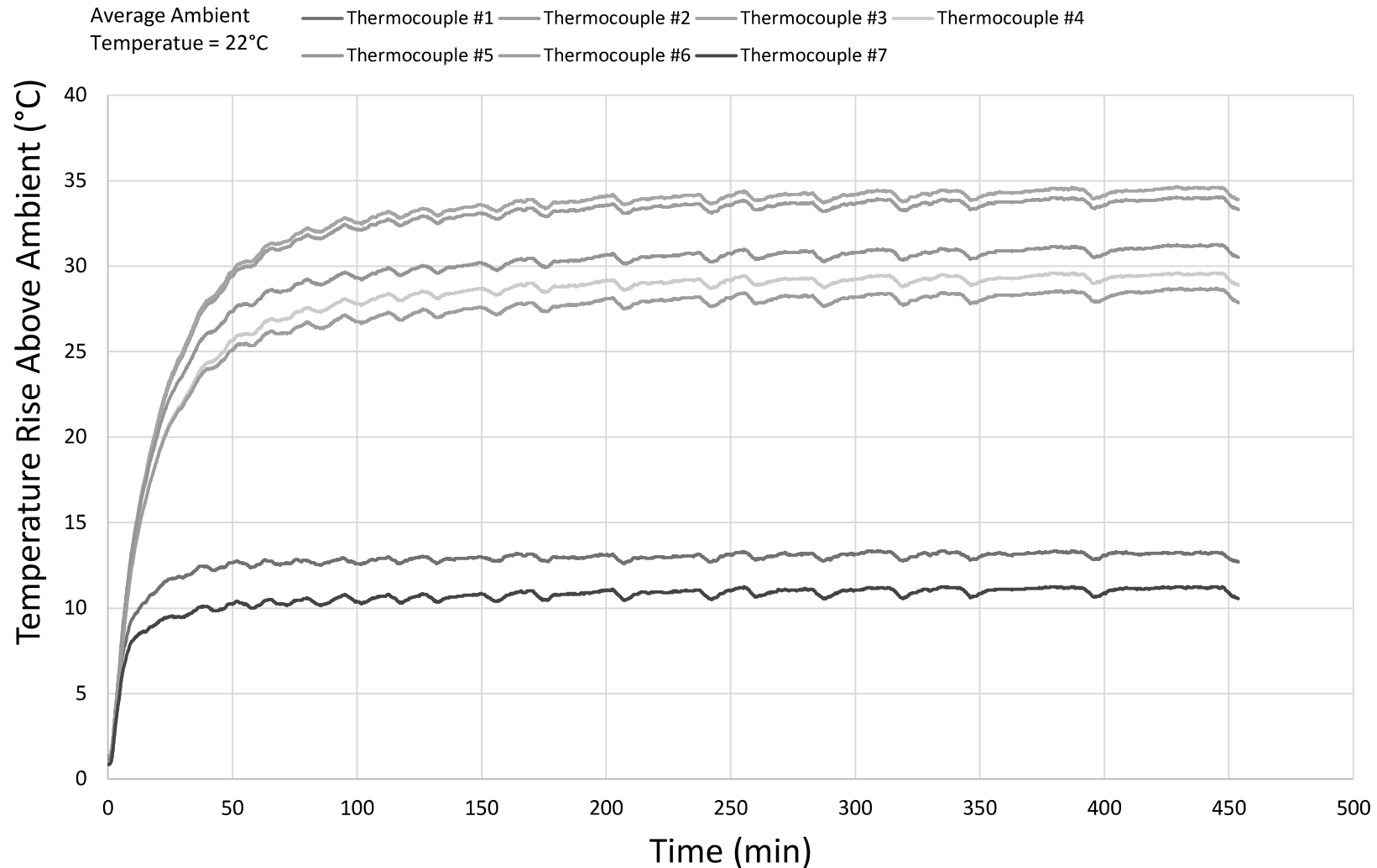


Figure 6: 14/2 CCA Spaced 12" in R26 Insulation at 10 Amps in Wall Configuration

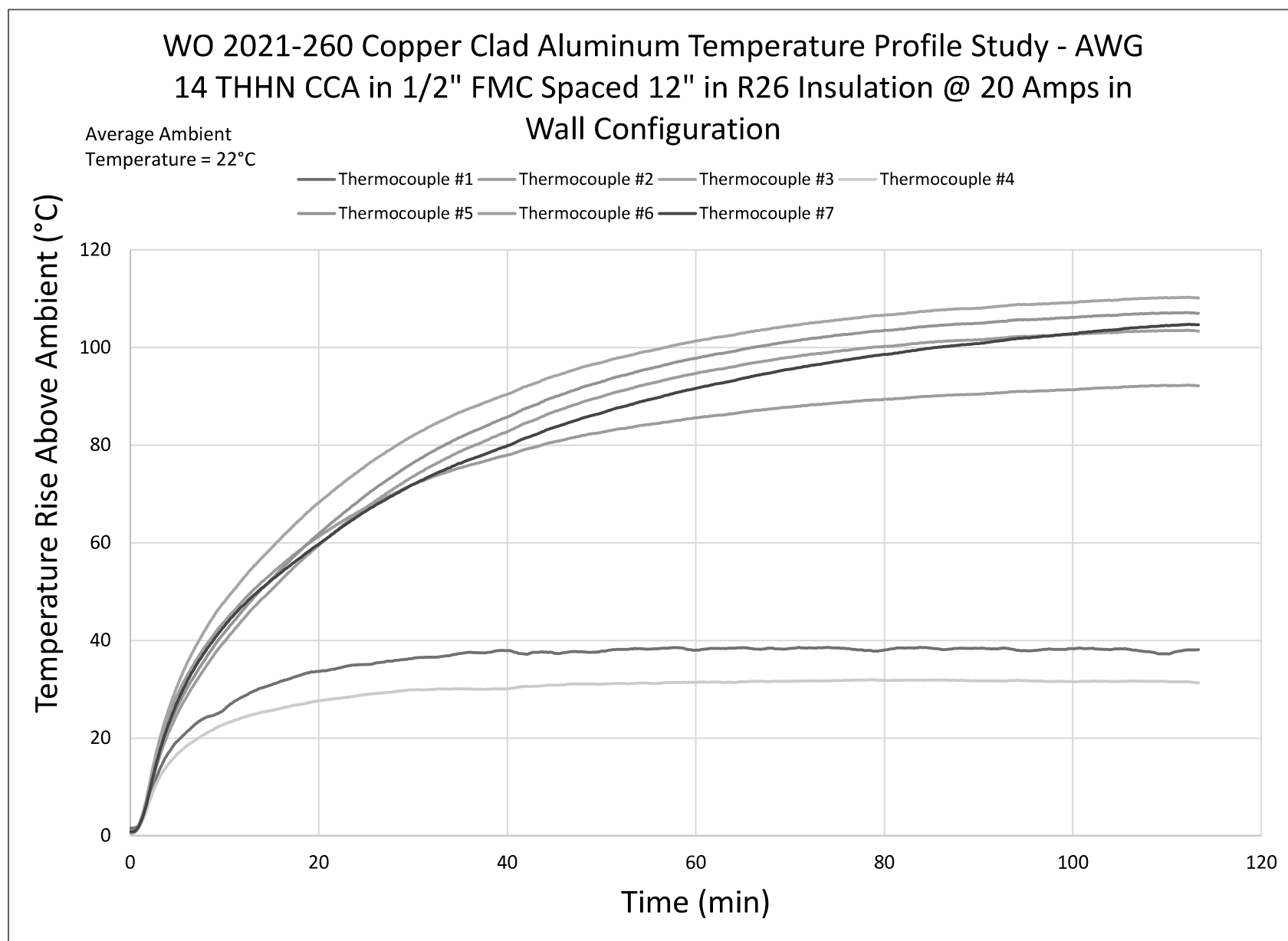


Figure 7: AWG 14 THHN CCA in 1/2" FMC Spaced 12" in R26 Insulation at 20 Amps in Wall Configuration

Appendix A: Calibration Certificates



Applied Technical Services

Certificate of Calibration

Certificate #3019464

**Customer:**

Southwire Company - D.B.Cofer
D.B.Cofer Technology Center
111 Development Drive
Carrollton, GA 30119

**Calibration Location:**

Southwire Company - D.B.Cofer
D.B.Cofer Technology Center
111 Development Drive
Carrollton, GA 30119

Instrument Information:

Manufacturer: Fluke
Model Number: 336
Description: Clamp Meter, AC / DC
Asset Number: 189
Serial Number: 88307992
PO Number: 4503214624

Calibration Information/Results:

As Found Condition : In Tolerance
Action Taken / As Left: In Tolerance - No Adjustment
Temperature: 71° F
Humidity: 55% RH
Calibration Date: 01-Jun-2021
Calibration Due Date: 01-Jun-2022
Calibration Interval: 12 Months

Calib. Procedure: ATS-1044 Rev 2:Calibration of Clamp-On Meters

This instrument has been calibrated using primary or secondary standards whose calibration is traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or applicable ASTM specification number for hardness testing equipment. Some measurements are traceable to natural, physical constants, consensus standards, or ratio type measurements.

The reported expanded measurement uncertainty is based on a standard uncertainty multiplied by a coverage factor of $k=2$, providing a confidence level of approximately 95%. This calibration certificate may contain data that is not covered by the Scope of Accreditation. The unaccredited test points, where applicable, are indicated by an asterisk (*), or confined to clearly marked sections. Functional tests are not accredited. The expanded measurement uncertainty is not considered when determining in-tolerance or out-of-tolerance conditions. Results are reviewed, if applicable, to establish where any measurement results exceeded the stated calibration tolerance and to communicate results by means of this certificate.

All calibrations are performed in accordance with the ATS Quality Manual QM1, Rev. 18, dated 10/16/20. Applied Technical Services, Inc.'s Quality System complies with the applicable requirements of ANSI/NCSL Z540-1, ISO 9001:2015, 10CFR50 Appendix B, 10CFR Part 21, and ISO/IEC 17025:2017. The reported data is valid only at the time of the test and related only to the item calibrated. Calibration due dates appearing on this certificate and calibration label are determined by the client and do not imply continued conformance to specifications. This certificate shall not be reproduced except in full, without written permission of Applied Technical Services, Inc.

Technical Remarks:

Calibrated By: *Taylor, Collin A*

Name

Calibration Tech

Title

Calibration Equipment Utilized

Standard I.D.	Mfg.	Model No.	Description	Serial	Cal. Date	Due Date
ATS-04852	Fluke	5522A/1G	Calibrator, Multi-Function	2034901	02/03/2021	02/03/2022
ATS-4049	Fluke	5500A/COIL	Current Amplifier, 50 Turn Current Coil	SV0001521	03/11/2021	03/11/2026

Calibration Data

FUNCTION TESTED	Nominal Value	CALIBRATION TOLERANCE	As Found	Out of Tol	As Left
AC Voltage Accuracy	20.0 V @ 50 Hz	19.3 to 20.7 V [EMU 58 mV]	20.2		Same
	600.0 V @ 50 Hz	593.5 to 606.5 V [EMU 200 mV]	600.9		Same
	600.0 V @ 400 Hz	563.5 to 636.5 V [EMU 200 mV]	593.2		Same
DC Voltage Accuracy	20.0 V	19.3 to 20.7 V [EMU 58 mV]	20.3		Same
	-20.0 V	-20.7 to -19.3 V [EMU 58 mV]	-20.1		Same
	600.0 V	593.5 to 606.5 V [EMU 59 mV]	601.3		Same
	-600.0 V	-606.5 to -593.5 V [EMU 59 mV]	-601.2		Same
Continuity Test: Audible Tone	25 Ohm	Pass/Fail	PASS		Same
Resistance Accuracy	600.0 Ohm	590.5 to 609.5 Ohm [EMU 61 mOhm]	603.0		Same

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Issue date: 01-Jun-2021

Batch Number: 2398705

Calibration Data

FUNCTION TESTED	Nominal Value	CALIBRATION TOLERANCE	As Found	Out of Tol	As Left
	6000 Ohm	5905 to 6095 Ohm [EMU 610 mOhm]	6009		Same
AC Current Accuracy	20.0 A @ 50 Hz	19.1 to 20.9 A [EMU 0.37 A]	20.1		Same
	200.0 A @ 50 Hz	195.5 to 204.5 A [EMU 2 A]	200.5		Same
	500.0 A @ 50 Hz	489.5 to 510.5 A [EMU 3.7 A]	501.2		Same
	600.0 A @ 50 Hz	587.5 to 612.5 A [EMU 4.3 A]	601.3		Same
INRUSH Verification	250.0 A @ 60 Hz	245.6 to 255.6 A [EMU 2.3 A]	253.6		Same
DC Current Accuracy	0.0 A	-0.5 to 0.5 A [EMU 58 mA]	0.0		Same
	20.0 A	19.1 to 20.9 A [EMU 0.25 A]	20.2		Same
	-20.0 A	-20.9 to -19.1 A [EMU 0.25 A]	-20.2		Same
	600.0 A	587.5 to 612.5 A [EMU 3.5 A]	601.3		Same
	-600.0 A	-612.5 to -587.5 A [EMU 3.5 A]	-601.0		Same

End Of Report

Test Number: 3019464 Asset Number: 189 Desc: Fluke / 336, Clamp Meter, AC / DC

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ATS 501, 10/20

Issue date: 01-Jun-2021

Batch Number: 2398705



Applied Technical Services
Certificate of Calibration
 Certificate #3019662

**Customer:**

Southwire Company - D.B.Cofer
 D.B.Cofer Technology Center
 111 Development Drive
 Carrollton, GA 30119

**Calibration Location:**

Southwire Company - D.B.Cofer
 D.B.Cofer Technology Center
 111 Development Drive
 Carrollton, GA 30119

Instrument Information:

Manufacturer: Graphtec
Model Number: GL840
Description: Data Acquisition Unit - Temperature
Asset Number: 948
Serial Number: C61215753
PO Number: 4503214624

Calibration Information/Results:

As Found Condition : In Tolerance
Action Taken / As Left: In Tolerance - No Adjustment
Temperature: 71° F
Humidity: 55% RH
Calibration Date: 02-Jun-2021
Calibration Due Date: 02-Jun-2022
Calibration Interval: 12 Months

Calib. Procedure: ATS-1046 Rev 2:Calibration of Data Loggers/Chart Recorders/Multifunction Recorders

This instrument has been calibrated using primary or secondary standards whose calibration is traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or applicable ASTM specification number for hardness testing equipment. Some measurements are traceable to natural, physical constants, consensus standards, or ratio type measurements.

The reported expanded measurement uncertainty is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a confidence level of approximately 95%. This calibration certificate may contain data that is not covered by the Scope of Accreditation. The unaccredited test points, where applicable, are indicated by an asterisk (*), or confined to clearly marked sections. Functional tests are not accredited. The expanded measurement uncertainty is not considered when determining in-tolerance or out-of-tolerance conditions. Results are reviewed, if applicable, to establish where any measurement results exceeded the stated calibration tolerance and to communicate results by means of this certificate.

All calibrations are performed in accordance with the ATS Quality Manual QM1, Rev. 18, dated 10/16/20. Applied Technical Services, Inc.'s Quality System complies with the applicable requirements of ANSI/NCCL Z540-1, ISO 9001:2015, 10CFR50 Appendix B, 10CFR Part 21, and ISO/IEC 17025:2017. The reported data is valid only at the time of the test and related only to the item calibrated. Calibration due dates appearing on this certificate and calibration label are determined by the client and do not imply continued conformance to specifications. This certificate shall not be reproduced except in full, without written permission of Applied Technical Services, Inc.

Technical Remarks:

Calibrated By: *Fugita, Aaron J*
 Name

Calibration Tech
 Title

Calibration Equipment Utilized

Standard I.D.	Mfg.	Model No.	Description	Serial	Cal. Date	Due Date
ATS-04962	Fluke	5522A	Calibrator, Multi-Function	2356901	10/07/2020	10/07/2021

Calibration Data

FUNCTION TESTED	Nominal Value	CALIBRATION TOLERANCE	As Found	Out of Tol	As Left
CH. 1	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.10		Same
CH.1	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.45		Same
CH. 2	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.65		Same
CH. 2	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.55		Same
CH. 3	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.45		Same
CH. 3	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.50		Same
CH. 4	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.50		Same
CH. 4	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.50		Same
CH. 5	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.75		Same
CH. 5	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.60		Same

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Issue date: 02-Jun-2021

Batch Number: 2398705

Calibration Data

FUNCTION TESTED	Nominal Value	CALIBRATION TOLERANCE	As Found	Out of Tot	As Left
CH. 6	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.55		Same
CH. 6	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.50		Same
CH. 7	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.50		Same
CH. 7	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.50		Same
CH. 8	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.55		Same
CH. 8	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.30		Same
CH. 9	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.40		Same
CH. 9	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.45		Same
CH. 10	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.55		Same
CH. 10	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.65		Same
CH. 11	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.90		Same
CH. 11	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.80		Same
CH. 12	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.90		Same
CH. 12	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.80		Same
CH. 13	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.90		Same
CH. 13	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.80		Same
CH. 14	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.80		Same
CH. 14	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.80		Same
CH. 15	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.80		Same
CH. 15	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.70		Same
CH. 16	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.60		Same
CH. 16	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.60		Same
CH. 17	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.90		Same
CH. 17	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.50		Same
CH. 18	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.90		Same
CH. 18	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.80		Same
CH. 19	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	49.70		Same
CH. 19	200.00 °C	198.45 to 201.55 °C [EMU 0.09 °C]	199.80		Same
CH. 20	50.00 °C	48.45 to 51.55 °C [EMU 0.07 °C]	50.10		Same
CH. 20	200.00 °C	198.45 to 201.55 °C [EMU 0.07 °C]	200.20		Same

End Of Report

Test Number: 3019662 Asset Number: 948 Desc: Graphtec / GL840, Data Acquisition Unit - Temperature

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Issue date: 02-Jun-2021

Batch Number: 2398705



Applied Technical Services
Certificate of Calibration
 Certificate #3019509

**Customer:**

Southwire Company - D.B.Cofer
 D.B.Cofer Technology Center
 111 Development Drive
 Carrollton, GA 30119

**Calibration Location:**

Southwire Company - D.B.Cofer
 D.B.Cofer Technology Center
 111 Development Drive
 Carrollton, GA 30119

Instrument Information:

Manufacturer: Fluke
Model Number: 289
Description: Multimeter, Digital - Handheld
Asset Number: 267
Serial Number: 10140030
PO Number: 4503214624

Calibration Information/Results:

As Found Condition : In Tolerance
Action Taken / As Left: In Tolerance - No Adjustment
Temperature: 71° F
Humidity: 54% RH
Calibration Date: 01-Jun-2021
Calibration Due Date: 01-Jun-2022
Calibration Interval: 12 Months

Calib. Procedure: ATS-1040 Rev 2:Calibration of Handheld Digital Multimeters

This instrument has been calibrated using primary or secondary standards whose calibration is traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or applicable ASTM specification number for hardness testing equipment. Some measurements are traceable to natural, physical constants, consensus standards, or ratio type measurements.

The reported expanded measurement uncertainty is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a confidence level of approximately 95%. This calibration certificate may contain data that is not covered by the Scope of Accreditation. The unaccredited test points, where applicable, are indicated by an asterisk (*), or confined to clearly marked sections. Functional tests are not accredited. The expanded measurement uncertainty is not considered when determining in-tolerance or out-of-tolerance conditions. Results are reviewed, if applicable, to establish where any measurement results exceeded the stated calibration tolerance and to communicate results by means of this certificate.

All calibrations are performed in accordance with the ATS Quality Manual QM1, Rev. 18, dated 10/16/20. Applied Technical Services, Inc.'s Quality System complies with the applicable requirements of ANSI/NCSL Z540-1, ISO 9001:2015, 10CFR50 Appendix B, 10CFR Part 21, and ISO/IEC 17025:2017. The reported data is valid only at the time of the test and related only to the item calibrated. Calibration due dates appearing on this certificate and calibration label are determined by the client and do not imply continued conformance to specifications. This certificate shall not be reproduced except in full, without written permission of Applied Technical Services, Inc.

