**Public Input No. 3085, Assigned to Code-Making Panel 1, Refer to Code-Making Panels 2 - 18**

# Public Input No. 3085-NFPA 70-2023 [ Global Input ]

**This Global Public Input is for all Technical Committees and review their informational notes and the requirements in the NEC Style Manual Section 2.1.10 for informational notes.**

## Statement of Problem and Substantiation for Public Input

This Global Public Input is for all Technical Committees and review their informational notes and the requirements in the NEC Style Manual Section 2.1.10 for informational notes.
2.1.10.3 Format. Informational notes shall be structured as shown in the example, using the word "See" followed by the reference standard, the title of the standard and section if used, and an explanation for the reference.
Example:
"See" "Referenced Standard", "Standard Title", "Section Number", "Explanation of the reference"
Informational Note: See NFPA 101, Life Safety Code, 7.8, for illumination of means of egress.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Submitter Information Verification


**Submitter Full Name:** David Williams
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**Submittal Date:** Tue Aug 29 11:15:17 EDT 2023
**Committee:** NEC-P01

**Public Input No. 3086, Assigned to Code-Making Panel 2, Refer to Code Making Panels 3 - 18**

# Public Input No. 3086-NFPA 70-2023 [ Global Input ]

**This Global Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document.**
**Articles may need to be revised to comply with the NEC Style Manual Section 2.2 for Numbering Conventions.**

## Statement of Problem and Substantiation for Public Input

This Global Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document.
Articles may need to be revised to comply with the NEC Style Manual Section 2.2 for Numbering Conventions. The Changes in 2.2.1 are requirements that may need to be revised.
2.2.1 Parallel Numbering Required. Technical committees shall use the following section numbers for the same purposes within articles. This requirement shall not apply to Articles 90, 100, and 110. If the article does not contain listing or reconditioning
requirements, the subdivisions shall not be included in the article.
Required Parallel Numbering Format
XXX.1 Scope.
XXX.2 Listing Requirements.
XXX.3 Reconditioned Equipment.
XXX.3(A) Permitted to be Installed.
XXX.3(B) Not Permitted to be Installed.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Submitter Information Verification


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**Committee:** NEC-P02

**Public Input No. 3099, Assigned to Code-Making Panel 15, Refer to Code-Making Panels 3, 4, 6, 10, 11, 12, 13, 14, 16, 17 and 18**

# Public Input No. 3099-NFPA 70-2023 [ Global Input ]

**Add Informational Notes to Scopes identifying Article specific and/or important definitions in one of the following formats:**

**Format A – the style used in NFPA Link's Enhanced Content material:**

**Informational Note No. x: Definitions. Each of the following terms has a definition in Article 100 that is unique to its use in "Article xxx":**

**Term 1**

**Term 2**

**Term 3**

**...**

**If needed:**

**Informational Note No. y: Definitions. Each of the following terms has a definition in Article 100 that appears in several articles but is important in its use in "Article xxx":**

**Term a**

**Term b**

**Term c**

**...**

**Format B – the style used in several places within the NEC itself:**

**Informational Note: See Article 100 for definitions of Term 1, Term 2, and Term 3 . . .**

## Statement of Problem and Substantiation for Public Input

The change to locations of definitions in the 2023 Edition of the NEC was controversial for many people because it reduced usability. Even though other NFPA codes and standards use this structure and was stated as a justification to the change in the 'NEC Style Manual' (some NFPA codes and standards include definitions within articles *), many believe this relocation leads to confusion among users, especially for those articles that are specialty topics – i.e., the articles in Chapters 5 through 8. There are over 37 pages of definitions in Article 100 to search through.

Common language terms often have more specific meanings within an article. One only needs to look at the multiple definitions for 'Portable Equipment' to get a sense of this issue. While the term 'Directly Controlled Emergency Luminaire' used in Article 700 seems self-explanatory, the actual definition is quite important. Without the proximate reference within Article 700, that distinction is not clear.

Article 200 does the following:
200.1 Scope.
This article provides requirements for the following:
(1) Identification of terminals
(2) Grounded conductors in premises wiring systems
(3) Identification of grounded conductors
Informational Note: See Article 100 for definitions of Grounded Conductor, Equipment Grounding Conductor, and Grounding Electrode Conductor.

Article 380 also adds a definition reference in an Informational Note to the scope.

There are approximately 30 references to Article 100 definitions within specific sections of the Code.

Under the current structure, important specialty definitions are lost in the sheer size of the Article 100 list. The usability of the NEC has been damaged, and users of specialty articles in Chapters 5 through 8 need help with this structure.

To restore the usability of the NEC, what is needed is a way to clearly identify and point to specialty definitions in a standardized location within articles (like we used to have with the .2 sections), while leaving the definitions themselves in Article 100. NFPA Link and the NEC Handbook add this information as Enhanced Content. Additionally, this "definition identification" model has proven its usability in other codes such as NFPA 1, NFPA 99, and NFPA 101. The NEC deserves no less.
* Example: NFPA 101 – Section 6.1.2.1 'Assembly Occupancy' is one of several definitions in an Article; and in this instance it is duplicated from 3.3.205.2]. In fact, there are multiple definitions throughout NFPA 101.

