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WORKING DRAFT OF NEC CODE-MAKING PANEL 4 MEETING OUTPUT

CONTENT NOT FINAL – SUBJECT TO REVISION PRIOR TO LETTER BALLOT AND PUBLICATION OF FIRST DRAFT REPORT

Document: National Electrical Code®

Revision Cycle: A2025

Meeting Dates: January 21 - 26, 2024

Panel Activity: Input Stage

This is a working draft, prepared by NFPA staff, to record the output generated at the Code-Making Panel 4 First Draft Meeting. It includes draft copies of the First Revisions and any Global Revisions.

It is being made available to Panel members for the purpose of facilitating early review, particularly for those Panel members who may be seeking input from their respective organizations in preparation for the First Draft Ballot.

First Revision No. 8503-NFPA 70-2024 [Detail]

[Update 690.43 Charging Statement and 690.43(A) as shown below]

690.43 Equipment Grounding and Bonding.

Exposed non-current-carrying metal parts of PV module frames, electrical equipment, and conductor enclosures of PV systems shall be connected to an equipment grounding conductor in accordance with 250.134 or 250.136, regardless of voltage. Equipment grounding conductors and devices shall comply with 690.43(A) through 690.43 (~~D~~ E).

(A) Photovoltaic Module Mounting Systems and Devices.

Devices and systems used for mounting PV modules that are also used for bonding module frames shall be listed, labeled, and identified for bonding the specific PV modules with which it is used .

Informational Note: See UL 2703-2023 , ~~*Standard for*~~ *Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels for PV Module Clamps*, and UL 3703-2020 ,~~*Standard for*~~ *Solar Trackers.*

Submitter Information Verification

Committee: NEC-P04
Submittal Date: Mon Jan 22 14:40:12 EST 2024

Committee Statement

Committee Statement: Text has been added to clarify that the bonding device must be listed, labeled, and identified for use with specific modules. The references in the informational note have been updated to align with the NEC style manual.

Response Message: FR-8503-NFPA 70-2024

Public Input No. 3860-NFPA 70-2023 [Section No. 690.43(A)]

First Revision No. 8251-NFPA 70-2024 [Definition: Array.]

Array (PV Array) (Solar PV Array) .

A mechanically and electrically integrated grouping of solar PV modules with ~~support structure~~ mounting system , including any attached system components such as inverter(s) or dc-to-dc converter(s) and attached associated wiring. (690) (CMP-4)

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Sun Jan 21 09:11:12 EST 2024

Committee Statement

Committee Statement: "PV array" is added as an alternate term since it is used repeatedly in Article 690. Alternate term "Solar PV Array" is added to harmonize terminology with the definition of "PV Module (Solar PV Module)" and "Photovoltaic Cell (PV) (Solar Cell). Changing the phrase "support structure" to "mounting system" improves the application of this Code to all PV system installations. Since UL 2703 uses the term "Mounting Systems" in the title, and 690.43(A) already uses "Mounting Systems" when referring to requirements involving metallic PV module frames and bonding devices used with mounting systems, this term is the correct term to use when referring to this element of a PV array.

Response Message: FR-8251-NFPA 70-2024

Public Input No. 3834-NFPA 70-2023 [Definition: Array.]

First Revision No. 8253-NFPA 70-2024 [Definition: Interactive Mode.]

Interactive Mode (Interactive) .

The operating mode for power production ~~equipment~~ sources or microgrids that operate in parallel with and are capable of delivering energy to an electric power production and distribution network or other primary source. (CMP-4)

Informational Note: Interactive mode is an operational mode of both interactive systems and of equipment such as interactive inverters.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Sun Jan 21 09:15:37 EST 2024

Committee Statement

Committee Statement: Adding the alternate term "Interactive" to this definition clarifies that where the term is used without "mode", which is common, a user is guided to this definition for clarity. The change from “equipment” to “sources” is to be more consistent with similar references in this Code including 705.1. (See FR-TG1-5&6 for related changes)

Response Message: FR-8253-NFPA 70-2024

Public Input No. 4189-NFPA 70-2023 [Definition: Interactive Mode.]

First Revision No. 8261-NFPA 70-2024 [Definition: Island Mode.]

Island Mode.

The operating mode for power production ~~equipment~~ sources or microgrids that allows energy to be supplied to loads that are disconnected from an electric power production and distribution network or other primary power source. (CMP-4)

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Sun Jan 21 09:25:25 EST 2024

Committee Statement

Committee Statement: The term "equipment" is changed to "sources" to be more consistent with similar references in this Code including 705.1.

Response Message: FR-8261-NFPA 70-2024

Public Input No. 4265-NFPA 70-2023 [Definition: Island Mode.]

First Revision No. 8881-NFPA 70-2024 [Definition: Maximum Output Power.]

Maximum Output Power (as applied to wind electric systems) **.**

The maximum 1 minute average power output a wind turbine produces in normal steady-state operation (instantaneous power output can be higher). (694) (CMP-4)

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Wed Jan 24 10:49:24 EST 2024

Committee Statement

Committee Statement: The title “Maximum Output Power” has been clarified to make the term unique to the application. NEC Style manual 2.1.2.7, states that defined terms must have a meaning that is unique to their application.

Response Message: FR-8881-NFPA 70-2024

Public Input No. 3035-NFPA 70-2023 [Definition: Maximum Output Power.]

Public Input No. 1845-NFPA 70-2023 [Definition: Maximum Output Power.]

First Revision No. 8878-NFPA 70-2024 [Definition: Microgrid.]

Microgrid.

An electric power system ~~capable of operating in island mode and capable of being interconnected to an electric~~ containing interconnected power production ~~and distribution network or other primary source while operating in interactive mode, which includes the ability to disconnect from and reconnect to a primary source and operate in island mode~~ sources and capable of acting as a primary source independent of an electric utility . (CMP-4)

Informational Note~~ No. 1~~ : ~~See IEEE 1547, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interface* ; IEEE 2030.7, *IEEE Standard for the Specification of Microgrid Controllers* ; IEEE 2030.8, *IEEE Standard for the Testing of Microgrid Controllers* ; and UL1008B, *Outline for Source Interconnection* , for additional information about microgrids. Informational Note No. 2:~~ Examples of power sources in microgrids include such items as photovoltaic systems, generators, fuel cell systems, wind electric systems, energy storage systems, electric vehicles that are used as a source of supply, and electrical power conversion from other energy sources.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Wed Jan 24 10:43:33 EST 2024

Committee Statement

Committee Statement: This revision clarifies the definition which referenced "operation in island mode" twice, and redefined interactive mode in a way that differed from the current Code definition. Informational Note #1 is deleted per NEC Style Manual 2.1.10.5 informational notes for the sole purpose of identifying applicable product standards are not allowed.

Response Message: FR-8878-NFPA 70-2024

Public Input No. 1714-NFPA 70-2023 [Definition: Microgrid.]

Public Input No. 3959-NFPA 70-2023 [Definition: Microgrid.]

Public Input No. 4150-NFPA 70-2023 [Definition: Microgrid.]

Public Input No. 4370-NFPA 70-2023 [Definition: Microgrid.]

First Revision No. 8280-NFPA 70-2024 [Definition: Power Production Equipment.]

Power Production ~~Equipment~~ Source (Power Source) .

Electrical ~~generating equipment supplied by any source~~ power production equipment other than a utility service, up to the source system disconnecting means. (CMP-4)

Informational Note: Examples of power production ~~equipment~~ source include ~~such items as~~ generators, both engine and wind, solar photovoltaic systems, fuel cells and ~~fuel cell~~ energy storage systems.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Sun Jan 21 10:37:08 EST 2024

Committee Statement

Committee Statement: This defined term is used in this Code to refer to any power source other than a utility source. While the defined term has had the word "equipment", the use of the term in this Code generally refers to an entire system, not just a discrete piece of equipment. This defined term is more accurate for the source rather than equipment, since any use of the term equipment would be a subset of the power source system. Additionally, there are multiple locations where "Power Source" is currently used in this Code, but it has been undefined, and so it is added as an alternate term. In the informational note, adding wind to generators as well as energy storage systems improves accuracy and clarifies that ESS are power sources not just storage. To provide clarification to the definition “supplied by the source” has been struck.

Response Message: FR-8280-NFPA 70-2024

Public Input No. 4167-NFPA 70-2023 [Definition: Power Production Equipment.]

Public Input No. 903-NFPA 70-2023 [Definition: Power Production Equipment.]

First Revision No. 8274-NFPA 70-2024 [Definition: PV Module (Module).]

PV Module (Module) (Solar PV Module) .

A complete, environmentally protected unit consisting of solar cells and other components designed to produce dc power. (CMP-4)

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Sun Jan 21 10:21:37 EST 2024

Committee Statement

Committee Statement: To harmonize terminology across definitions and cross-reference terms with the definition of Photovoltaic Cell (PV) (Solar Cell), the alternate term “Solar PV Module” is added to the definition of “PV module.”

Response Message: FR-8274-NFPA 70-2024. The term solar cell is not used within the mandatory text, so the recommended revisions as shown in the public input have not been adopted.

Public Input No. 1380-NFPA 70-2023 [Definition: Photovoltaic Cell (PV). (Solar Cell).]

First Revision No. 8884-NFPA 70-2024 [New Definition after Definition: Equipment.]

Equipment, Interconnection. (Interconnection Equipment).

Equipment that performs protective and control functions that enables power sources, or systems supplied by power sources, to operate in parallel, to separate from and reconnect to systems supplied by other power sources. (CMP-4)

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Wed Jan 24 10:56:54 EST 2024

Committee Statement

Committee Statement: This new term is needed to capture the broad range of applications where equipment is required to disconnect and reconnect a single power source, or an electrical wiring system supplied by power sources, from other systems supplied by other power sources. The use of such equipment is essential to ensure safety and reliability. This term aligns with current product standards and has been introduced into this Code with several revisions during the current development process. The adoption of this new defined term assists in ensuring that the Code uses consistent terminology for critical requirements as they evolve over time.

Response Message: FR-8884-NFPA 70-2024

First Revision No. 8295-NFPA 70-2024 [Section No. 690.1]

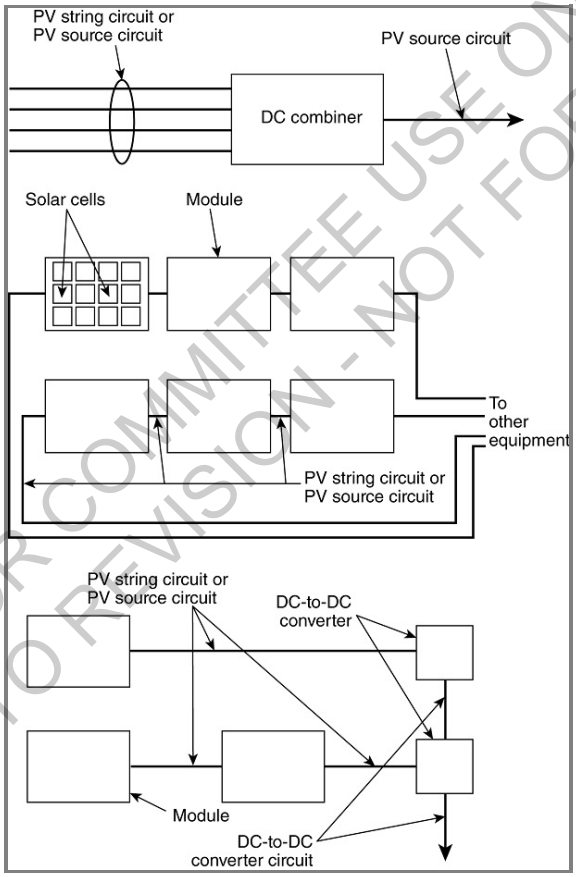
690.1 Scope.

This article applies to solar PV systems, other than those ~~covered by Article 691 , including the array circuit(s), inverter(s), and controller(s) for such systems.~~ described in 691.4. The systems covered by this article include those interactive with other electric power production sources or stand-alone, or both. These PV systems may have ac or dc output for utilization.

Informational Note No. 1: See Informational Note Figure 690.1.

Informational Note No. 2: Article 691 covers the installation of large-scale PV electric supply stations.

~~Figure Informational~~ Informational Note Figure 690.1 Illustration of PV System DC Circuits and PV System Components in a Typical PV Installation.



Submitter Information Verification

Committee: NEC-P04
Submittal Date: Sun Jan 21 11:02:39 EST 2024

Committee Statement

Committee Statement: This revised language has been made to comply with Section 4.1.4 of the NEC Style Manual.

The PV system elements “array circuits”, “inverters”, and “controllers” are removed because the terms are no longer used and addressed through the requirements of Article 690.

The reduced danger for fire & shock are recognized for limited energy installations. However, a system more than 30v/8 amperes may be comprised of individual modules of less than 30v/8 amperes. Introduction of the minimum values may confuse users. The thresholds for application of ground-fault, arc-fault, and rapid shutdown requirements are already identified through the applicable sections of Article 690.

Response Message: FR-8295-NFPA 70-2024

Public Input No. 3862-NFPA 70-2023 [Section No. 690.1]

Public Input No. 3277-NFPA 70-2023 [Section No. 690.1]

First Revision No. 8314-NFPA 70-2024 [Section No. 690.4(B)]

[Move section to come after Section 690.1. See Word Document attached]

(B) Equipment.

Electronic power converters, motor generators, PV modules, ac modules and ac module systems, dc combiners, PV rapid shutdown equipment (PVRSE), PV hazard control equipment (PVHCE), PV hazard control systems (PVHCS), dc circuit controllers, and charge controllers intended for use in PV systems shall be listed or be evaluated for the application and have a field label applied.

Supplemental Information

File Name	Description	Approved
70_CMP4_FR8314_690.4_B_.docx	See revsions to 690.4(B).	
NEC_CMP4_FR-8314_690.4_B_.docx	For prod use	

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Sun Jan 21 12:51:42 EST 2024

Committee Statement

Committee Statement: Listing requirements have been moved from 690.4(B) in keeping with the NEC Style Manual Section 2.2.1. The original sentence has been reorganized into a listed format to improve readability. The requirement for dc PV circuit overcurrent protection devices to be listed previously found in 690.9 has been added here to be located with the listing requirements for other equipment and devices. The term retrofit kits for the equipment on this list has been added to recognize that these can be used but must be listed.

Response Message: FR-8314-NFPA 70-2024

Public Input No. 3843-NFPA 70-2023 [New Section after 690.1]

Public Input No. 1532-NFPA 70-2023 [Section No. 690.4(B)]

Public Input No. 4153-NFPA 70-2023 [Section No. 690.4(B)]

Public Input No. 2809-NFPA 70-2023 [New Section after 690.1]

Public Input No. 2810-NFPA 70-2023 [Section No. 690.4]

Public Input No. 3839-NFPA 70-2023 [Section No. 690.4(B)]

~~690.4(B) Equipment~~690.2 Listing Requirements.

The following equipment, and any associated retrofit kits, shall be listed or be evaluated for the application and have a field label applied.

(1) Electronic power converters~~,~~
(2) ~~motor~~ Motor generators~~,~~
(3) PV modules~~,~~
(4) ~~ac~~ Ac modules ~~and~~
(5) ~~ac~~ Ac module systems~~,~~
(6) PV Dc overcurrent protective devices
(7) ~~dc~~ Dc combiners~~,~~
(8) PV rapid shutdown equipment (PVRSE)~~,~~
(9) PV hazard control equipment (PVHCE)~~,~~
(10) PV hazard control systems (PVHCS)~~,~~
(11) ~~dc~~ Dc circuit controllers~~, and~~
(12) ~~charge~~ Charge controllers ~~intended for use in PV systems shall be listed or be evaluated for the application and have a field label applied.~~

First Revision No. 8608-NFPA 70-2024 [Section No. 690.4(F)]

(F) Electronic Power Converters Mounted in Not Readily Accessible Locations.

Electronic power converters and their associated devices shall be permitted to be mounted ~~on roofs or other~~ in areas that are not readily accessible. Disconnecting means shall be installed in accordance with 690.15.

Submitter Information Verification

Committee: NEC-P04
Submittal Date: Mon Jan 22 22:42:38 EST 2024

Committee Statement

Committee Statement: Unnecessary language applying to locations has been removed.
Response Message: FR-8608-NFPA 70-2024

Public Input No. 4241-NFPA 70-2023 [Section No. 690.4(F)]

First Revision No. 8609-NFPA 70-2024 [New Section after 690.4(G)]

[New Section after 690.4(G).]

690.4(H) Fractions of an Ampere or Volt.

Calculations shall be permitted to be rounded to the nearest whole number, with decimal fractions smaller than 0.5 dropped.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Mon Jan 22 22:44:52 EST 2024

Committee Statement

Committee Statement: Language has been added based on an existing allowance in 220.5(B), which applies to ampere calculations for branch-circuits, feeders, and services. This new language clarifies that rounding to the nearest whole number of volts and amperes for all calculations applying to any circuit in this article is permitted.

Response Message: FR-8609-NFPA 70-2024

Public Input No. 4252-NFPA 70-2023 [New Section after 690.4(G)]

First Revision No. 8331-NFPA 70-2024 [Section No. 690.6(A)]

(A) Photovoltaic Source Circuits.

~~The requirements of Article~~ 690 Requirements pertaining to PV source circuits shall not apply to ac modules or ac module systems. The PV source circuit, conductors, and inverters shall be considered as internal components of an ac module or ac module system.

Submitter Information Verification

Committee: NEC-P04
Submittal Date: Sun Jan 21 13:59:11 EST 2024

Committee Statement

Committee Statement: Language changed to comply with NEC Style Manual, 4.1.4.
Response Message: FR-8331-NFPA 70-2024

Public Input No. 3323-NFPA 70-2023 [Section No. 690.6(A)]

First Revision No. 8332-NFPA 70-2024 [Section No. 690.7]

690.7 Maximum Dc Voltage.

The maximum dc voltage shall be used to determine the voltage and voltage to ground of circuits in the application of this *Code*. Maximum voltage shall be used for conductors, cables, equipment, working space, and other applications where voltage limits and ratings are used. The maximum voltage of PV system dc circuits shall be the highest voltage between any two conductors of a circuit or any conductor and ground and shall comply with the following:

(1) ~~PV system dc circuits shall not~~ Not exceed 1000 volts within or originating from arrays located on or attached to buildings and PV system dc circuits inside buildings.

(2) ~~PV system dc circuits shall not~~ Not exceed 600 volts on or in one- and two-family dwellings.

(3) ~~PV system dc circuits~~ Circuits exceeding 1000 volts shall comply with 690.31(G).

(A) Photovoltaic Source Circuits.

The maximum dc voltage for a PV source circuit shall be ~~calculated in accordance with one of~~ the ~~following methods:The~~ sum of the series-connected PV ~~module–rated~~ module rated open-circuit voltage ~~of the series-connected modules in the PV string circuit corrected~~ adjusted using one of the following methods:

(1) ~~_~~ Corrected for the lowest expected ambient temperature using the open-circuit voltage temperature coefficients in accordance with the instructions included in the listing or labeling of the module

(2) For crystalline and multicrystalline silicon modules, ~~the sum of the PV module–rated open-circuit voltage of the series-connected modules in the PV string circuit~~ corrected for the lowest expected ambient temperature using the correction factors provided in Table 690.7(A)

(3) ~~_ For PV systems with an inverter generating capacity of 100 kW or greater, a~~ A documented and stamped PV system design, using an industry standard method maximum voltage calculation provided by a licensed professional electrical engineer

Informational Note No. 1: One source for lowest-expected, ambient temperature design data for various locations the chapter titled “Extreme Annual Mean Minimum Design Dry Bulb Temperature” found in the *ASHRAE Handbook — Fundamentals*, 2017. These temperature data can be used to calculate maximum voltage.

Informational Note No. 2: See SAND 2004-3535, *Photovoltaic Array Performance Model* , for one industry standard method for calculating maximum voltage of a PV system.