Technical Remarks:

Calibrated By: *Taylor, Collin A*
 Name

Calibration Tech
 Title

Calibration Equipment Utilized

Standard I.D.	Mfg.	Model No.	Description	Serial	Cal. Date	Due Date
ATS-04852	Fluke	5522A/1G	Calibrator, Multi-Function	2034901	02/03/2021	02/03/2022

Calibration Data

FUNCTION TESTED	Nominal Value	CALIBRATION TOLERANCE	As Found	Out of Tol	As Left
DC mV: 50mV Range: REL Offset On	0.000 mV	-0.020 to 0.020 mV [EMU 1.2 µV]	0.001		Same
DC mV: 50mV Range: REL Offset On	0.025 mV	0.005 to 0.045 mV [EMU 1.2 µV]	0.027		Same
	-0.025 mV	-0.045 to -0.005 mV [EMU 1.2 µV]	-0.022		Same
	50.000 mV	49.955 to 50.045 mV [EMU 2.1 µV]	50.011		Same
500mV Range: Rel Off	500.00 mV	499.85 to 500.15 mV [EMU 9.5 µV]	500.00		Same
	-250.00 mV	-250.08 to -249.92 mV [EMU 8.3 µV]	-250.07		Same
mV DC/AC: 500mV Range	50.00 mV @ 0 Hz	49.97 to 50.03 mV [EMU 6.1 µV]	49.99		Same
	250.00 mV @ 35 kHz	237.10 to 262.90 mV [EMU 96 µV]	248.33		Same
Ohms:REL On: 4 wire: 500Ohm Rng	0.00 Ohm	-0.10 to 0.10 Ohm [EMU 5.9 mOhm]	-0.01		Same
	0.20 Ohm	0.10 to 0.30 Ohm [EMU 5.9 mOhm]	0.18		Same

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Issue date: 01-Jun-2021

Batch Number: 2398705

Calibration Data

FUNCTION TESTED	Nominal Value	CALIBRATION TOLERANCE	As Found	Out of Tol	As Left
	500.00 Ohm	499.65 to 500.35 Ohm [EMU 17 mOhm]	499.91		Same
5 kOhm Range: Rel Off	5.0000 kOhm	4.9973 to 5.0027 kOhm [EMU 170 mOhm]	5.0020		Same
50 kOhm Range	50.000 kOhm	49.973 to 50.027 kOhm [EMU 1.7 Ohm]	49.980		Same
500 kOhm Range	500.00 kOhm	499.60 to 500.40 kOhm [EMU 19 Ohm]	499.66		Same
5 MOhm Range	5.0000 MOhm	4.9921 to 5.0079 MOhm [EMU 0.7 kOhm]	4.9930		Same
30 MOhm Range	30.000 MOhm	29.546 to 30.454 MOhm [EMU 10 kOhm]	29.904		Same
500 MOhm Range	300.0 MOhm	275.8 to 324.2 MOhm [EMU 1 MOhm]	293.3		Same
AC mV: 50mV Range	5.000 mV @ 20Hz	4.865 to 5.135 mV [EMU 10 µV]	4.973		Same
	50.000 mV @ 65kHz	48.210 to 51.790 mV [EMU 72 µV]	49.580		Same
ACmV: 500mV Range	50.00 mV @ 100kHz	47.85 to 52.15 mV [EMU 72 µV]	49.32		Same
	250.00 mV @ 65 kHz	240.85 to 259.15 mV [EMU 45 µV]	248.39		Same
	500.00 mV @ 45Hz	498.25 to 501.75 mV [EMU 140 µV]	499.90		Same
ACmV: Hz	45.000 Hz @ 500mV	44.986 to 45.014 Hz [EMU 580 µHz]	45.000		Same
	950.00 kHz @ 600mV	949.90 to 950.10 kHz [EMU 5.8 Hz]	950.00		Same
VAC: 5V Range	0.1000 V @ 60 Hz	0.0952 to 0.1048 V [EMU 62 µV]	0.1023		Same
	0.5000 V @ 10 kHz	0.4945 to 0.5055 V [EMU 150 µV]	0.4965		Same
	3.0000 V @ 100 kHz	2.8160 to 3.1840 V [EMU 2.2 mV]	3.0363		Same
VAC, Hz% (Duty Cycle) 5 Vpp @50 kHz Sq.	15.00 %	4.90 to 25.10 %	23.16		Same
VAC: 50V Range	15.000 V @ 100 kHz	14.435 to 15.565 V [EMU 15 mV]	15.024		Same
VAC, Lo Pass 500V Range	50.00 V @ 60 Hz	48.60 to 51.40 V [EMU 13 mV]	50.00		Same
"Lo Pass" 500V Rng: 50V @ 1.6kHz	0.00 V	0.00 to 8.00 V	0.00		Same
VAC: 500V Range	500.00 V @ 10kHz	497.75 to 502.25 V [EMU 160 mV]	499.47		Same
VAC: 1000V Range	1000.0 V @ 10kHz	993.5 to 1006.5 V [EMU 320 mV]	999.1		Same
DCV: 5V Range	4.0000 V	3.9988 to 4.0012 V [EMU 89 µV]	4.0004		Same
DCV: 50V Range	-40.000 V	-40.012 to -39.988 V [EMU 1 mV]	-40.003		Same
DCV: 500V Range	400.00 V	399.86 to 400.14 V [EMU 10 mV]	400.05		Same
DCV: 1000V Range	600.0 V	599.6 to 600.4 V [EMU 59 mV]	600.1		Same
DCV: DC/AC	0.2000 V @ 0 Hz	0.1978 to 0.2022 V [EMU 58 µV]	0.2002		Same
	2.0000 V @ 5kHz	1.9640 to 2.0360 V [EMU 360 µV]	1.9994		Same
ACV Peak: 4Vpp Sq Wave:+1V Offset	2.000 V @ 2 kHz	1.863 to 2.137 V [EMU 680 µV]	1.996		Same
Capacitance	5.00 nF	4.90 to 5.10 nF [EMU 23 pF]	4.92		Same
Diode Test: 3.5kOhm Input	2.0000 V	2.0000 to 3.1000 V [EMU 63 µV]	2.8900		Same
Diode Test: 0Ohm Input	0.0000 V	Pass/Fail	PASS		Same
Lo Ohm Test: REL offset	0.200 Ohm	0.180 to 0.220 Ohm [EMU 1.2 mOhm]	0.194		Same
@ 50 Ohm Range	50.000 Ohm	49.905 to 50.095 Ohm [EMU 2.9 mOhm]	50.001		Same
µA AC: 500µA Range	500.00 µA @ 60 Hz	496.80 to 503.20 µA [EMU 0.65 µA]	499.56		Same
	500.00 µA @ 30 kHz	492.85 to 507.15 µA [EMU 5.6 µA]	498.08		Same
µA AC: 5000µA Range	5000.00 µA @ 30kHz	4928.50 to 5071.50 µA [EMU 24 µA]	4999.30		Same
µA DC: 500µA Range	500.00 µA	499.42 to 500.58 µA [EMU 0.1 µA]	500.01		Same
µA DC: 5000µA Range	5000.0 µA	4996.0 to 5004.0 µA [EMU 0.75 µA]	5000.3		Same
mA AC: 50mA Range	4.000 mA @ 20Hz	3.940 to 4.060 mA [EMU 5.6 µA]	3.979		Same
	30.000 mA @ 30 kHz	29.375 to 30.625 mA [EMU 120 µA]	29.922		Same
mA AC: 400mA Range	300.00 mA @ 30kHz	284.60 to 315.40 mA [EMU 1.4 mA]	300.41		Same
	400.00 mA @ 60Hz	397.55 to 402.45 mA [EMU 300 µA]	400.05		Same
mA DC: 50mA Range	0.100 mA	0.090 to 0.110 mA [EMU 0.58 µA]	0.098		Same
	50.000 mA	49.965 to 50.035 mA [EMU 7.5 µA]	50.001		Same
mA DC: 400mA Range	400.00 mA	399.38 to 400.62 mA [EMU 120 µA]	399.97		Same
AAC: 5A Range	5.0000 A @ 1kHz	4.9580 to 5.0420 A [EMU 7 mA]	4.9983		Same
AAC: 10A Range	5.000 A @ 1 kHz	4.955 to 5.045 A [EMU 7 mA]	4.998		Same
ADC: 5A Range	5.0000 A	4.9840 to 5.0160 A [EMU 3 mA]	5.0001		Same
ADC: 10A Range	10.000 A	9.968 to 10.032 A [EMU 5.5 mA]	10.001		Same
LoZ: 1 kVolt Range	120.0 V @ 60Hz	113.6 to 126.4 V [EMU 63 mV]	120.2		Same
Temperature: Type K	0.0 °C	-1.0 to 1.0 °C [EMU 0.17 °C]	1.0		Same
	100.0 °C	98.0 to 102.0 °C [EMU 0.17 °C]	101.5		Same

Test Number: 3019509 Asset Number: 267 Desc: Fluke / 289, Multimeter, Digital - Handheld

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ATS 501, 10/20

Issue date: 01-Jun-2021

Batch Number: 2398705

Calibration Data

FUNCTION TESTED	Nominal Value	CALIBRATION TOLERANCE	As Found	Out of Tol	As Left
	1000.0 °C	989.0 to 1011.0 °C [EMU 0.27 °C]	1001.7		Same
Audible Tone from Length of Leads	25.0 Ohm	PASS/FAIL	PASS		Same

End Of Report

Test Number: 3019509 Asset Number: 267 Desc: Fluke / 289, Multimeter, Digital - Handheld

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Applied Technical Services
1049 Triad Court
Marietta, GA 30062
Phone 770 423-1400 www.atslab.com

ATS 501, 10/20

Issue date: 01-Jun-2021

Batch Number: 2398705



Applied Technical Services Certificate of Calibration



Certificate #3019603



Customer:

Southwire Company - D.B.Cofer
D.B.Cofer Technology Center
111 Development Drive
Carrollton, GA 30119

Calibration Location:

Southwire Company - D.B.Cofer
D.B.Cofer Technology Center
111 Development Drive
Carrollton, GA 30119

Instrument Information:

Manufacturer: Fluke
Model Number: 789
Description: Process Meter
Asset Number: 679
Serial Number: 25200003
PO Number: 4503214624

Calibration Information/Results:

As Found Condition : In Tolerance
Action Taken / As Left: In Tolerance - No Adjustment
Temperature: 73° F
Humidity: 53% RH
Calibration Date: 01-Jun-2021
Calibration Due Date: 01-Jun-2022
Calibration Interval: 12 Months

Calib. Procedure: ATS-1040 Rev 2:Calibration of Handheld Digital Multimeters

This instrument has been calibrated using primary or secondary standards whose calibration is traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST) or applicable ASTM specification number for hardness testing equipment. Some measurements are traceable to natural, physical constants, consensus standards, or ratio type measurements.

The reported expanded measurement uncertainty is based on a standard uncertainty multiplied by a coverage factor of $k=2$, providing a confidence level of approximately 95%. This calibration certificate may contain data that is not covered by the Scope of Accreditation. The unaccredited test points, where applicable, are indicated by an asterisk (*), or confined to clearly marked sections. Functional tests are not accredited. The expanded measurement uncertainty is not considered when determining in-tolerance or out-of-tolerance conditions. Results are reviewed, if applicable, to establish where any measurement results exceeded the stated calibration tolerance and to communicate results by means of this certificate.

All calibrations are performed in accordance with the ATS Quality Manual QM1, Rev. 18, dated 10/16/20. Applied Technical Services, Inc.'s Quality System complies with the applicable requirements of ANSI/NCSL Z540-1, ISO 9001:2015, 10CFR50 Appendix B, 10CFR Part 21, and ISO/IEC 17025:2017. The reported data is valid only at the time of the test and related only to the item calibrated. Calibration due dates appearing on this certificate and calibration label are determined by the client and do not imply continued conformance to specifications. This certificate shall not be reproduced except in full, without written permission of Applied Technical Services, Inc.

Technical Remarks:

Calibrated By: *Taylor, Collin A*

Name

Calibration Tech

Title

Calibration Equipment Utilized

Standard I.D.	Mfg.	Model No.	Description	Serial	Cal. Date	Due Date
ATS-04852	Fluke	5522A/1G	Calibrator, Multi-Function	2034901	02/03/2021	02/03/2022
ATS-4124	Agilent Technologies	34401A	Multimeter, Digital - Benchtop	3146A21255	10/07/2020	10/07/2021

Calibration Data

FUNCTION TESTED	Nominal Value	CALIBRATION TOLERANCE	As Found	Out of Tol	As Left
AC Voltage Accuracy: 400mV Range	100.0 mV @60Hz	98.9 to 101.1 mV [EMU 62 μ V]	99.8		Same
	300.0 mV @60Hz	297.5 to 302.5 mV [EMU 77 μ V]	299.9		Same
4V Range	1.000 V @60Hz	0.991 to 1.009 V [EMU 610 μ V]	0.999		Same
	2.000 V @60Hz	1.984 to 2.016 V [EMU 680 μ V]	1.998		Same
	3.000 V @60Hz	2.977 to 3.023 V [EMU 770 μ V]	2.999		Same
40V Range	10.00 V @60Hz	9.91 to 10.09 V [EMU 6.1 mV]	9.99		Same
	30.00 V @60Hz	29.77 to 30.23 V [EMU 7.7 mV]	29.99		Same
400V Range	100.0 V @60Hz	99.1 to 100.9 V [EMU 61 mV]	99.9		Same
	300.0 V @60Hz	297.7 to 302.3 V [EMU 83 mV]	299.9		Same

Applied Technical Services

1049 Triad Court
Marietta, GA 30062

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ATS 501, 10/20

Issue date: 01-Jun-2021

Batch Number: 2398705

Calibration Data

FUNCTION TESTED	Nominal Value	CALIBRATION TOLERANCE	As Found	Out of Tol	As Left
1000V Range	100 V @60Hz	97 to 103 V [EMU 580 mV]	100		Same
	800 V @60Hz	792 to 808 V [EMU 630 mV]	801		Same
Frequency Accuracy: 199.99 Hz Range	100.00 Hz @ 5 V	99.99 to 100.01 Hz [EMU 5.8 mHz]	100.00		Same
1999.9 Hz Range	1000.0 Hz @ 5 V	999.9 to 1000.1 Hz [EMU 58 mHz]	1000.0		Same
19.999 kHz Range	10.000 kHz @ 5 V	9.999 to 10.001 kHz [EMU 0.58 Hz]	10.000		Same
DC Voltage Accuracy: 4 V Range	1.000 V	0.998 to 1.002 V [EMU 580 μ V]	1.000		Same
	3.000 V	2.996 to 3.004 V [EMU 580 μ V]	3.000		Same
40 V Range	10.00 V	9.98 to 10.02 V [EMU 5.8 mV]	10.00		Same
	30.00 V	29.96 to 30.04 V [EMU 5.8 mV]	30.00		Same
400 V Range	100.0 V	99.8 to 100.2 V [EMU 58 mV]	100.0		Same
	300.0 V	299.6 to 300.4 V [EMU 58 mV]	300.0		Same
1000 V Range	100 V	99 to 101 V [EMU 580 mV]	100		Same
	800 V	798 to 802 V [EMU 580 mV]	800		Same
400 mV Range	100.0 mV	99.7 to 100.3 mV [EMU 58 μ V]	100.1		Same
	300.0 mV	299.5 to 300.5 mV [EMU 58 μ V]	300.0		Same
Resistance Accuracy: 400 Ohm Range	120.0 Ohm	119.6 to 120.4 Ohm [EMU 58 mOhm]	120.0		Same
	300.0 Ohm	299.2 to 300.8 Ohm [EMU 59 mOhm]	300.0		Same
4 kOhm Range	1.200 kOhm	1.197 to 1.203 kOhm [EMU 580 mOhm]	1.200		Same
	3.000 kOhm	2.993 to 3.007 kOhm [EMU 590 mOhm]	3.000		Same
40 kOhm Range	12.00 kOhm	11.97 to 12.03 kOhm [EMU 5.8 Ohm]	12.00		Same
	30.00 kOhm	29.93 to 30.07 kOhm [EMU 5.9 Ohm]	29.99		Same
400 kOhm Range	120.0 kOhm	119.7 to 120.3 kOhm [EMU 58 Ohm]	120.0		Same
	200.0 kOhm	199.5 to 200.5 kOhm [EMU 58 Ohm]	200.0		Same
4 MOhm Range	1.200 MOhm	1.193 to 1.207 MOhm [EMU 0.59 kOhm]	1.200		Same
	3.000 MOhm	2.987 to 3.013 MOhm [EMU 0.61 kOhm]	2.999		Same
40 MOhm Range	12.00 MOhm	11.67 to 12.33 MOhm [EMU 8 kOhm]	12.00		Same
	30.00 MOhm	29.22 to 30.78 MOhm [EMU 12 kOhm]	30.00		Same
DC Current Accuracy: 30 mA Range	4.000 mA	3.996 to 4.004 mA [EMU 0.87 μ A]	4.000		Same
	12.000 mA	11.992 to 12.008 mA [EMU 1.6 μ A]	12.000		Same
	20.000 mA	19.988 to 20.012 mA [EMU 2.3 μ A]	19.999		Same
1 A Range	0.100 A	0.098 to 0.102 A [EMU 580 μ A]	0.100		Same
	0.400 A	0.398 to 0.402 A [EMU 590 μ A]	0.400		Same
AC Current Accuracy: 1 A Range	0.100 A @ 60 Hz	0.097 to 0.103 A [EMU 580 μ A]	0.100		Same
	0.400 A @ 60 Hz	0.394 to 0.406 A [EMU 650 μ A]	0.401		Same
Current Source: DC mA Test	4.000 mA	3.996 to 4.004 mA [EMU 0.59 μ A]	3.999		Same
	12.000 mA	11.992 to 12.008 mA [EMU 1.1 μ A]	11.999		Same
	20.000 mA	19.988 to 20.012 mA [EMU 1.3 μ A]	20.000		Same
Loop Power	>30 V	Pass / Fail	PASS		Same
250 Ohm Button	>24 V	Pass / Fail	PASS		Same
Diode Test	2.000 V	1.959 to 2.041 V [EMU 580 μ V]	1.999		Same
Continuity Test Beeper On	120 Ohm	Pass Fail	PASS		Same
Beeper Off	240 Ohm	Pass Fail	PASS		Same

End Of Report

Test Number: 3019603 Asset Number: 679 Desc: Fluke / 789, Process Meter

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ATS 501, 10/20

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Appendix B: Pictures



Figure B.1: Apparatus in Ceiling Configuration with Insulation

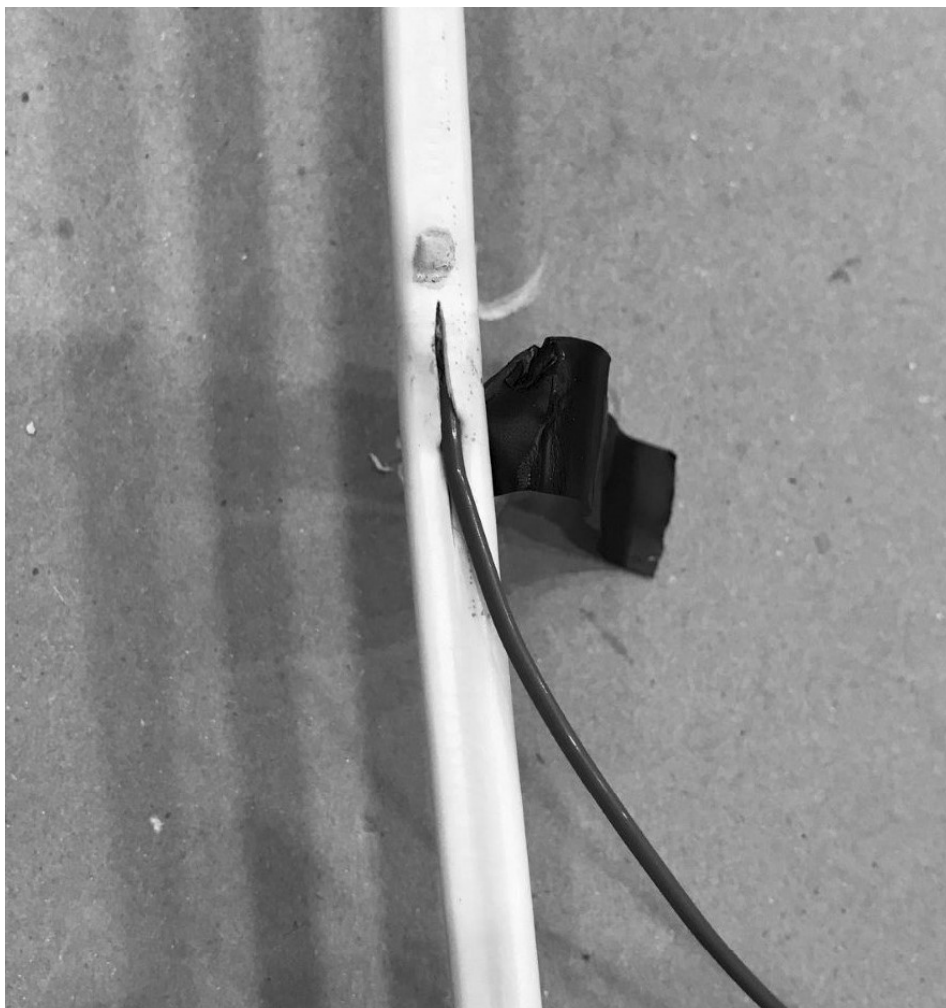


Figure B.2: Thermocouple Installed in NM-B Sample



Figure B.3: Thermocouple Installed in NM-B Sample

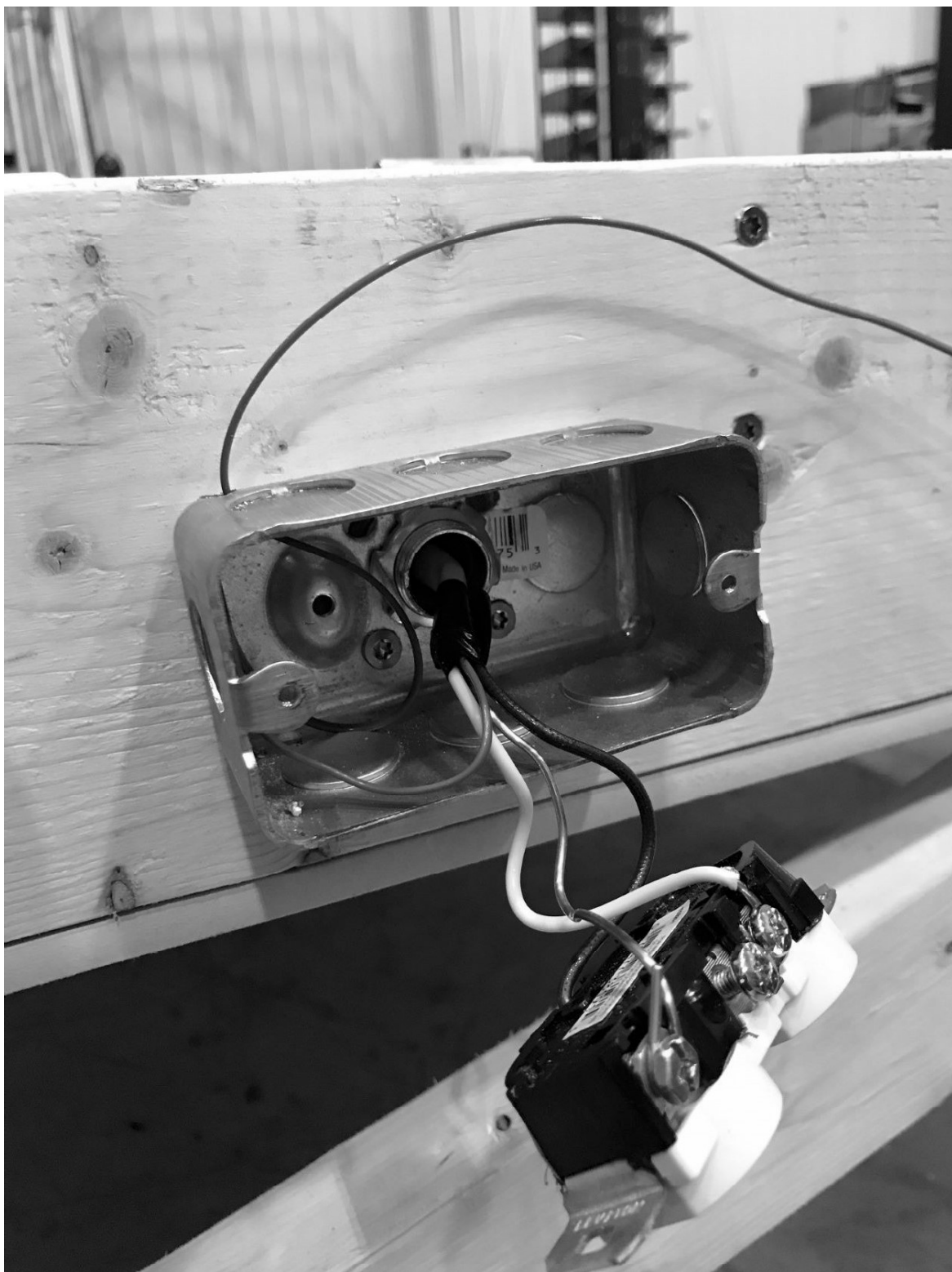


Figure B.4: Thermocouple Installed in Electrical Box



Figure B.5: Apparatus in Wall Configuration with Sheetrock Doors Closed



Figure B.6: Flexible Metal Conduit Installed in Apparatus



Figure B.7: Breaker Box



Figure B.8: Ampmeter, Data Logger, and Load Bank



Figure B.9: NM-B Sample Installed in Apparatus in Ceiling Configuration

**Public Comment No. 2112-NFPA 70-2021 [Section No. 240.6(C)]****(C) Local Restricted Access Adjustable-Trip Circuit Breakers.**

A circuit breaker(s) that has restricted access to the adjusting means shall be permitted to have an ampere rating(s) that is equal to the adjusted current setting (long-time pickup setting). Restricted access shall be achieved by one of the following methods:

- (1) Located behind removable and sealable covers over the adjusting means
- (2) Located behind bolted equipment enclosure doors
- (3) Located behind locked doors accessible only to qualified personnel
- (4) ~~Password-protected~~ Electronically locked , with ~~password-~~ required credentials accessible only to qualified personnel

Informational Note No. 1: See NFPA 730-2020, Guide for Premises Security, and ANSI/TIA-5017-2016, Telecommunications Physical Network Security Standard, for further information regarding physical security.

Statement of Problem and Substantiation for Public Comment

Passwords are increasingly regarded as inferior security mechanisms. The code should not require any one method of electronic access control over another. For instance one or more of a badge reader, fingerprint sensor, or facial recognition method could be combined to provide superior security to a simple password.

Related Item

- FR-7947-NFPA 70-2020

Submitter Information Verification

Submitter Full Name: Jason Potterf

Organization: Cisco

Affiliation: Entertainment Services and Technology Association (ESTA)

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 19 12:40:47 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8394-NFPA 70-2021](#)

Statement: The password protection indicated in 240.6(C)(4) is an integral feature of the circuit breaker. Other means of electronically locking are applicable to doors in (C)(3). An informational note is added to provide additional guidance regarding physical network.

**Public Comment No. 857-NFPA 70-2021 [Section No. 240.6(C)]****(C) Local Restricted Access Adjustable-Trip Circuit Breakers.**

A circuit breaker(s) that has restricted access to the adjusting means shall be permitted to have an ampere rating(s) that is equal to the adjusted current setting (long-time pickup setting). Restricted access shall be achieved by one of the following methods:

- (1) Located behind removable and sealable covers over the adjusting means
- (2) Located behind bolted equipment enclosure doors
- (3) Located behind locked doors accessible only to qualified personnel
- (4) Password protected, with password accessible only to qualified personnel

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_152.pdf	70_CN152

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 152 appeared in the First Draft Report on First Revision No. 7947.

The Correlating Committee requests that the Panel determine if "Qualified Electrical Testing Laboratory" or other terminology would be more appropriate than "Nationally Recognized Testing Laboratory" in consideration of the NEC Style Manual, Section 3.2.5.3, Consistent Application of Terms.

Related Item

- First Revision No. 7947

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 04 14:47:08 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected
Resolution: The restriction of the term "Nationally Recognized Testing Laboratory" in the NEC Style Manual is based on the use of "listed" providing sufficient information to the user. The term "listed" is not used in 240.6(D) and there is no requirement for equipment to be listed for cybersecurity. The use of the term "Nationally Recognized Testing Laboratory" is appropriate in this instance.

**Correlating Committee Note No. 152-NFPA 70-2021 [Section No. 240.6(C)]****Submitter Information Verification**

Committee: NEC-P10

Submittal Date: Tue May 04 18:15:36 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee requests that the Panel determine if "Qualified Electrical Testing Laboratory" or other terminology would be more appropriate than "Nationally Recognized Testing Laboratory" in consideration of the NEC Style Manual, Section 3.2.5.3, Consistent Application of Terms.

First Revision No. 7947-NFPA 70-2020 [Section No. 240.6(C)]

Ballot Results

✓ **This item has passed ballot**

12 Eligible Voters

0 Not Returned

12 Affirmative All

0 Affirmative with Comments

0 Negative with Comments

0 Abstention

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Johnston, Michael J.

Kendall, David H.

Kovacik, John R.

Manche, Alan

McDaniel, Roger D.

Porter, Christine T.

Williams, David A.



Public Comment No. 2113-NFPA 70-2021 [Sections 240.6(C), 240.6(D)]

Sections 240.6(C), 240.6(D)

(C) Local-Restricted Access Adjustable-Trip Circuit Breakers.

A circuit breaker(s) that has restricted access to the adjusting means shall be permitted to have an ampere rating(s) that is equal to the adjusted current setting (long-time pickup setting). Restricted access shall be achieved by one of the following methods:

- (1) Located behind removable and sealable covers over the adjusting means
- (2) Located behind bolted equipment enclosure doors
- (3) Located behind locked doors accessible only to qualified personnel
- (4) Password protected, with password accessible only to qualified personnel

(D) Remotely Accessible Adjustable-Trip Circuit Breakers.

A circuit breaker(s) that is remotely accessible and has password-protected access to the adjusting means shall be permitted to have an ampere rating(s) that is equal to the adjusted current setting (long-time pickup setting). Remote access shall be achieved by one of the following methods:

- (1) Connected directly through a local nonnetworked interface.
- (2) Connected through a networked interface complying with one of the following methods:
 - (3) The circuit breaker and associated software for adjusting the settings are identified as being evaluated for cybersecurity.
 - (4) A cybersecurity assessment of the network is completed. Documentation of the assessment and certification shall be made available to those authorized to inspect, operate, and maintain the system.

Informational Note No. 1: See ANSI/ISA-62443, *Cybersecurity Standards series* -UL 2900- *Cybersecurity Standard series* -or the NIST- *Framework for Improving Critical Infrastructure Cybersecurity* ,Version 1.1 for assessment requirements.

Informational Note No. 2: Examples of the commissioning certification used to demonstrate the system has been investigated for cybersecurity vulnerabilities could be one of the following:

- (1) The ISA Security Compliance Institute (ISCI) conformity assessment program
- (2) Certification of compliance by a nationally recognized test laboratory
- (3) Manufacturer certification for the specific type and brand of system provided

Statement of Problem and Substantiation for Public Comment

While I applaud the panel for recognizing the cybersecurity threat, the code requirements around cybersecurity evaluation as stated lead users of the code to the false conclusion that installations that meet these requirements will be secure. That is not what these requirements accomplish, and the code language should either be removed in its entirety (1st preference) or revised as indicated in my other public comment (2nd preference). Please note that similar code language was rejected by CMP 1 and CMP 12.

Standards such as UL 2900 only serve to establish that a secure system is possible using the listed components. It makes no further guarantees. Security is ultimately the responsibility and liability of the building operator that maintains the constituent systems.

Put in physical security terms, these standards require devices to have software lock features, much like residential building codes require that exterior access doors include a deadbolt lock. However, if the building occupant is annoyed by the lock and simply leaves the key in the door, security is lost. While this kind of poor physical security habit is abhorrent to any reasonable person, the cybersecurity equivalent of this practice occurs on a daily basis. Poorly formed passwords, or good passwords that are too difficult to remember that are then scribbled on notes under keyboards lead to frequent security breaches. Further, no software system is immune from bugs and can be susceptible to further exploits.

The reason that the assessments and certifications suggested in the proposed code language are of minor value to cybersecurity is due to the fact that these systems depend entirely on how they are configured in the actual building. A networking device can be 99% secure from the factory, and then have all security features defeated by a user configuration in a matter of minutes.

The proposed code attempts to address this by allowing an assessment to be conducted as an alternative to the device certificate. This is highly misleading as both are required to achieve true security. Allowing only one contributes to a false sense of security. Assessing an installed network requires a high level of sophistication and technical knowledge. These evaluations also require an enormous amount of trust with the assessing entity, and any code that forces disclosure of security measures to third parties is dangerous to overall security. Due to the obvious difficulties presented to the authorities having jurisdiction, the whole issue of on-site assessments should be omitted from the NEC and left to more appropriate NFPA documents such as NFPA 70B or other regulatory processes.

It's important to remember that even if security is perfect at the moment of final inspection in the context of the NEC, the most likely outcome is that any breach will occur after the authority having jurisdiction has signed off on building occupancy. This places the vast majority of the cybersecurity problem outside of the reach of the NEC, which is why my first preference is for wholesale removal of these requirements. There is some value in ensuring devices are able to be secured, but even insecure devices can be made secure by competent security professionals using additional security layers after installation. Thus, I feel any resources required by the NEC to solve the device security listing would be better allocated to solving the operational challenges, and as such belong in a more appropriate NFPA document such as NFPA 70B or a dedicated NFPA Cybersecurity document.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 2111-NFPA 70-2021 [Section No. 240.6(D)]	Alternative revision if this comment is not accepted.
Public Comment No. 2111-NFPA 70-2021 [Section No. 240.6(D)]	

Related Item

- FR-7947-NFPA 70-2020

Submitter Information Verification

Submitter Full Name: Jason Potterf

Organization: Cisco
Affiliation: Entertainment Services and Technology Association (ESTA)
Street Address:
City:
State:
Zip:
Submittal Date: Thu Aug 19 12:47:18 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Rejected

Action:

Resolution: Life-safety devices like circuit breakers are being increasingly provided with network communication capabilities allowing for settings that are remotely adjustable. Improper, inadvertent, or malicious adjustment of these settings may defeat the protection provided by these devices. Complying with one of the methods in 240.6(D) establishes a minimum baseline for cybersecurity protection, and extends the concept of restricted access to devices which are remotely adjustable. Each one provides a different method of evaluation, and the option presented in 240.6(D)(1) or 240.6(D)(2)(a) may be used for installations where the documentation of the assessment cannot be shared with the inspector. The section does not restrict the owner in taking additional steps to secure the facility, nor does it prevent future maintenance necessary to keep or improve the level of security.

**Public Comment No. 1312-NFPA 70-2021 [Section No. 240.6(D)]****(D) Remotely Accessible Adjustable-Trip Circuit Breakers.**

A circuit breaker(s) that ~~is- can be adjusted~~ remotely ~~accessible~~ and has password protected access to the adjusting means shall be permitted to have an ampere rating(s) that is equal to the adjusted current setting (long-time pickup setting). Remote access shall be achieved by one of the following methods:

- (1) Connected directly through a local nonnetworked interface.
- (2) Connected through a networked interface complying with one of the following methods:
 - (3) The circuit breaker and associated software for adjusting the settings are identified as being evaluated for cybersecurity.
 - (4) A cybersecurity assessment of the network is completed. Documentation of the assessment and certification shall be made available to those authorized to inspect, operate, and maintain the system.

Informational Note No. 1: See ANSI/ISA 62443, *Cybersecurity Standards series*, UL 2900 *Cybersecurity Standard series*, or the NIST *Framework for Improving Critical Infrastructure Cybersecurity*, Version 1.1 for assessment requirements.

Informational Note No. 2: Examples of the commissioning certification used to demonstrate the system has been investigated for cybersecurity vulnerabilities could be one of the following:

- (1) The ISA Security Compliance Institute (ISCI) conformity assessment program
- (2) Certification of compliance by a nationally recognized test laboratory
- (3) Manufacturer certification for the specific type and brand of system provided

Statement of Problem and Substantiation for Public Comment

The term "remotely accessible" is a contradiction of the definition of "accessible" in Article 100.

Related Item

- FR 7947

Submitter Information Verification

Submitter Full Name: Ryan Jackson

Organization: Ryan Jackson

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 11 17:49:23 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8391-NFPA 70-2021](#)

Statement: Editorial changes are made to improve clarity and useability. "Remotely accessible" is a defined term that is removed for consistency. "Password protection" is removed because this section applies to circuit breakers which permit changes to the adjusting means, whether they are provided with or without password protection.

Complying with one of the methods in 240.6(D)(2) establishes a minimum baseline for cybersecurity protection. The proposed text "acceptable levels" contains unenforceable terms and violates the NEC Style Manual 3.2.1. An informational note is added to stress the importance of vulnerability due to cyber or physical attacks.

**Public Comment No. 1486-NFPA 70-2021 [Section No. 240.6(D)]****(D) Remotely Accessible Adjustable-Trip Circuit Breakers.**

A circuit breaker(s) that is remotely accessible ~~and has password-protected access to~~ to permit changes to the adjusting means shall be permitted to have an ampere rating(s) that is equal to the adjusted current setting (long-time pickup setting). Remote access shall be achieved by one of the following methods:

- (1) Connected directly through a local nonnetworked interface.
- (2) Connected through a networked interface complying with one of the following methods:
 - (3) The circuit breaker and associated software for adjusting the settings are identified as being evaluated for cybersecurity.
 - (4) A cybersecurity assessment of the network is completed. Documentation of the assessment and certification shall be made available to those authorized to inspect, operate, and maintain the system.

Informational Note No. 1: See ANSI/ISA 62443, *Cybersecurity Standards series*, UL 2900 *Cybersecurity Standard series*, or the NIST *Framework for Improving Critical Infrastructure Cybersecurity*, Version 1.1 for assessment requirements.

Informational Note No. 2: Examples of the commissioning certification used to demonstrate the system has been investigated for cybersecurity vulnerabilities could be one of the following:

- (1) The ISA Security Compliance Institute (ISCI) conformity assessment program
- (2) Certification of compliance by a nationally recognized test laboratory
- (3) Manufacturer certification for the specific type and brand of system provided

Statement of Problem and Substantiation for Public Comment

With the current language, a remotely accessible circuit breaker that permits the changes to the set points that has no password protection would be permitted without cybersecurity requirements. This seems counterproductive. This change addresses this language deficiency.

Related Item

- FR 7947

Submitter Information Verification

Submitter Full Name: Thomas Domitrovich

Organization: Eaton Corporation

Street Address:

City:

State:

Zip:

Submittal Date: Sun Aug 15 11:58:36 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8391-NFPA 70-2021](#)

Statement: Editorial changes are made to improve clarity and useability. "Remotely accessible" is a defined term that is removed for consistency. "Password protection" is removed because this section applies to circuit breakers which permit changes to the adjusting means, whether they are provided with or without password protection.

Complying with one of the methods in 240.6(D)(2) establishes a minimum baseline for cybersecurity protection. The proposed text "acceptable levels" contains unenforceable terms and violates the NEC Style Manual 3.2.1. An informational note is added to stress the importance of vulnerability due to cyber or physical attacks.

**Public Comment No. 1712-NFPA 70-2021 [Section No. 240.6(D)]****(D) Remotely Accessible Adjustable-Trip Circuit Breakers.**

A circuit breaker(s) that is remotely accessible and has password protected access to the adjusting means shall be permitted to have an ampere rating(s) that is equal to the adjusted current setting (long-time pickup setting). Remote access shall be achieved by one of the following methods:

- (1) Connected directly through a local nonnetworked interface.
- (2) Connected through a networked interface complying with ~~one~~ both of the following methods:
 - (3) The circuit breaker and associated software and firmware for adjusting the settings are identified as being evaluated for cybersecurity.
 - (4) A cybersecurity assessment of the network is completed. Documentation of the assessment and certification shall be made available to those authorized to inspect, operate, and maintain the system.

Informational Note No. 1: See ANSI/ISA 62443, *Cybersecurity Standards series*, UL 2900 *Cybersecurity Standard series*, or the NIST *Framework for Improving Critical Infrastructure Cybersecurity*, Version 1.1 for assessment requirements.

Informational Note No. 2: Examples of the commissioning certification used to demonstrate the system has been investigated for cybersecurity vulnerabilities could be one of the following:

- (1) The ISA Security Compliance Institute (ISCI) conformity assessment program
- (2) Certification of compliance by a nationally recognized test laboratory
- (3) Manufacturer certification for the specific type and brand of system provided

Statement of Problem and Substantiation for Public Comment

As the Managing Director of ISA99, the ISA-62443 series of standards, cybersecurity of the hardware is required as these devices have, more often than not, been designed without cyber security considerations. I have experience of finding cybersecurity issues with circuit breaker hardware. In fact, the 2007 Aurora demonstration test at the Idaho National Laboratory exploited these issues to destroy a diesel generator. Consequently, I appeal to the code panel to address these safety concerns in the first revision to address these missing serious safety concerns as cybersecurity is needed for the hardware, software, firmware, and networks.

Related Item

- PI4026 and FR7947

Submitter Information Verification

Submitter Full Name: Joe Weiss

Organization: Applied Control Solutions

Street Address:

City:

State:

Zip:

Submittal Date: Tue Aug 17 13:47:07 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: Cybersecurity evaluation of the circuit breaker and associated software and firmware is one of the options covered by 240.6(D). Each option provides a different method of evaluation and establishes a minimum baseline for cybersecurity protection. Substantiation was not provided to require evaluation of circuit breakers, associated software and hardware, and evaluation of the network.



Public Comment No. 2111-NFPA 70-2021 [Section No. 240.6(D)]

(D) Remotely Accessible Adjustable-Trip Circuit Breakers.