Table 690.7(A) Voltage Correction Factors for Crystalline and Multicrystalline Silicon Modules

Correction Factors for Ambient Temperatures Below 25°C (77°F). (Multiply the rated open-circuit voltage by the appropriate correction factor shown below.)		
Ambient Temperature (°C)	**Factor**	**Ambient Temperature (°F)**
24 to 20	1.02	76 to 68
19 to 15	1.04	67 to 59
14 to 10	1.06	58 to 50
9 to 5	1.08	49 to 41
4 to 0	1.10	40 to 32
–1 to –5	1.12	31 to 23
–6 to –10	1.14	22 to 14
–11 to –15	1.16	13 to 5
–16 to –20	1.18	4 to –4
–21 to –25	1.20	–5 to –13
–26 to –30	1.21	–14 to –22
–31 to –35	1.23	–23 to –31
–36 to –40	1.25	–32 to –40

(B) DC-to-DC Converter Circuits.

In PV dc-to-dc converter circuits, the maximum voltage shall be calculated in accordance with 690.7(B)(1) or (B)(2).

(1) Single DC-to-DC Converter.

For circuits connected to the output of a single dc-to-dc converter, the maximum voltage shall be determined in accordance with the instructions included in the listing or labeling of the dc-to-dc converter. If the instructions do not provide a method to determine the maximum voltage, the maximum voltage shall be the maximum rated voltage output of the dc-to-dc converter.

(2) Two or More Series-Connected DC-to-DC Converters.

For circuits connected to the output of two or more series-connected dc-to-dc converters, the maximum voltage shall be determined in accordance with the instructions included in the listing or labeling of the dc-to-dc converter. If the instructions do not provide a method to determine the maximum voltage, the maximum voltage shall be the sum of the maximum rated voltage output of the dc-to-dc converters in series.

(C) Bipolar PV Source Circuits.

For monopole subarrays in bipolar systems, the maximum voltage shall be the highest voltage between the monopole circuit conductors where one conductor of the monopole circuit is connected to the functionally grounded reference. To prevent overvoltage in the event of a ground fault or arc fault, the monopole circuits shall be isolated from ground.

(D) Marking DC PV Circuits.

A permanent readily visible label indicating the highest maximum dc voltage in a PV system, ~~calculated in accordance with 690.7 ,~~ shall be provided by the installer at one of the following locations:

(1) DC PV system disconnecting means

(2) PV system electronic power conversion equipment

(3) Distribution equipment associated with the PV system

Informational Note: Rounding up to a value greater than the calculated PV dc circuit maximum voltage, for example 600, 1000 or 1500 volts DC, allows standardized labeling. Equipment manufacturers often provide a permanent visible label on the electronic power conversion equipment.

Supplemental Information

File Name	Description	Approved
NEC_CMP4_FR-8332_690.7.docx		

Submitter Information Verification

Committee: NEC-P04
Submittal Date: Sun Jan 21 14:04:13 EST 2024

Committee Statement

Committee Statement: Terms have been added to clarify that this section only applies to dc voltages. Language has been simplified.

Repeated language in (1) and (2) has been moved to the charging paragraph to improve readability and be more concise.

In (3), the 100 kW size limit for allowing a licensed professional electrical engineer to use an industry standard method to determine maximum voltage was removed to recognize that there is no practical difference between (10) identical 10 kW systems and (1) 100kW system. The licensed PE is the qualified person to do this design work. The reference to 690.7 is removed as unnecessary and incomplete.

A new informational note has been added to clarify that it is common for factory-installed labels on listed equipment to meet this requirement and that where desired, rounding up to a higher value than that calculated in 690.7 is often done when marking equipment since this can be an effective way to provide a simple indication of the voltage class of the circuits. This gives on-site technicians the information they need to choose the appropriate PPE and meters for accurate measurements.

Response Message: FR-8332-NFPA 70-2024

Public Input No. 4172-NFPA 70-2023 [Section No. 690.7(D)]

Public Input No. 4328-NFPA 70-2023 [Section No. 690.7(A)]

690.7 Maximum Dc Voltage.

The maximum dc voltage shall be used to determine the voltage and voltage to ground of circuits in the application of this *Code*. Maximum voltage shall be used for conductors, cables, equipment, working space, and other applications where voltage limits and ratings are used. The maximum voltage of PV system dc circuits shall be the highest voltage between any two conductors of a circuit or any conductor and ground and shall comply with the following:

1. ~~PV system dc circuits shall not~~Not exceed 1000 volts within or originating from arrays located on or attached to buildings and PV system dc circuits inside buildings.
2. ~~PV system dc circuits shall not~~Not exceed 600 volts on or in one- and two-family dwellings.
3. ~~PV system dc circuits~~Circuits exceeding 1000 volts shall comply with 690.31(G).

(A) Photovoltaic Source Circuits.

The maximum dc voltage for a PV source circuit shall be ~~calculated in accordance with~~the sum of the series-connected PV module rated open-circuit voltage adjusted using one of the following methods:

1. ~~The sum of the PV module rated open-circuit voltage of the series-connected modules in the PV string circuit corrected~~Corrected for the lowest expected ambient temperature using the open-circuit voltage temperature coefficients in accordance with the instructions included in the listing or labeling of the module
2. For crystalline and multicrystalline silicon modules, ~~the sum of the PV module rated open-circuit voltage of the series-connected modules in the PV string circuit~~ corrected for the lowest expected ambient temperature using the correction factors provided in Table 690.7(A)
3. ~~For PV systems with an inverter generating capacity of 100 kW or greater, a~~A documented and stamped PV system design, using an industry standard method maximum voltage calculation provided by a licensed professional electrical engineer

   Informational Note No. 1: One source for lowest-expected, ambient temperature design data for various locations the chapter titled “Extreme Annual Mean Minimum Design Dry Bulb Temperature” found in the *ASHRAE Handbook — Fundamentals*, 2017. These temperature data can be used to calculate maximum voltage.

   Informational Note No. 2: See SAND 2004-3535, *Photovoltaic Array Performance Model*, for one industry standard method for calculating maximum voltage of a PV system.

Table 690.7(A) Voltage Correction Factors for Crystalline and Multicrystalline Silicon Modules

Correction Factors for Ambient Temperatures Below 25°C (77°F). (Multiply the rated open-circuit voltage by the appropriate correction factor shown below.)		
Ambient Temperature (°C)	**Factor**	**Ambient Temperature (°F)**
24 to 20	1.02	76 to 68
19 to 15	1.04	67 to 59
14 to 10	1.06	58 to 50

Correction Factors for Ambient Temperatures Below 25°C (77°F). (Multiply the rated open-circuit voltage by the appropriate correction factor shown below.)		
Ambient Temperature (°C)	**Factor**	**Ambient Temperature (°F)**
9 to 5	1.08	49 to 41
4 to 0	1.10	40 to 32
–1 to –5	1.12	31 to 23
–6 to –10	1.14	22 to 14
–11 to –15	1.16	13 to 5
–16 to –20	1.18	4 to –4
–21 to –25	1.20	–5 to –13
–26 to –30	1.21	–14 to –22
–31 to –35	1.23	–23 to –31
–36 to –40	1.25	–32 to –40

(B) DC-to-DC Converter Circuits.
In PV dc-to-dc converter circuits, the maximum voltage shall be calculated in accordance with 690.7(B)(1) or (B)(2).

(1) Single DC-to-DC Converter.
For circuits connected to the output of a single dc-to-dc converter, the maximum voltage shall be determined in accordance with the instructions included in the listing or labeling of the dc-to-dc converter. If the instructions do not provide a method to determine the maximum voltage, the maximum voltage shall be the maximum rated voltage output of the dc-to-dc converter.

(2) Two or More Series-Connected DC-to-DC Converters.
For circuits connected to the output of two or more series-connected dc-to-dc converters, the maximum voltage shall be determined in accordance with the instructions included in the listing or labeling of the dc-to-dc converter. If the instructions do not provide a method to determine the maximum voltage, the maximum voltage shall be the sum of the maximum rated voltage output of the dc-to-dc converters in series.

(C) Bipolar PV Source Circuits.
For monopole subarrays in bipolar systems, the maximum voltage shall be the highest voltage between the monopole circuit conductors where one conductor of the monopole circuit is connected to the functionally grounded reference. To prevent overvoltage in the event of a ground fault or arc fault, the monopole circuits shall be isolated from ground.

(D) Marking DC PV Circuits.
A permanent readily visible label indicating the highest maximum dc voltage in a PV system, ~~calculated in accordance with 690.7,~~ shall be provided by the installer at one of the following locations:

1. DC PV system disconnecting means
2. PV system electronic power conversion equipment
3. Distribution equipment associated with the PV system

Informational Note: Rounding up to a value greater than the calculated PV dc circuit maximum voltage, for example 600, 1000 or 1500 volts DC, allows standardized labeling. Equipment manufacturers often provide a permanent visible label on the electronic power conversion equipment.

First Revision No. 8339-NFPA 70-2024 [Section No. 690.8(A)(1)]

[See attached word file for changes to 690.8 (A)(1) .]

(1) PV System Circuits.

The maximum current shall be calculated in accordance with 690.8(A)(1)(a) through (A)(1)(c).

(a) *Photovoltaic Source Circuit Currents* The maximum current shall be as calculated in either of the following:

(2) The maximum current shall be the sum of the short-circuit current ratings of the PV modules connected in parallel multiplied by 125 percent.

(3) For PV systems with an inverter generating capacity of 100 kW or greater, a documented and stamped PV system design, using an industry standard method maximum current calculation provided by a licensed professional electrical engineer, shall be permitted. The calculated maximum current value shall be based on the highest 3-hour current average resulting from the simulated local irradiance on the PV array accounting for elevation and orientation. The current value used by this method shall not be less than 70 percent of the value calculated using 690.8(A)(1) (a)(1).

Informational Note: See SAND 2004-3535, *Photovoltaic Array Performance Model*, for one industry standard method for calculating maximum current of a PV system. This model is used by the System Advisor Model simulation program provided by the National Renewable Energy Laboratory.

(d) *PV DC-to-DC Converter Circuit Current.* The maximum current shall be the sum of parallel connected dc-to-dc converter continuous output current ratings.

(e) *Inverter Output Circuit Current.* The maximum current shall be the inverter continuous output current rating.

Informational Note: Modules that can produce electricity when exposed to light on multiple surfaces are labeled with applicable short-circuit currents. Additional guidance is provided in the instructions included with the listing.

Supplemental Information

File Name	Description	Approved
70_CMP4_FR8339_690.8_A_1_.docx		

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Sun Jan 21 14:31:01 EST 2024

Committee Statement

Committee Statement: Revisions in 690.8(A)(1)(a)(1) were made to clarify the reference to “short-circuit” current since there are some PV modules, such as bifacial modules, that may have higher max current values depending on application. For this simple method, the highest value is required.

New 690.8(A)(1)(a)(2) is added to recognize that the instructions included with the PV module's listings may provide a different method of max current calculation than is required in 690.8(A) (1)(a)(1).

In 690.8(A)(1)(a)(3) the 100 kW size limit for allowing a licensed professional electrical engineer to use an industry standard method to determine maximum current was removed to recognize that there is no practical difference between (10) identical 10 kW systems and 690.8(A)(1) 100kW system. The licensed PE is the qualified person to do this design work.

The Informational note has been moved to more clearly apply to 690.8 (A)(1)(a) and not 690.8(A)(1)(b) or 690.8(A)(1)(c).

Response Message: FR-8339-NFPA 70-2024

Public Input No. 4254-NFPA 70-2023 [Section No. 690.8(A)]

Public Input No. 4345-NFPA 70-2023 [Section No. 690.8(A)(1)]

Section 690.8(A)(1)

(1) PV System Circuits.

The maximum current shall be calculated in accordance with 690.8(A)(1)(a) through (A)(1)(c).

(a) *Photovoltaic Source Circuit Currents* The maximum current shall be as calculated in either of the following:

(1) ~~The maximum current shall be t~~he sum of the ~~largest short-circuit~~ highest short-circuit current ratings~~s~~ of the PV modules connected in parallel multiplied by 125 percent.

(2) The sum of the short-circuit current ratings of the PV modules connected in parallel calculated in accordance with the instructions included in the listing or labeling of the module.

(~~2~~3) ~~For PV systems with an inverter generating capacity of 100 kW or greater, a~~A documented and stamped PV system design, using an industry standard method maximum current calculation provided by a licensed professional electrical engineer, shall be permitted. The calculated maximum current value shall be based on the highest 3-hour current average resulting from the simulated local irradiance on the PV array accounting for elevation and orientation. The current value used by this method shall not be less than 70 percent of the value calculated using 690.8(A)(1)(a)(1).

Informational Note 1: See SAND 2004-3535, *Photovoltaic Array Performance Model*, for one industry standard method for calculating maximum current of a PV system. This model is used by the System Advisor Model simulation program provided by the National Renewable Energy Laboratory.

Informational Note 2: Modules that can produce electricity when exposed to light on multiple surfaces are labeled with applicable short-circuit currents. Additional guidance is provided in the instructions included with the listing.

(b) *PV DC-to-DC Converter Circuit Current.* The maximum current shall be the sum of parallel connected dc-to-dc converter continuous output current ratings.

(c) *Inverter Output Circuit Current.* The maximum current shall be the inverter continuous output current rating.

~~Informational Note: Modules that can produce electricity when exposed to light on multiple surfaces are labeled with applicable short-circuit currents. Additional guidance is provided in the instructions included with the listing.~~

First Revision No. 8343-NFPA 70-2024 [Section No. 690.8(A)(2)]

[See attached Word document for updates to 690.8 (A)(2)]

(2) Circuits ~~Connected to~~ Terminating on the Input of Electronic Power Converters (EPC) .

Where a circuit is ~~protected with an overcurrent device not exceeding the conductor ampacity~~ terminated at the input of an electronic power converter , the maximum current shall be permitted to be the rated input current of the electronic power converter input to which it is ~~connected.~~ terminated provided one of the following conditions is met:

(a) The circuit terminated at the input of the EPC is protected at its source of supply with an overcurrent device not exceeding the conductor ampacity.

(b) The circuit complies with 690.9(A)(1) for the maximum current as calculated in 690.8(A)(1).

(c) The circuit complies with 690.9(A)(3).

Informational Note: Electronic power converters have rated maximum input short-circuit ratings. See 110.3(B).

Supplemental Information

File Name	Description	Approved
70_CMP4_FR8343_690.8_A_2_.docx		

Submitter Information Verification

Committee: NEC-P04
Submittal Date: Sun Jan 21 14:56:25 EST 2024

Committee Statement

Committee Statement: A change from “Connected to” to “Terminated on” was made to clarify this subsection applies to the circuit connected to the device, not any circuit upstream or downstream of the device.

A list has been created to more clearly outline all the options available to these circuits. For option (a) the location of the overcurrent device has been clarified to be at the portion of the circuit where the power source supplies it, not at the EPC. Options (b) and (c) are provided to make clear in this one location that all these options are available for these circuits.

An informational note has been added to alert users that some equipment may have maximum input ratings that would need to be complied with through the equipment’s listing.

Response Message: FR-8343-NFPA 70-2024

Public Input No. 2474-NFPA 70-2023 [Section No. 690.4(B)]

Public Input No. 3156-NFPA 70-2023 [Sections 690.8, 690.9]

Section 690.8(A)(2)

(2) Circuits ~~Connected~~ Terminating on~~to~~ the Input of Electronic Power Converters (EPC).

Where a circuit is~~ protected with an overcurrent device not exceeding the conductor ampacity~~ terminated at the input of an electronic power converter, the maximum current shall be permitted to be the rated input current of the electronic power converter input to which it is ~~connected~~terminated provided one of the following conditions is met:~~.~~

(a) The circuit terminated at the input of the EPC is protected at its source of supply with an overcurrent device not exceeding the conductor ampacity.

(b) The circuit complies with 690.9(A)(1) for the maximum current as calculated in 690.8(A)(1).

(c) The circuit complies with 690.9(A)(3).

Informational Note: Electronic power converters have rated maximum input short-circuit ratings. See 110.3(B).

First Revision No. 8351-NFPA 70-2024 [Section No. 690.8(B)(1)]

(1) Without Adjustment and Correction Factors.

The minimum conductor size with an ampacity not less than the maximum currents calculated in 690.8(A) multiplied by 125 percent.

Exception No. 1 : Circuits containing an assembly, together with its overcurrent device(s), if any, that is listed for continuous operation at 100 percent of its rating shall be permitted to be used at 100 percent of its rating.

Exception No. 2: Where a portion of a circuit 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 calculated maximum current of 690.8(A). No portion of the circuit installed under this exception shall extend into an enclosure containing either the circuit supply or the circuit load terminations, as covered in 110.14(C)(1).

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Sun Jan 21 15:27:01 EST 2024

Committee Statement

Committee Statement: Language is added to clarify that in the case a circuit has no overcurrent devices the exception may still be used provided the rest of the equipment in the circuit is listed for continuous operation at 100 percent of its rating or ampacity.

Exception No. 2 is added to harmonize ampacity requirements in this Section with Sections 210.19(A)(1), 215.2(A)(1), and 705.28(B).

Response Message: FR-8351-NFPA 70-2024

Public Input No. 3490-NFPA 70-2023 [Section No. 690.8(B)(1)]

Public Input No. 381-NFPA 70-2023 [Section No. 690.8(B)(1)]

First Revision No. 8355-NFPA 70-2024 [Section No. 690.9(A) [Excluding any Sub-Sections]]

PV system dc circuit and inverter output conductors and equipment shall be protected against overcurrent. ~~Circuits sized in accordance with 690.8(A)(2) are required to be protected against overcurrent with overcurrent protective devices.~~ Each circuit shall be protected from overcurrent in accordance with 690.9(A)(1), (A)(2), or (A)(3).

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Sun Jan 21 15:36:00 EST 2024

Committee Statement

Committee Statement: The requirement to provide overcurrent protective devices to be listed has been deleted since all listing requirements now reside in 690.2 to align with the NEC Style Manual, 2.2.1. Also see related action taken on 690.4(B).

Response Message: FR-8355-NFPA 70-2024

First Revision No. 8356-NFPA 70-2024 [Section No. 690.9(B)]

(B) Device Ratings.

~~Overcurrent devices used in PV source circuits shall be listed for use in PV systems.~~ Electronic devices that are listed to prevent backfeed current in PV system dc circuits shall be permitted to prevent overcurrent of conductors on the PV array side of the device. Overcurrent devices, where required, shall be rated in accordance with one of the following and permitted to be rounded up to the next higher standard size in accordance with 240.4(B):

(1) Overcurrent devices shall be rated not less than 125 percent of the maximum currents calculated in 690.8(A).

(2) An assembly, together with its overcurrent device(s), that is listed for continuous operation at 100 percent of its rating shall be permitted to be used at 100 percent of its rating.

Informational Note: Some electronic devices prevent backfeed current, which in some cases is the only source of overcurrent in PV system dc circuits.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Sun Jan 21 15:39:14 EST 2024

Committee Statement

Committee Statement: The requirement for overcurrent devices to be listed has been deleted since all listing requirements now reside in 690.2 to align with the NEC Style Manual, 2.2.1. Also see related action taken on 690.4(B).

Response Message: FR-8356-NFPA 70-2024

First Revision No. 8366-NFPA 70-2024 [Section No. 690.9(D)]

~~**(D)** Transformers.~~

~~Overcurrent protection for power transformers shall be installed in accordance with 705.30(F) .~~

~~*Exception: A power transformer with a current rating on the side connected toward the interactive inverter output, not less than the rated continuous output current of the inverter, shall be permitted without overcurrent protection from the inverter.*~~

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Sun Jan 21 16:09:16 EST 2024

Committee Statement

Committee Statement: Section is deleted since article 705 is the correct location for interconnection of PV systems to a utility-supplied grid or other primary source. 705.30 (F) addresses the requirements for transformers used with interconnected electric power production sources. Deletion of the current language from 690 combined with the revised 2023 NEC transformer requirements of 705.30(F) increase clarity and aid in enforcement for the inspection community. Previous 690.9(D) language was retained for the 2023 edition only to provide a pointer to the new 705.30(F).

Response Message: FR-8366-NFPA 70-2024

Public Input No. 499-NFPA 70-2023 [Section No. 690.9(D)]

Public Input No. 894-NFPA 70-2023 [Section No. 690.9(D)]

Public Input No. 3010-NFPA 70-2023 [Section No. 690.9(D)]

First Revision No. 9270-NFPA 70-2024 [Section No. 690.12(B)(2)]

[See attached Word document for revisions to 690.12 (B)(2).]

(2) Inside the Array Boundary.

The PV system shall comply with ~~one of the following:~~ 690.12(B)(2)(a) or 690.12(B)(2)(b).

(1) (a) The PV system shall provide shock hazard control for firefighters through the use of a PVHCS installed in accordance with the instructions included with the listing or field labeling. Where a PVHCS requires initiation to transition to a controlled state, the rapid shutdown initiation device required in 690.12(C) shall perform this initiation.

Informational Note ~~No. 1~~ : See UL 3741, *Photovoltaic Hazard Control* . A listed or field-labeled PVHCS is comprised of either an individual piece of equipment that fulfills the necessary functions or multiple pieces of equipment coordinated to perform the functions as described in the installation instructions to reduce the risk of electric shock hazard within a damaged PV array for firefighters. ~~See UL 3741, *Photovoltaic Hazard Control* .~~

(2) (b) The PV system shall provide shock hazard control for firefighters by limiting the highest voltage inside equipment or between any two conductors of a circuit or any conductor and ground inside array boundary to not more than 80 volts within 30 seconds of rapid shutdown initiation.

Informational Note ~~No. 2~~ : Common methods include the use of PV equipment with a limited maximum voltage of 80 volts as determined by 690.7, PVRSE, PVHCE, or any combination of these.

Supplemental Information

File Name	Description	Approved
70_CMP4_FR9270_690.12_B_2_.docx	Revisions to 690.12(B)(2).	
70_CMP4_FR9270_690.12_B_2.docx	For prod use	

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Fri Jan 26 14:06:26 EST 2024

Committee Statement

Committee Statement: Section 690.12(B)(2) has been revised to align with the NEC style manual. The edition year for the UL references has been included and subsections updated to remove the numbered indication for the informational notes.

Response Message: FR-9270-NFPA 70-2024

(2) Inside the Array Boundary.
The PV system shall comply with ~~one of the following:~~690.12(B)(2)(a) or 690.12(B)(2)(b).

(~~1~~a) The PV system shall provide shock hazard control for firefighters through the use of a PVHCS installed in accordance with the instructions included with the listing or field labeling. Where a PVHCS requires initiation to transition to a controlled state, the rapid shutdown initiation device required in 690.12(C) shall perform this initiation.

Informational Note ~~No. 1~~: See UL 3741-2020, *Photovoltaic Hazard Control*. A listed or field-labeled PVHCS is comprised of either an individual piece of equipment that fulfills the necessary functions or multiple pieces of equipment coordinated to perform the functions as described in the installation instructions to reduce the risk of electric shock hazard within a damaged PV array for firefighters. ~~See UL 3741, *Photovoltaic Hazard Control*.~~

(~~2~~b) The PV system shall provide shock hazard control for firefighters by limiting the highest voltage inside equipment or between any two conductors of a circuit or any conductor and ground inside array boundary to not more than 80 volts within 30 seconds of rapid shutdown initiation.

Informational Note ~~No. 2~~: Common methods include the use of PV equipment with a limited maximum voltage of 80 volts as determined by 690.7, PVRSE, PVHCE, or any combination of these.

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First Revision No. 8369-NFPA 70-2024 [Section No. 690.12(C)]

[See attached Word Document for changes.]

(C) Initiation Device.

Where circuits identified in 690.12(A) are required to meet the requirements in 690.12(B), an initiation device(s) shall be provided and shall initiate the rapid shutdown function. The device's "off" position shall indicate that the rapid shutdown function has been initiated for all PV systems connected to that device. For one-and two-family dwellings, an initiation device(s), where required, shall be located at a readily accessible outdoor location.

For a single PV system, the rapid shutdown initiation shall occur by the operation of any single initiation device. Devices shall consist of at least one or more of the following:

(1) Service disconnecting means

(2) PV system disconnecting means

(3) Readily accessible switch that plainly indicates whether it is in the "off" or "on" position

Where multiple PV systems are installed with rapid shutdown functions on a single service, the initiation device(s) shall consist of not more than six switches or six sets of circuit breakers, or a combination of not more than six switches and sets of circuit breakers, mounted in a single enclosure, or in a group of separate enclosures. These initiation device(s) shall initiate the rapid shutdown of all PV systems with rapid shutdown functions on that service.

Supplemental Information

File Name	Description	Approved
70_CMP4_FR8369_690.12_C.docx	Revisions to 690.12(C).	
70_CMP4_FR8369_690.12_C.docx	For prod use	

Submitter Information Verification

Committee: NEC-P04
Submittal Date: Sun Jan 21 16:17:17 EST 2024

Committee Statement

Committee Statement: Reorganization of this section into subdivisions has been made for ease of use and to better comply with the NEC Style Manual.

The phrase "readily accessible" is moved to apply generally to all devices, reduce redundancy, and add clarity.

Language which points to the listed rapid shutdown equipment language has been added to ensure the initiation device selected does not conflict with the operation of the equipment.

Language around the use of listed switches in (3) has been simplified and "listed" has been added to reinforce that the devices used be suitable for the application and conditions of use.

Some listed devices do not include "Off" and "On" markings while their operation is

widely understood, so the marking requirement has been deleted.

Language specifically allowing additional means of initiation has been added to recognize that there may be other methods to initiate rapid shutdown in addition to the required manual initiation device. This change does not eliminate the existing requirement for a manually operated initiation device in (C)(1).

Rework of the language addressing multiple PV systems has been done to improve ease of use and to clarify that the acceptable devices are those as identified in (C)(1) and that, where used, these shall be grouped.

Response Message: FR-8369-NFPA 70-2024

Public Input No. 3986-NFPA 70-2023 [Section No. 690.12(C)]

Public Input No. 4180-NFPA 70-2023 [Section No. 690.12(C)]

690.12(C)

(C) Initiation Device.

Where circuits identified in 690.12(A) are required to meet the requirements in 690.12(B), an initiation device~~(s)~~ meeting the requirements in 690.12(C)(1) through 690.12(C)(3) shall be provided ~~and shall~~ to initiate the rapid shutdown function.

~~The device's "off" position shall indicate that the rapid shutdown function has been initiated for all PV systems connected to that device. For one-and two-family dwellings, an initiation device(s), where required, shall be located at a readily accessible outdoor location.~~

~~For a single PV system, the rapid shutdown initiation shall occur by the operation of any single initiation device.~~

(1) Type and Location. The initiation d~~D~~evice~~s~~ shall be readily accessible and shall consist of ~~at least~~ one or more of the following as specified in the rapid shutdown equipment instructions:

(1) Service disconnecting means

(2) PV system disconnecting means

(3) A listed switch ~~Readily accessible switch that plainly indicates whether it is in the "off" or "on" position~~

For one-and two-family dwellings, initiation devices, where required, shall be located at a readily accessible outdoor location.

(2) Operation. The device's "off" position shall perform the rapid shutdown function for all PV systems connected to that device. Additional manual or automatic initiation methods not meeting the requirements in 690.12(C)(1) shall be permitted. For a single PV system, the rapid shutdown initiation shall occur by the operation of any single initiation device.

(3) More than One System. Where multiple PV systems are installed with rapid shutdown functions on a single service, ~~the~~ initiation device~~s(s)~~ shall consist of not more than six ~~switches or six sets of circuit breakers, or a combination of not more than six switches and sets of circuit breakers, mounted in a single enclosure, or in a group of separate enclosures. These initiation device(s)~~ devices meeting the requirements in 690.12(C)(1) grouped together whose combined operation shall initiate the rapid shutdown of all PV systems with rapid shutdown functions on that service.

First Revision No. 8377-NFPA 70-2024 [Section No. 690.12(D) [Excluding any Sub-Sections]]

Buildings with PV systems shall have a permanent label located at each service equipment location to which the PV systems are connected or at an approved readily visible location and shall indicate the location of rapid shutdown initiation devices. The label shall include a simple diagram of a building with a roof and shall include the following words:

SOLAR PV SYSTEM ~~IS~~ EQUIPPED WITH RAPID SHUTDOWN.

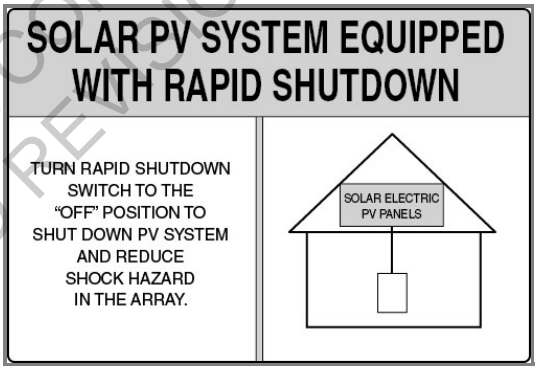
TURN RAPID SHUTDOWN SWITCH TO THE "OFF" POSITION TO SHUT DOWN

PV SYSTEM AND REDUCE SHOCK HAZARD IN ARRAY.

The title "SOLAR PV SYSTEM ~~IS~~ EQUIPPED WITH RAPID SHUTDOWN" shall have these letters capitalized and having a minimum height of 9.5 mm (3/8 in.). All text shall be legible and contrast the background.

Informational Note: See Informational Note Figure 690.12(D).

~~Figure Informational~~ Informational Note Figure 690.12(D) Label for Roof-Mounted PV Systems with Rapid Shutdown.



Submitter Information Verification

Committee: NEC-P04

Submittal Date: Sun Jan 21 16:36:59 EST 2024

Committee Statement

Committee Statement: The word "is" is removed as unnecessary to communicate this information. This is also consistent with the Figure in the informational note. As written the requirement allows for additional language for tailoring for a specific use.

Response Message: FR-8377-NFPA 70-2024

Public Input No. 458-NFPA 70-2023 [Section No. 690.12(D) [Excluding any Sub-Sections]]

First Revision No. 8434-NFPA 70-2024 [Section No. 690.13]

[See attached Word Document for revisions to 690. 13.]

690. 13 Photovoltaic System Disconnecting Means.

Means shall be provided to disconnect the PV system from all wiring systems including power systems, energy storage systems, and utilization equipment and its associated premises wiring.

(A) Location.

(1) Readily Accessible.

The PV system disconnecting means shall be installed at a readily accessible location.

(2) Enclosure Doors and Covers.

Where a disconnecting means for circuits operating above 30 volts is readily accessible to unqualified persons, an enclosure door or hinged cover that exposes energized parts when open shall have its door or cover locked or require a tool to be opened.

(B) Marking.

Each PV system disconnecting means shall plainly indicate whether in the open (off) or closed (on) position and be permanently marked “PV SYSTEM DISCONNECT” or equivalent. Additional markings shall be permitted based upon the specific system configuration. For PV system disconnecting means where the line and load terminals may be energized in the open position, the device shall be marked with the following words or equivalent:

WARNING

ELECTRIC SHOCK HAZARD TERMINALS ON THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION

The warning sign(s) or label(s) shall comply with 110.21(B).

(C) Maximum Number of Disconnects.

Each PV system disconnecting means shall consist of not more than six switches or six sets of circuit breakers, or a combination of not more than six switches and sets of circuit breakers, mounted in a single enclosure, or in a group of separate enclosures. A single PV system disconnecting means shall be permitted for the combined ac output of one or more inverters or ac modules.

Informational Note: This requirement does not limit the number of PV systems connected to a service as permitted in 690.4(D). This requirement allows up to six disconnecting means to disconnect a single PV system. For PV systems where all power is converted through interactive inverters, a dedicated circuit breaker, in 705.12(B)(1), is an example of a single PV system disconnecting means.

(D) Ratings.

The PV system disconnecting means shall have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals of the PV system disconnect.

(E) Type of Disconnect.

The PV system disconnecting means shall simultaneously disconnect the PV system conductors that are not solidly grounded from all conductors of other wiring systems. The PV system disconnecting means or its remote operating device or the enclosure providing access to the disconnecting means shall be capable of being locked in accordance with 110.25. The PV system disconnecting means shall be one of the following:

(1) A manually operable switch or circuit breaker

(2) A connector meeting the requirements of 690.33(D)(1) or (D)(3)

(3) A pull-out switch with the required interrupting rating

(4) A remote-controlled switch or circuit breaker that is operable locally and opens automatically when control power is interrupted

(5) A device listed or approved for the intended application

Informational Note: Circuit breakers marked “line” and “load” may not be suitable for backfeed or reverse current.

Supplemental Information

File Name	Description	Approved
70_CMP4_FR8434_690.13.docx		

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Mon Jan 22 10:29:05 EST 2024

Committee Statement

Committee Statement: The trend is for multiple power sources to be used on the same premises. There are advantages to users of this Code toward having harmonized source system disconnecting means wherever possible. Therefore, a pointer has been made to 705.20 and duplicative content has been removed from this section.

Section 690.13(A)(2) has been removed with the addition of 404.30 during the last cycle. Relying on the product listings will ensure such requirements are applied consistently. No additional hazards exist for users of this equipment from those supplied by other power sources.

Unnecessary permissive language on markings has been removed.

References to specific sections are removed from the informational note as unnecessary.

The text addressing locking is revised to comply with the NEC Style Manual.

The list of disconnecting means types has been removed since it is largely duplicative with 705.20. The reference to specific connector requirements is removed as redundant and since such a device would be covered under 705.20(1)(d).

Suitable disconnecting means devices and their markings are covered under 705.20.

Response Message: FR-8434-NFPA 70-2024

Public Input No. 4483-NFPA 70-2023 [Section No. 690.13]

Public Input No. 3090-NFPA 70-2023 [Section No. 690.13(E)]

Public Input No. 3009-NFPA 70-2023 [Section No. 690.13(A)(2)]

Public Input No. 4017-NFPA 70-2023 [Section No. 690.13(E)]

Public Input No. 3393-NFPA 70-2023 [Section No. 690.13(B)]

Public Input No. 2544-NFPA 70-2023 [Section No. 690.13(E)]

690.13 Photovoltaic System Disconnecting Means.

PV system disconnecting means shall be installed in accordance with ~~Article~~ 705.20.~~Means shall be provided to disconnect the PV system from all wiring systems including power systems, energy storage systems, and utilization equipment and its associated premises wiring.~~

~~**(A) Location.**~~

~~**(1) Readily Accessible.**~~

~~The PV system disconnecting means shall be installed at a readily accessible location.~~

~~**(2) Enclosure Doors and Covers.**~~

~~Where a disconnecting means for circuits operating above 30 volts is readily accessible to unqualified persons, an enclosure door or hinged cover that exposes energized parts when open shall have its door or cover locked or require a tool to be opened.~~

(B) Marking.

Each PV system disconnecting means shall ~~plainly indicate whether in the open (off) or closed (on) position and~~ be permanently marked "PV SYSTEM DISCONNECT" or equivalent. ~~Additional markings shall be permitted based upon the specific system configuration. For PV system disconnecting means where the line and load terminals may be energized in the open position, the device shall be marked with the following words or equivalent:~~

~~WARNING~~

~~ELECTRIC SHOCK HAZARD TERMINALS ON THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION~~

~~The warning sign(s) or label(s) shall comply with 110.21(B).~~

(C) Maximum Number of Disconnects.

Each PV system disconnecting means shall consist of not more than six switches or six sets of circuit breakers, or a combination of not more than six switches and sets of circuit breakers, mounted in a single enclosure, or in a group of separate enclosures. A single PV system disconnecting means shall be permitted for the combined ac output of one or more inverters or ac modules.

> Informational Note: This requirement does not limit the number of PV systems connected to a service ~~as permitted in 690.4(D)~~. This requirement allows up to six disconnecting means to disconnect a single PV system. For PV systems where all power is converted through interactive inverters, a dedicated circuit breaker~~, in 705.12(B)(1),~~ is an example of a single PV system disconnecting means.

~~**(D) Ratings.**~~

~~The PV system disconnecting means shall have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals of the PV system disconnect.~~

(~~E~~A) Type of Disconnect.

The PV system disconnecting means shall simultaneously disconnect the PV system conductors that are not solidly grounded from all conductors of other wiring systems. The PV system disconnecting means or its remote operating device or the enclosure providing access to the disconnecting means shall be ~~capable of being locked~~lockable open in accordance with 110.25. ~~The PV system disconnecting means shall be one of the following:~~

~~(1) A manually operable switch or circuit breaker~~

~~(2) A connector meeting the requirements of 690.33(D)(1) or (D)(3)~~

~~(3) A pull-out switch with the required interrupting rating~~

~~(4) A remote-controlled switch or circuit breaker that is operable locally and opens automatically when control power is interrupted~~

~~(5) A device listed or approved for the intended application~~

~~Informational Note: Circuit breakers marked "line" and "load" may not be suitable for backfeed or reverse current.~~

First Revision No. 8893-NFPA 70-2024 [Section No. 690.15(C)]

[See attached Word Document for revisions to 690.15 (C).]

(C) Equipment Disconnecting Means.

Equipment disconnecting means shall comply with the following:

(1) Have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals.

(2) Simultaneously disconnect all current-carrying conductors that are not solidly grounded to the circuit to which it is connected.

(3) Be externally operable without exposing the operator to contact with energized parts and shall indicate whether in the open (off) or closed (on) position. ~~Where not within sight or not within 3 m (10 ft) of the equipment, the disconnecting means or its remote operating device or the enclosure providing access to the disconnecting means shall be capable of being locked in accordance with 110.25 .~~

(4) Be one of the ~~types in 690.13(E) (1) through (E)(5).~~ following types:

(a) a manually operable switch or circuit breaker

(b) a load-break-rated pull-out switch

(c) a device listed or approved for the intended application

Equipment disconnecting means, other than those complying with 690.33, shall be marked in accordance with the warning in ~~690~~ 705 ~~.13~~ 20 (~~B~~ F) if the line and load terminals can be energized in the open position.

Informational Note: A common installation practice is to terminate PV source-side dc conductors in the same manner that utility source-side ac conductors are generally connected on the line side of a disconnecting means. This practice is more likely to de-energize load-side terminals, blades, and fuses when the disconnect is in the open position and no energized sources are connected to the load side of the disconnect.

Supplemental Information

File Name	Description	Approved
70_CMP4_FR8893_690.15_C_.docx	Revisions to 690.15(C)	
70_CMP4_FR8893_690.15_C.docx	For prod use	

Submitter Information Verification

Committee: NEC-P04
Submittal Date: Wed Jan 24 11:11:16 EST 2024

Committee Statement

Committee Statement: Section 690.15(C)(3) was revised to remove duplication and potential conflicts between 690.15(C)(3) and 690.15(D).

Section 690.15(C)(4) was revised to add a list of acceptable types of equipment disconnecting means. The addition of this list was necessary due to other revisions to

690.13. List now matches those in the related 705.20. Reference to the label previously outlined in 690.13(B) was removed with new reference to 705.20(F) to ensure requirements remain unchanged.

Response Message: FR-8893-NFPA 70-2024

Public Input No. 2545-NFPA 70-2023 [Section No. 690.15(C)]

Section 690.15(C)

(3) Be externally operable without exposing the operator to contact with energized parts and shall indicate whether in the open (off) or closed (on) position. ~~Where not within sight or not within 3 m (10 ft) of the equipment, the disconnecting means or its remote operating device or the enclosure providing access to the disconnecting means shall be capable of being locked in accordance with 110.25.~~

(4) Be one of the following types:

(a) a manually operable switch or circuit breaker

(b) a load-break-rated pull-out switch

(c) a device listed or approved for the intended application

~~in 690.13(E)(1) through (E)(5).~~

Equipment disconnecting means, other than those complying with 690.33, shall be marked in accordance with the warning in ~~690.13(B)~~ 705.20(F) if the line and load terminals can be energized in the open position.

Informational Note: A common installation practice is to terminate PV source-side dc conductors in the same manner that utility source-side ac conductors are generally connected on the line side of a disconnecting means. This practice is more likely to de-energize load-side terminals, blades, and fuses when the disconnect is in the open position and no energized sources are connected to the load side of the disconnect.

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First Revision No. 8981-NFPA 70-2024 [Section No. 690.15(D)]

[See attached Word document for revisions to 690.15 (D).]

(D) Location and Control.