A circuit breaker(s) that is remotely accessible and has password protected access to the adjusting means shall be permitted to have an ampere rating(s) that is equal to the adjusted current setting (long-time pickup setting). Remote access shall be achieved by one of the following methods:

- (1) Connected directly through a local nonnetworked interface.
- (2) ~~Connected through a networked interface complying with one of the following methods: The circuit breaker and associated software for adjusting the settings are identified as being evaluated for cybersecurity. A cybersecurity assessment of the network is completed. Documentation of the assessment and certification shall be made available to those authorized to inspect, operate, and maintain the system having features necessary to achieve acceptable levels of cybersecurity if properly configured and maintained.~~

Informational Note No. 1: See ANSI/ISA 62443, *Cybersecurity Standards series*, UL 2900 *Cybersecurity Standard series*, or the NIST *Framework for Improving Critical Infrastructure Cybersecurity*, Version 1.1 for assessment requirements.

Informational Note No. 2: Examples of the commissioning certification used to demonstrate the system has been investigated for cybersecurity vulnerabilities could be one of the following:

- (1) The ISA Security Compliance Institute (ISCI) conformity assessment program
- (2) Certification of compliance by a nationally recognized test laboratory
- (3) Manufacturer certification for the specific type and brand of system provided

Informational Note No. 3: Cybersecurity is a specialized field requiring constant, vigilant attention to security vulnerabilities. Installation of devices that can be secured is an important first step, but not sufficient to guarantee a secure system.

Statement of Problem and Substantiation for Public Comment

While I applaud the panel for recognizing the cybersecurity threat, the code requirements around cybersecurity evaluation as stated lead users of the code to the false conclusion that installations that meet these requirements will be secure. That is not what these requirements accomplish, and the code language should either be removed in its entirety (1st preference) or revised as indicated in this public comment (2nd preference). Please note that similar code language was rejected by CMP 1 and CMP 12.

Standards such as UL 2900 only serve to establish that a secure system is possible using the listed components. It makes no further guarantees. Security is ultimately the responsibility and liability of the building operator that maintains the constituent systems.

Put in physical security terms, these standards require devices to have software lock features, much like residential building codes require that exterior access doors include a deadbolt lock. However, if the building occupant is annoyed by the lock and simply leaves the key in the door, security is lost. While this kind of poor physical security habit is abhorrent to any reasonable person, the cybersecurity equivalent of this practice occurs on a daily basis. Poorly formed passwords, or good passwords that are too difficult to remember that are then scribbled on notes under keyboards lead to frequent security breaches. Further, no software system is immune from bugs and can be susceptible to further exploits.

The reason that the assessments and certifications suggested in the proposed code language are of minor value to cybersecurity is due to the fact that these systems depend entirely on how they are configured in the actual building. A networking device can be 99% secure from the factory, and then have all security features defeated by a user configuration in a matter of minutes.

The proposed code attempts to address this by allowing an assessment to be conducted as an alternative to the device certificate. This is highly misleading as both are required to achieve true security. Allowing only one contributes to a false sense of security. Assessing an installed network requires a high level of sophistication and technical knowledge. These evaluations also require an enormous amount of trust with the assessing entity, and any code that forces disclosure of security measures to third parties is dangerous to overall security. Due to the obvious difficulties presented to the authorities having jurisdiction, the whole issue of on-site assessments should be omitted from the NEC and left to more appropriate NFPA documents such as NFPA 70B or other regulatory processes.

It's important to remember that even if security is perfect at the moment of final inspection in the context of the NEC, the most likely outcome is that any breach will occur after the authority having jurisdiction has signed off on building occupancy. This places the vast majority of the cybersecurity problem outside of the reach of the NEC, which is why my first preference is for wholesale removal of these requirements. There is some value in ensuring devices are able to be secured, but even insecure devices can be made secure by competent security professionals using additional security layers after installation. Thus, I feel any resources required by the NEC to solve the device security listing would be better allocated to solving the operational challenges, and as such belong in a more appropriate NFPA document such as NFPA 70B or a dedicated NFPA Cybersecurity document.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 2113-NFPA 70-2021 [Sections 240.6(C), 240.6(D)]	Preferred modification to the code.
Public Comment No. 2113-NFPA 70-2021 [Sections 240.6(C), 240.6(D)]	
Related Item	
• FR-7947-NFPA 70-2020	

Submitter Information Verification

Submitter Full Name: Jason Potterf
Organization: Cisco
Affiliation: Entertainment Services and Technology Association (ESTA)
Street Address:
City:
State:
Zip:
Submission Date: Thu Aug 19 12:28:48 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Rejected but see related SR

Action:**Resolution:** [SR-8391-NFPA 70-2021](#)**Statement:** Editorial changes are made to improve clarity and useability. "Remotely accessible" is a defined term that is removed for consistency. "Password protection" is removed because this section applies to circuit breakers which permit changes to the adjusting means, whether they are provided with or without password protection.

Complying with one of the methods in 240.6(D)(2) establishes a minimum baseline for cybersecurity protection. The proposed text "acceptable levels" contains unenforceable terms and violates the NEC Style Manual 3.2.1. An informational note is added to stress the importance of vulnerability due to cyber or physical attacks.



Public Comment No. 352-NFPA 70-2021 [Section No. 240.6(D)]

(D)– Remotely Accessible Adjustable-Trip Circuit Breakers.

A circuit breaker(s) that is remotely accessible and has password-protected access to the adjusting means shall be permitted to have an ampere rating(s) that is equal to the adjusted current setting (long-time pickup setting). Remote access shall be achieved by one of the following methods:

- (1) Connected directly through a local nonnetworked interface.
- (2) Connected through a networked interface complying with one of the following methods:
 - (3) The circuit breaker and associated software for adjusting the settings are identified as being evaluated for cybersecurity.
 - (4) A cybersecurity assessment of the network is completed. Documentation of the assessment and certification shall be made available to those authorized to inspect, operate, and maintain the system.

Informational Note No. 1: See ANSI/ISA 62443, *Cybersecurity Standards series*, UL 2900, *Cybersecurity Standard series*, or the NIST *Framework for Improving Critical Infrastructure Cybersecurity*, Version 1.1 for assessment requirements.

Informational Note No. 2: Examples of the commissioning certification used to demonstrate the system has been investigated for cybersecurity vulnerabilities could be one of the following:

- (1) The ISA Security Compliance Institute (ISCI) conformity assessment program
- (2) Certification of compliance by a nationally recognized test laboratory
- (3) Manufacturer certification for the specific type and brand of system provided

Statement of Problem and Substantiation for Public Comment

I do not believe this rule is necessary, or will be helpful. Are there documented instances for substantiation, where a facility using circuit breakers that are adjustable over a network connection and are so connected are hacked, and in such a manner that if this rule were present and followed, they wouldn't have happened? The public inputs for this proposed change certainly don't mention any. Three issues:

1. Facilities that may use circuit breakers that are constantly online are the likes of industrial or power generation facilities, where there is sufficient caution taken to protect the facility from cyber attacks. Thus, again likely there is no substantiation of a need for this rule being added. Instead, this rule might substantiate a lower standard of care, since many like to argue things only need to meet the requirements of the NEC. Or it might needlessly confuse the industry.
2. As for this rule, it requires an assessment to have been done. Nothing will require that the assessment be redone, reviewed, or repeated. Nothing will require manufacturer continuing software support. Nothing will require facility operators to maintain up to date cyber security practices, disable adjustable equipment that becomes unable to be updated for security, or notify customers of a discovered and irreparable vulnerability. Thus, the assessment will be useless, as the concern this language tries to address is detrimental events due to the circuit breakers having been changed -- more likely an event that will have occurred some time after installation completion, and usually not immediately upon commissioning.
3. NASDAQ, the CIA, USOPM, Solarwinds, and many others have been hacked. We should stop buying what the cyber security consultants are trying to sell us: a false promise that we can have reliable non-defeatable cyber security if we do assessments. We should instead start thinking in terms of: since things inevitably will be compromised, do we want to accept the risk of things like breakers being remotely adjustable or not? NFPA is limited in its ability to act as the US military and protect our critical infrastructure from the acts of a foreign Nation State. It should be focusing its attention elsewhere and appealing to the proper authorities and industry stakeholders to take proper action to protect their assets.

Related Item

- First Revision No. 7947-NFPA 70-2020 [Section No. 240.6(C)]

Submitter Information Verification

Submitter Full Name: Josh Weaver

Organization: Josh Weaver

Street Address:

City:

State:

Zip:

Submittal Date: Sat Jul 24 20:52:11 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Rejected

Action:

Resolution: Life-safety devices like circuit breakers are being increasingly provided with network communication capabilities allowing for settings that are remotely adjustable. Improper, inadvertent, or malicious adjustment of these settings may defeat the protection provided by these devices. Complying with one of the methods in 240.6(D) establishes a minimum baseline for cybersecurity protection, and extends the concept of restricted access to devices which are remotely adjustable. Each one provides a different method of evaluation, and the option presented in 240.6(D)(1) or 240.6(D)(2)(a) may be used for installations where the documentation of the assessment cannot be shared with the inspector. The section does not restrict the owner in taking additional steps to secure the facility, nor does it prevent future maintenance necessary to keep or improve the level of security.

**Public Comment No. 881-NFPA 70-2021 [Section No. 240.6(D)]****(D)– Remotely Accessible Adjustable-Trip Circuit Breakers.**

A circuit breaker(s) that is remotely accessible and has password-protected access to the adjusting means shall be permitted to have an ampere rating(s) that is equal to the adjusted current setting (long-time pickup setting). Remote access shall be achieved by one of the following methods:

- (1) Connected directly through a local nonnetworked interface.
- (2) Connected through a networked interface complying with one of the following methods:
 - (3) The circuit breaker and associated software for adjusting the settings are identified as being evaluated for cybersecurity.
 - (4) A cybersecurity assessment of the network is completed. Documentation of the assessment and certification shall be made available to those authorized to inspect, operate, and maintain the system.

Informational Note No. 1: See ANSI/ISA 62443, Cybersecurity Standards series ; UL 2900 Cybersecurity Standard series ; or the NIST Framework for Improving Critical Infrastructure Cybersecurity , Version 1.1 for assessment requirements.

Informational Note No. 2: Examples of the commissioning certification used to demonstrate the system has been investigated for cybersecurity vulnerabilities could be one of the following:

- (1) The ISA Security Compliance Institute (ISCI) conformity assessment program
- (2) Certification of compliance by a nationally recognized test laboratory
- (3) Manufacturer certification for the specific type and brand of system provided

Statement of Problem and Substantiation for Public Comment

Most companies today have cybersecurity reviews for such equipment installations and I can't imagine that we'd submit such a review for review by an electrical inspector, nor can I expect that an electrical inspector would be trained or qualified to review such a cybersecurity review. While I understand the possibilities, here, even a proper cybersecurity review is just a snapshot in time. The software out there is continually changing and what is deemed secure today may not be adequate in just a few short years (or less). As such, the date the cybersecurity review or approval was made, in my mind, would be subject to continued scrutiny. While this is something that folks may want to consider, I don't know how such a requirement could be enforceable given the current enforcement structure and training of the individuals that would be reviewing such a submission.

Related Item

- First Revision No. 7947

Submitter Information Verification

Submitter Full Name: Richard Holub

Organization: The DuPont Company, Inc.

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 04 15:33:54 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: Life-safety devices like circuit breakers are being increasingly provided with network communication capabilities allowing for settings that are remotely adjustable. Improper, inadvertent, or malicious adjustment of these settings may defeat the protection provided by these devices. Complying with one of the methods in 240.6(D) establishes a minimum baseline for cybersecurity protection, and extends the concept of restricted access to devices which are remotely adjustable. Each one provides a different method of evaluation, and the option presented in 240.6(D)(1) or 240.6(D)(2)(a) may be used for installations where the documentation of the assessment cannot be shared with the inspector. The section does not restrict the owner in taking additional steps to secure the facility, nor does it prevent future maintenance necessary to keep or improve the level of security.

**Public Comment No. 1230-NFPA 70-2021 [Section No. 240.7]****240.7 Listing Requirements.**

~~Branch-circuit overcurrent~~ Overcurrent protective devices protecting branch, feeder and service conductors shall be listed.

Statement of Problem and Substantiation for Public Comment

Although the term "branch-circuit overcurrent protective device" is defined under Article 100 as a device "capable of providing protection for service, feeder and branch circuits", the verbiage in 240.7 may not be clear that the listing requirement applies to overcurrent protection devices protecting the feeder and service conductors as well. The revised verbiage in this public comment provides further clarity to the user and resolves any ambiguity.

Related Item

- First Revision No. 7805

Submitter Information Verification

Submitter Full Name: Danish Zia

Organization: UL LLC

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 11 09:42:40 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8295-NFPA 70-2021](#)

Statement: Listing requirements for branch circuit overcurrent protective devices and relays and circuit breakers and ground-fault circuit interrupter devices are relocated to 240.7 for usability.

Ground-fault protection of equipment was included in this list as it was originally included in the first draft but inadvertently not included in the document as indicated in the first draft ballot report.

**Public Comment No. 1730-NFPA 70-2021 [Section No. 240.7]****240.7 Listing Requirements.**

Branch-circuit overcurrent protective devices shall be listed.

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_153.pdf	10 CN153

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 153 appeared in the First Draft Report on First Revision No. 7805

The Correlating Committee directs that FR 7805 be referred to Code-Making Panel 1 for action, regarding adding UL 1066 to Informative Annex A.

Related Item

- First Revision No. 7805

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 17 15:27:14 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected
Resolution: The annex is outside of the purview of CMP-10. The panel supports the addition of UL 1066 to this annex, however, there is no action for CMP-10 to take.

**Correlating Committee Note No. 153-NFPA 70-2021 [New Section after 240.6]****Submitter Information Verification**

Committee: NEC-P10

Submittal Date: Tue May 04 18:22:56 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs that FR 7805 be referred to Code-Making Panel 1 for action, regarding adding UL 1066 to Informative Annex A.

First Revision No. 7805-NFPA 70-2020 [New Section after 240.6]

Ballot Results

✓ **This item has passed ballot**

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

Affirmative All

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

Affirmative with Comment

Hickman, Palmer L.

The following committee statement should be corrected by adding "Informative" before "Annex": The Correlating Committee directs that FR 7805 be referred to Code-Making Panel 1 for action, regarding adding UL 1066 to Annex A.

**Public Comment No. 1872-NFPA 70-2021 [Section No. 240.11]****240.11- Selective Coordination.**

If one or more feeder overcurrent protective devices are required to be selectively coordinated with a service overcurrent protective device by other requirements in this Code, all feeder overcurrent protective devices supplied directly by the service overcurrent protective device shall be selectively coordinated with the service overcurrent protective device.

Statement of Problem and Substantiation for Public Comment

No technical substantiation was provided to support requiring every feeder to be selectively coordinated when there is an emergency power source. Note that 700.32 does not require coordination of the feeders unrelated to the emergency system.

Related Item

- FR7807

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz

Organization: NECA

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 18 13:15:53 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: Adequate substantiation was not provided to reduce the current level of reliability afforded by 240.11.

**Public Comment No. 546-NFPA 70-2021 [Section No. 240.11]****240.11- Selective Coordination.**

If one or more feeder overcurrent protective devices are required to be selectively coordinated with a service overcurrent protective device by other requirements in this Code, all feeder overcurrent protective devices supplied directly by the service overcurrent protective device shall be selectively coordinated with the service overcurrent protective device.

Statement of Problem and Substantiation for Public Comment

No substantiation was given in the public input that created this, and therefore there has been little justification presented for the added burden of consulting and studies that will be required to meet this proposed new rule. No record exists from the public input to document an example of a case where an incident (or even near miss incident occurred) due to lack of an entire system being selectively coordinated. Neither did the public input even describe how such a thing would be such a hazard that in all cases we should have a general rule in article 240 applying to all selectively coordinated systems. The public input has an example related to the service-supplied feeder breakers specifically supplying the emergency loads, but it seems this proposed rule would go further than to protect against that by requiring selective coordination of all feeder breakers on the load side of the service disconnect, not just the ones on that service disconnect that are related to the emergency system.

The only example that the public input gives is related to article 700, emergency systems. No other examples were given. I believe that the relevant committee that deals with emergency systems has the judgment and authority to require what may be needed. I also think that the other committees that deal with other articles requiring selective coordination have the judgment and authority to require what may be needed.

In some cases with emergency systems, the equipment needing the emergency power only needs to operate during the emergency. One example might be stairway pressurization. The committees that wrote article 700 thought a 10 second start and switch over time (not less than that) was sufficient. So in the unlikely event of both a major fault and a coordination issue results in the main service disconnect opening, the generator will start within its required time, and power the emergency loads. The emergency system would operate as intended. Thus, there seems to be no substantiation that there is a significant and similar enough hazard in all applications requiring selective coordination, so as to require a general rule. Also, there seems to be no substantiation to suggest that there is a problem, that it is not one that the relevant committees having jurisdiction over the differing special installations can't solve.

In summary I am opposed to this proposed rule for the following reasons:

- Jurisdiction. The special articles in chapter 5-7 should govern the level of additional safety needed for these situations and not article 240, which deals with general overcurrent rules. Scattering requirements that apply only to special circumstances throughout the code defeats the reason for the special articles, and makes code compliance as well as updating the code sections for a special condition, occupancy, or equipment more difficult.
- Substantiation. No incidents were presented and, in some cases, a reasonable hypothetical of an incident may not be able to be presented.

Related Item

- First Revision No. 7807-NFPA 70-2020 [New Section after 240.10]

Submitter Information Verification

Submitter Full Name: Josh Weaver

Organization: Josh Weaver

Street Address:

City:

State:

Zip:

Submission Date: Thu Jul 29 20:17:42 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: Adequate substantiation was not provided to reduce the current level of reliability afforded by 240.11.

**Public Comment No. 866-NFPA 70-2021 [Section No. 240.13]****240.13** Ground-Fault Protection of Equipment.**(A)** General.

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

This section shall not apply to the disconnecting means for the following:

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

(B) Reconditioned Equipment.

Equipment providing ground-fault protection of equipment shall not be permitted to be reconditioned.

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_240.pdf	70_CN240

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 240 appeared in the First Draft Report on First Revision No. 7829.

The Correlating Committee directs the panel to reconsider the text "shall not be permitted to be" for clarification and ease of use. Simplifying the text to state that the equipment "shall not be reconditioned" is suggested as an alternative.

Related Item

- First Revision No. 7829

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC

Organization: NEC Correlating Committee

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 04 15:14:06 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8704-NFPA 70-2021](#)

Statement: Reconditioning provisions are relocated to 240.2 to comply with Correlating Committee recommendations in PC 896. A reference to 110.21 (A)(2) is added to include a reference to additional marking requirements.

Response to PC-1929: The new text is modified to comply with the style manual.

**Correlating Committee Note No. 240-NFPA 70-2021 [Section No. 240.13]****Submitter Information Verification**

Committee: NEC-P10

Submittal Date: Thu May 06 09:18:31 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs the panel to reconsider the text "shall not be permitted to be" for clarification and ease of use. Simplifying the text to state that the equipment "shall not be reconditioned" is suggested as an alternative.

First Revision No. 7829-NFPA 70-2020 [Section No. 240.13]

Ballot Results

✓ **This item has passed ballot**

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

Affirmative All

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



Public Comment No. 327-NFPA 70-2021 [Section No. 240.13(A)]

(A) General.

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

This section shall not apply to the disconnecting means for the following:

- (1) Continuous industrial processes where a nonorderly shutdown will introduce additional or increased hazards
- (2) Installations where ground-fault protection is provided by other requirements for services or feeders
- (3) Fire pumps
- (4) For fused disconnects, where the available fault current is 10,000 amperes or greater, if the fuses have a clearing time of 0.07 seconds or less at the lower of the calculated minimum available arcing current or 38% of the available fault current, or if the disconnect switch complies with Section 240.67(B)(1), 240.67(B)(3), or 240.67(B)(4), and is set to operate at the lower of the calculated minimum arcing current or 38% of the available fault current.
- (5) For circuit breakers, where the available fault current is 10,000 amperes or greater, if the circuit breaker complies with Section 240.87(B)(2), 240.87(B)(4), 240.87(B)(5), or 240.87(B)(6), and is set to operate at the lower of the calculated minimum arcing current or 38% of the available fault current.

Statement of Problem and Substantiation for Public Comment

A sincere "Thank You" goes to Code Making Panels 2 and 10 for discovering the flaw with Public Inputs 693, 694, 695, and 696. The Panels stated: "Substantiation was not provided to support the equivalency of alternate technologies. As an example, it is possible that alternate systems could be set such that they might provide arc energy reduction, but not operate during a lower level ground fault where traditional GFPE will provide protection." To rectify this flaw, this Public Comment has added the requirement that the methods to reduce clearing time operate at the lower of the calculated minimum arcing current or 38% of the available fault current. While an arcing fault from phase to ground is almost certainly going to escalate into a three phase arcing fault, it is possible that the arcing fault could remain as a phase to ground arcing fault. When this occurs, it has been shown, in numerous IEEE papers, that the minimum phase to ground arcing fault, on a 480/277 volt, solidly grounded system, must be at least 38% of the available fault current in order to sustain the arc. With this requirement added in, it is assured that the method to reduce clearing time will function to clear the circuit.