Isolating devices or equipment disconnecting means shall comply with one or more of the following:

(1) Located within the equipment

(2) Located in sight from and readily accessible from the equipment for those to whom access is required

(3) Lockable open in accordance with 110.25

(4) Located in an enclosure with a door or cover capable of being locked closed that restricts access to the operation of the disconnecting means

(5) Provided with remote controls to activate the disconnecting means ~~where the remote controls~~ that comply with one of the following:

(6) The disconnecting means and their controls are located within the same equipment.

(7) The disconnecting means is lockable open in accordance with 110.25 , and the location of the controls are marked on the disconnecting means.

Supplemental Information

File Name	Description	Approved
70_CMP4_FR8981_690.15_D_.docx	Revisions to 690.15(D)	
70_CMP4_FR8981_690.15_D.docx	For prod use	

Submitter Information Verification

Committee: NEC-P04
Submittal Date: Wed Jan 24 14:53:53 EST 2024

Committee Statement

Committee Statement: In section (D) text was revised to comply with NEC Style Manual Section 3.2.5 Consistent Application of Terms, 3.2.5.3 Lockable Open. New list item section (D)(4) was added to continue to allow a lockable enclosure cover to be used to maintain control of an open disconnecting means inside the enclosure. Text in list item (5) was updated simplified for ease of use.

Response Message: FR-8981-NFPA 70-2024

Public Input No. 2546-NFPA 70-2023 [Section No. 690.15(D)]

690.15(D) Location and Control.
Isolating devices or equipment disconnecting means shall comply with one or more of the following:

(1) Located within the equipment

(2) Located in sight from and readily accessible from the equipment for those to whom access is required

(3) Lockable open in accordance with 110.25

(4) Located in an enclosure with a door or cover capable of being locked closed that restricts access to the operation of the disconnecting means

(5) Provided with remote controls to activate the disconnecting means that ~~where the remote controls~~ comply with one of the following:

a. The disconnecting means and their controls are located within the same equipment.

b. The disconnecting means is lockable open in accordance with 110.25, and the location of the controls are marked on the disconnecting means.

First Revision No. 8448-NFPA 70-2024 [Section No. 690.31(A)(4)]

(4) Special Equipment.

In addition to wiring methods included elsewhere in this *Code*, other wiring systems ~~specifically~~ listed for use in PV systems shall be permitted.

Informational Note: See 110.14(C) for conductor temperature limitations due to termination provisions.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Mon Jan 22 11:24:54 EST 2024

Committee Statement

Committee Statement: The word “specifically” is not needed to apply this allowance and has been removed.

Response Message: FR-8448-NFPA 70-2024

Public Input No. 572-NFPA 70-2023 [Section No. 690.31(A)(4)]

First Revision No. 8449-NFPA 70-2024 [Section No. 690.31(B)(1)]

[See attached Word Document for revsions to 690.31 (B)(1) .]

(1) Conductors of Different Systems.

~~Where not otherwise allowed in an equipment's listing,~~ PV system dc circuits shall not occupy the same equipment wiring enclosure, cable, or raceway as other non-PV systems or inverter output circuits unless ~~separated from other circuits by a barrier or partition.~~

~~Exception:~~ ~~Where all~~

installed in accordance with one or more of the following:

(1) A barrier or partition separates the PV system dc circuits from the other circuits.

(2) The installation of other circuit conductors is permitted by the equipment listing.

(3) All conductors or cables have an insulation rating equal to at least the maximum circuit voltage applied to any conductor installed within the same wiring method

~~, the following shall be permitted:Multiconductor jacketed cables for remote control, signaling, or power-limited circuits shall be permitted within the same wiring enclosure, cable, or raceway as~~

(1) and the PV system dc circuits

~~where all circuits serve the PV system.Inverter output circuits shall be permitted to occupy the same junction box, pull box, or wireway with PV system dc circuits that~~

(1) are identified and grouped as required by 690.31(B)(2) and (B)(3).

~~PV system dc circuits utilizing multiconductor jacketed cable or metal-clad cable assemblies or listed wiring harnesses identified for the application shall be permitted to occupy the same wiring method as inverter output circuits and other non-PV systems~~

(1) The other circuit conductors are part of a multiconductor jacketed cable with a jacket insulation rating equal to at least the maximum circuit voltage applied to any conductor installed within the same wiring method, and are used for remote control, signaling, or a Class 1 power-limited circuit associated with the PV system or energy management system .

Supplemental Information

File Name	Description	Approved
70_CMP4_FR8449_690.31_B_1_.docx		
70_CMP4_FR8449_690.31_B_1.docx	For prod use	

Submitter Information Verification

Committee: NEC-P04
Submittal Date: Mon Jan 22 11:27:08 EST 2024

Committee Statement

Committee The exceptions are revised to positive code language in accordance with 2.1.9 of the

Statement: Style Manual. The revised text maintains similar requirements as the 2023 NEC. Conductors associated with an energy management system are added to the permitted applications since it is increasingly common for monitoring and control circuits to be used with both PV and EMS applications.

Response Message: FR-8449-NFPA 70-2024

Public Input No. 3810-NFPA 70-2023 [Section No. 690.31(B)(1)]

(B) Identification and Grouping.

(1) Conductors of Different Systems.

~~Where not otherwise allowed in an equipment's listing,~~ PV system dc circuits shall not occupy the same equipment wiring enclosure, cable, or raceway as other non-PV systems or inverter output circuits unless ~~separated from other circuits by a barrier or partition.~~ installed in accordance with one or more of the following:

1. A barrier or partition separates the PV system dc circuits from the other circuits.
2. The installation of other circuit conductors is permitted by the equipment listing.
3. All conductors or cables have an insulation rating equal to at least the maximum circuit voltage applied to any conductor installed within the same wiring method and the PV system dc circuits are identified and grouped as required by 690.31(B)(2) and (B)(3).
4. The other circuit conductors are part of a multiconductor jacketed cable with a jacket insulation rating equal to at least the maximum circuit voltage applied to any conductor installed within the same wiring method, and are used for remote control, signaling, or a Class 1 power-limited circuit associated with the PV system or energy management system.

~~*Exception: Where all conductors or cables have an insulation rating equal to at least the maximum circuit voltage applied to any conductor within the same wiring method, the following shall be permitted:*~~

~~*(1) Multiconductor jacketed cables for remote control, signaling, or power-limited circuits shall be permitted within the same wiring enclosure, cable, or raceway as PV system dc circuits where all circuits serve the PV system.*~~

~~*(2) Inverter output circuits shall be permitted to occupy the same junction box, pull box, or wireway with PV system dc circuits that are identified and grouped as required by 690.31(B)(2) and (B)(3).*~~

~~*(3) PV system dc circuits utilizing multiconductor jacketed cable or metal-clad cable assemblies or listed wiring harnesses identified for the application shall be permitted to occupy the same wiring method as inverter output circuits and other non-PV systems.*~~

First Revision No. 8457-NFPA 70-2024 [Section No. 690.31(B)(2)]

(2) Identification.

PV system dc circuit conductors shall be identified at all termination, connection, and splice points by color coding, marking tape, tagging, or other approved means in accordance ~~with 690~~ 705 . ~~31~~ 25 (~~B~~ D)(~~2~~ 1) through 705.25 (a D) ~~and (B)(2)(b)~~ 3) .

Exception: Where the identification of the conductors is evident by spacing or arrangement, further identification shall not be required.

(a) ~~Conductors that rely on other than color coding for polarity identification shall be identified by an approved permanent marking means such as labeling, sleeving, or shrink-tubing that is suitable for the conductor size.~~

(b) ~~The permanent marking means for nonsolidly grounded positive conductors shall include imprinted plus signs (+) or the word POSITIVE or POS durably marked on insulation of a color other than green, white, or gray. The permanent marking means for nonsolidly grounded negative conductors shall include imprinted negative signs (−) or the word NEGATIVE or NEG durably marked on insulation of a color other than green, white, gray, or red. Only solidly grounded PV system dc circuit conductors shall be marked in accordance with 200.6 .~~

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Mon Jan 22 11:48:57 EST 2024

Committee Statement

Committee Statement: Requirements have been moved to new 705.25(D) to create a common set of requirements for all dc conductors associated with dc power sources. Revised language points to the specific requirements in 705.25(D)(1) through 705.25(D)(3) instead of the entire subdivision since the marking requirements apply to all PV dc circuit conductors, not just those on the PV power source output.

Response Message: FR-8457-NFPA 70-2024

Public Input No. 2058-NFPA 70-2023 [Section No. 690.31(B)(2)]

First Revision No. 9275-NFPA 70-2024 [Section No. 690.31(C)]

[See attached Word document for revisions to 690.31 (C).]

(C) Cables.

Type PV wire or cable and Type distributed generation (DG) cable shall be listed.

Informational Note: See UL 4703, *Standard for Photovoltaic Wire*, for PV wire and UL 3003, *Distributed Generation Cables*, for DG cable. PV wire and cable and DG cable have a nonstandard outer diameter.

(1) Single-Conductor Cable.

Single-conductor cables shall comply with 690.31(C)(1)(a) through (C)(1)(c).

(a) Single-conductor cable in exposed outdoor locations in PV system dc circuits within the PV array shall be permitted to be one of the following:

(2) PV wire or cable

(3) Single-conductor cable marked sunlight resistant and Type USE-2 and Type RHW-2

(d) Exposed cables sized 8 AWG or smaller shall be supported and secured at intervals not to exceed 600 mm (24 in.) by cable ties, straps, hangers, or similar fittings listed and identified for securement and support in outdoor locations. PV wire or cable shall be permitted in all locations where RHW-2 is permitted.

Exception: PV systems meeting the requirements of 691.4 shall be permitted to have support and securement intervals as defined in the engineered design.

(e) Exposed cables sized larger than 8 AWG shall be supported and secured at intervals not to exceed 1400 mm (54 in.) by cable ties, straps, hangers, or similar fittings listed and identified for securement and support in outdoor locations.

(2) Cable Tray.

Single-conductor PV wire or cable of all sizes or distributed generation (DG) cable of all sizes, with or without a cable tray rating, shall be permitted in cable trays installed in outdoor locations, provided that the cables are supported at intervals not to exceed 300 mm (12 in.) and secured at intervals not to exceed 1400 mm (54 in.).

Where installed in uncovered cable trays, ampacity of single-conductor PV wire smaller than 1/0 AWG, the adjustment factors for 1/0 AWG single conductor cable in 392.80(A)(2) shall be permitted to be used.

Where single-conductor PV wire smaller than 1/0 AWG is installed in ladder ventilated trough cable trays, the following shall apply:

(1) All single conductors shall be installed in a single layer.

(2) Conductors that are bound together to comprise each circuit pair shall be permitted to be installed in other than a single layer.

(3) The sum of diameters of all single conductor cables shall not exceed the cable tray width.

(3) Multiconductor Jacketed Cables.

Where part of a listed PV assembly, multiconductor jacketed cables shall be installed in accordance with the included instructions. Where not part of a listed assembly, or where not otherwise covered in this *Code*, multiconductor jacketed cables, including DG cable, shall be installed in accordance with the product listing and shall be permitted in PV systems. These cables shall be installed in accordance with the following:

(1) In raceways, where on or in buildings other than rooftops

(2) Where not in raceways, in accordance with the following:

(3) Marked sunlight resistant in exposed outdoor locations

(4) Protected or guarded, where subject to physical damage

(5) Closely follow the surface of support structures

(6) Secured at intervals not exceeding 1.8 m (6 ft)

(7) Secured within 600 mm (24 in.) of mating connectors or entering enclosures

(8) Marked direct burial, where buried in the earth

(4) Flexible Cords and Cables Connected to Tracking PV Arrays.

Flexible cords and flexible cables, where connected to moving parts of tracking PV arrays, shall comply with Article 400 and shall be of a type identified as a hard service cord or portable power cable; they shall be suitable for extra-hard usage, listed for outdoor use, water resistant, and sunlight resistant. Allowable ampacities shall be in accordance with 400.5. Stranded copper PV wire shall be permitted to be connected to moving parts of tracking PV arrays in accordance with the minimum number of strands specified in Table 690.31(C)(4).

Table 690.31(C)(4) Minimum PV Wire Strands

PV Wire AWG	Minimum Strands
18	17
16–10	19
8–4	49
2	130
1 AWG–1000 MCM	259

(5) Flexible, Fine-Stranded Cables.

Flexible, fine-stranded cables shall be terminated only with terminals, lugs, devices, or connectors in accordance with 110.14.

(6) Small-Conductor Cables.

Single-conductor cables listed for outdoor use that are sunlight resistant and moisture resistant in sizes 16 AWG and 18 AWG shall be permitted for module interconnections where such cables meet the ampacity requirements of 400.5. Section 310.14 shall be used to determine the cable ampacity adjustment and correction factors.

Supplemental Information

File Name	Description	Approved
70_CMP4_FR9275_690.31_C_.docx	Revisions to 690.31(C).	

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Fri Jan 26 15:20:42 EST 2024

Committee Statement

Committee Statement: For Section 690.31(C)(1):

The reference to RHW-2 is relocated since the previous structure of this section incorrectly inferred that the RHW-2 reference only applied to conductors #8 and smaller.

Some of the examples for suitable supports have been removed with the general term kept to better capture the range of suitable supports. The use of “and” was changed to “or” since some supports may only be individually recognized as part of a listed mounting system. In those cases, they will need to be identified through the system listing.

The exception has been relocated to the bottom of the list to clarify that it applies to the entire list, not the entire subsection.

For 690.31(C)(2):

The word “or” is added between “ladder” and “trough” in 690.31(C)(2) as these are two different types of cable tray.

For 690.31(C)(4):

“MCM” is revised to “kcmil” for consistency with Article 310.

Response Message: FR-9275-NFPA 70-2024

Public Input No. 407-NFPA 70-2023 [Section No. 690.31(C)(4)]

Public Input No. 4242-NFPA 70-2023 [Section No. 690.31(C)(2)]

Public Input No. 4159-NFPA 70-2023 [Section No. 690.31(C) [Excluding any Sub-Sections]]

Public Input No. 4161-NFPA 70-2023 [Section No. 690.31(C)(1)]

(C) Cables.
Type PV wire or cable and Type distributed generation (DG) cable shall be listed. PV wire or cable shall be permitted in all locations where RHW-2 is permitted.

Informational Note: See UL 4703, *Standard for Photovoltaic Wire*, for PV wire and UL 3003, *Distributed Generation Cables*, for DG cable. PV wire and cable and DG cable have a nonstandard outer diameter.

(1) Single-Conductor Cable.
Single-conductor cables shall comply with 690.31(C)(1)(a) through (C)(1)(c).

(a) Single-conductor cable in exposed outdoor locations in PV system dc circuits within the PV array shall be permitted to be one of the following:

(1) PV wire or cable

(2) Single-conductor cable marked sunlight resistant and Type USE-2 and Type RHW-2

(b) Exposed cables ~~sized 8 AWG or smaller~~ shall be supported and secured ~~at intervals not to exceed 600 mm (24 in.)~~ by cable ties~~, straps, hangers, or similar~~ or fittings that are listed ~~and~~ or identified for securement and support in outdoor locations. ~~PV wire or cable shall be permitted in all locations where RHW-2 is permitted.~~

~~*Exception: PV systems meeting the requirements of 691.4 shall be permitted to have support and securement intervals as defined in the engineered design.*~~

(~~c~~1) ~~Exposed cables~~Cables sized larger than 8 AWG shall be supported and secured at intervals not to exceed 1400 mm (54 in.)~~ by cable ties, straps, hangers, or similar fittings listed and identified for securement and support in outdoor locations~~.

Exception: PV systems meeting the requirements of 691.4 shall be permitted to have support and securement intervals as defined in the engineered design.

(2) Cable Tray.
Single-conductor PV wire or cable of all sizes or distributed generation (DG) cable of all sizes, with or without a cable tray rating, shall be permitted in cable trays installed in outdoor locations, provided that the cables are supported at intervals not to exceed 300 mm (12 in.) and secured at intervals not to exceed 1400 mm (54 in.). Where installed in uncovered cable trays, ampacity of single-conductor PV wire smaller than 1/0 AWG, the adjustment factors for 1/0 AWG single conductor cable in 392.80(A)(2) shall be permitted to be used. Where single-conductor PV wire smaller than 1/0 AWG is installed in ladder or ventilated trough cable trays, the following shall apply:

(1) All single conductors shall be installed in a single layer.

(2) Conductors that are bound together to comprise each circuit pair shall be permitted to be installed in other than a single layer.

(3) The sum of diameters of all single conductor cables shall not exceed the cable tray width.

(3) Multiconductor Jacketed Cables.
Where part of a listed PV assembly, multiconductor jacketed cables shall be installed in accordance with the included instructions. Where not part of a listed assembly, or where not otherwise covered in this *Code*, multiconductor jacketed cables, including DG cable, shall be installed in accordance with the product listing and shall be permitted in PV systems. These cables shall be installed in accordance with the following:

(1) In raceways, where on or in buildings other than rooftops

(2) Where not in raceways, in accordance with the following:

a. Marked sunlight resistant in exposed outdoor locations

b. Protected or guarded, where subject to physical damage

c. Closely follow the surface of support structures

d. Secured at intervals not exceeding 1.8 m (6 ft)

e. Secured within 600 mm (24 in.) of mating connectors or entering enclosures

f. Marked direct burial, where buried in the earth

(4) Flexible Cords and Cables Connected to Tracking PV Arrays.
Flexible cords and flexible cables, where connected to moving parts of tracking PV arrays, shall comply with Article 400 and shall be of a type identified as a hard service cord or portable power cable; they shall be suitable for extra-hard usage, listed for outdoor use, water resistant, and sunlight resistant. Allowable ampacities shall be in accordance with 400.5. Stranded copper PV wire shall be permitted to be connected to moving parts of tracking PV arrays in accordance with the minimum number of strands specified in Table 690.31(C)(4).

Table 690.31(C)(4) Minimum PV Wire Strands

PV Wire AWG	Minimum Strands
18	17
16–10	19
8–4	49
2	130
1 AWG–1000 ~~MCM~~kcmil	259

(5) Flexible, Fine-Stranded Cables.
Flexible, fine-stranded cables shall be terminated only with terminals, lugs, devices, or connectors in accordance with 110.14.

(6) Small-Conductor Cables.
Single-conductor cables listed for outdoor use that are sunlight resistant and moisture resistant in sizes 16 AWG and 18 AWG shall be permitted for module interconnections where such cables meet the ampacity requirements of 400.5. Section 310.14 shall be used to determine the cable ampacity adjustment and correction factors.

(D) Direct-Current Circuits on or in Buildings.
Wiring methods on or in buildings shall comply with the installation requirements in 690.31(D)(1) and (D)(2).

First Revision No. 8482-NFPA 70-2024 [Section No. 690.31(D)(1)]

(1) Metal ~~Raceways~~ Wiring Methods and Enclosures.

Where inside buildings, PV system dc circuits that exceed 30 volts or 8 amperes shall be contained in metal raceways, in Type MC metal-clad cable that complies with 250.118(A)(10)(b) or (A)(10)(c), or in metal enclosures.

Exception: PVHCS installed in accordance with 690.12(B)(2)(1) shall be permitted to be provided with or listed for use with nonmetallic enclosure(s), nonmetallic raceway(s), and cables other than Type MC metal-clad cable(s), at the point of penetration of the surface, and in the interior spaces, of the building.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Mon Jan 22 14:01:55 EST 2024

Committee Statement

Committee Statement: The title of the section is revised to include all metal wiring methods, not just raceways. “Metal wiring methods” is inclusive of both raceways and cable systems, including type MC cable, in accordance with Chapter 3.

The exception is modified to clearly indicate applicability to both the point of penetration of the surface of a building and the interior of the building.

Response Message: FR-8482-NFPA 70-2024

Public Input No. 550-NFPA 70-2023 [Section No. 690.31(D)(1)]

Public Input No. 4155-NFPA 70-2023 [Section No. 690.31(D)(1)]

First Revision No. 8489-NFPA 70-2024 [Section No. 690.33(C)]

(C) Type.

The mating connectors shall be of the latching or locking type. Mating connectors that are readily accessible and that are used in circuits operating at over 30 volts dc or 15 volts ac shall require a tool for opening. Where mating connectors are not of the identical type and brand, they shall be listed and identified for intermatability, as ~~described in the manufacturer's instructions~~ documented by both manufacturers .