In addition to this requirement, and to add even more conservatism, this Public Comment has added a minimum available fault current of 10,000 amperes to the proposed requirement. Based on a 32mm spacing, 480 volts, and HCB configuration, IEEE 1584-2018 calculates the minimum arcing current to be 6.09 kA for an available (bolted) fault current of 10,000 amperes. The minimum arcing current of 6.09 KA is 5 times the maximum 1200 ampere setting and 2 times the 3000 ampere value used with the one second maximum delay. (NEC 230.95(A) allows for a maximum setting of 1200 amperes and a maximum time delay of 1 second at 3000 amperes or greater.) The 6.09 KA current for 60 cycles produces an expected equipment damage level of 36,540 KW-Cycles (6.09KA X 100 arcing volts X 60 cycles). In contrast, this Public Comment would provide a worst case, expected equipment damage level of only 4,263 KW-Cycles. Yes, that is correct, the proposed exception would allow less than 12% of the damage level allowed by the existing 230.95(A) requirements.

The following paragraphs provide a detailed comparison of expected equipment damage levels allowed by 230.95(A), proposed exceptions for fusible switches (240.67), and proposed exceptions for circuit breakers (240.87).

Expected Equipment Damage from 230.95(A)

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 10kA, the IEEE 1584-2018 arcing current is 7.07kA with a minimum arcing current of 6.09kA. Using the maximum 230.95(A) opening time of 60 cycles, the expected equipment damage is 36,540 kW-cycles.

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 25kA, the IEEE 1584-2018 arcing current is 17.64kA with a minimum arcing current of 15.21kA. Using the maximum 230.95(A) opening time of 60 cycles, the expected equipment damage is 91,260 kW-cycles.

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 50kA, the IEEE 1584-2018 arcing current is 30.14kA with a minimum arcing current of 25.98kA. Using the maximum 230.95(A) opening time of 60 cycles, the expected equipment damage is 155,880 kW-cycles.

Expected Equipment Damage from Proposal for Fusible Switches (240.67)

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 10kA, the IEEE 1584-2018 arcing current is 7.07kA with a minimum arcing current of 6.09kA. Assuming an opening time of 4 cycles for 240.67(B), the expected equipment damage is 2,436 kW-cycles. Assuming an opening time of 7 cycles for 240.67(B)(1) or (B)(3), the expected equipment damage is 4,263 kW-cycles. Assuming an opening time of 1/2 cycle for 240.67(B)(4), the expected equipment damage is 305 kW-cycles. Worst case damage (4,263 kW-cycles) is less than 12% of the damage allowed by 230.95(A) (36,540 kW-cycles).

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 25kA, the IEEE 1584-2018 arcing current is 17.64kA with a minimum arcing current of 15.21kA. Assuming an opening time of 4 cycles for 240.67(B), the expected equipment damage is 6,084 kW-cycles. Assuming an opening time of 7 cycles for 240.67(B)(1) or (B)(3), the expected equipment damage is 10,647 kW-cycles. Assuming an opening time of 1/2 cycle for 240.67(B)(4), the expected equipment damage is 761 kW-cycles. Worst case damage (10,647 kW-cycles) is less than 12% of the damage allowed by 230.95(A) (91,260 kW-cycles).

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 50kA, the IEEE 1584-2018 arcing current is 30.14kA with a minimum arcing current of 25.98kA. Assuming an opening time of 4 cycles for 240.67(B), the expected equipment damage is 10,392 kW-cycles. Assuming an opening time of 7 cycles for 240.67(B)(1) or (B)(3), the expected equipment damage is 18,186 kW-cycles. Assuming an opening time of 1/2 cycle for 240.67(B)(4), the expected equipment damage is 1,299 kW-cycles. Worst case damage (18,186 kW-cycles) is less than 12% of the damage allowed by 230.95(A) (155,880 kW-cycles).

Expected Equipment Damage from Proposal for Circuit Breakers (240.87)

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 10kA, the IEEE 1584-2018 arcing current is 7.07kA with a minimum arcing current of 6.09kA. Assuming an opening time of 4 cycles for 240.87(B)(1), (B)(2), or (B)(4), the expected equipment damage is 2,436 kW-cycles. Assuming an opening time of 3 cycles for 240.87(B)(5) or (B)(6), the expected equipment damage is 1,827 kW-cycles. Worst case damage (2,426 KW-Cycles) is less than 7% of the damage allowed by 230.95(A) (36,540 kW-cycles).

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 25kA, the IEEE 1584-2018 arcing current is 17.64kA with a minimum arcing current of 15.21kA. Assuming an opening time of 4 cycles for 240.87(B)(1), (B)(2), or (B)(4), the expected equipment damage is 6,084 kW-cycles. Assuming an opening time of 3 cycles for 240.87(B)(5) or (B)(6), the expected equipment damage is 4,563 kW-cycles. Worst case damage (6,084 kW-Cycles) is less than 7% of the damage allowed by 230.95(A) (91,260 kW-cycles).

For a 32mm spacing, 480 volts, and HCB configuration, and an available fault current of 50kA, the IEEE 1584-2018 arcing current is 30.14kA with a minimum arcing current of 25.98kA. Assuming an opening time of 4 cycles for 240.87(B)(1), (B)(2), or (B)(4), the expected equipment damage is 10,392 kW-cycles. Assuming an opening time of 3 cycles for 240.87(B)(5) or (B)(6), the expected equipment damage is 7,794 kW-cycles. Worst case damage (10,392 KW-Cycles) is less than 7% of the damage allowed by 230.95(A) (155,880 kW-cycles).

Other Change from Public Input Stage

The other change that is made from the original Public Input is that the text lists the methods that can be used rather than the methods that cannot be used.

Background from Public Input Stage

A requirement (230.95) for ground fault protection of equipment (GFPE) was added to the 1971 NEC® because 480/277 volt, solidly grounded wye services, protected by 1000 ampere and larger overcurrent protective devices, were burning down due to arcing faults. 208/120 volt services and those services protected by smaller overcurrent protective devices were not burning down, so they weren't included in the new requirement. Over many Code cycles, GFPE requirements were also added for branch circuits (210.13), feeders (215.10), and equipment (240.13). In all cases, the intent was to limit damage to the switchboard, switchgear, panelboard or equipment, not the downstream conductors or busway.

The electrical industry has evolved considerably since those early GFPE requirements were introduced. IEEE 1584 now predicts the magnitude of the arcing current along with the incident energy to which a worker could be exposed while working on energized equipment. It has become clearly evident that the level of protection necessary to protect an employee is orders of magnitude greater than that required to protect equipment.

Energy reducing maintenance switches (240.67(B)(2) and 240.87(B)(3)) are excluded because energy-reducing maintenance switches are typically turned off when a worker is not working on energized equipment, whereas ground fault protection is constantly protecting the equipment, whether or not a worker is working on the energized equipment.

The Approved Equivalent Means (240.67(B)(5) and 240.87(B)(7)) are excluded because the opening times for these methods are unknown at this time.

Key Benefit

One very key benefit of this Public Comment is that when these alternate methods are utilized, it provides the consulting engineer with significantly more design options to meet the selective coordination requirements of 700.32, 701.32, and 708.54. This becomes especially important now, because it appears that GFPE will be required at 800 amperes and above, rather than 1000 amperes and above, making selective coordination even more challenging for the consulting engineer.

Conclusion

This Public Comment takes advantage of the arc-energy reduction requirements found in 240.67 and 240.87. It provides an exception for GFPE requirements whenever specific 240.67 and 240.87 methods to reduce clearing time are utilized. The methods to reduce clearing time will limit the arcing fault damage to the equipment to a level that is considerably less than currently allowed by the requirements found in 230.95(A).

Related Item

- PI 696

Submitter Information Verification

Submitter Full Name: Vincent Saporita
Organization: Saporita Consulting
Affiliation: Saporita Consulting
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jul 21 21:42:13 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected
Resolution: Arc flash protection is primarily for the protection of personnel and, secondarily, for the protection of equipment. Arc flash protection may or may not open under a ground fault condition depending on the protection scheme design. Ground fault protection is not considered in incident energy calculations as provided in NFPA70E and IEEE1584. Additional protection means to reduce arc flash hazards are considered in 240.67 or 240.87 and should not impact the use of ground fault protection identified in 230.95.

**Public Comment No. 547-NFPA 70-2021 [Section No. 240.14]****~~240.14- Ground-Fault-Circuit-Interrupter Protection.~~****~~(A)- Listing.~~**~~Ground-fault-circuit-interrupters shall be listed.~~**~~(B)- Reconditioned Equipment.~~**~~Ground-fault-circuit-interrupters shall not be permitted to be reconditioned.~~**Statement of Problem and Substantiation for Public Comment**

The statement on this proposed change says it is intended to establish the fact that these requirements are important regardless of whether or not they are installed in a branch circuit (Article 210) or in a feeder (Article 215) or other location. The language seems to be written as well, such that it would cover GFCI receptacles, not just breakers that happen to have GFCI protection. However, it doesn't seem apparent that a class A GFCI device falls under the definition of overcurrent that appears in article 100. Putting a requirement for a piece of equipment in a code article that's not intended to regulate it could cause issues over time. While many won't just forget the rules for GFCI's, the no one has memorized the NEC, and as a general rule putting things where they might not be expected could result in rules not being followed. Additionally, needlessly scattering things in different places makes updating the NEC when needed more difficult.

We do have proposed section 210.15 for 2023 that will prohibit reconditioning of ground fault circuit interrupters. We also have section 240.7 and section 240.88A1 for 2023, which would for all practical purposes require that any GFCI breakers be both listed and not reconditioned. If it is thought that it is needed to put this prohibition somewhere else so it could be a general rule, it would seem that locating it in article 110 might be more appropriate.

Related Item

• First Revision No. 7831-NFPA 70-2020 [Detail] [Add new section after 240.13]

• First Revision No. 7831-NFPA 70-2020 [Detail]

• [Add new section after 240.13]

• Public Input No. 3416-NFPA 70-2020 [Section No. 210.15]

Submitter Information Verification

Submitter Full Name: Josh Weaver

Organization: Josh Weaver

Street Address:

City:

State:

Zip:

Submittal Date: Thu Jul 29 20:27:04 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The requirements of Article 240 cover ground fault circuit-interrupter protection requirements which are defined in article 100 and are applicable throughout chapters 1-4 of the NEC.

**Public Comment No. 880-NFPA 70-2021 [Section No. 240.14]**

240.14 Ground-Fault Circuit-Interrupter Protection.

(A) Listing.

Ground-fault circuit interrupters shall be listed.

(B) Reconditioned Equipment.

Ground-fault circuit interrupters shall not be permitted to be reconditioned.

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_241_Detail.pdf	70_CN241

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 241 appeared in the First Draft Report on First Revision No. 7831.

The Correlating Committee directs the panel to reconsider the text "shall not be permitted to be" for clarification and ease of use. Simplifying the text to state that the equipment "shall not be reconditioned" is suggested as an alternative.

Related Item

- First Revision No. 7831

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC

Organization: NEC Correlating Committee

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 04 15:32:13 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8631-NFPA 70-2021](#)

Statement: This section is deleted as the listing requirements are relocated to 240.7 (see SR-8295) and the reconditioned equipment requirement are relocated to 240.2 (see SR-8704).



Correlating Committee Note No. 241-NFPA 70-2021 [Detail]

Submitter Information Verification

Committee: NEC-P10

Submittal Date: Thu May 06 09:19:56 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs the panel to reconsider the text "shall not be permitted to be" for clarification and ease of use. Simplifying the text to state that the equipment "shall not be reconditioned" is suggested as an alternative.

[First Revision No. 7831-NFPA 70-2020 \[Detail\]](#)

Ballot Results

✓ **This item has passed ballot**

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

Affirmative All

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



Public Comment No. 1635-NFPA 70-2021 [Sections 240.21(B), 240.21(C)]

Sections 240.21(B), 240.21(C)

(B) Feeder Taps.

Conductors shall be permitted to be tapped, without overcurrent protection at the tap, to a feeder as specified in 240.21(B)(1) through (B)(5). The tap shall be permitted at any point on the load side of the feeder overcurrent protective device. Section 240.4(B) shall not be permitted for tap conductors.

(1) Taps Not over 3 m (10 ft) Long.

If the length of the tap conductors does not exceed 3 m (10 ft) and the tap conductors comply with all of the following:

- (1) The ampacity of the tap conductors is as follows:
 - (2) Not less than the combined calculated loads on the circuits supplied by the tap conductors
 - (3) Not less than the rating of the equipment containing an overcurrent device(s) supplied by the tap conductors or not less than the rating of the overcurrent protective device at the termination of the tap conductors

Exception to b: Where listed equipment, such as a surge-protective device(s) [SPD(s)], is provided with specific instructions on minimum conductor sizing, the ampacity of the tap conductors supplying that equipment shall be permitted to be determined based on the manufacturer's instructions.

- (4) The tap conductors do not extend beyond the switchboard, switchgear, panelboard, disconnecting means, or control devices they supply.
- (5) Except at the point of connection to the feeder, the tap conductors are enclosed in a raceway wiring method, which extends from the tap to the enclosure of an enclosed switchboard, switchgear, a panelboard, or control devices, or to the back of an open switchboard.
- (6) For field installations, if the tap conductors leave the enclosure or vault in which the tap is made, the ampacity of the tap conductors is not less than one-tenth of the rating of the overcurrent device protecting the feeder conductors.

Informational Note: See 408.36 for overcurrent protection requirements for panelboards.

(2) Taps Not over 7.5 m (25 ft) Long.

Where the length of the tap conductors does not exceed 7.5 m (25 ft) and the tap conductors comply with all the following:

- (1) The ampacity of the tap conductors is not less than one-third of the rating of the overcurrent device protecting the feeder conductors.
- (2) The tap conductors terminate in a single circuit breaker or a single set of fuses that limit the load to the ampacity of the tap conductors. This device shall be permitted to supply any number of additional overcurrent devices on its load side.
- (3) The tap conductors are protected from physical damage by being enclosed in ~~an approved raceway or by other approved means~~ a wiring method.
- (3) Taps Supplying a Transformer [Primary Plus Secondary Not over 7.5 m (25 ft) Long].

Where the tap conductors supply a transformer and comply with all the following conditions:

- (1) The conductors supplying the primary of a transformer have an ampacity at least one-third the rating of the overcurrent device protecting the feeder conductors.
- (2) The conductors supplied by the secondary of the transformer shall have an ampacity that is not less than the value of the primary-to-secondary voltage ratio multiplied by one-third of the rating of the overcurrent device protecting the feeder conductors.
- (3) The total length of one primary plus one secondary conductor, excluding any portion of the primary conductor that is protected at its ampacity, is not over 7.5 m (25 ft).
- (4) The primary and secondary conductors are protected from physical damage by being enclosed in ~~an approved raceway or by other approved means~~ a wiring method.
- (5) The secondary conductors terminate in a single circuit breaker or set of fuses that limit the load current to not more than the conductor ampacity that is permitted by 310.14.

(4) Taps over 7.5 m (25 ft) Long.

Where the feeder is in a high bay manufacturing building over 11 m (35 ft) high at walls and the installation complies with all the following conditions:

- (1) Conditions of maintenance and supervision ensure that only qualified persons service the systems.
- (2) The tap conductors are not over 7.5 m (25 ft) long horizontally and not over 30 m (100 ft) total length.
- (3) The ampacity of the tap conductors is not less than one-third the rating of the overcurrent device protecting the feeder conductors.
- (4) The tap conductors terminate at a single circuit breaker or a single set of fuses that limit the load to the ampacity of the tap conductors. This single overcurrent device shall be permitted to supply any number of additional overcurrent devices on its load side.
- (5) The tap conductors are protected from physical damage by being enclosed in ~~an approved raceway or by other approved means~~ a wiring method.
- (6) The tap conductors are continuous from end-to-end and contain no splices.
- (7) The tap conductors are sized 6 AWG copper or 4 AWG aluminum or larger.
- (8) The tap conductors do not penetrate walls, floors, or ceilings.
- (9) The tap is made no less than 9 m (30 ft) from the floor.

(5) Outside Taps of Unlimited Length.

Where the conductors are located outside of a building or structure, except at the point of load termination, and comply with all of the following conditions:

- (1) The tap conductors are protected from physical damage in an approved manner.
- (2) The tap conductors terminate at a single circuit breaker or a single set of fuses that limits the load to the ampacity of the tap conductors. This single overcurrent device shall be permitted to supply any number of additional overcurrent devices on its load side.
- (3) The overcurrent device for the tap conductors is an integral part of a disconnecting means or shall be located immediately adjacent thereto.
- (4) The disconnecting means for the tap conductors is installed at a readily accessible location complying with one of the following:
 - (5) Outside of a building or structure
 - (6) Inside, nearest the point of entrance of the tap conductors
 - (7) Where installed in accordance with 230.6, nearest the point of entrance of the tap conductors

(C) Transformer Secondary Conductors.

A set of conductors feeding a single load, or each set of conductors feeding separate loads, shall be permitted to be connected to a transformer secondary, without overcurrent protection at the secondary, as specified in 240.21(C)(1) through (C)(6). Section 240.4(B) shall not be permitted for transformer secondary conductors.

Informational Note: See 450.3 for overcurrent protection requirements for transformers.

(1) Protection by Primary Overcurrent Device.

Conductors supplied by the secondary side of a single-phase transformer having a 2-wire (single-voltage) secondary, or a three-phase, delta-delta connected transformer having a 3-wire (single-voltage) secondary, shall be permitted to be protected by overcurrent protection provided on the primary (supply) side of the transformer, provided this protection is in accordance with 450.3 and does not exceed the value determined by multiplying the secondary conductor ampacity by the secondary-to-primary transformer voltage ratio.

Single-phase (other than 2-wire) and multiphase (other than delta-delta, 3-wire) transformer secondary conductors are not considered to be protected by the primary overcurrent protective device.

(2) Transformer Secondary Conductors Not over 3 m (10 ft) Long.

If the length of secondary conductor does not exceed 3 m (10 ft) and complies with all of the following:

- (1) The ampacity of the secondary conductors is as follows:
 - (2) Not less than the combined calculated loads on the circuits supplied by the secondary conductors
 - (3) Not less than the rating of the equipment containing an overcurrent device(s) supplied by the secondary conductors or not less than the rating of the overcurrent protective device at the termination of the secondary conductors
Exception: Where listed equipment, such as a surge protective device(s) [SPD(s)], is provided with specific instructions on minimum conductor sizing, the ampacity of the tap conductors supplying that equipment shall be permitted to be determined based on the manufacturer's instructions.

- (4) The secondary conductors do not extend beyond the switchboard, switchgear, panelboard, disconnecting means, or control devices they supply.
- (5) The secondary conductors are enclosed in a raceway wiring method, which shall extend from the transformer to the enclosure of an enclosed switchboard, switchgear, a panelboard, or control devices or to the back of an open switchboard.
- (6) For field installations where the secondary conductors leave the enclosure or vault in which the supply connection is made, the secondary conductors shall have an ampacity that is not less than the value of the primary-to-secondary voltage ratio multiplied by one-tenth of the rating of the overcurrent device protecting the primary of the transformer.

Informational Note: See 408.36 for overcurrent protection requirements for panelboards.

(3) Industrial Installation Secondary Conductors Not over 7.5 m (25 ft) Long.

For the supply of switchgear or switchboards in industrial installations only, where the length of the secondary conductors does not exceed 7.5 m (25 ft) and complies with all of the following:

- (1) Conditions of maintenance and supervision ensure that only qualified persons service the systems.
- (2) The ampacity of the secondary conductors is not less than the secondary current rating of the transformer, and the sum of the ratings of the overcurrent devices does not exceed the ampacity of the secondary conductors.
- (3) All overcurrent devices are grouped.
- (4) The secondary conductors are protected from physical damage by being enclosed in an approved raceway or by other approved means a wiring method.

(4) Outside Secondary Conductors.

Where the conductors are located outside of a building or structure, except at the point of load termination, and comply with all of the following conditions:

- (1) The conductors are protected from physical damage in an approved manner.
- (2) The conductors terminate at a single circuit breaker or a single set of fuses that limit the load to the ampacity of the conductors. This single overcurrent device shall be permitted to supply any number of additional overcurrent devices on its load side.
- (3) The overcurrent device for the conductors is an integral part of a disconnecting means or shall be located immediately adjacent thereto.
- (4) The disconnecting means for the conductors is installed at a readily accessible location complying with one of the following:
 - (5) Outside of a building or structure
 - (6) Inside, nearest the point of entrance of the conductors
 - (7) Where installed in accordance with 230.6, nearest the point of entrance of the conductors

(5) Secondary Conductors from a Feeder Tapped Transformer.

Transformer secondary conductors installed in accordance with 240.21(B)(3) shall be permitted to have overcurrent protection as specified in that section.

(6) Secondary Conductors Not over 7.5 m (25 ft) Long.

Where the length of secondary conductor does not exceed 7.5 m (25 ft) and complies with all of the following:

- (1) The secondary conductors shall have an ampacity that is not less than the value of the primary-to-secondary voltage ratio multiplied by one-third of the rating of the overcurrent device protecting the primary of the transformer.
- (2) The secondary conductors terminate in a single circuit breaker or set of fuses that limit the load current to not more than the conductor ampacity that is permitted by 310.14.
- (3) The secondary conductors are protected from physical damage by being enclosed in an approved raceway or by other approved means.

Statement of Problem and Substantiation for Public Comment

Flexible metal conduit is permitted, but MC cable is not. They have the same mechanical properties. A wireway is permitted, but an auxiliary is not. They are literally the same piece of equipment. The same trough is often listed as BOTH a wireway and a gutter. The difference is simply how they are installed. The committee says that a raceway is needed for protection but will allow ENT and reject mineral insulated cable!! That is indefensible.

Related Item

- PI 2257

Submitter Information Verification

Submitter Full Name: Ryan Jackson

Organization: Ryan Jackson

Street Address:

City:

State:

Zip:

Submittal Date: Mon Aug 16 18:36:20 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: Not all wiring methods provide adequate protection for circuit conductors.

**Public Comment No. 860-NFPA 70-2021 [Section No. 240.24(A)]****(A) Accessibility.**

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

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

Exception: The use of a tool shall be permitted to access overcurrent devices located within listed industrial control panels, within enclosures designed for hazardous (classified) locations or enclosures to protect against environmental conditions. An enclosure within the scope of this exception, and all overcurrent device(s) within such enclosures as judged with the enclosure open, shall comply with the accessibility provisions of 240.24(A).

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_154.pdf	70_CN154

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 154 appeared in the First Draft Report on First Revision No. 7811.

The Correlating Committee directs that FR 7811 be referred to Code-Making Panel 14 for information. First Revision No. 7811-NFPA 70-2020 [Section No. 240.24(8)]

Related Item

- First Revision No. 7811

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 04 14:54:07 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected
Resolution: The public comment is not directing the panel to take any action.



Correlating Committee Note No. 154-NFPA 70-2021 [Section No. 240.24(A)]

Submitter Information Verification

Committee: NEC-P10

Submittal Date: Tue May 04 18:27:31 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs that FR 7811 be referred to Code-Making Panel 14 for information.

First Revision No. 7811-NFPA 70-2020 [Section No. 240.24(A)]

Ballot Results

✓ **This item has passed ballot**

12 Eligible Voters

0 Not Returned

12 Affirmative All

0 Affirmative with Comments

0 Negative with Comments

0 Abstention

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Johnston, Michael J.

Kendall, David H.

Kovacik, John R.

Manche, Alan

McDaniel, Roger D.

Porter, Christine T.

Williams, David A.

**Public Comment No. 1014-NFPA 70-2021 [Section No. 240.24(E)]**

(E) Not Located in Bathrooms.

Overcurrent devices, other than supplementary overcurrent protection located within the equipment it protects , shall not be located in bathrooms, showering facilities, or locker rooms with showering facilities.

Statement of Problem and Substantiation for Public Comment

Remote supplementary overcurrent devices can pose a similar hazard.

Related Item

- P11033

Submitter Information Verification

Submitter Full Name: David Shapiro

Organization: Safety First Electrical

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 05 18:51:03 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: No technical substantiation was provided to suggest that supplementary overcurrent protection located outside of the equipment it protects can pose a hazard.

**Public Comment No. 1873-NFPA 70-2021 [Section No. 240.24(E)]**

(E) Not Located in Bathrooms.

~~Overcurrent devices, In dwelling units, dormitory units, and guest suites, overcurrent devices, other than supplementary overcurrent protection, shall not be located in bathrooms, showering facilities, or locker rooms with showering facilities .~~

Statement of Problem and Substantiation for Public Comment

The prohibition against installing overcurrent devices in bathrooms was expanded to all bathrooms with no technical substantiation. As an example panelboards can be safely installed in large restrooms found in many occupancies such as airports, big box retail, malls, etc.

Related Item

- FR 7813

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz

Organization: [Not Specified]

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 18 13:17:23 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: Overcurrent protective devices are prohibited in showering facilities, or locker rooms with showering facilities as they represent similar hazards to residential bathrooms. The hazard is the same in a non-residential bathroom as in a residential bathroom.

**Public Comment No. 862-NFPA 70-2021 [Section No. 240.24(F)]**

(F) Not Located over Steps.

Overcurrent devices shall not be located over steps of a stairway.

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_155.pdf	70_CN155

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 155 appeared in the First Draft Report on First Revision No. 7813.

The Correlating Committee requests that FR 7813 be reconsidered to include the proper terminology for "overcurrent protective devices".

Related Item

- First Revision No. 7813

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 04 15:04:08 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: [SR-8313-NFPA 70-2021](#)
Statement: The text is revised to include proper terminology in 240.24,

**Correlating Committee Note No. 155-NFPA 70-2021 [Section No. 240.24(E)]****Submitter Information Verification**

Committee: NEC-P10

Submittal Date: Tue May 04 18:34:41 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee requests that FR 7813 be reconsidered to include the proper terminology for "overcurrent protective devices".

First Revision No. 7813-NFPA 70-2020 [Section No. 240.24(E)]

Ballot Results

✓ **This item has passed ballot**

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

Affirmative All

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

**Public Comment No. 1929-NFPA 70-2021 [Section No. 240.62]****240.62** Reconditioned Equipment.

Low-voltage fuseholders and low-voltage nonrenewable fuses shall not be permitted to be reconditioned.

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
CN_244.pdf	70_CN244

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 244 appeared in the First Draft Report.

The Correlating Committee directs the panel to reconsider the text "shall not be permitted to be" for clarification and ease of use. Simplifying the text to state that the equipment "shall not be reconditioned" is suggested as an alternative.

Related Item

- Correlating Note No. 244

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 18 16:47:56 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: [SR-8704-NFPA 70-2021](#)
Statement: Reconditioning provisions are relocated to 240.2 to comply with Correlating Committee recommendations in PC 896. A reference to 110.21 (A)(2) is added to include a reference to additional marking requirements.

Response to PC-1929: The new text is modified to comply with the style manual.

**Correlating Committee Note No. 244-NFPA 70-2021 [Section No. 240.62]****Submitter Information Verification**

Committee: NEC-AAC

Submittal Date: Thu May 06 09:25:20 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs the panel to reconsider the text "shall not be permitted to be" for clarification and ease of use. Simplifying the text to state that the equipment "shall not be reconditioned" is suggested as an alternative.

Ballot Results

✓ **This item has passed ballot**

12 Eligible Voters

0 Not Returned

12 Affirmative All

0 Affirmative with Comments

0 Negative with Comments

0 Abstention

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Johnston, Michael J.

Kendall, David H.

Kovacik, John R.

Manche, Alan

McDaniel, Roger D.

Porter, Christine T.

Williams, David A.



Public Comment No. 1876-NFPA 70-2021 [Section No. 240.67]

240.67 Arc Energy Reduction.

Where fuses rated ~~1000 amperes~~ 1200 amperes or higher are installed, 240.67(A), and (B) ~~and (C)~~ shall apply. This requirement shall become effective January 1, 2020.

(A) Documentation.

Documentation shall be available to those authorized to design, install, operate, or inspect the installation as to the location of the fuses.

Documentation shall also be provided to demonstrate that the method chosen to reduce clearing time is set to operate at a value below the available arcing current.

(B) Method to Reduce Clearing Time.

A fuse shall have a clearing time of 0.07 seconds or less at the available arcing current, or one of the following means shall be provided and shall be set to operate at less than the available arcing current:

- (1) Differential relaying
- (2) Energy-reducing maintenance switching with local status indicator
- (3) Energy-reducing active arc-flash mitigation system
- (4) Current-limiting, electronically actuated fuses
- (5) An approved equivalent means

Informational Note No. 1: An energy-reducing maintenance switch allows a worker to set a disconnect switch to reduce the clearing time while the worker is working within an arc-flash boundary as defined in *NFPA 70E-2024 2018*, *Standard for Electrical Safety in the Workplace*, and then to set the disconnect switch back to a normal setting after the potentially hazardous work is complete.

Informational Note No. 2: An energy-reducing active arc-flash mitigation system helps in reducing arcing duration in the electrical distribution system. No change in the disconnect switch or the settings of other devices is required during maintenance when a worker is working within an arc-flash boundary as defined in *NFPA 70E-2024 2018*, *Standard for Electrical Safety in the Workplace*.

Informational Note No. 3: IEEE 1584-2018, *IEEE Guide for Performing Arc Flash Hazard Calculations*, is one of the available methods that provides guidance in determining arcing current.

(C) Performance Testing.

The arc energy reduction protection system shall be performance tested by primary current injection testing or another approved method when first installed on site. This testing shall be conducted by a qualified person(s) in accordance with the manufacturer's instructions.

A written record of this testing shall be made and shall be available to the authority having jurisdiction.

Informational Note: Some energy reduction protection systems cannot be tested using a test process of primary current injection due to either the protection method being damaged such as with the use of fuse technology or because current is not the primary method of arc detection.

Statement of Problem and Substantiation for Public Comment

No technical substantiation was provided to reduce the threshold for the requirement for Arc Energy Reduction methods where fuses are installed from 1200 amps to 1000 amps.

Related Item

- FR 7834

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz

Organization: NECA

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 18 13:19:59 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8323-NFPA 70-2021

Statement: No technical substantiation was provided to reduce the threshold for the requirement for Arc Energy Reduction methods where fuses are installed from 1200 amps to 1000 amps.

The hazards posed by arc flashes are known. The panel is open to reconsidering the threshold for arc flash protection during the next code cycle based on scientific data in accordance with the NFPA Regs.

**Public Comment No. 148-NFPA 70-2021 [Section No. 240.67(B)]****(B) Method to Reduce Clearing Time.**

A fuse shall have a clearing time of 0.07 seconds or less at the available arcing current, or one of the following means shall be provided and shall be set to operate at less than the available arcing current:

- (1) Differential relaying
- (2) Energy-reducing maintenance switching with local status indicator
- (3) Energy-reducing active arc-flash mitigation system
- (4) Current-limiting, electronically actuated fuses
- (5) An approved equivalent means

Informational Note No. 1: An energy-reducing maintenance switch allows a worker to set a disconnect switch to reduce the clearing time while the worker is working within an arc-flash boundary as defined in *NFPA 70E-2021, Standard for Electrical Safety in the Workplace*, and then to set the disconnect switch back to a normal setting after the potentially hazardous work is complete.

Informational Note No. 2: An energy-reducing active arc-flash mitigation system helps in reducing arcing duration in the electrical distribution system. No change in the disconnect switch or the settings of other devices is required during maintenance when a worker is working within an arc-flash boundary as defined in *NFPA 70E-2021, Standard for Electrical Safety in the Workplace*.

Informational Note No. 3: IEEE 1584-2018, *IEEE Guide for Performing Arc Flash Hazard Calculations*, provides guidance in determining arcing current.

Exception: Coordination of arc energy reduction technologies may extend to downstream overcurrent protective devices, as far as required by 240.67, providing that they operate below the available arcing current of the downstream devices. Downstream devices protected by upstream arc energy reduction technologies shall be considered compliant with 240.67.

Additional Proposed Changes

File Name	Description	Approved
NEC_AERM.pdf	240.67 graphical substantiation	

Statement of Problem and Substantiation for Public Comment

If protection against arc faults at an overcurrent protection device (OCPD) that is rated $\geq 1000A$ is provided through an arc energy reduction means (AERM) located at an upstream device, an additional, redundant AERM at the OCPD in question is not needed because the requirement is satisfied by the upstream device. To accomplish this, an exception is added to allow arc energy reduction to be provided by an upstream device if the upstream device is capable of providing protection of the downstream device and is setup for that purpose. An example is provided to illustrate how this proposal would impact installations. Referring to Figure 1 (Attachment to PC) and making the following assumptions: 1. I_{aerm1} is the pick-up current setting of AERM1 2. I_{arc_1} is the arc flash current value at the line terminals of FDS2 as calculated in the arc flash study 3. I_{arc_2} is the arc flash current value at the line terminals of the load as calculated in the arc flash study 4. $I_{aerm1} < I_{arc_1}$ 5. The OCPD in FDS1 is rated $\geq 1000A$ 6. The OCPD in FDS2 is rated $\geq 1000A$ The following cases would arise: Case 1: $I_{aerm1} \geq I_{arc_2}$ results in a system that is non-compliant, FDS2 would need its own AERM installed and set to operate at $< I_{arc_2}$. Case 2: $I_{aerm1} < I_{arc_2}$ results in a system that is compliant, FDS2 does not need an AERM because that section of the installation is covered by AERM1, from upstream. This logic follows as OCPDs are added farther downstream from FDS1. For example, if a third disconnect switch is added, as illustrated in Figure 2 (Attachment to PC), the associated OCPD is rated at $\geq 1000A$ and AERM3 is installed and set to $I_{aerm3} < I_{arc_3}$. If Case 2 applies to FSD 1 and FSD 2, the following additional cases arise: Case 3: $I_{aerm1} \geq I_{arc_3}$ is Compliant, because FSD3 has its own AERM installed Case 4: $I_{aerm1} < I_{arc_3}$ is Compliant, AERM3 is not needed because that section of the installation is covered by AERM1, upstream, AERM3 would be redundant, but permitted The submitter believes that PI 3972-NFPA 70-2020 has value and the changes proposed are helpful to reduce complexity and redundancy, while not reducing safety. Installations are not required to use all technologies that are listed in this section, only a minimum of one. If a designer, installer, or owner chooses to use a technology that can provide protection to downstream devices, they should not be required to provide redundant protection because other technologies lack this ability. Furthermore, when technologies are employed that cannot provide downstream protection, arc-flash reduction installed at each level from the source towards the load provides only a single level of protection and no redundancy. Allowing this change does not remove a level of protection required, it only allows for the variable of efficiency of the technology chosen to be considered. Finally, the system design must be proven based on the documentation requirement of this section and the installation must be tested based on the performance testing requirement of this section before it is approved.

Related Item

- Public Comment 148

Submitter Information Verification

Submitter Full Name: Eric Maier
Organization: Boltswitch, Inc.
Street Address:
City:
State:
Zip:
Submission Date: Wed Jul 07 14:55:45 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected
Resolution: The suggested language does not recognize that some technologies required as part of this section of the NEC do not respond to downstream events as they are outside of the zone of protection. The suggested exception would remove a layer of arc reduction technology without justification. In addition, the proposed language implies that the available arcing current is related to the downstream device which is incorrect. Arcing current is not driven by a downstream device. It is driven by characteristics of the equipment including bus distances, voltage levels, and bus configurations to name a few parameters important to determining arcing current when IEEE 1584-2018 is used. This new language would cause confusion in the application of this section.

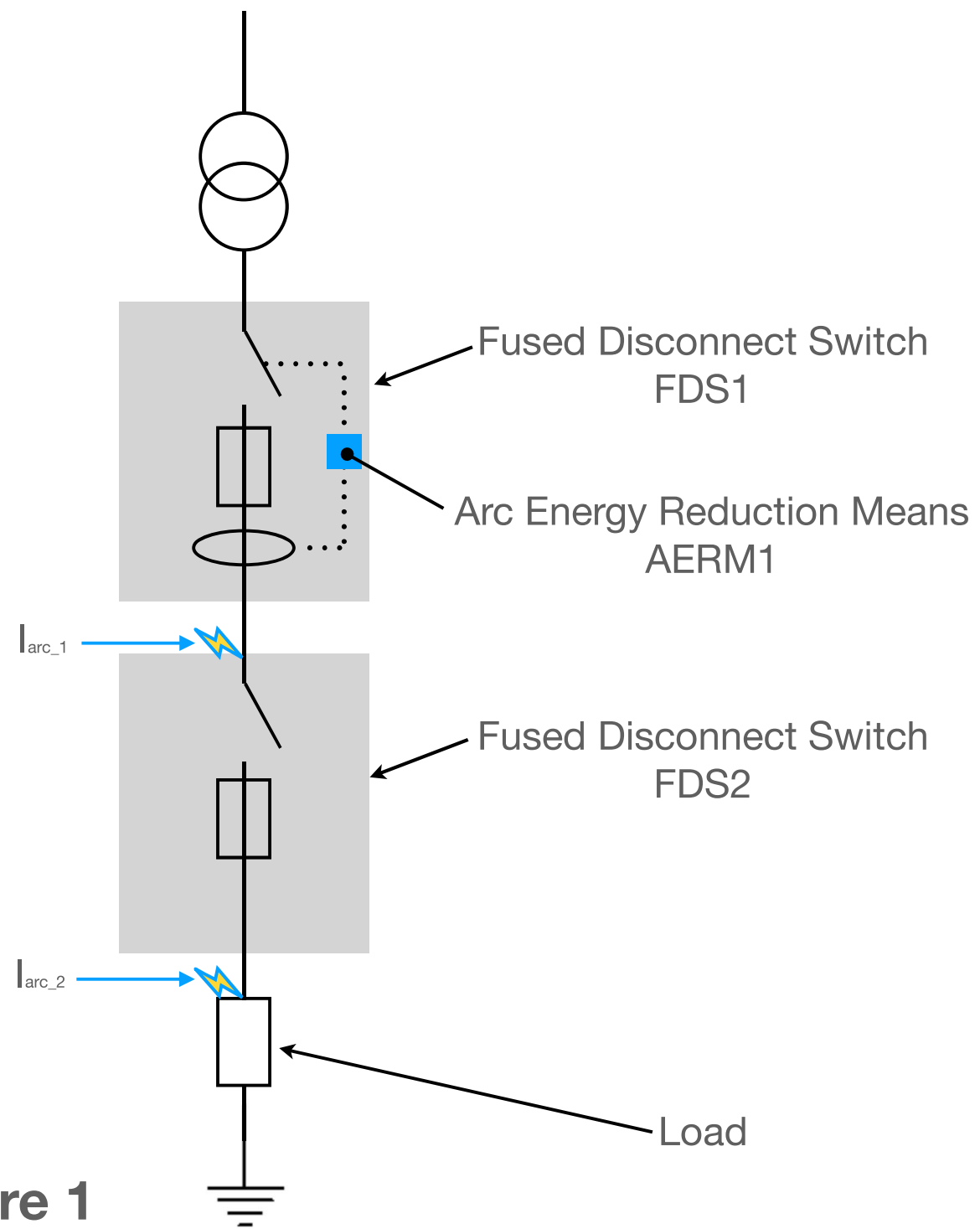


Figure 1

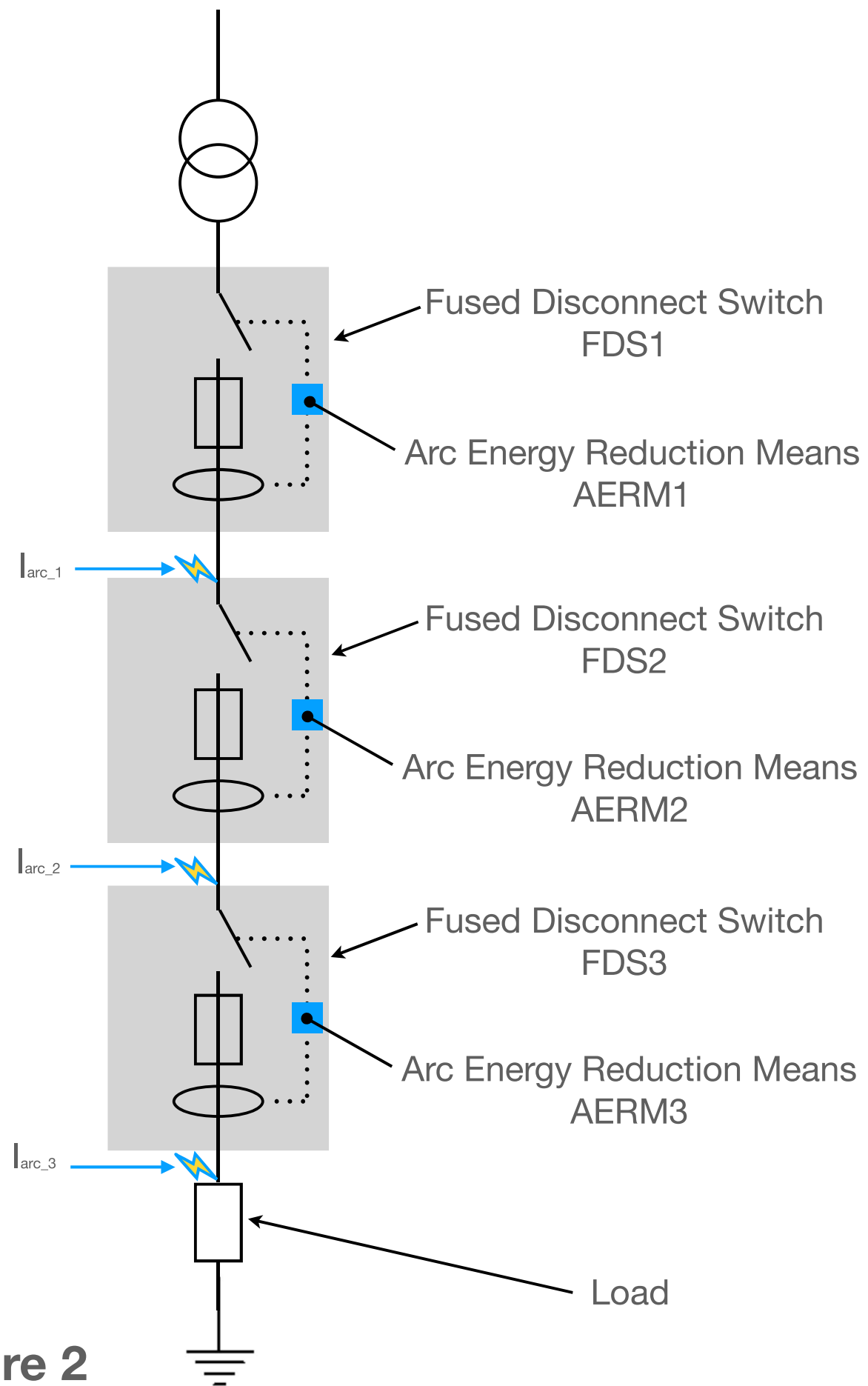


Figure 2

**Public Comment No. 310-NFPA 70-2021 [Section No. 240.83(E)]****(E) Voltage Marking.**

Circuit breakers shall be marked with a voltage rating not less than the nominal system voltage that is indicative of their capability to interrupt fault currents between phases or phase to ground.