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Mon Jan 22 14:12:22 EST 2024

Committee Statement

Committee Statement: Language has been changed to expand the documentation requirement beyond just the "instructions" for the devices since for some products, this may be impractical.

Response Message: FR-8489-NFPA 70-2024

Public Input No. 4182-NFPA 70-2023 [Section No. 690.33(C)]

First Revision No. 8492-NFPA 70-2024 [Section No. 690.41(A)]

(A) PV System DC Circuit Grounding Configurations.

One or more of the following system configurations shall be employed for PV system dc circuits:

(1) ~~2-wire circuits with one functionally grounded conductor~~

(2) ~~Bipolar circuits according to~~ 690.7(C) ~~with a functional ground reference (center tap)~~

(3) Functionally grounded circuit

(4) Circuits not isolated from the grounded inverter output circuit

(5) Ungrounded circuits

(6) Solidly grounded circuits as permitted in 690.41(B)

(7) Circuits protected by equipment listed and identified for the use

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Mon Jan 22 14:21:33 EST 2024

Committee Statement

Committee Statement: This revision simplifies the language while still permitting the application of this requirement to either 2-wire or 3-wire (bipolar) circuits.

Response Message: FR-8492-NFPA 70-2024

Public Input No. 3392-NFPA 70-2023 [Section No. 690.41(A)]

First Revision No. 9272-NFPA 70-2024 [Section No. 690.41(B)]

(B) DC Ground-Fault Detector-Interrupter (GFDI) Protection.

PV system dc circuits that exceed 30 volts or 8 amperes shall be provided with GFDI protection meeting the requirements of 690.41(B)(1) and 690.41 (B)(2) to reduce fire hazards.

Solidly grounded PV source circuits with not more than two modules in parallel and not on or in buildings shall be permitted without GFDI protection.

Informational Note: Not all inverters, charge controllers, or dc-to-dc converters include dc GFDI protection. Equipment that does not have GFDI protection often includes the following statement in the manual: “Warning: This unit is not provided with a GFDI device.”

(1) Ground-Fault Detection.

The GFDI device or system shall detect ground fault(s) in the PV system dc circuits, including any functionally grounded conductors, and be listed for providing GFDI protection. ~~For dc-to-dc converters not listed as providing GFDI protection, where required, listed GFDI protection equipment~~ Where the GFDI function is not integral to an electronic power converter, PVRSE, or PVHCE installed in the PV dc circuit, GFDI protection shall be provided for the entire circuit and be identified for the combination of the ~~dc-to-dc converter~~ electronic power converter, PVRSE, PVHCE and the GFDI device ~~shall be installed to protect the circuit~~ .

Informational Note: Some dc-to-dc converters without integral GFDI protection on their input (source) side can prevent other GFDI protection equipment from properly functioning on portions of PV system dc circuits.

(2) Faulted Circuits.

The faulted circuits shall be controlled by one of the following methods:

(1) The current-carrying conductors of the faulted circuit shall be automatically disconnected.

(2) The device providing GFDI protection fed by the faulted circuit shall automatically cease to supply power to output circuits and interrupt the faulted PV system dc circuits from the ground reference in a functionally grounded system.

(3) Indication of Faults.

The GFDI protection equipment shall provide indication of ground faults at a readily accessible location.

Informational Note: It is common for GFDI functionality to be included in a PV inverter. Examples of indication include, but are not limited to, the following: remote indicator light, display, monitor, signal to a monitored alarm system, or receipt of notification by web-based services.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Fri Jan 26 14:43:24 EST 2024

Committee Statement

Committee Statement: A reference to 690.41(B)(3) is added to clarify that this requirement also has to be met.

Language has been added to clarify that where an electronic device is included in a dc

circuit, GFDI protection must be provided for the entire circuit, either as being integral into the device or by some other means such as the identification that the device in combination with another GFDI device provides the circuit protection.

Response Message: FR-9272-NFPA 70-2024

Public Input No. 360-NFPA 70-2023 [Section No. 690.41(B)]

Public Input No. 3817-NFPA 70-2023 [Section No. 690.41(B)(1)]

First Revision No. 8508-NFPA 70-2024 [Section No. 690.43(B)]

(B) Equipment Secured to Grounded Metal ~~Supports~~ Support Structures .

Devices listed, labeled, and identified for bonding and grounding the metal parts of PV ~~systems~~ arrays shall be permitted to bond the equipment to grounded metal ~~supports~~ support structures . Metallic support structures shall have identified bonding jumpers connected between separate metallic sections or shall be identified for equipment bonding and shall be connected to the equipment grounding conductor.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Mon Jan 22 14:50:39 EST 2024

Committee Statement

Committee Statement: This revision has changed “systems” to “arrays” to add clarity since this is the only component of a PV system that is applicable to this section. The term “support structure” has been added to be consistent with the language used in Article 250.

Response Message: FR-8508-NFPA 70-2024

Public Input No. 3093-NFPA 70-2023 [Section No. 690.43(B)]

Public Input No. 3836-NFPA 70-2023 [Section No. 690.43(B)]

First Revision No. 8512-NFPA 70-2024 [New Section after 690.43(D)]

(E) Flexible Equipment Grounding Conductors Connected to Tracking PV Arrays.
Where connected to moving parts of tracking PV arrays, wire-type equipment grounding conductors shall be installed in accordance with 690.31(C)(4).

Submitter Information Verification

Committee: NEC-P04
Submittal Date: Mon Jan 22 14:58:27 EST 2024

Committee Statement

Committee Statement: New subsection has been added to require the same consideration for equipment grounding conductors that are placed on other conductors on movable parts of tracking arrays to ensure the effectiveness of the equipment grounding path.

Response Message: FR-8512-NFPA 70-2024

Public Input No. 3919-NFPA 70-2023 [New Section after 690.43(D)]

First Revision No. 8522-NFPA 70-2024 [Section No. 690.47]

690.47 Grounding Electrode System.

(A) Buildings or Structures Supporting a PV System.

A building or structure(s) supporting a PV system shall utilize a grounding electrode system installed in accordance with ~~690.47(B) .~~ Article 250, Part III.

PV array equipment grounding conductors shall be connected to a grounding electrode system in accordance with ~~Part VII of~~ Article 250, Part VII . This connection shall be in addition to any other equipment grounding conductor requirements in 690.43(C). The minimum size of a grounding electrode conductor shall be sized in accordance with 250.66. The PV array equipment grounding conductors shall be sized in accordance with 690.45. For specific PV system grounding configurations permitted in 690.41(A), one of the following conditions shall apply:

(1) For PV systems that are not solidly grounded, the equipment grounding conductor for the output of the PV system, where connected to associated distribution equipment connected to a grounding electrode system, shall be permitted to be the only connection to ground for the system.

(2) For solidly grounded PV systems, as permitted in 690.41(A)(5), the grounded conductor shall be connected to a grounding electrode system by means of a grounding electrode conductor sized in accordance with 250.166.

Informational Note: Most PV systems are functionally grounded systems rather than solidly grounded systems as defined in this *Code*. For functionally grounded PV systems with an interactive inverter output, the ac equipment grounding conductor is connected to associated grounded ac distribution equipment. This connection is most often the connection to ground for ground-fault protection and equipment grounding of the PV array.

~~**(B)** Grounding Electrodes and Grounding Electrode Conductors.~~

~~Additional grounding electrodes shall be permitted to be installed in accordance with 250.52 and 250.54 . Grounding electrodes shall be permitted to be connected directly to the PV module frame(s) or support structure. A grounding electrode conductor shall be sized according to 250.66 . A support structure for a ground-mounted PV array shall be permitted to be considered a grounding electrode if it meets the requirements of 250.52 . PV arrays mounted to buildings shall be permitted to use the metal structural frame of the building if the requirements of 250.68(C)(2) are met.~~

Submitter Information Verification

Committee: NEC-P04
Submittal Date: Mon Jan 22 15:21:32 EST 2024

Committee Statement

Committee Statement: This revision reverts the reference for a grounding electrode system to the proper reference of Part III of Article 250, since the published 2023 version of 690.47(B) does not include the proper language for the 690.47(A) reference.

The text has been revised to comply with the NEC Style Manual Section 4.1.4, regarding the use of Parts. Section 690.47(B) has been deleted as it is not modifying

the requirements in article 250, nor is it adding additional requirements.

Response Message: FR-8522-NFPA 70-2024

Public Input No. 2929-NFPA 70-2023 [Section No. 690.47(A)]

Public Input No. 4164-NFPA 70-2023 [Section No. 690.47(A)]

Public Input No. 3387-NFPA 70-2023 [Section No. 690.47(B)]

Public Input No. 3837-NFPA 70-2023 [Section No. 690.47(B)]

Public Input No. 3247-NFPA 70-2023 [Section No. 690.47]

First Revision No. 8536-NFPA 70-2024 [Section No. 690.59]

690.59 Connection to Other Sources.

PV systems connected to other sources shall be installed in accordance with Article 705, Parts I and II ~~of Article 705~~ .

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Mon Jan 22 15:48:33 EST 2024

Committee Statement

Committee Statement: The text is revised to comply with the NEC Style Manual Section 4.1.4, regarding the use of Parts.

Response Message: FR-8536-NFPA 70-2024

Public Input No. 2930-NFPA 70-2023 [Section No. 690.59]

First Revision No. 8783-NFPA 70-2024 [Section No. 691.1]

691.1 Scope.

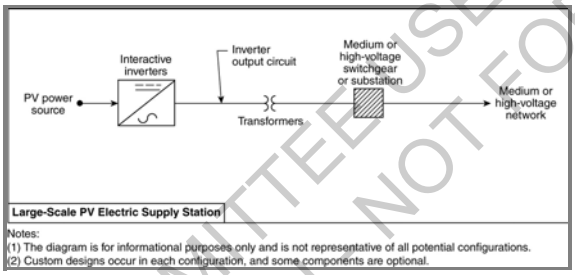
This article covers the installation of large-scale PV electric supply stations not under exclusive utility control.

Informational Note No. 1: Facilities covered by this article have specific design and safety features unique to large-scale PV facilities outlined in 691.4 and are operated for the sole purpose of providing electric supply to a system operated by a regulated utility for the transfer of electric energy.

Informational Note No. 2: See 90.2(B)(5) for additional information about utility-owned properties not covered under this *Code*. See ANSI/IEEE C2-~~2017~~ 2023 , *National Electrical Safety Code*, for additional information on electric supply stations.

Informational Note No. 3: See Informational Note Figure 691.1.

Figure Informational Note Figure 691.1 Identification of Large-Scale PV Electric Supply Station Components.



Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 15:46:49 EST 2024

Committee Statement

Committee Statement: The ANSI/IEEE C2 standard reference is updated to the current edition in accordance with NFPA requirements.

Response Message: FR-8783-NFPA 70-2024

Public Input No. 4264-NFPA 70-2023 [Section No. 691.1]

First Revision No. 8780-NFPA 70-2024 [Section No. 691.5]

691.5 ~~Equipment~~ 2 Listing Requirements .

All electrical equipment shall be approved for installation by one of the following:

(1) Listing and labeling

(2) Be evaluated for the application and have a field label applied

(3) Where products complying with 691.5 2 (1) or 691.2 (2) are not available, by engineering review validating that the electrical equipment is evaluated and tested to relevant standards or industry practice

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 15:39:21 EST 2024

Committee Statement

Committee Statement: The listing requirements are relocated to 691.2 in accordance with 2.2.1 of the Style Manual. In item 3, the 691.5 was changed to 691.2 due to the relocation.

Response Message: FR-8780-NFPA 70-2024

Public Input No. 2812-NFPA 70-2023 [New Section after 691.1]

Public Input No. 2811-NFPA 70-2023 [Section No. 691.5]

First Revision No. 8810-NFPA 70-2024 [Section No. 691.9]

691.9 Disconnecting Means for Isolating Photovoltaic Equipment.

Disconnecting means for equipment shall not be required within sight of equipment and shall be permitted to be located remotely from equipment. The engineered design required by 691.6 shall document disconnection procedures and means of isolating equipment.

Informational Note: See NFPA 70B ~~2019~~ 2023 , ~~*Recommended Practice*~~ *Standard for Electrical Equipment Maintenance*, for information on electrical system maintenance. See NFPA *70E* ~~2021~~ 2024 , *Standard for Electrical Safety in the Workplace*, for information on written procedures and conditions of maintenance, including lockout/tagout procedures.

Buildings whose sole purpose is to house and protect supply station equipment shall not be required to comply with 690.12. Written standard operating procedures shall be available at the site detailing necessary shutdown procedures in the event of an emergency.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 19:39:30 EST 2024

Committee Statement

Committee Statement: NFPA 70B and 70E references have been updated to their latest editions. The title for NFPA 70B has been updated from Recommended Practice to Standard, per the NEC Style Manual.

Response Message: FR-8810-NFPA 70-2024

First Revision No. 8793-NFPA 70-2024 [Section No. 691.11]

691.11 Bonding and Grounding.

(A) Grounding Electrode System.

Details of the grounding electrode system shall be included in the documentation required in 691.6.

Informational Note: Grounding requirements for personnel and equipment safety for large-scale PV electric supply stations are designed under engineering supervision based on site-specific geotechnical data. See IEEE 2778-2020 Guide for Solar Power Plant Grounding for Personnel Protection.

(B) Fence Bonding and Grounding.

Fence bonding and grounding requirements and details shall be included in the documentation required in 691.6.

Informational Note: See 250.194 for fence bonding and grounding requirements enclosing substation portions of an electric supply station. Grounding requirements for other portions of electric supply station fencing are assessed based on the presence of overhead conductors, proximity to generation and distribution equipment, and associated step and touch potential.

Supplemental Information

File Name	Description	Approved
NEC_CMP4_FR-8793_691.11.docx		

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 16:37:14 EST 2024

Committee Statement

Committee Statement: Large-scale PV electric supply stations present challenges when designing safe grounding networks as these systems cover hundreds (or thousands) of acres, with miles of above-and below ground conductors. In addition the systems contain many thousands of linear feet of metal racking structures that must be grounded and bonded effectively. Licensed professional electrical engineers rely on software modeling using site-specific design specifications, geotechnical soil and electrical resistivity data to analyze touch and step potential and fault current splits to design grounding systems that ensure personnel and equipment protection requirements are met on large-scale sites.

This revision clarifies that grounding systems for large-scale PV electric supply stations need to be site-specific engineered designs using industry standard practices.

Response Message: FR-8793-NFPA 70-2024

Public Input No. 3984-NFPA 70-2023 [Section No. 691.11]

691.11 ~~Fence~~ Bonding and Grounding. [Move text and IN to (B)]

~~Fence grounding requirements and details shall be included in the documentation required in 691.6.~~

~~Informational Note: See 250.194 for fence bonding and grounding requirements enclosing substation portions of an electric supply station. Grounding requirements for other portions of electric supply station fencing are assessed based on the presence of overhead conductors, proximity to generation and distribution equipment, and associated step and touch potential.~~

(A) Grounding Electrode System.

Details of the grounding electrode system shall be included in the documentation required in 691.6.

Informational Note: Grounding requirements for personnel and equipment safety for large-scale PV electric supply stations are designed under engineering supervision based on site-specific geotechnical data. See IEEE 2778-2020 Guide for Solar Power Plant Grounding for Personnel Protection.

(B) Fence Bonding and Grounding.

Fence bonding and grounding requirements and details shall be included in the documentation required in 691.6.

Informational Note: See 250.194 for fence bonding and grounding requirements enclosing substation portions of an electric supply station. Grounding requirements for other portions of electric supply station fencing are assessed based on the presence of overhead conductors, proximity to generation and distribution equipment, and associated step and touch potential.

First Revision No. 8800-NFPA 70-2024 [Section No. 692.6]

692.6~~–~~ 2 Listing Requirement.

The fuel cell system shall be approved for the application in accordance with one of the following:

(1) Be listed for the application

(2) Be evaluated for the application and have a field label applied.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 17:01:39 EST 2024

Committee Statement

Committee Statement: The listing requirements are relocated to 692.2 in accordance with 2.2.1 of the Style Manual.

Response Message: FR-8800-NFPA 70-2024

Public Input No. 554-NFPA 70-2023 [Section No. 692.6]

Public Input No. 2814-NFPA 70-2023 [Section No. 692.6]

Public Input No. 2813-NFPA 70-2023 [New Section after 692.1]

First Revision No. 8943-NFPA 70-2024 [Section No. 692.13]

692.13 ~~All Conductors~~ 13 System Disconnecting Means .

~~Means shall be provided to disconnect all current-carrying conductors of a fuel cell system power source from all other conductors in a building or other structure.~~ Fuel cell system disconnecting means shall be installed in accordance with 705.20.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Wed Jan 24 13:27:58 EST 2024

Committee Statement

Committee Statement: Title changes to System Disconnecting Means. The word “Article” was removed to align with the NEC Style Manual.

Response Message: FR-8943-NFPA 70-2024

Public Input No. 4494-NFPA 70-2023 [Section No. 692.13]

First Revision No. 8949-NFPA 70-2024 [Section No. 692.17]

692.~~17~~ ~~Switch or Circuit Breaker~~ 15 Equipment Disconnecting Means .

The disconnecting means for ungrounded conductors shall consist of readily accessible, manually operable switch(es) or circuit breaker(s).

Where all terminals of the disconnecting means may be energized in the open position, a warning sign shall be mounted on or adjacent to the disconnecting means. The sign shall be clearly legible and shall have the following words or equivalent:

DANGER

ELECTRIC SHOCK HAZARD. DO NOT TOUCH TERMINALS. TERMINALS ON BOTH THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION.

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

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Wed Jan 24 13:34:35 EST 2024

Committee Statement

Committee Statement: The requirements for fuel cell equipment disconnecting means are relocated to the new 692.15 for consistency with other power source Articles.

Response Message: FR-8949-NFPA 70-2024

Public Input No. 4528-NFPA 70-2023 [Section No. 692.17]

First Revision No. 8957-NFPA 70-2024 [Section No. 692.60]

692.60 Connection to Other Systems.

Fuel cell systems connected to other sources shall be installed in accordance with Article 705, Parts I and II ~~of Article 705~~ .

Submitter Information Verification

Committee: NEC-P04
Submittal Date: Wed Jan 24 13:45:29 EST 2024

Committee Statement

Committee Statement: Article 705 has been moved to align with the NEC style manual.
Response Message: FR-8957-NFPA 70-2024

Public Input No. 2931-NFPA 70-2023 [Section No. 692.60]

First Revision No. 8959-NFPA 70-2024 [Section No. 692.61]

~~**692.61** Transfer Switch.~~

~~A transfer switch shall be required in non-grid-interactive systems that use utility grid backup. The transfer switch shall maintain isolation between the electrical production and distribution network and the fuel cell system. The transfer switch shall be permitted to be located externally or internally to the fuel cell system unit. Where the utility service conductors of the structure are connected to the transfer switch, the switch shall comply with Article 230 , Part V.~~

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Wed Jan 24 13:52:45 EST 2024

Committee Statement

Committee Statement: Section 692.61 is removed because the rules for the connection of the power source are the purview of Articles 700, 701, 702, and 705 depending on application.

Response Message: FR-8959-NFPA 70-2024

Public Input No. 3011-NFPA 70-2023 [Sections 692.60, 692.61]

First Revision No. 8960-NFPA 70-2024 [Section No. 694.7(B)]

[Moved to 694.7 (B) – ~~Equipment.~~ **~~to 694.2.~~]**

694.2 Listing Requirements .

Wind electric systems shall comply with one of the following:

(1) Be listed

(2) Be evaluated for the application and have a field label applied

Wind electric systems undergoing evaluation for type certification and listing shall be permitted to be operated in a controlled location with access limited to qualified personnel.

Informational Note: See UL 6141-2022 , *~~Standard for~~ Wind Turbines Permitting Entry of Personnel*, and UL 6142-2020 , *~~Standard for~~ Small Wind Turbine Systems*, for further information on wind turbine equipment. Ratings for wind turbines could include limitations on installation locations such as onshore or offshore. Testing is typically performed under supervision of a qualified electrical testing organization.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Wed Jan 24 13:57:27 EST 2024

Committee Statement

Committee Statement: The listing requirements are relocated to 694.2 in accordance with 2.2.1 of the NEC Style Manual. UL document editions and titles updated for the NEC Style Manual.