(F) Individual Pole-Interrupting Capability. [page587image31800](#) [page587image32000](#) [page587image32200](#)

Two and three-pole molded-case circuit breakers, intended for use on corner-grounded delta systems, ungrounded systems, and impedance-grounded systems, shall be marked with an individual pole-interrupting capability that is indicative of their ability for an individual pole to safely interrupt phase-to-phase fault current at phase-to-phase voltage. This requirement shall become effective January 1, 2026.

Statement of Problem and Substantiation for Public Comment

Public Input 1071 was resolved with the following statement: "The single pole interrupting capability is part of the product evaluation. A proposal to UL 489 would be required to change the marking requirements. The information the submitter addresses is available from CB manufacturers."

CMP 10 is encouraged to investigate this issue in greater depth. Sometimes the product standards drive requirements in the NEC. And sometimes, requirements in the NEC drive the product standards. In this case, if CMP 10 feels that the issue of single-pole interrupting capabilities is significant, the panel should accept the requirement into the NEC and force the product standards follow.

Are the issues significant? Yes, absolutely! Tests were undertaken before the latest version of the 240.85 Informational Note was accepted into the NEC. As fully expected, those tests showed that violent explosions could result when the single-pole interrupting capability was violated.

How can users of the NEC properly apply single-pole interrupting capabilities if there is no marking on the circuit breakers?

Here is a challenge to the members of CMP 10. If you can find (determine) the single pole interrupting capability of your favorite manufacturer's 600 ampere, three pole, 480 volt, 65kA, circuit breaker within 10 minutes, then this Public Comment should be resolved. If however, the rating cannot be found in 10 minutes, this Public Comment has merit and should be accepted.

Here's another challenge for the electrical inspectors. If you routinely check for proper application of single-pole interrupting capabilities on other than solidly grounded wye electrical systems, then this Public Comment should be resolved. If however, you rarely, or never, check for the single-pole interrupting capabilities, this Public Comment is needed.

And here's a challenge for the consulting and plant engineers. If you routinely check for proper application of single-pole interrupting capabilities when designing your new electrical systems (on other than solidly grounded wye systems), this Public Input should be rejected. If, on the other hand, you rarely, or never, check for proper single-pole interrupting capabilities, you now understand why this Public Comment needs to be approved.

Related Item

• Public Input 1071 • Public Comment 308

Submitter Information Verification

Submitter Full Name: Vincent Saporita

Organization: Saporita Consulting

Affiliation: Saporita Consulting

Street Address:

City:

State:

Zip:

Submittal Date: Tue Jul 20 11:55:59 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: This is a product evaluation and standard issue and should not be resolved with a new requirement in the NEC. No evidence of failures or accidents resulting from the current method of communicating the single pole ratings was provided.

**Public Comment No. 308-NFPA 70-2021 [Section No. 240.85]****240.85 Applications.**

Two and three-pole molded-case circuit breakers, applied on corner-grounded delta systems, ungrounded systems, and impedance-grounded systems, intended to interrupt current at fault levels, shall have an individual pole-interrupting capability at nominal circuit voltage at least equal to the available phase-to-phase fault current at the line terminals of the equipment. This requirement shall become effective January 1, 2026.

Informational Note: Available phase to phase fault current is equal to 87% of three phase available fault current.

A circuit breaker with a straight voltage rating, such as 240V or 480V, shall be permitted to be applied in a circuit in which the nominal voltage between any two conductors does not exceed the circuit breaker's voltage rating. A two-pole circuit breaker shall not be used for protecting a 3-phase, corner-grounded delta circuit unless the circuit breaker is marked 1 ϕ -3 ϕ to indicate such suitability.

A circuit breaker with a slash rating, such as 120/240V or 480Y/277V, shall be permitted to be applied in a solidly grounded circuit where the nominal voltage of any conductor to ground does not exceed the lower of the two values of the circuit breaker's voltage rating and the nominal voltage between any two conductors does not exceed the higher value of the circuit breaker's voltage rating.

~~Informational Note: Proper application of molded case circuit breakers on 3-phase systems, other than solidly grounded wye, particularly on corner grounded delta systems, considers the circuit breakers' individual pole interrupting capability.~~

Statement of Problem and Substantiation for Public Comment

Public Input 1076 was resolved with the following statement: "The single pole interrupting capability of two and three-pole circuit breaker is a performance issue already addressed in the product standard. Additionally, 110.9 already addresses interrupting ratings for devices."

CMP 10 is encouraged to investigate this issue in greater depth. While the product standard does provide for single-pole testing of two and three-pole circuit breakers, it is not an interrupting rating test, as per the definition of interrupting rating and therefore is not covered by 110.9. Neither does the NEC specifically mandate that the single-pole rating be properly applied on other than solidly grounded wye electrical systems.

I offer a challenge to the members of CMP 10. If you can find the actual (published) single-pole interrupting capability of your favorite manufacturer's 600 ampere, 480 volt, 65kA, three phase circuit breaker in 10 minutes, you should resolve this Public Comment. If you can't determine the single-pole interrupting capability in that amount of time, you now perfectly understand why this Public Comment needs to be accepted.

Finally, the single-pole interrupting capability is not marked on two and three pole circuit breakers. If the electrical inspectors on CMP 10 can testify that they routinely check the single-pole interrupting capability when inspecting other than solidly grounded wye electrical installations, then resolve this Public Comment. If however, the electrical inspectors seldom or have never checked this requirement, then this Public Comment needs to be accepted.

Related Item

• Public Input 1076 • Public Comment 310

Submitter Information Verification

Submitter Full Name: Vincent Saporita

Organization: Saporita Consulting

Affiliation: Saporita Consulting

Street Address:

City:

State:

Zip:

Submittal Date: Tue Jul 20 11:15:00 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: This is a product evaluation and standard issue and should not be resolved with a new requirement in the NEC. No evidence of failures or accidents resulting from the current method of communicating the single pole ratings was provided.



Public Comment No. 1877-NFPA 70-2021 [Section No. 240.87]

240.87 Arc Energy Reduction.

Where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated or can be adjusted is 1000 amperes, ~~1200 amperes~~ or higher, 240.87(A) ~~+~~ and (B) , and (C) shall apply.

(A) Documentation.

Documentation shall be available to those authorized to design, install, operate, or inspect the installation as to the location of the circuit breaker(s). Documentation shall also be provided to demonstrate that the method chosen to reduce clearing time is set to operate at a value below the available arcing current.

(B) Method to Reduce Clearing Time.

One of the following means shall be provided and shall be set to operate at less than the available arcing current:

- (1) Zone-selective interlocking
- (2) Differential relaying
- (3) Energy-reducing maintenance switching with local status indicator
- (4) Energy-reducing active arc flash mitigation system
- (5) An instantaneous trip setting. Temporary adjustment of the instantaneous trip setting to achieve arc energy reduction shall not be permitted.
- (6) An instantaneous override
- (7) An approved equivalent means

Informational Note No. 1: An energy-reducing maintenance switch allows a worker to set a circuit breaker trip unit to "no intentional delay" to reduce the clearing time while the worker is working within an arc-flash boundary as defined in *NFPA 70E-2021 2018* , *Standard for Electrical Safety in the Workplace*, and then to set the trip unit back to a normal setting after the potentially hazardous work is complete.

Informational Note No. 2: An energy-reducing active arc-flash mitigation system helps in reducing arcing duration in the electrical distribution system. No change in the circuit breaker or the settings of other devices is required during maintenance when a worker is working within an arc-flash boundary as defined in *NFPA 70E-2021 2018* , *Standard for Electrical Safety in the Workplace*.

Informational Note No. 3: An instantaneous trip is a function that causes a circuit breaker to trip with no intentional delay when currents exceed the instantaneous trip setting or current level. If arcing currents are above the instantaneous trip level, the circuit breaker will trip in the minimum possible time.

Informational Note No. 4: See IEEE 1584-2018, *IEEE Guide for Performing Arc Flash Hazard Calculations*, ~~for guidance-~~ is one of the available methods that provide guidance in determining arcing current.

(C) Performance Testing.

The arc energy reduction protection system shall be performance tested by primary current injection testing or another approved method when first installed on site. This testing shall be conducted by a qualified person(s) in accordance with the manufacturer's instructions.

A written record of this testing shall be made and shall be available to the authority having jurisdiction.

Informational Note: Some energy reduction protection systems cannot be tested using a test process of primary current injection due to either the protection method being damaged such as with the use of fuse technology or because current is not the primary method of arc detection.

Statement of Problem and Substantiation for Public Comment

No technical substantiation was provided to reduce the threshold for the requirement for Arc Energy Reduction methods where circuit breakers are installed from 1200 amps to 1000 amps.

Related Item

- FR 7818

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz

Organization: NECA

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 18 13:24:01 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8320-NFPA 70-2021

Statement: No technical substantiation was provided to reduce the threshold for the requirement for Arc Energy Reduction methods where fuses are installed from 1200 amps to 1000 amps.

The hazards posed by arc flashes are known. The panel is open to reconsidering the threshold for arc flash protection during the next code cycle based on scientific data in accordance with the NFPA Regs.



Public Comment No. 595-NFPA 70-2021 [Section No. 240.87(B)]

(B) Method to Reduce Clearing Time.

One of the following means shall be provided and shall be set to operate at less than the available arcing current:

- (1) Zone-selective interlocking
- (2) Differential relaying
- (3) Energy-reducing maintenance switching with local status indicator
- (4) Energy-reducing active arc flash mitigation system
- (5) An instantaneous trip setting. Temporary adjustment of the instantaneous trip setting to achieve arc energy reduction shall not be permitted.
- (6) An instantaneous override
- (7) An approved equivalent means

Exception: Coordination of arc energy reduction technologies may extend to downstream overcurrent protective devices, as far as required by 240.87, providing that they operate below the available arcing current of the downstream devices. Downstream devices protected by upstream arc energy reduction technologies shall be considered compliant with 240.87.

Informational Note No. 1: An energy-reducing maintenance switch allows a worker to set a circuit breaker trip unit to "no intentional delay" to reduce the clearing time while the worker is working within an arc-flash boundary as defined in *NFPA 70E-2021, Standard for Electrical Safety in the Workplace*, and then to set the trip unit back to a normal setting after the potentially hazardous work is complete.

Informational Note No. 2: An energy-reducing active arc-flash mitigation system helps in reducing arcing duration in the electrical distribution system. No change in the circuit breaker or the settings of other devices is required during maintenance when a worker is working within an arc-flash boundary as defined in *NFPA 70E-2021, Standard for Electrical Safety in the Workplace*.

Informational Note No. 3: An instantaneous trip is a function that causes a circuit breaker to trip with no intentional delay when currents exceed the instantaneous trip setting or current level. If arcing currents are above the instantaneous trip level, the circuit breaker will trip in the minimum possible time.

Informational Note No. 4: See IEEE 1584-2018, *IEEE Guide for Performing Arc Flash Hazard Calculations*, for guidance in determining arcing current.

Additional Proposed Changes

<u>File Name</u>	<u>Description</u>	<u>Approved</u>
NEC_AERM.pdf	Figures for Substantiation	

Statement of Problem and Substantiation for Public Comment

This PC was written to clarify and add detail to the proposal within PI 3972-NFPA 70-2020. The original PI attempted to clarify that if protection against arc faults at an overcurrent protection device (OCPD) that is rated $\geq 1000A$ is provided through an arc energy reduction means (AERM) located at an upstream device, an additional, redundant AERM at the OCPD in question is not needed because the requirement is satisfied by the upstream device. To accomplish this, an exception is added to allow arc energy reduction to be provided by an upstream device if the upstream device is capable of providing protection of the downstream device and is setup for that purpose.

An example is provided to illustrate how this proposal would impact installations. Referring to Figure 1 (Attachment to PC) and making the following assumptions:

1. I_{aerm1} is the pick-up current setting of AERM1
2. I_{arc_1} is the arc flash current value at the line terminals of FDS2 as calculated in the arc flash study
3. I_{arc_2} is the arc flash current value at the line terminals of the load as calculated in the arc flash study
4. $I_{aerm1} < I_{arc_1}$
5. The OCPD in FDS1 is rated $\geq 1000A$
6. The OCPD in FDS2 is rated $\geq 1000A$

The following cases would arise:

Case 1: $I_{aerm1} \geq I_{arc_2}$ results in a system that is non-compliant, FDS2 would need its own AERM installed and set to operate at $< I_{arc_2}$.

Case 2: $I_{aerm1} < I_{arc_2}$ results in a system that is compliant, FDS2 does not need an AERM because that section of the installation is covered by AERM1, from upstream.

This logic follows as OCPDs are added farther downstream from FDS1. For example, if a third disconnect switch is added, as illustrated in Figure 2 (Attachment to PC), the associated OCPD is rated at $\geq 1000A$ and AERM3 is installed and set to $I_{aerm3} < I_{arc_3}$. If Case 2 applies to FSD 1 and FSD 2, the following additional cases arise:

Case 3: $I_{aerm1} \geq I_{arc_3}$ is Compliant, because FSD3 has its own AERM installed

Case 4: $I_{aerm1} < I_{arc_3}$ is Compliant, AERM3 is not needed because that section of the installation is covered by AERM1, upstream, AERM3 would be redundant, but permitted

The submitter believes that PI 3972-NFPA 70-2020 has value and the changes proposed are helpful to reduce complexity and redundancy, while not reducing safety. Installations are not required to use all technologies that are listed in this section, only a minimum of one. If a designer, installer, or owner chooses to use a technology that can provide protection to downstream devices, they should not be required to provide redundant protection because other technologies lack this ability. Furthermore, when technologies are employed that cannot provide downstream protection, arc-flash reduction installed at each level from the source towards the load provides only a single level of protection and no redundancy. Allowing this change does not remove a level of protection required, it only allows for the variable of efficiency of the technology chosen to be considered.

Finally, the system design must be proven based on the documentation requirement of this section and the installation must be tested based on the performance testing requirement of this section before it is approved.

Related Item

- PI 3972-NFPA 70-2020

Submitter Information Verification

Submitter Full Name: John Cowans

Organization: Siemens
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 02 11:29:32 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The suggested language does not recognize that some technologies required as part of this section of the NEC do not respond to downstream events as they are outside of the zone of protection. The suggested exception would remove a layer of arc reduction technology without justification. In addition, the proposed language implies that the available arcing current is related to the downstream device which is incorrect. Arcing current is not driven by a downstream device. It is driven by characteristics of the equipment including bus distances, voltage levels, and bus configurations to name a few parameters important to determining arcing current when IEEE 1584-2018 is used. This new language would cause confusion in the application of this section.