Response Message: FR-8960-NFPA 70-2024

Public Input No. 2815-NFPA 70-2023 [Section No. 694.7]

Public Input No. 2816-NFPA 70-2023 [New Section after 694.1]

First Revision No. 8964-NFPA 70-2024 [Section No. 694.7(D)]

(D) ~~Overvoltage Protection~~ Surge Protection .

A listed surge protective device shall be installed between a wind electric system and any loads served by the premises electrical system. The SPD shall be permitted to be a Type 3 SPD on the circuit serving a wind electric system or a Type 2 SPD located anywhere on the load side of the service disconnect. ~~SPDs shall be installed in accordance with Part II of Article 242 .~~

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Wed Jan 24 14:09:06 EST 2024

Committee Statement

Committee Statement: The term “overvoltage” is replaced with “surge” for correlation with all other Articles. The last sentence is deleted in accordance with 90.3 and 4.1.1 of the Style Manual.

Response Message: FR-8964-NFPA 70-2024

Public Input No. 3416-NFPA 70-2023 [Section No. 694.7(D)]

First Revision No. 8967-NFPA 70-2024 [Section No. 694.7(G)]

(G) Working Clearances.

Working space shall be provided for electrical cabinets and other electrical equipment in accordance with 110.26(A).

For large wind turbines where service personnel enter the equipment, where conditions of maintenance and supervision ensure that only qualified persons perform the work, working clearances shall be permitted to comply with Table 694.7(G) for systems ~~up to 1000 volts~~ not over 1000 volts ac, 1500 volts dc, nominal.

Table 694.7(G) Working Spaces

Nominal Voltage to Ground	Condition 1	Condition 2	Condition 3
0–150	900 mm (3 ft)	900 mm (3 ft)	900 mm (3 ft)
151–1000 V ac / 1500 V dc	900 mm (3 ft)	1.0 m (3 ft 6 in.)	1.2 m (4 ft)

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Wed Jan 24 14:15:49 EST 2024

Committee Statement

Committee Statement: The revisions to the voltage limits are to align with similar voltage limits in the code.

Response Message: FR-8967-NFPA 70-2024

Public Input No. 2432-NFPA 70-2023 [Section No. 694.7(G)]

First Revision No. 8971-NFPA 70-2024 [Section No. 694.15(B)]

(B) ~~Power~~ Transformers.

~~Overcurrent protection for a transformer with sources on each side shall be provided in accordance with 450.3 by considering first one side of the transformer, then the other side of the transformer, as the primary.~~

~~Exception: A power transformer with a current rating on the side connected to the inverter output, which is not less than the rated continuous output current rating of the inverter, shall not be required to have overcurrent protection at the inverter.~~

The following shall apply to the installation of transformers:

(1) For the purpose of overcurrent protection, the primary side of transformers with sources on each side shall be connected to the largest source of available fault current.

(2) Transformer secondary conductors shall be protected in accordance with 240.21(C).

Supplemental Information

File Name	Description	Approved
NEC_CMP4_FR-8971_694.15_B_.docx		

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Wed Jan 24 14:24:29 EST 2024

Committee Statement

Committee Statement: The language is revised for correlation with the identical requirements of Articles 690 and 705.

Response Message: FR-8971-NFPA 70-2024

Public Input No. 276-NFPA 70-2023 [Section No. 694.15(B)]

Public Input No. 3012-NFPA 70-2023 [Section No. 694.15(B)]

(B) ~~Power~~ Transformers.

~~Overcurrent protection for a transformer with sources on each side shall be provided in accordance with 450.3 by considering first one side of the transformer, then the other side of the transformer, as the primary.~~The following shall apply to the installation of transformers:

(1) For the purpose of overcurrent protection, the primary side of transformers with sources on each side shall be connected to the largest source of available fault current.
(2) Transformer secondary conductors shall be protected in accordance with 240.21(C).

~~*Exception: A power transformer with a current rating on the side connected to the inverter output, which is not less than the rated continuous output current rating of the inverter, shall not be required to have overcurrent protection at the inverter.*~~

First Revision No. 8999-NFPA 70-2024 [Section No. 694.30(B)]

[See attached Word document for revisions to 694.30 (B).]

(B) Flexible Cords and Cables.

Flexible cords and cables, where used to connect the moving parts of turbines or where used for ready removal for maintenance and repair, shall comply with Article 400 and shall be of a type identified as hard service cord or portable power cable, shall be suitable for extra-hard usage, shall be listed for outdoor use, and shall be water resistant. Cables exposed to sunlight shall be sunlight resistant. Flexible, fine-stranded cables shall be terminated only with terminals, lugs, devices, or connectors in accordance with 110.14(A).

Supplemental Information

File Name	Description	Approved
70_CMP4_FR8999_694.30_B_.docx	Revisions to 694.30(B).	
70_CMP4_FR8999_694.30_B.docx	For prod use	

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Wed Jan 24 15:58:37 EST 2024

Committee Statement

Committee Statement: The reference to Article 400 is modified to comply with 4.1.4 of the Style Manual. The section has been revised per the NEC Style Manual, 2.1.8.1. The reference to 110.14(A) has been deleted in accordance with NEC Section 90.3 and 4.1.1 of the NEC Style Manual.

Response Message: FR-8999-NFPA 70-2024

Public Input No. 3324-NFPA 70-2023 [Section No. 694.30(B)]

694.30(B) Flexible Cords and Cables.

Flexible cords and cables, where used to connect the moving parts of turbines or where used for ready removal for maintenance and repair~~,~~ shall be in accordance with all of the following:

(1) ~~comply with Article 400 and shall~~ be of a type identified as hard service cord or portable power cable~~, shall~~

(2) be suitable for extra-hard usage~~, shall~~

(3) be listed for outdoor use~~, and shall be~~

(4) be water resistant

(5) comply with Table 400.4~~.~~

(6) ~~Cables exposed to sunlight shall be~~ be sunlight resistant where exposed to sunlight~~.~~ ~~Flexible, fine-stranded cables shall be terminated only with terminals, lugs, devices, or connectors in accordance with 110.14(A).~~

First Revision No. 8973-NFPA 70-2024 [Section No. 694.62]

694.62 Installation.

Wind electric systems connected to other sources shall be installed in accordance with Article 705, Parts I and II ~~of Article 705~~ .

Submitter Information Verification

Committee: NEC-P04
Submittal Date: Wed Jan 24 14:31:04 EST 2024

Committee Statement

Committee Statement: Revision has been made to align with the NEC style manual.
Response Message: FR-8973-NFPA 70-2024

Public Input No. 2933-NFPA 70-2023 [Section No. 694.62]

First Revision No. 8560-NFPA 70-2024 [Section No. 705.6]

705.6 ~~Equipment Approval~~ 2 Listing Requirements .

Interconnection and interactive equipment intended to connect to or operate in parallel with power production sources shall be listed for the required interactive function or be evaluated for the interactive function and have a field label applied, or both.

Informational Note No. 1: See UL 1741-2023 , ~~*Standard for*~~ *Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources*, for evaluating interconnected equipment. Sources identified as stand-alone, interactive, or multimode are specifically identified and certified to operate in these operational modes. Stand-alone sources operate in island mode, interactive sources operate in interactive mode, and multimode sources operate in either island mode or interactive mode. Stand-alone sources are not evaluated for interactive capabilities.

Informational Note No. 2: An interactive function is common in equipment such as microgrid interconnect devices, power control systems, interactive inverters, synchronous engine generators, ac energy storage systems, and ac wind turbines.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Mon Jan 22 16:43:31 EST 2024

Committee Statement

Committee Statement: This revision aligns with the 2023 NEC Style Manual. This action has involved revising 705.6 from “Equipment Approval” to “Listing Requirements,” and changing the section number from 705.6 to 705.2. The addition of a third informational note has not been adopted since the standards referenced have not yet been issued.

Response Message: FR-8560-NFPA 70-2024

Public Input No. 2826-NFPA 70-2023 [Section No. 705.6]

Public Input No. 2824-NFPA 70-2023 [New Section after 705.1]

Public Input No. 4400-NFPA 70-2023 [Section No. 705.6]

First Revision No. 8561-NFPA 70-2024 [Section No. 705.10]

705.10 Identification of Power Sources.

Permanent plaques, labels, or directories shall be installed at each service equipment location, or at an approved readily visible location in accordance with the following:

(1) Denote the location of each power source disconnecting means for the building or structure.

Exception: Installations with multiple colocated power production sources shall be permitted to be identified as a group(s). The plaque, label, or directory shall not be required to identify each power source individually.

(2) Indicate the emergency telephone numbers of any off-site entities servicing the power source systems.

Informational Note: See NFPA 1-2021, *Fire Code*, 11.12.2.1.5 for installer information.

(3) Be marked with the wording “CAUTION: MULTIPLE SOURCES OF POWER.” ~~The marking shall comply with 110.21(B) .~~

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Mon Jan 22 16:54:25 EST 2024

Committee Statement

Committee Statement: This revision to remove reference to 110.21(B) aligns with an effort to remove references to 110.21 throughout Article 705. This complies with the NEC style manual as the requirements in section 110.21 are not modified in this section.

Response Message: FR-8561-NFPA 70-2024

First Revision No. 8564-NFPA 70-2024 [Section No. 705.11(B)]

(B) ~~Conductors~~ Service Conductors Connected to Power Sources .

Service conductors connected to power ~~production~~ sources shall comply with the following:

(1) The ampacity of the service conductors connected to the power ~~production~~ source service disconnecting means shall not be less than ~~the sum~~ of the power production source maximum circuit current in accordance with 705.28(A).

(2) The service conductors connected to the power ~~production~~ source service disconnecting means shall be sized in accordance with 705.28 and not ~~be~~ smaller than 6 AWG copper or 4 AWG aluminum or copper-clad aluminum.

(3) The ampacity of ~~any other~~ the service conductors to which the power ~~production sources~~ source service conductors are connected shall not be less than that required in 705.11(B)(1) or 705 . 11(B) (2) .

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Mon Jan 22 16:57:48 EST 2024

Committee Statement

Committee Statement: Subsection 705.11(B) is renamed Service Conductors Connected to Power Sources to clarify that these conductors relate specifically to the service conductors connected to power sources.

The redundant word “production” is removed in four places in this subsection shortening the term from “power production source” to “power source” for simplicity.

In 705.11(B)(1), the phrase “the sum of” is removed as it is stated in 705.28(A) and does not require restating here. Also in 705.11(B)(1), the phrase “accordance with” is added for compliance with the style manual. In item (2), “be” has been removed for simplicity and reference to 705(B)(1) and 705.11(B)(2) was added to (3) to remove a circular reference.

Response Message: FR-8564-NFPA 70-2024

Public Input No. 258-NFPA 70-2023 [Section No. 705.11(B)]

First Revision No. 8568-NFPA 70-2024 [Sections 705.11(C), 705.11(D), 705.11(E)]

Sections 705.11(C), 705.11(D), 705.11(E)

~~**(C)** Connections.~~

~~Connections to service conductors or equipment shall comply with 705.11(C)(1) through (C)(3).~~

~~**(1)** Splices or Taps.~~

~~Service conductorsplices and taps shall be made in accordance with 230.33 or 230.46 and comply with all applicable enclosure fill requirements.~~

~~**(2)** Existing Equipment.~~

~~Any modifications to existing equipment shall be made in accordance with the manufacturer's instructions, or the modification must be field evaluated for the application and be field labeled.~~

~~**(3)** Utility-Controlled Equipment.~~

~~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.~~

~~**(D)** Service Disconnecting Means.~~

~~A disconnecting means in accordance with Parts VI through VII of Article 230 shall be provided to disconnect all ungrounded conductors of a power production source from the conductors of other systems.~~

~~**(E)** Bonding and Grounding.~~

~~All metal enclosures, metal wiring methods, and metal parts associated with the service connected to a power production source shall be bonded in accordance with Parts II through V and VIII of Article 250 .~~

Submitter Information Verification

Committee: NEC-P04
Submittal Date: Mon Jan 22 17:08:29 EST 2024

Committee Statement

Committee Statement: 705.11(C), 11(D), and 11(E) have been removed as they restate requirements that are found in the first four chapters which is a violation of Section 4.1.1 of the 2023 NEC Style Manual.

705.11(C)(1) – The language is removed as the requirements of Chapter 2 are applicable unless modified in accordance with 90.3.

705.11(C)(2) – The language has been removed as the requirements of Chapter 1 are applicable unless modified in accordance with 90.3.

705.11(C)(3) – Utility owned equipment is not within the purview of the NEC in accordance with 90.2(D)(5).

705.11(D) – The language has been removed as the requirements of Chapter 2 are applicable unless modified in accordance with 90.3. The requirements of and for a

service disconnecting means are already referenced through 230.2(A)(5) and 230.82(6). Subsection 705.11(E) – Article 250 applies unless modified by Article 705.

Response Message: FR-8568-NFPA 70-2024

Public Input No. 248-NFPA 70-2023 [Section No. 705.11]

First Revision No. 8812-NFPA 70-2024 [Section No. 705.11(F)]

[See attached Word document for revisions to 705.11 (F).]

(F) Overcurrent Protection.

The power ~~production~~ source service conductors shall be protected from overcurrent in accordance with ~~Part VII of Article~~ 230 ~~. The rating of the overcurrent protection device of the power production~~ 705.30.

(1) Power source connections in buildings. Power source service conductors located within a building and connected to existing service conductors or equipment shall be protected in accordance with one of the following methods:

(a) In dwelling units, with an overcurrent protective device located within 3 m (10 ft) of conductor length from the point of connection.

(b) In other than dwelling units, with an overcurrent protective device located within 5 m (16.5 ft) of conductor length from the point of connection.

(c) In other than dwelling units with cable limiters located within 5 m (16.5 ft) of conductor length from the point of connection, with an overcurrent protective device located within 20 m (66 ft) of conductor length from the point of connection.

Informational Note: The limits in 705.11(F)(1) are intended to provide guidance on practical distances for unprotected power source service conductors inside buildings .

(2) Ground Fault Protection of Equipment. The rating of the overcurrent protective device of the power source service disconnecting means shall be used to determine if ground

fault protection of equipment is required in accordance with 230.95 .

Supplemental Information

File Name	Description	Approved
70_CMP4_FR8812_705.11_F_.docx	Revisions to 705.11(F).	
70_CMP4_FR8812_705.11_F.docx	For prod use	

Submitter Information Verification

Committee: NEC-P04
Submittal Date: Tue Jan 23 19:59:20 EST 2024

Committee Statement

Committee The word “production” is removed from the first sentence to match other similar

Statement: simplifying language in other actions, also see definition for the term “power source.” Rather than reference Part VII of Article 230 for overcurrent protection, the relevant section 705.30 is referenced. The last sentence is moved to 705.11(F)(2). A new subsection 705.11(F)(1) is added to provide clarifying language on the limits to which power source connections to service conductors can be run in buildings. Similar language was provided in the 2020 NEC, but was removed from the 2023 NEC without sufficient technical substantiation. The language provides clarity since some users believe that these conductors are limited to very short distances by 230.91 which requires overcurrent protection to be “immediately adjacent.” Other users believe that Article 230 has no limit on the distance allowed for these conductors and their overcurrent devices. Both extremes are problematic. The stipulations on types of overcurrent devices and the distances allowed for each are based on the experience of panel members with many hundreds of installations where these issues have arisen. Rather than leave it unclear, these practical distances allow for adequate protection of these conductors inside buildings given the constraints of switchgear and equipment rooms. Dwelling units, per 705.11(F)(1)(1), are given the most restrictive distances, given the potentially larger hazard and the smaller sizes of electrical equipment. Two options are given for non-dwelling units. Subsection 705.11(F)(1)(2) provides a slightly larger distance than dwellings due to the larger typical sizes of non-dwelling electrical equipment that these systems will connect to. Subsection 705.11(F)(1)(3) allows an additional option where it is not feasible to install the overcurrent devices within 5m of the connection point. This scenario often occurs when switchgear is larger than 2000A and where the electrical rooms are physically unable to house an additional disconnect and overcurrent device. The added informational note provides the user with the background to understand that this language is to provide practical distances and are not arbitrary distances as some users have supposed.

Response Message: FR-8812-NFPA 70-2024

Public Input No. 1952-NFPA 70-2023 [Section No. 705.11(F)]

Public Input No. 1716-NFPA 70-2023 [Section No. 705.11(F)]

705.11(F)

(F) Overcurrent Protection.

The power ~~production~~ source service conductors shall be protected from overcurrent in accordance with 705.30. ~~Part VII of Article 230. The rating of the overcurrent protection device of the power production source service disconnecting means shall be used to determine if ground-fault protection of equipment is required in accordance with 230.95.~~

(1) Power source connections in buildings. Power source service conductors located within a building and connected to existing service conductors or equipment shall be protected in accordance with one of the following methods:

(a) In dwelling units, with an overcurrent protective device located within 3 m (10 ft) of conductor length from the point of connection.

(b) In other than dwelling units, with an overcurrent protective device located within 5 m (16.5 ft) of conductor length from the point of connection.

(c) In other than dwelling units with cable limiters located within 5 m (16.5 ft) of conductor length from the point of connection, with an overcurrent protective device located within 20 m (66 ft) of conductor length from the point of connection.

Informational Note: The limits in 705.11(F)(1) are intended to provide guidance on practical distances for unprotected power source service conductors inside buildings .

(2) Ground Fault Protection of Equipment. The rating of the overcurrent protective device of the power source service disconnecting means shall be used to determine if ground fault protection of equipment is required in accordance with 230.95.

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First Revision No. 8678-NFPA 70-2024 [Section No. 705.12(A)]

(A) Feeders and Feeder Taps.

Where the power source output connection is made to a feeder, the following shall apply:

(1) The feeder ampacity ~~is~~ shall be greater than or equal to 125 percent of the power-source output circuit current.

(2) Where the power-source output connection is made at a location other than the opposite end of the feeder from the primary source overcurrent device, that portion of the feeder on the load side of the power source output connection shall be protected by one of the following:

a. The feeder ampacity shall be not less than the sum of the rating of the primary source overcurrent device and 125 percent of the power-source output circuit current.

b. An overcurrent device at the load side of the power source connection point shall be rated not greater than the ampacity of the feeder.

(3) For taps sized in accordance with 240.21(B)(2) or (B)(4), the ampacity of taps conductors shall not be less than one-third of the sum of the rating of the overcurrent device protecting the feeder plus the ratings of any power source overcurrent devices connected to the feeder.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 11:03:48 EST 2024

Committee Statement

Committee Statement: The new language provides the necessary “shall” to make the subsection a requirement.

Response Message: FR-8678-NFPA 70-2024

Public Input No. 192-NFPA 70-2023 [Section No. 705.12(A)]

Public Input No. 3799-NFPA 70-2023 [Section No. 705.12(A)]

Public Input No. 4243-NFPA 70-2023 [Section No. 705.12(A)]

First Revision No. 8813-NFPA 70-2024 [Section No. 705.12(B)]

[See Attached Word document 705.12 (B).]

(B) Busbars.

For power source connections to distribution equipment with no specific listing and instructions for combining multiple sources, one of the following methods shall be used to determine the required ampere ratings of busbars:

(1) The sum of 125 percent of the power source(s) output circuit current and the rating of the overcurrent device protecting the busbar shall not exceed the busbar ampere rating.

Informational Note: This general rule assumes no limitation in the number of the loads or sources applied to busbars or their locations.

(2) Where two sources, one a primary power source and the other another power source, are located at opposite ends of a busbar that contains loads, the sum of 125 percent of the power-source(s) output circuit current and the rating of the overcurrent device protecting the busbar shall not exceed 120 percent of the busbar ampere rating. The busbar shall be sized for the loads connected in accordance with 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 DO NOT RELOCATE THIS OVERCURRENT DEVICE.

The warning sign(s) or label(s) shall comply with 110.21(B).

(3) 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:

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) A connection at either end of a center-fed panelboard in dwellings shall be permitted where the sum of 125 percent of the power-source(s) output circuit current and the rating of the overcurrent device protecting the busbar does not exceed 120 percent of the busbar ampere rating.