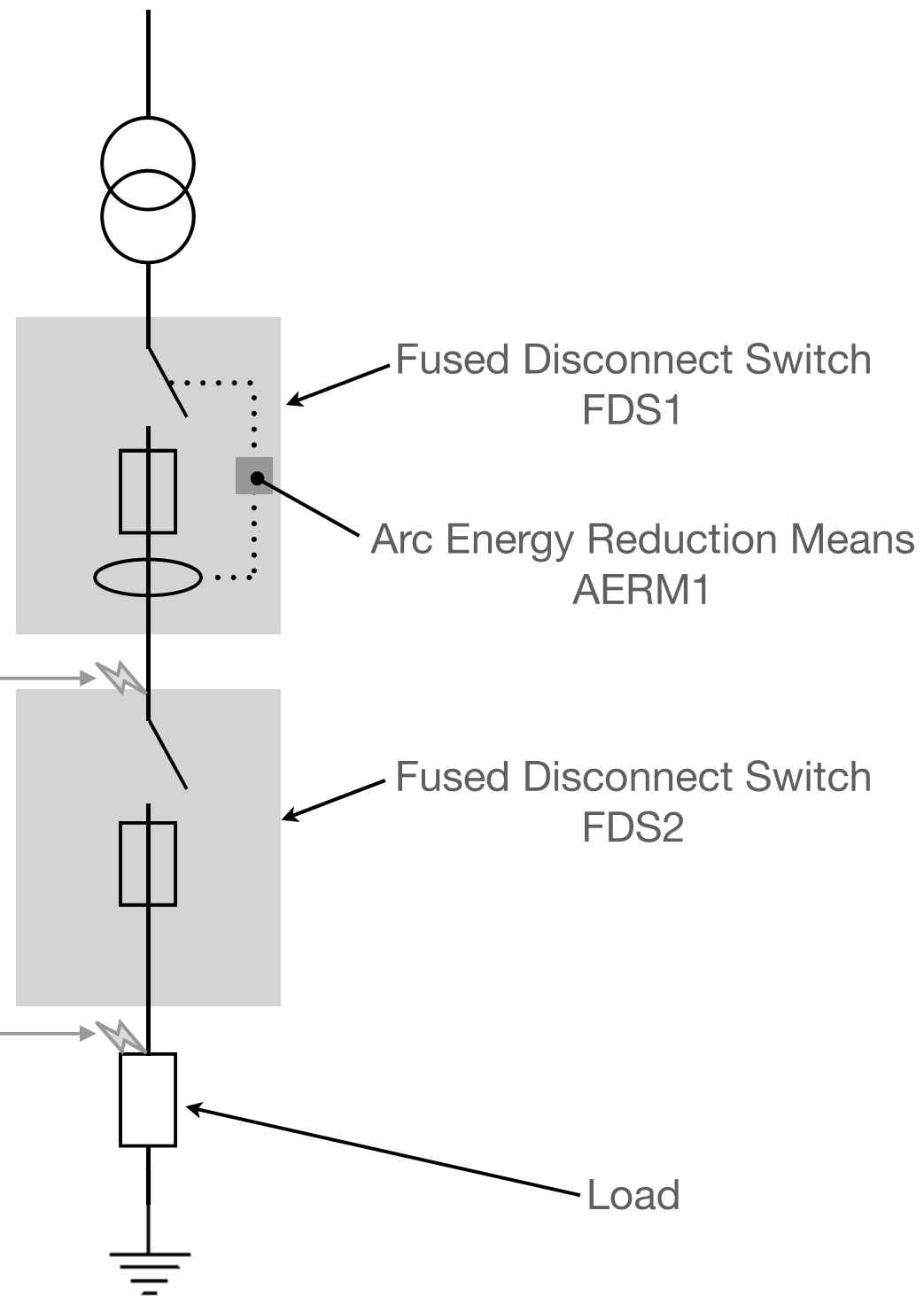


Figure 1

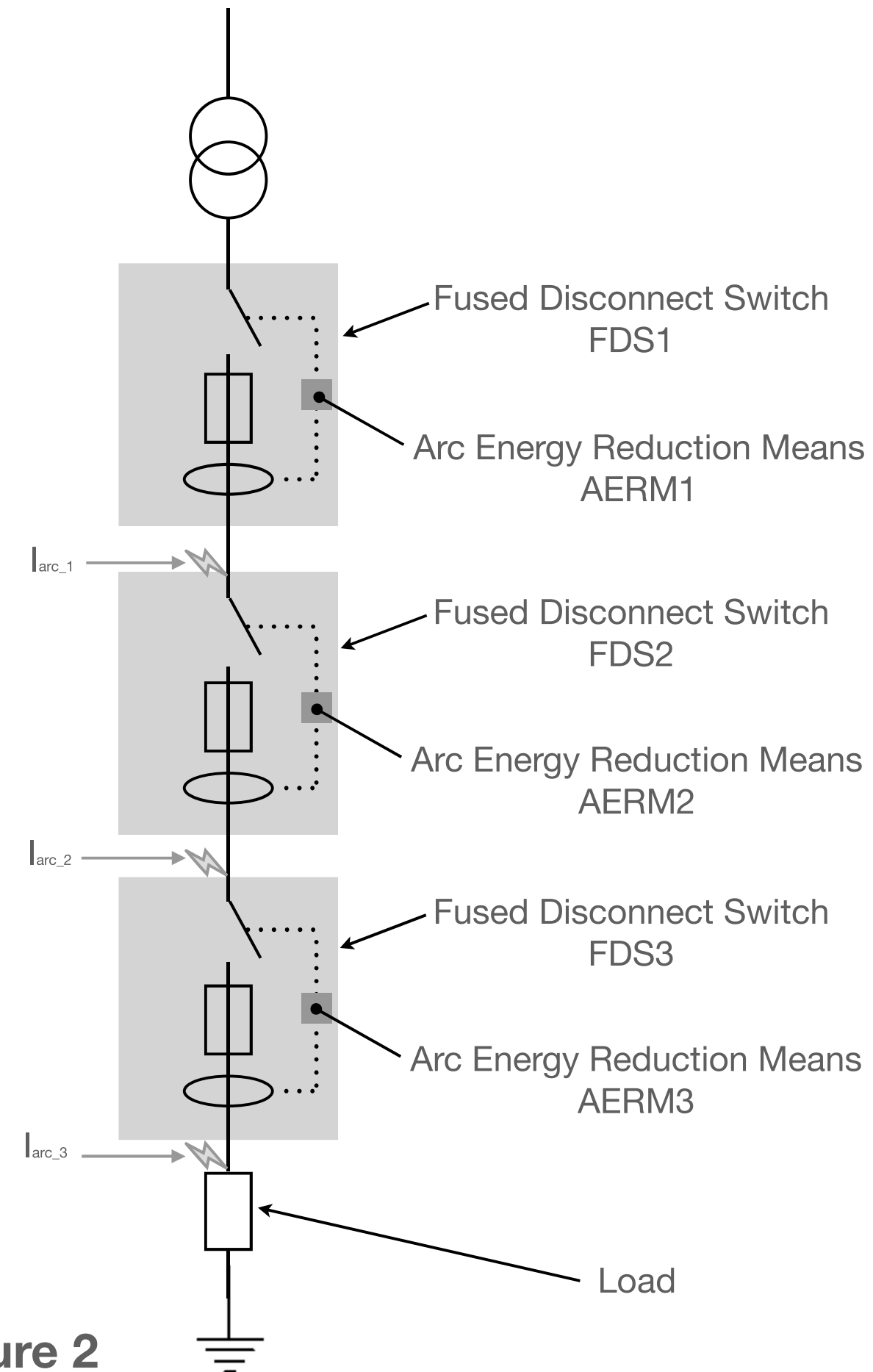


Figure 2

**Public Comment No. 139-NFPA 70-2021 [Section No. 240.87(C)]****(C) Performance Testing.**

The arc energy reduction protection system shall be performance tested by ~~primary current injection testing or another approved method~~ when first installed on site. This testing shall be conducted by a qualified person(s) in accordance with the manufacturer's instructions.

(1) Manufacturers shall furnish instructions for on site performance testing.

(2) A written record of this testing shall be made and shall be available to the authority having jurisdiction.

~~Informational Note: Some energy reduction protection systems cannot be tested using a test process of primary current injection due to either the protection method being damaged such as with the use of fuse technology or because current is not the primary method of arc detection.~~

Statement of Problem and Substantiation for Public Comment

I support Public Input No. 2616-NFPA 70-2020 [Section No. 240.87(C)] submitted by Dean Hunter. In addition to his comment, primary injection testing is NOT feasible for all installations. The lowest ampere setting of an arc fault mitigation system is typically an order of magnitude greater than ground fault current. The smallest device required (1200A) would typically need to be tested at 2.5X its full load rating; 3000A. Ground fault testing of a 1200A circuit breaker requires as little as 300A of test current. Primary injection testing of arc flash mitigation system introduces additional hazards; especially when performed on bolt-in, group-mounted switchboards most commonly used.

Related Item

• Public Input No. 2616-NFPA 70-2020 [Section No. 240.87(C)] • Public Input No. 2615-NFPA 70-2020 [Section No. 240.67(C)]

Submitter Information Verification

Submitter Full Name: Robert Arbetman

Organization: Century A&E - Facilities Design

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City:

State:

Zip:

Submittal Date: Tue Jul 06 16:37:50 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: The testing methods listed in 240.87(C) are technically correct, feasible and well understood in the electrical industry. The concerns of the submitter are addressed by the existing language in 240.87(C).

**Public Comment No. 869-NFPA 70-2021 [Section No. 240.88]****240.88** Reconditioned Equipment.

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

(A) Molded Case Circuit Breakers.

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

(B) Low-Voltage Power Circuit Breakers.

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

(C) Components.

The use of reconditioned trip units, protective relays, and current transformers shall comply with the following:

- (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.

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_242.pdf	70_CN242

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 242 appeared in the First Draft Report on First Revision No. 7824.

The Correlating Committee directs the panel to reconsider the text in this section to remove redundant requirements in accordance with 4.1.1 of the NEC Style Manual and correlate with FR 8577.

The Correlating Committee directs the panel to reconsider the text "shall not be permitted to be" for clarification and ease of use. Simplifying the text to state that the equipment "shall not be reconditioned" is suggested as an alternative.

Related Item

- First Revision No. 7824

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC

Organization: NEC Correlating Committee

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 04 15:18:25 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8704-NFPA 70-2021](#)

Statement: Reconditioning provisions are relocated to 240.2 to comply with Correlating Committee recommendations in PC 896. A reference to 110.21 (A)(2) is added to include a reference to additional marking requirements.

Response to PC-1929: The new text is modified to comply with the style manual.

**Correlating Committee Note No. 242-NFPA 70-2021 [Section No. 240.88]****Submitter Information Verification**

Committee: NEC-P10

Submittal Date: Thu May 06 09:20:54 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs the panel to reconsider the text in this section to remove redundant requirements in accordance with 4.1.1 of the NEC Style Manual and correlate with FR 8577.

The Correlating Committee directs the panel to reconsider the text "shall not be permitted to be" for clarification and ease of use. Simplifying the text to state that the equipment "shall not be reconditioned" is suggested as an alternative.

First Revision No. 7824-NFPA 70-2020 [Section No. 240.88]

Ballot Results

✓ **This item has passed ballot**

12 Eligible Voters

0 Not Returned

12 Affirmative All

0 Affirmative with Comments

0 Negative with Comments

0 Abstention

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Johnston, Michael J.

Kendall, David H.

Kovacik, John R.

Manche, Alan

McDaniel, Roger D.

Porter, Christine T.

Williams, David A.

**Public Comment No. 1076-NFPA 70-2021 [Section No. 240.88 [Excluding any Sub-Sections]]**

Reconditioned equipment shall be listed as *reconditioned* and ~~the original listing mark removed.~~ comply with 110.21(A)(2).

Statement of Problem and Substantiation for Public Comment

It would provide clarity to direct the code reader back to 110.21(A)(2) where additional requirements are found. If the code user goes to this section directly, they would only see two requirements; to be listed as reconditioned, and to have the original listing mark removed.

There is much more to it for those who are familiar with NRTL requirements for reconditioning of equipment, and directing the code reader back to 110.21(A)(2) would provide further information than what is currently in 240.88.

Related Item

- FR-7824

Submitter Information Verification

Submitter Full Name: Jeff Simpson

Organization: ElectricalLicenseRenewal.com

Street Address:

City:

State:

Zip:

Submittal Date: Mon Aug 09 09:40:40 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: SR-8704-NFPA 70-2021

Statement: Reconditioning provisions are relocated to 240.2 to comply with Correlating Committee recommendations in PC 896. A reference to 110.21 (A)(2) is added to include a reference to additional marking requirements.

Response to PC-1929: The new text is modified to comply with the style manual.

**Public Comment No. 871-NFPA 70-2021 [Section No. 240.102]****240.102** Reconditioned Equipment.**(A)** Medium-Voltage Fuseholders.

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

(B) Medium-Voltage Power Circuit Breakers.

Medium-voltage power circuit breakers shall be permitted to be reconditioned.

(C) High-Voltage Circuit Breakers.

High-voltage circuit breakers shall be permitted to be reconditioned.

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_243.pdf	70_CN243

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 243 appeared in the First Draft Report on First Revision No. 7825.

The Correlating Committee directs the panel to reconsider the text "shall not be permitted to be" for clarification and ease of use. Simplifying the text to state that the equipment "shall not be reconditioned" is suggested as an alternative.

Related Item

- First Revision No. 7825

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC

Organization: NEC Correlating Committee

Street Address:

City:

State:

Zip:

Submittal Date: Wed Aug 04 15:21:16 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR

Resolution: [SR-8457-NFPA 70-2021](#)

Statement: The requirements of Part IX of 240 are moved to Article 245.

**Correlating Committee Note No. 243-NFPA 70-2021 [Section No. 240.102]****Submitter Information Verification**

Committee: NEC-P10

Submittal Date: Thu May 06 09:23:36 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs the panel to reconsider the text "shall not be permitted to be" for clarification and ease of use. Simplifying the text to state that the equipment "shall not be reconditioned" is suggested as an alternative.

First Revision No. 7825-NFPA 70-2020 [Section No. 240.102]

Ballot Results

✓ **This item has passed ballot**

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

Affirmative All

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

**Public Comment No. 863-NFPA 70-2021 [Section No. 242.1]****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: This article combines and replaces Articles 280 and 285 in *NFPA 70-2017*.

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_156.pdf	70_CN156

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 156 appeared in the First Draft Report on First Revision No. 7948.

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and the Correlating Committee accepts the panel action. The Correlating Committee requests that the Informational Note be reviewed to determine if it is still necessary.

Related Item

- First Revision No. 7948

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 04 15:06:52 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: [SR-8331-NFPA 70-2021](#)
Statement: The informational note has been removed because it is no longer necessary.

**Correlating Committee Note No. 156-NFPA 70-2021 [Section No. 242.1]****Submitter Information Verification**

Committee: NEC-P10

Submittal Date: Tue May 04 18:36:44 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and the Correlating Committee accepts the panel action. The Correlating Committee requests that the Informational Note be reviewed to determine if it is still necessary.

First Revision No. 7948-NFPA 70-2020 [Section No. 242.1]

Ballot Results

✓ **This item has passed ballot**

12 Eligible Voters

0 Not Returned

12 Affirmative All

0 Affirmative with Comments

0 Negative with Comments

0 Abstention

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Johnston, Michael J.

Kendall, David H.

Kovacik, John R.

Manche, Alan

McDaniel, Roger D.

Porter, Christine T.

Williams, David A.

**Public Comment No. 1733-NFPA 70-2021 [Section No. 242.7]**

242.7 Reconditioned Equipment.
SPDs shall not be permitted to be reconditioned.

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_245.pdf	10 CN245

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 245 appeared in the First Draft Report on First Revision No. 7956

The Correlating Committee directs the panel to reconsider the text "shall not be permitted to be" for clarification and ease of use. Simplifying the text to state that the equipment "shall not be reconditioned" is suggested as an alternative.

Related Item

- First Revision No. 7956

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 17 15:31:36 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: [SR-8705-NFPA 70-2021](#)
Statement: Reconditioning provisions are relocated to 242.2 to comply with Correlating Committee recommendations in PC 896.
Sections 242.7 and 242.41 are relocated to 242.2. The text "shall not be permitted to be" is revised.

**Correlating Committee Note No. 245-NFPA 70-2021 [New Section after 242.6]****Submitter Information Verification**

Committee: NEC-P10

Submittal Date: Thu May 06 09:27:23 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs the panel to reconsider the text "shall not be permitted to be" for clarification and ease of use. Simplifying the text to state that the equipment "shall not be reconditioned" is suggested as an alternative.

First Revision No. 7956-NFPA 70-2020 [New Section after 242.6]

Ballot Results

✓ **This item has passed ballot**

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

Affirmative All

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

**Public Comment No. 864-NFPA 70-2021 [Section No. 242.28]****242.28** Conductor Size.

Line conductors and conductors to ground shall not be smaller than 14 AWG copper or 12 AWG aluminum.

Additional Proposed Changes

<u>File Name</u>	<u>Description</u> <u>Approved</u>
10_CN_157.pdf	70_CN157

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 157 appeared in the First Draft Report on First Revision No. 7934.

The Correlating Committee directs that FR 7934 be referred to Code-Making Panel 5 for information. The first revision does not reference which Type SPDs this rule includes.

Related Item

- First Revision No. 7934

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 04 15:09:14 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: SR-8334-NFPA 70-2021
Statement: Added "SPD" to clarify that this section applies to all types of SPDs.

**Correlating Committee Note No. 157-NFPA 70-2021 [Section No. 242.28]****Submitter Information Verification**

Committee: NEC-P10

Submittal Date: Tue May 04 18:39:07 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs that FR 7934 be referred to Code-Making Panel 5 for information. The first revision does not reference which Type SPDs this rule includes.

First Revision No. 7934-NFPA 70-2020 [Section No. 242.28]

Ballot Results

✓ **This item has passed ballot**

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

Affirmative All

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

**Public Comment No. 1734-NFPA 70-2021 [Section No. 242.41]**

242.41 Reconditioned Equipment.
Surge arresters shall not be permitted to be reconditioned.

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_246.pdf	10 CN246

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 246 appeared in the First Draft Report on First Revision No. 7958

The Correlating Committee directs the panel to reconsider the text "shall not be permitted to be" for clarification and ease of use. Simplifying the text to state that the equipment "shall not be reconditioned" is suggested as an alternative.

Related Item

- First Revision No. 7958

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 17 15:35:45 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: [SR-8705-NFPA 70-2021](#)
Statement: Reconditioning provisions are relocated to 242.2 to comply with Correlating Committee recommendations in PC 896.
Sections 242.7 and 242.41 are relocated to 242.2. The text "shall not be permitted to be" is revised.

**Correlating Committee Note No. 246-NFPA 70-2021 [New Section after 242.40]****Submitter Information Verification**

Committee: NEC-P10

Submittal Date: Thu May 06 09:28:14 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs the panel to reconsider the text "shall not be permitted to be" for clarification and ease of use. Simplifying the text to state that the equipment "shall not be reconditioned" is suggested as an alternative.

First Revision No. 7958-NFPA 70-2020 [New Section after 242.40]

Ballot Results

✓ **This item has passed ballot**

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

Affirmative All

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

**Public Comment No. 865-NFPA 70-2021 [Section No. 242.42]****242.42** Surge Arrester Rating.

The duty cycle rating of a surge arrester shall be not less than 125 percent of the maximum system voltage available at the point of application.

For solidly grounded systems, the maximum continuous operating voltage shall be the phase-to-ground voltage of the system.

For impedance or ungrounded systems, the maximum continuous operating voltage shall be the phase-to-phase voltage of the system.

Informational Note No. 1: See IEEE C62.11-2020, *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*, for further information on surge arresters.

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.

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
10_CN_158.pdf	70_CN158

Statement of Problem and Substantiation for Public Comment

The following CC Note No. 158 appeared in the First Draft Report on First Revision No. 8283.

The Correlating Committee directs that FR-8283 be reviewed for clarity and asks that the terms "maximum system voltage" and "maximum continuous operating voltage" be reviewed for accuracy and consistency.

Related Item

- First Revision No. 8283

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Wed Aug 04 15:11:32 EDT 2021
Committee: NEC-P10

Committee Statement

Committee Action: Rejected but see related SR
Resolution: [SR-8335-NFPA 70-2021](#)
Statement: The language is revised in the parent text for consistency and clarity.

**Correlating Committee Note No. 158-NFPA 70-2021 [Section No. 242.42]****Submitter Information Verification**

Committee: NEC-P10

Submittal Date: Tue May 04 18:43:24 EDT 2021

Committee Statement

Committee Statement: The Correlating Committee directs that FR-8283 be reviewed for clarity and asks that the terms "maximum system voltage" and "maximum continuous operating voltage" be reviewed for accuracy and consistency.

First Revision No. 8283-NFPA 70-2020 [Section No. 242.42]

Ballot Results

✓ **This item has passed ballot**

12 Eligible Voters

0 Not Returned

12 Affirmative All

0 Affirmative with Comments

0 Negative with Comments

0 Abstention

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Johnston, Michael J.

Kendall, David H.

Kovacik, John R.

Manche, Alan

McDaniel, Roger D.

Porter, Christine T.

Williams, David A.



Public Comment No. 1349-NFPA 70-2021 [Part III.]

Part III. Over 1000 Volts.

Insert new material as follows:

225.70. Outdoor Overhead Conductors . Outdoor overhead conductors over 1000 volts shall be permitted to be installed outdoors in free air, and for services, feeders, and branch circuits.

Informational Note: See ANSI/IEEE C2, *National Electrical Safety Code*, and ANSI/IEEE 3001.2, *Recommended Practice for Evaluating the Electrical Service Requirements of Industrial and Commercial Power Systems* for additional information on outdoor overhead conductors over 1000 volts.

225.71 Support . . Outdoor, overhead conductors operating over 1000 volts shall meet any specified clearance requirements as covered in 225.60 and 225.61 The engineering designs required by this section shall be in accordance with accepted national standards and performed by licensed professional engineers engaged primarily in the design of such systems. The designs shall include the conductor spacings and clearances, and the installation of support structures. The designs shall be documented and the documentation shall be made available to the authority having jurisdiction.

(A) Conductors, The spacing design shall shall address the following topics:

- (1) Applied voltage.
- (2) Conductor size.
- (3) Distance between support structures.
- (4) Type of structure.
- (5) Wind/ice loading.
- (6) Surge protection.

(B) Structures, Structures of wood, metal, or concrete, or combinations of those materials shall be provided for support of overhead conductors, over 1000 volts. . The structure design and the clearances to be obtained by that design shall address the following topics:

- (1) Soil conditions.
- (2) Foundations and structure settings.
- (3) Weight of all supported conductors and equipment.
- (4) Weather loading and other conditions such as, but not limited to, ice, wind, temperature, and lightning.
- (5) Angle where change of direction occurs.
- (6) Spans between adjacent structures.
- (7) Effect of dead end structures.
- (8) Strength of guy wires and guy anchors.
- (9) Structure size and material(s).
- (10) Hardware.

(C) Insulators, Insulators used to support conductors shall be rated for all of the following:

- (1) The applied phase to phase voltage.
- (2) Mechanical strength required for each individual installation.
- (3) Impulse Withstand BIL in accordance with Table 490.24.

Informational Note: 225.81 (A), (B), and (C) are not all inclusive lists.

Statement of Problem and Substantiation for Public Comment

This is a companion comment to one that deletes Article 399/395; with editorial changes to accommodate the revised location, no technical changes have been made. The definition is already being moved into Article 100; if this is accepted, then the jurisdiction will need to be reassigned to CMP 10. This is most definitely not properly considered a Chapter 3 wiring method (a key reason for relocating it) the uses permitted and not permitted rules have been reformatted into text appropriate for a Chapter 2 location. This material was long overdue for inclusion in the NEC when it came in in 2011, and this submitter has no problem with the concepts presented. However, it should be incorporated into the existing article of the NEC that not only has extensive coverage of closely related material, Obviously this is up to the Correlating Committee in the end, but this topic is too important to allow the "NIH" concept ("not invented here") to drive what is in the best interest of the document. It is apparent that much work will be forthcoming in this area, and this is a natural fit for CMP 10. The "open wiring" phrase was inserted in (A) to clarify that this topic does not include other medium-voltage single-conductor applications such as cable tray installations that usually run overhead and outdoors. The new parent language incorporates the specific clearances required in this part of Article 225. In addition, it is structured to avoid the necessity for repeating the rule for professional engineering and the rule for making documentation available to the AHJ. The language suggested for (A) and (B) partially addresses the concerns about enforceability. The terminology "accepted national standards" is taken from the last sentence of 490.24, which involves similar concerns.

Related Item

- Global FR-8560

Submitter Information Verification

Submitter Full Name: Frederic Hartwell

Organization: Hartwell Electrical Services, Inc.

Street Address:

City:

State:

Zip:

Submittal Date: Thu Aug 12 11:22:17 EDT 2021

Committee: NEC-P10

Committee Statement

Committee Action: Rejected

Resolution: This PC proposes to relocate material under the purview of CMP 6 to Article 225 which is under the purview of CMP 10. The Correlating Committee establishes purview.