(5) Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors or are supplied by feed-through conductors. The feed-through conductors shall be sized in accordance with 705.12(A). Where an overcurrent device is installed at either end of the feed-through conductors, panelboard busbars on either side of the feed-through conductors shall be permitted to be sized in accordance with 705.12(B)(1) through (B)(3).

(6) Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 705.12(B)(1) through (B)(5) where designed

under engineering supervision that includes available fault-current and busbar load calculations.

Informational Note: Specifically designed equipment exists, listed to UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*, for the combination and distribution of sources to supply loads. The options provided in 705.12(B) are for equipment with no specific listing for combining sources.

Supplemental Information

File Name	Description	Approved
70_CMP4_FR8813_705.12_B_.docx	Revisions to 705.12(B).	
70_CMP4_FR8813_705.12_B.docx	For prod use	

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 20:14:34 EST 2024

Committee Statement

Committee Statement: The words “or more” are added to make it clear that multiple options under 705.12(B) may be used for compliance. The list introduction is changed for consistency with the NEC Style Manual. The informational note below 705.12(B)(6) is moved to appear below the charging paragraph where it is better suited for usability. The informational note is reorganized to comply with the NEC Style Manual, 2.1.13. The informational note below 705.12(B)(1) is removed as it is no longer necessary and conflicts with NEC Style Manual 2.1.13.

705.12(B)(2):

The whole sentence related to Article 220 is removed since it does not establish new requirements and conflicts with the NEC style manual. The language in the last sentence is revised to remove the less correct term, “back-fed breaker” and use the simpler and more correct term “overcurrent device.” Not all overcurrent devices using this section are back-fed breakers. The reference to 110.21(B) is removed as it violates 4.1.1. of the Style Manual.

705.12(B)(3):

The word “on” in the first sentence is replaced with “protecting circuits connected to” since the overcurrent devices may not actually be on the panelboard. The reference to 110.21(B) is removed since it is no longer necessary, and violates 4.1.1 of the Style Manual.

705.12(B)(4):

The proposed revision of PI-956 has not been adopted since the proposal limits the source breakers to one end of a center-fed panelboard which conflicts with this section, which is constrained to panels supplying dwellings. The reference to the label in 705.12(B)(2) has been adopted as it addresses concerns raised in the substantiation of PI-956.

Response Message: FR-8813-NFPA 70-2024

Public Input No. 3352-NFPA 70-2023 [Section No. 705.12(B)]

Public Input No. 956-NFPA 70-2023 [Section No. 705.12(B)]

705.12(B)

(B) Busbars.

For power source connections to distribution equipment with no specific listing and instructions for combining multiple sources, one or more of the ~~following~~ methods in 705.12(B)(1) through (B)(6) shall be used to determine the required ampere ratings of busbars.~~:~~

Informational Note: ~~Specifically designed equipment exists, listed to~~See UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources.* ~~,~~Specifically designed equipment exists for the combination and distribution of sources to supply loads. The options provided in 705.12(B) are for equipment with no specific listing for combining sources.

(1) The sum of 125 percent of the power source(s) output circuit current and the rating of the overcurrent device protecting the busbar shall not exceed the busbar ampere rating.

~~Informational Note: This general rule assumes no limitation in the number of the loads or sources applied to busbars or their locations.~~

(2) Where two sources, one a primary power source and the other another power source, are located at opposite ends of a busbar that contains loads, the sum of 125 percent of the power source(s) output circuit current and the rating of the overcurrent device protecting the busbar shall not exceed 120 percent of the busbar ampere rating. ~~The busbar shall be sized for the loads connected in accordance with Article 220.~~ A permanent warning label shall be applied to the distribution equipment adjacent to the ~~back-fed breaker from the~~ power source overcurrent device that displays the following or equivalent wording:

WARNING:

POWER SOURCE OUTPUT DO NOT RELOCATE THIS OVERCURRENT DEVICE.

~~The warning sign(s) or label(s) shall comply with 110.21(B).~~

(3) The sum of the ampere ratings of all overcurrent devices protecting circuits connected to ~~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:

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) A connection at either end of a center-fed panelboard in dwellings shall be permitted where the sum of 125 percent of the power-source(s) output circuit current and the rating of the overcurrent device protecting the busbar does not exceed 120 percent of the busbar ampere rating. The warning label in 705.12(B)(2) shall be applied to the power source overcurrent devices complying with 705.12(B)(4).

(5) Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors or are supplied by feed-through conductors. The feed-through conductors shall be sized in accordance with 705.12(A). Where an overcurrent device is installed at either end of the feed-through conductors, panelboard busbars on either side of the feed-through conductors shall be permitted to be sized in accordance with 705.12(B)(1) through (B)(3).

(6) Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 705.12(B)(1) through (B)(5) where designed under engineering supervision that includes available fault-current and busbar load calculations.

~~Informational Note: Specifically designed equipment exists, listed to UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*, for the combination and distribution of sources to supply loads. The options provided in 705.12(B) are for equipment with no specific listing for combining sources.~~

First Revision No. 8689-NFPA 70-2024 [Section No. 705.13]

705.13 ~~Energy Management~~ 13 Power Control Systems (~~EMS~~ PCS).

~~An EMS~~ A PCS in accordance with Article 750~~.30~~ , Part II shall be permitted to limit current and loading on the busbars and conductors supplied by the output of one or more interconnected electric power production or energy storage sources.

Informational Note: See UL 3141-2024, *Outline of Investigation for Power Control Systems* , and UL 1741-2023, *Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources for information on PCS* . A listed power control system (PCS) is a type of EMS that is capable of monitoring multiple power sources and controlling the current on busbars and conductors to prevent overloading. ~~See UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources* , and UL 916, *Energy Management Equipment,* for information on PCS and EMS.~~

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 11:24:55 EST 2024

Committee Statement

Committee Statement: The text is revised to revert the title back to the 2020 NEC title for 705.13 to align with the requirements. The new standard UL3141 is added to the informational note which incorporates safety standards to differentiate circuit requirements for products using control to prevent overload. UL 3141 is an outline of investigation developed by UL, to augment UL 1741. It is important to state both UL 3141 and UL 1741 in the informational note for the user due to their mutual relevance. The informational note is restructured to comply with 2.1.13 of the Style Manual.

Response Message: FR-8689-NFPA 70-2024

Public Input No. 4367-NFPA 70-2023 [Section No. 705.13]

First Revision No. 8734-NFPA 70-2024 [Section No. 705.20]

[See attached word document for revisions to 705.20.]

705. 20 Source Disconnecting Means.

Means shall be provided to disconnect power source output conductors of electric power production equipment from conductors of other systems. A single disconnecting means shall be permitted to disconnect multiple power sources from conductors of other systems.

Informational Note: See 480.7, Part II of Article 445, Part III of Article 690, Part IIIof Article 692, Part IIIof Article 694, and Part II of Article 706 for specific source disconnecting means requirements.

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) Located where readily accessible

(8) Externally operable without exposed live parts

(9) Plainly indicate whether in the open (off) or closed (on) position

(10) Have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals

(11) Where the line and load terminals are capable of being energized in the open position, be marked with the following words or equivalent:

WARNING

ELECTRIC SHOCK HAZARD TERMINALS ON THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION.

Informational Note: With interconnected power sources, some equipment, including switches and fuses, is capable of being energized from both directions.

Supplemental Information

File Name	Description	Approved
70_CMP4_FR8734_705.20.docx	Revisions to 705.20.	

NEC_CMP4_FR-8734_705.20.docx For prod use

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 13:42:11 EST 2024

Committee Statement

Committee Statement: The article numbers in the informational note are moved to precede the Part reference to comply with 4.1.4 of the Style manual.

The organization of the section was revised for better usability and to make it easier to reference specific requirements by the articles listed in the informational note. Headings and consistent structure were added to each section for compliance with the style manual. No technical changes were made outside of reorganizing the listed items.

New section (G) has been added for dc power source connections that addresses the concerns related to how disconnecting means for dc are evaluated. Informational note explaining the concerns has been created to assist the user in understanding the issue.

Response Message: FR-8734-NFPA 70-2024

Public Input No. 4469-NFPA 70-2023 [Section No. 705.20]

Public Input No. 2942-NFPA 70-2023 [Section No. 705.20]

705.20 Source Disconnecting Means.
Means shall be provided to disconnect power source output conductors of electric power production equipment from conductors of other systems. A single disconnecting means shall be permitted to disconnect multiple power sources from conductors of other systems.

Informational Note: See 480.7, Article 445, Part II ~~of Article 445~~, Article 690, Part III ~~of Article 690~~, Article 692, Part III ~~of Article 692~~, ~~Part III of~~ Article 694, Part III and ~~Part II of~~ Article 706, Part II for specific source disconnecting means requirements.

(A)Location.
The disconnecting means shall ~~comply with the following:~~ be readily accessible.

(B)Ratings.
The disconnecting means shall have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals of the disconnecting means.

(C)Type.
The disconnecting means shall simultaneously disconnect all ungrounded conductors of the circuit and shall be one of the following types:

~~(1) Be one of the following types:~~

~~a.~~(1) A manually operable switch or circuit breaker

~~b.~~(2) A load-break-rated pull-out switch

~~c.~~(3) A power-operated or remote-controlled switch or circuit breaker that is manually operable locally and opens automatically when control power is interrupted

~~d.~~(4) A device listed or approved for the intended application

~~(2) Simultaneously disconnect all ungrounded conductors of the circuit~~

~~(3) Located where readily accessible~~

(4D) Live Parts.
The disconnection means shall be externally~~Externally~~ operable without exposed live parts.

(5E) Indication.

The disconnection means shall ~~Plainly~~ plainly indicate whether in the open (off) or closed (on) position.

~~(6) Have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals~~

(~~7~~F) Marking.

Where the line and load terminals of the disconnecting means are capable of being energized in the open position, shall be marked with the following words or equivalent:

WARNING

ELECTRIC SHOCK HAZARD TERMINALS ON THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION.

Informational Note: With interconnected power sources, some equipment, including switches and fuses, is capable of being energized from both directions.

(G) Dc Power Source Connections.

Dc power source output conductors terminated to disconnecting means shall comply with one of the following:

(1) terminated to either side of disconnecting means not marked "line" and "load"
(2) terminated only to the line side of disconnecting means marked "line" and "load"

Informational Note: The disconnect markings referred to in this section relate to markings on the disconnect means itself and not to the equipment in which it is mounted. Dc disconnecting means marked "line" and "load" may have not been evaluated for source connection to the load terminals, backfeed or reverse current.

First Revision No. 8814-NFPA 70-2024 [Section No. 705.25]

[See attached Word document for revisions to 705.25.]

705. 25 Wiring Methods.

Power source output conductors shall comply with 705.25(A) through (C).

(A) General.

Wiring methods and fittings listed for use with power production systems shall be permitted in addition to general wiring methods and fittings permitted elsewhere in this *Code*.

(B) Flexible Cords and Cables.

Flexible cords and cables, where used to connect the moving parts of power production equipment, or where used for ready removal for maintenance and repair, shall be listed and identified as DG cable, or other cable suitable for extra hard use, and shall be water resistant. Cables exposed to sunlight shall be sunlight resistant. Flexible, fine-stranded cables shall be terminated only with terminals, lugs, devices, or connectors in accordance with 110.14(A).

(C) Multiconductor Cable Assemblies.

Multiconductor cable assemblies used in accordance with their listings shall be permitted.

Informational Note: See UL 3003, *Distributed Generation Cables*, and UL 9703, *Outline of Investigation for Distributed Generation Wiring Harnesses*, for additional information on DG cable (distributed generation cable) and harnesses. An ac module harness is one example of a multiconductor cable assembly.

Supplemental Information

File Name	Description	Approved
70_CMP4_FR8814_705.25.docx	Revisions to 705.25	
NEC_CMP4_FR-8814_705.25.docx	For prod use	

Submitter Information Verification

Committee: NEC-P04
Submittal Date: Tue Jan 23 20:45:34 EST 2024

Committee Statement

Committee Statement: The general section is deleted as it does not establish any new requirements that are not already supported by 90.9 or chapters 1 through 4.

Flexible Cords and Cables is revised to not restrict the use to moving parts or maintenance. Also, the reference to the requirements of 110.14(A) are removed since the general requirement is not modified.

The section on multiconductor cable assemblies is deleted, but the informational note is retained to be located beneath the Flexible Cords section.

Identification of Dc Conductors and Grounded Conductors subsections are added since the requirements of Article 210 do not specifically apply to power sources.

Response Message: FR-8814-NFPA 70-2024

Public Input No. 568-NFPA 70-2023 [Section No. 705.25]

Public Input No. 4186-NFPA 70-2023 [Section No. 705.25]

705.25 Wiring Methods.
Power source output conductors shall comply with 705.25(A) through (C).

~~**(A) General.**~~
~~Wiring methods and fittings listed for use with power production systems shall be permitted in addition to general wiring methods and fittings permitted elsewhere in this *Code*.~~

(~~B~~A) Flexible Cords and Cables.
Flexible cords and cables~~, where used to connect the moving parts of power production equipment, or where used for ready removal for maintenance and repair,~~ shall be listed and identified as DG cable, or other cords and cables suitable for extra hard use, and shall be water resistant. Cables exposed to sunlight shall be sunlight resistant.
~~Flexible, fine-stranded cables shall be terminated only with terminals, lugs, devices, or connectors in accordance with 110.14(A).~~

~~**(C) Multiconductor Cable Assemblies.**~~
~~Multiconductor cable assemblies used in accordance with their listings shall be permitted.~~
Informational Note: See UL 3003-2018, *Distributed Generation Cables*, and UL 9703-2018, *Outline of Investigation for Distributed Generation Wiring Harnesses*, for additional information on DG cable (distributed generation cable) and harnesses. An ac module harness is one example of a multiconductor cable assembly.

(B) Identification of Dc Power Source Output Conductors
Dc power source output conductors shall be identified at all termination, connection, and splice points by color coding, marking tape, tagging, or other approved means in accordance with 705.25(B~~D~~)(1) through 705.25(B~~D~~)(3).

(1) Positive Polarity.
Dc positive conductors identified by one of the following means:
(a) Imprinted plus signs (+) or the word POSITIVE or POS durably marked on conductor insulation.
(b) 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.

(2) Negative Polarity.
Dc negative conductors identified by one of the following means:
(a) Imprinted minus signs (–) or the word NEGATIVE or NEG durably marked on conductor insulation.
(b) 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.

(3) Color Identification.
Where color is used, by one of the following means:
(a) Dc nonsolidly grounded positive conductors with an insulation color other than green, white, or gray.
(b) Dc nonsolidly grounded negative conductors with an insulation color other than green, white, gray, or red.
(c) Only solidly grounded dc conductors shall be marked in accordance with 200.6.

Informational Note: See Article 100 for the definitions of functionally grounded and solidly grounded.

(C) Grounded Conductors of Different Nominal Voltage Systems.
If functionally or solidly grounded conductors of different nominal voltage systems are installed in the same raceway, cable, box, auxiliary gutter, or other type of enclosure, each grounded conductor shall be identified by nominal voltage system. Identification that distinguishes each nominal voltage system grounded conductor shall be permitted by color coding, marking tape, tagging, or other approved means. The means of identification shall be documented in a manner that is readily available or shall be permanently posted where the conductors of different nominal voltage systems originate and terminate.

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First Revision No. 8700-NFPA 70-2024 [Section No. 705.28(A)]

(A) Power Source Output Maximum Current.

~~Where not elsewhere required or permitted in this~~ *Code* ~~, the~~ The maximum current for power sources shall be calculated ~~using one of the following methods:~~ in accordance with 705.28(A)(1) through 705.28(A)(3). Calculations shall be permitted to be rounded to the nearest whole ampere, with decimal fractions smaller than 0.5 dropped.

(1) The sum of the continuous output current ratings of ~~the~~ power production ~~equipment~~ sources at the circuit nominal system voltage unless different requirements elsewhere in this Code apply to the power source(s)

(2) For power production ~~equipment~~ sources controlled by ~~an EMS~~ PCS, the current setpoint of the ~~EMS~~ PCS

(3) Where sources controlled by ~~an EMS~~ a PCS are combined with other sources on the same power source output circuit, the sum of 705.28(A)(1) and 705.28 (A)(2)

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 12:40:35 EST 2024

Committee Statement

Committee Statement: The ambiguous phrase at the beginning of 705.28(A) is removed and a phrase is added to 705.28(A)(1) in an effort to address the issue of the ambiguous phrase.

The new sentence in 705.28(A) explicitly allows rounding of calculations in the same manner as permitted for load calculations in 220.5(B).

The phrase in 705.28(A)(1) “the power production equipment” is changed to “power production sources” to align with definitions in Article 100. Also added is a phrase that allows for calculations in source articles to be used in place of the “continuous output current ratings” since all power sources may not have a continuous rating. Since not all requirements pertaining to power source(s) can be individually identified, language has been added to 705.28(A)(1) which directs the user to any applicable requirements within the code that may exempt the requirement of 705.28(A)(1).

The word “equipment” is changed to “sources” in 705.28(A)(2) to match similar actions throughout Article 705 and the revised definition. The term “EMS” is changed to the revised term in 705.13 of “PCS”.

Response Message: FR-8700-NFPA 70-2024

Public Input No. 3096-NFPA 70-2023 [Section No. 705.28(A)]

Public Input No. 4248-NFPA 70-2023 [Section No. 705.28(A)]

First Revision No. 8704-NFPA 70-2024 [Section No. 705.28(B)]

(B) Conductor Ampacity.

~~Where not elsewhere required or permitted in this~~ *Code* ~~, the~~ The power source output conductors shall have an ampacity not less than the larger of the following and comply with 110.14(C):

(1) The maximum currents in 705.28(A) multiplied by 125 percent without adjustment or correction factors

Exception No. 1: If the assembly, including the overcurrent devices protecting the circuit, is listed for operation at 100 percent of its rating, the ampacity of the conductors shall be permitted to be not less than the calculated maximum current of 705.28(A).

Exception No. 2: Where a portion of a circuit 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 calculated maximum current of 705.28(A). No portion of the circuit installed under this exception shall extend into an enclosure containing either the circuit supply or the circuit 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 calculated maximum current of 705.28(A).

(2) The maximum currents in 705.28(A) after the application of adjustment and correction factors in accordance with 310.14

(3) Where connected to feeders, if smaller than the feeder conductors, the ampacity as calculated in 240.21(B) based on the over-current device protecting the feeder

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 12:49:49 EST 2024

Committee Statement

Committee Statement: The opening phrase is deleted as vague and unenforceable.

Response Message: FR-8704-NFPA 70-2024

Public Input No. 3097-NFPA 70-2023 [Section No. 705.28(B)]

First Revision No. 8757-NFPA 70-2024 [Section No. 705.30(D)]

(D) 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 ~~be considered suitable for backfeed or reverse current if specifically rated~~ not be used to satisfy the requirements in 705.30(A).

Informational Note: The markings referred to in this section relate to markings on the disconnecting means or circuit breaker itself and not to the equipment in which it is mounted.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 15:00:44 EST 2024

Committee Statement

Committee Statement: Language is added to clarify that a circuit breaker which is marked “line” and “load” may not be evaluated to provide overcurrent protection under reverse current. An informational note is added to clarify that the “line” and “load” markings must be on the circuit breaker itself and not the equipment.

Response Message: FR-8757-NFPA 70-2024

Public Input No. 4014-NFPA 70-2023 [Section No. 705.30(D)]

Public Input No. 1298-NFPA 70-2023 [Section No. 705.30(D)]

First Revision No. 8710-NFPA 70-2024 [Section No. 705.30(E)]

(E) Fastening.

~~Listed~~ Where the power output circuit can only operate in interactive mode, plug-in-type circuit breakers ~~backfed from electric power sources that are listed and identified as interactive~~ shall be permitted to omit the additional fastener normally required by 408.36(D) ~~for such applications~~ .

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 13:03:33 EST 2024

Committee Statement

Committee Statement: The sentence is reorganized and edited for clarity. Language is added to restrict the use with circuits that only operate in interactive mode. Since some power sources are multimode devices, only those power sources that are constrained to only operate in interactive mode can use this provision.

Response Message: FR-8710-NFPA 70-2024

Public Input No. 4535-NFPA 70-2023 [Section No. 705.30(E)]

First Revision No. 8715-NFPA 70-2024 [Section No. 705.32]

705.32 Ground-Fault Protection of Equipment .

Where ground-fault protection of equipment is installed in ~~ac circuits as required elsewhere in this *Code* , the output of interconnected power production equipment shall be connected to the supply side of the~~ accordance with 230.95 or 215.10 and a power source that is capable of providing ground-fault current is installed on the load side of this ground-fault protection equipment~~.~~

~~Exception: Connection of power production equipment shall be permitted to be made to~~

, such ground-fault protection of equipment and any added power source ground-fault protection of equipment shall be performance tested as a system in accordance with 230.95(C). This testing shall consider all sources and any associated main and system bonding jumpers.

Informational Note: Current carrying neutral conductors from power sources connected on the load side of ground-fault protection ~~equipment where installed in accordance with 705.11 or where there is ground-fault protection for equipment from all ground-fault current sources~~ can result in the over-sensitization or de-sensitization of ground-fault protection due to circulating neutral currents. Common measures used to prevent this are alternative ground-fault current sensor placements, proper location of neutral-to-ground bonding, and power source tripping functions provided by the ground-fault protection scheme .

Supplemental Information

File Name	Description	Approved
NEC_CMP4_FR-8715_705.32.docx		

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 13:06:59 EST 2024

Committee Statement

Committee Statement: This section is revised to clarify that Article 705 is the proper operation of ground-fault protection of equipment with interconnected sources. The requirement is only for power sources that can source ground-fault current. Since a large percentage of inverter-based sources cannot source ground-fault current, those sources are not applicable to 705.32. This revision clarifies that those sources which can provide ground-fault current must be performance tested with all required GFP devices as a system to make sure that all GFP work as intended. The informational note provides detail that directly identifies the problem and provides examples of how the problem can be addressed. The language in the exception is written in positive language and the exception removed as recommended in 2.1.9.1 of the style manual.

Response Message: FR-8715-NFPA 70-2024

Public Input No. 320-NFPA 70-2023 [Section No. 705.32]

705.32 Ground-Fault Protection of Equipment.

Where ground-fault protection of equipment is installed in ~~ac circuits as required elsewhere in this *Code*, the output of interconnected power production equipment shall be connected to the supply side of the ground-fault protection equipment.~~accordance with 230.95 or 215.10 and a power source that is capable of providing ground-fault current is installed on the load side of this ground-fault protection equipment, such ground-fault protection of equipment and any added power source ground-fault protection of equipment shall be performance tested as a system in accordance with 230.95(C). This testing shall consider all sources and any associated main and system bonding jumpers.

Informational Note: Current carrying neutral conductors from power sources connected on the load side of ground-fault protection can result in the over-sensitization or de-sensitization of ground-fault protection due to circulating neutral currents. Common measures used to prevent this are alternative ground-fault current sensor placements, proper location of neutral-to-ground bonding, and power source tripping functions provided by the ground-fault protection scheme.

~~*Exception: Connection of power production equipment shall be permitted to be made to the load side of ground-fault protection equipment where installed in accordance with 705.11 or where there is ground-fault protection for equipment from all ground-fault current sources.*~~

First Revision No. 8761-NFPA 70-2024 [Section No. 705.40]

705.40 Loss of Primary Source.

The output of interactive electric power production ~~equipment~~ sources shall be automatically disconnected from all ungrounded conductors of the primary source when one or more of the phases of the primary source to which it is connected opens. The interactive electric power production equipment shall not be reconnected to the primary source until all the phases of the primary source to which it is connected are restored. This requirement shall not be applicable to electric power production ~~equipment~~ sources 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 primary source 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.

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.

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.

Interactive power production ~~equipment~~ sources shall be permitted to operate in island mode to supply loads that have been disconnected from the electric utility or other electric power production and distribution network.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 15:10:16 EST 2024

Committee Statement

Committee Statement: The term “power production equipment” is changed to “power production sources” in three locations in 705.40 to match the change in the Article 100 definition.

Response Message: FR-8761-NFPA 70-2024

Public Input No. 4268-NFPA 70-2023 [Section No. 705.40]

First Revision No. 8763-NFPA 70-2024 [Section No. 705.45]

705.45 Unbalanced Interconnections.

(A) Single Phase.

Single-phase power sources in interactive systems shall be connected to ~~3-phase~~ multiphase power systems in order to limit unbalanced voltages at the point of interconnection to not more than 3 percent.

Informational Note: See ANSI/C84.1-2020, Electric Power Systems and Equipment — Voltage Ratings (60 Hertz). For interactive power sources, unbalanced voltages can be minimized by the same methods that are used for single-phase loads on a ~~3-phase~~ multiphase power system. ~~See ANSI/C84.1-2016, *Electric Power Systems and Equipment — Voltage Ratings (60 Hertz)* .~~

(B) ~~Three Phase~~ Multiphase .

~~Three-phase~~ Multiphase power sources in interactive systems shall have all phases automatically de-energized upon loss of, or unbalanced, voltage in one or more phases unless the interconnected system is designed so that significant unbalanced voltages will not result.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 15:15:58 EST 2024

Committee Statement

Committee Statement: The term used in 250.26 and elsewhere is multiphase rather than polyphase. This term is more inclusive than three-phase as this article may address configurations than three-phase systems. Changes made to all of 705.45. The informational note is reorganized to comply with Style Manual 2.1.13.3.

Response Message: FR-8763-NFPA 70-2024

Public Input No. 2917-NFPA 70-2023 [Section No. 705.45(B)]

First Revision No. 8766-NFPA 70-2024 [Section No. 705.50]

705.50 System Operation.

Interconnected microgrid systems shall be capable of operating in interactive mode with a primary source of power, or electric utility, or other electric power production and distribution network. Microgrid systems shall be permitted to disconnect from other sources and operate in island mode.

Informational Note ~~No. 1~~ : ~~Microgrid systems often include a single source or a compatible interconnection of multiple sources such as engine generators, solar PV, wind, or ESS. Informational Note No. 2:~~ See Article 517.30(B)(5) for health care facilities incorporating microgrids.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 15:23:17 EST 2024

Committee Statement

Committee Statement: The informational notes are revised by removing the first note and modifying the second note to more accurately reference the appropriate section of Article 517 and be in compliance with 2.1.13 of the Style Manual. Additionally, the definition for microgrid is in Article 100.

Response Message: FR-8766-NFPA 70-2024

Public Input No. 3254-NFPA 70-2023 [Section No. 705.50]

Public Input No. 3359-NFPA 70-2023 [Section No. 705.50]

Public Input No. 4406-NFPA 70-2023 [Section No. 705.50]

First Revision No. 8769-NFPA 70-2024 [Section No. 705.60]

705.60 Primary Power Source Connection.

Connections to primary power sources that are external to the microgrid system shall comply with the requirements of 705.11 ~~,~~ or 705.12~~, or 705~~ . ~~13.~~ Power source conductors connecting to a microgrid system, including conductors supplying distribution equipment, shall be considered as power source output conductors.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 15:25:58 EST 2024

Committee Statement

Committee Statement: The redundant reference to 705.13 is removed as it is covered adequately in references to 705.28(A) in 705.11 and 705.12.

Response Message: FR-8769-NFPA 70-2024

Public Input No. 2570-NFPA 70-2023 [Section No. 705.60]

First Revision No. 8772-NFPA 70-2024 [Section No. 705.76]

705.76 Microgrid Control System (MCS).

Microgrid control systems shall comply with the following:

(1) Coordinate interaction between multiple power sources of similar or different types, manufacturers, and technologies (including energy storage)

(2) Be evaluated for the application and have a field label applied, or be listed, or be designed under engineering supervision

(3) Monitor and control microgrid power production and power quality

(4) Monitor and control transitions with a primary source external to the microgrid

~~Informational Note: MID functionality is often incorporated in an interactive or multimode inverter, energy storage system, or similar device identified for interactive operation.~~

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 15:28:10 EST 2024

Committee Statement

Committee Statement: The informational note is deleted as it is more relevant to the previous section 705.70 where the same informational note is used.

Response Message: FR-8772-NFPA 70-2024

Public Input No. 3255-NFPA 70-2023 [Section No. 705.76]

First Revision No. 8775-NFPA 70-2024 [Section No. 705.82]

~~**705.82** Single 120-Volt Supply.~~

~~Systems operating in island mode shall be permitted to supply 120 volts to single-phase, 3-wire, 120/240-volt distribution equipment where there are no 240-volt outlets and where there are no multiwire branch circuits. In all installations, the sum of the ratings of the power sources shall be less than the rating of the neutral bus in the distribution equipment. This equipment shall be marked with the following words or equivalent:~~

~~WARNING:~~

~~SINGLE 120-VOLT SUPPLY~~

~~DO NOT CONNECT MULTIWIRE BRANCH CIRCUITS~~

~~The warning sign(s) or label(s) shall comply with 110.21(B) .~~

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Tue Jan 23 15:31:26 EST 2024

Committee Statement

Committee Statement: Part III is retained as it is necessary to differentiate from Article 710 requirements and provides detail on the requirements for sources operating in island mode. Section 705.82 is deleted as it is unnecessary in this section of the Code.

Response Message: FR-8775-NFPA 70-2024

Public Input No. 1404-NFPA 70-2023 [Sections Part III., 705.80, 705.81, 705.82]

First Revision No. 8983-NFPA 70-2024 [Section No. 710.1]

710.1 Scope.

This article covers ~~electric power production systems that operate in island mode not connected to an electric utility or other electric power production and distribution network~~ stand-alone systems .

Informational Note: These systems operate independently from an electric utility and include isolated microgrid systems. Stand-alone systems often include a single or a compatible interconnection of sources such as engine generators, solar PV, wind, ESS, or batteries.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Wed Jan 24 15:08:22 EST 2024

Committee Statement

Committee Statement: The scope has been modified to correlate with the defined term, stand-alone systems, in Article 100.

Response Message: FR-8983-NFPA 70-2024

Public Input No. 4092-NFPA 70-2023 [Section No. 710.1]

Public Input No. 4253-NFPA 70-2023 [Section No. 710.1]

First Revision No. 8986-NFPA 70-2024 [Section No. 710.6]

[Section is moving to 710.6 ~~Equipment Approval.~~ **~~2, after 710.1.~~]**

710.2 Listing Requirements.

All power production equipment or systems shall ~~be approved for use in island mode and~~ comply with one of the following:

(1) Be listed

(2) Be evaluated for the application and have a field label applied

Informational Note: See UL1741-2021, *Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources,* and UL 62109-1-2014, *Power Converters for use in Photovoltaic Power Systems - Part 1: General Requirements* . See UL 2200-2020, *Stationary Engine Generator Assemblies Edition 3,* for engine generators used in stand-alone applications. This equipment is commonly used in power production sources.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Wed Jan 24 15:13:32 EST 2024

Committee Statement

Committee Statement: The listing requirements were relocated from 710.6 to 710.2 in accordance with the style manual. Island mode references were removed, and new informational note was added with informational references to align with standards and certifications language, per NEC Style Manual 2.1.10.3.

Response Message: FR-8986-NFPA 70-2024

Public Input No. 2836-NFPA 70-2023 [Section No. 710.6]

Public Input No. 4094-NFPA 70-2023 [Section No. 710.6]

Public Input No. 2833-NFPA 70-2023 [New Section after 710.1]

First Revision No. 8989-NFPA 70-2024 [Section No. 710.10]

710.10 Identification of Power Sources.

A permanent plaque, label, or directory shall be installed at ~~a building supplied by a stand-alone system at the~~ each building power source disconnecting means location, or at an approved readily visible location. The plaque, label, or directory shall denote the location of each power source disconnecting means for the building~~ or be grouped with other plaques or directories for other on-site sources~~ . Where multiple sources supply the building, markings shall comply with 705.10.

Submitter Information Verification

Committee: NEC-P04
Submittal Date: Wed Jan 24 15:22:06 EST 2024

Committee Statement

Committee Statement: The requirement was revised for clarity and to align with Article 705.
Response Message: FR-8989-NFPA 70-2024

Public Input No. 4097-NFPA 70-2023 [Section No. 710.10]

First Revision No. 8992-NFPA 70-2024 [Section No. 710.12]

~~**710.12** Stand-Alone Inverter Input Circuit Current.~~

~~The maximum current shall be the stand-alone continuous inverter input current rating when the inverter is producing rated power at the lowest input voltage.~~

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Wed Jan 24 15:24:02 EST 2024

Committee Statement

Committee Statement: This section has been deleted since the individual equipment listings address ratings and application of use. See action taken on 710.6.

Response Message: FR-8992-NFPA 70-2024

Public Input No. 4100-NFPA 70-2023 [Section No. 710.12]

First Revision No. 8993-NFPA 70-2024 [Section No. 710.15]

~~**(B)** Sizing and Protection.~~

~~**710.15** General.~~

~~Premises wiring systems shall be adequate to meet the requirements of this *Code* for similar installations supplied by a feeder or service. The wiring on the supply side of the building or structure disconnecting means shall comply with the requirements of this *Code* , except as modified by 710.15(A) through (G).~~

~~**(A)** Supply Output.~~

~~Power supply to premises wiring systems fed by stand-alone or isolated microgrid power sources shall be permitted to have less capacity than the calculated load. The capacity of the sum of all sources of the stand-alone supply shall be equal to or greater than the load posed by the largest single utilization equipment connected to the system. Calculated general lighting loads shall not be considered as a single load.~~

~~Informational Note: For general-use loads the system capacity can be calculated using the sum of the capacity of the firm sources, such as generators and ESS inverters. For specialty loads intended to be powered directly from a variable source, the capacity can be calculated using the sum of the variable sources, such as PV or wind inverters, or the combined capacity of both firm and variable sources.~~

15 Power Production Source Circuit.

The circuit conductors between a stand-alone source and a building or structure disconnecting means shall be sized based on the sum of the output ratings of the stand-alone source(s). ~~For three-phase interconnections, the phase loads shall be controlled or balanced to be compatible with specifications of the sum of the power supply capacities.~~

~~**(C)** Single 120-Volt Supply.~~

~~Stand-alone and isolated microgrid systems shall be permitted to supply 120 volts to single-phase, 3-wire, 120/240-volt service equipment or distribution panels where there are no 240-volt outlets and where there are no multiwire branch circuits. In all installations, the sum of the ratings of the power sources shall be less than the rating of the neutral bus in the service equipment. This equipment shall be marked with the following words or equivalent:~~

~~WARNING:~~

~~SINGLE 120-VOLT SUPPLY. DO NOT CONNECT MULTIWIRE BRANCH CIRCUITS!~~

~~The warning sign(s) or label(s) shall comply with 110.21(B) .~~

~~**(D)** Three-phase Supply.~~

~~Stand-alone and microgrid systems shall be permitted to supply three-phase, 3-wire or 4-wire systems.~~

~~**(E)** Energy Storage or Backup Power System Requirements.~~

~~Energy storage or backup power supplies shall not be required.~~

~~**(F)** Voltage and Frequency Control.~~

~~The stand-alone power sources shall be controlled during operation so that voltage and frequency are supplied within limits compatible with the connected loads.~~

Supplemental Information

File Name	Description	Approved
NEC_CMP4_FR-8993_710.15.docx		

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Wed Jan 24 15:32:08 EST 2024

Committee Statement

Committee Statement: The language has been revised to clarify that the power source ratings are used for sizing of the electrical system equipment and conductors. The revised language addressed section references that no longer apply to the removed subsections. The reference to service equipment is removed. Multiwire branch circuits are addressed by Article 210 and requirement for 120V supply has been removed to prevent conflicts with ratings and functionality of listed equipment. The reference to three phase supplies is deleted as the wiring configurations are not limited for the standalone supply applications. The application of various source system configurations is not restricted by this article.

Response Message: FR-8993-NFPA 70-2024

Public Input No. 4247-NFPA 70-2023 [Section No. 710.15(C)]

Public Input No. 4110-NFPA 70-2023 [Section No. 710.15(E)]

Public Input No. 4249-NFPA 70-2023 [Section No. 710.15(D)]

Public Input No. 4102-NFPA 70-2023 [Section No. 710.15 [Excluding any Sub-Sections]]

Public Input No. 1410-NFPA 70-2023 [Section No. 710.15(C)]

Public Input No. 4105-NFPA 70-2023 [Section No. 710.15(A)]

710.15 ~~General~~Power Production Source Circuit.

~~Premises wiring systems shall be adequate to meet the requirements of this *Code* for similar installations supplied by a feeder or service. The wiring on the supply side of the building or structure disconnecting means shall comply with the requirements of this *Code*, except as modified by 710.15(A) through (G).~~ The circuit conductors between a stand-alone source and a building or structure disconnecting means shall be sized based on the sum of the output ratings of the stand-alone source(s).

~~**(A) Supply Output.**~~

~~Power supply to premises wiring systems fed by stand-alone or isolated microgrid power sources shall be permitted to have less capacity than the calculated load. The capacity of the sum of all sources of the stand-alone supply shall be equal to or greater than the load posed by the largest single utilization equipment connected to the system. Calculated general lighting loads shall not be considered as a single load.~~

~~Informational Note: For general-use loads the system capacity can be calculated using the sum of the capacity of the firm sources, such as generators and ESS inverters. For specialty loads intended to be powered directly from a variable source, the capacity can be calculated using the sum of the variable sources, such as PV or wind inverters, or the combined capacity of both firm and variable sources.~~

~~**(B) Sizing and Protection.**~~ **[Move 1st line text to main section]**

~~The circuit conductors between a stand-alone source and a building or structure disconnecting means shall be sized based on the sum of the output ratings of the stand-alone source(s). For three-phase interconnections, the phase loads shall be controlled or balanced to be compatible with specifications of the sum of the power supply capacities.~~

~~**(C) Single 120-Volt Supply.**~~

~~Stand-alone and isolated microgrid systems shall be permitted to supply 120 volts to single-phase, 3-wire, 120/240-volt service equipment or distribution panels where there are no 240-volt outlets and where there are no multiwire branch circuits. In all installations, the sum of the ratings of the power sources shall be less than the rating of the neutral bus in the service equipment. This equipment shall be marked with the following words or equivalent:~~

~~WARNING:~~
~~SINGLE 120-VOLT SUPPLY. DO NOT CONNECT MULTIWIRE BRANCH CIRCUITS!~~
~~The warning sign(s) or label(s) shall comply with 110.21(B).~~

~~**(D) Three-phase Supply.**~~

~~Stand-alone and microgrid systems shall be permitted to supply three-phase, 3-wire or 4-wire systems.~~

~~**(E) Energy Storage or Backup Power System Requirements.**~~

~~Energy storage or backup power supplies shall not be required.~~

~~**(F) Voltage and Frequency Control.**~~

~~The stand-alone power sources shall be controlled during operation so that voltage and frequency are supplied within limits compatible with the connected loads.~~

First Revision No. 8833-NFPA 70-2024 [New Part after II.]

[New section after 692 Part II.]

692.7 Maximum Voltage

The maximum voltage shall be used to determine the voltage and voltage to ground of circuits in the application of this *Code* . Maximum voltage shall be used for conductors, cables, equipment, working space, and other applications where voltage limits and ratings are used. The maximum voltage of fuel cell system dc circuits shall be the highest voltage between any two conductors of a circuit or any conductor and ground and shall comply with the following:

(1) Fuel cell system dc circuits shall not exceed 1000 volts on or in buildings.

(2) Fuel cell system dc circuits shall not exceed 600 volts on or in one- and two-family dwellings.

Submitter Information Verification

Committee: NEC-P04

Submittal Date: Wed Jan 24 08:08:58 EST 2024

Committee Statement

Committee Statement: This creates a new maximum dc voltage limit that is applicable to fuel cell systems in or on buildings. As fuel cell system installations are increasing in the next decade, this begins providing appropriate safety thresholds in Article 692. The voltage limitations in this revision have been written to harmonize with the limitations now applied to dc circuits for Solar PV Systems in Article 690 and Energy Storage Systems in Article 706. The 600V dc limit for 1 and 2 family dwellings in Article 690 has provided a stable and safe Code-mandated limit for over 20 years. Expanding this tried and tested limit to other dc circuits in 1 and 2 family dwellings makes sense for installers, equipment manufacturers, and for residential safety.

Response Message: FR-8833-NFPA 70-2024

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