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**Committee:** NEC-P15

**Public Input No. 4050, Assigned to Code-Making Panel 10, Refer to Code-Making Panels 1 - 9 and 11 - 18**

# Public Input No. 4050-NFPA 70-2023 [ Global Input ]

**Review the terms regarding overcurrent protection and determine if the correct term is being used.**

**(1) Branch-Circuit Overcurrent Protective Device**

**(2) Current-Limiting Overcurrent Protective Device**

**(3) Current-Limiting**

**(4) Current-Limiting Overcurrent**

**(5) Overcurrent Protection**

**(6) Overcurrent Protection Device**

**(7) Overcurrent Protective Device**

**(8) Supplementary Overcurrent Protective Device**

**(9) Supplementary Overcurrent Protection**

## Statement of Problem and Substantiation for Public Input

The defined terms regarding overcurrent protection need to be reviewed by all code making panels and determine if the correct term is being used. The code has too many terms regarding overcurent protection, some that are defined and some that are not defined. These terms are often used interchangeably in the wrong context.

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**Submittal Date:** Wed Sep 06 14:59:12 EDT 2023

**Committee:** NEC-P10

**Public Input No. 4075, Assigned to Code-Making Panel 1, Refer to Code-Making Panels 3, 4, 13 and 14**

# Public Input No. 4075-NFPA 70-2023 [ Global Input ]

**Anywhere that 2019 NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance* is referenced in the NEC as an informational note, that it be changed to: NFPA 70B, *Standard for Electrical Equipment Maintenance.***

## Statement of Problem and Substantiation for Public Input

There are two problems this will correct:
1. NFPA 70B was elevated to a standard during the last revision cycle, unfortunately it was not completed prior to the Public Input deadline for the 2023 NEC so many of the references are outdated.
2. By removiong the date in the informational note reference, there will be built in shelf life as this will now imply the most recent edition of 70B is being referenced.

## Submitter Information Verification


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**Submittal Date:** Wed Sep 06 15:44:53 EDT 2023
**Committee:** NEC-P01

**Public Input No. 4287, Assigned to Code-Making Panel 1, Refer to Code-Making Panels 2 - 18**

# Public Input No. 4287-NFPA 70-2023 [ Global Input ]

Clearly identify any requirements which are not applicable to DC circuits by incorporating the recommended terminology as applicable:

"Applicable to…[ac][single-phase][three-phase][wye][delta] circuits only".

"Not applicable to dc circuits"

"[Volts] ac only"

Other terminology that clearly applies to a specific ac (or dc) application, such as through a defined term or unique equipment.

## Statement of Problem and Substantiation for Public Input

This Public Input is submitted on behalf of a Correlating Committee DC Task Group consisting of Danish Zia, Jason Fisher, Randy Dollar, Larry Wildermuth, Scott Higgins, Scott Harding, Mark Earley, Jason Hopkins, Christopher Vance, Chad Kennedy and Derrick Atkins. This Public Input, along with other Public Inputs, was developed with the goal of improving usability and accuracy on requirements associated with DC circuits.

DC residential and commercial installations are emerging in the electrical infrastructure and are expected to be a growing alternative to the traditional AC utility fed building. Examples include the US DOE Grid-interactive Efficient Buildings project (Note 1), the Purdue University RENEWW house (Note 2), and a DC Microgrid community in Vermont (Note 3). These installations may involve buildings that are distributed entirely with DC, or with an AC/DC hybrid distribution.

Although DC electrical distribution topics are covered by the NEC, the focus of most residential and commercial installations and the Code has historically been AC power. Many requirements are written using AC terminology or referencing only AC technology, but without distinction as to whether the requirement is also applicable to DC circuits or installations. Usage of terms such as "2-wire" and "3-wire", or listing AC only voltages as informative references without appropriate mandatory language or further clarification may not provide sufficient clarity as to whether a requirement applies to DC circuits. This may leave the AHJ and other users of the Code confused. This public input recommends that such requirements be reviewed and clarified using the recommended terminology proposed.

Note 1 - https://www.energy.gov/sites/default/files/2020/09/f79/bto-geb-project-summary-093020.pdf
Note 2 - https://engineering.purdue.edu/ME/News/2022/purdue-house-runs-entirely-on-dc-power
Note 3 - https://www.efficiencyvermont.com/Media/Default/docs/white-papers/Energy_Resilience.pdf

## Submitter Information Verification


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**Committee:** NEC-P01

**Copyright Assignment**

I, Danish Zia, hereby irrevocably grant and assign to the National Fire Protection Association (NFPA) all and full rights in copyright in this Public Input (including both the Proposed Change and the Statement of Problem and Substantiation). I understand and intend that I acquire no rights, including rights as a joint author, in any publication of the NFPA in which this Public Input in this or another similar or derivative form is used. I hereby warrant that I am the author of this Public Input and that I have full power and authority to enter into this copyright assignment.

☑ By checking this box I affirm that I am Danish Zia, and I agree to be legally bound by the above Copyright Assignment and the terms and conditions contained therein. I understand and intend that, by checking this box, I am creating an electronic signature that will, upon my submission of this form, have the same legal force and effect as a handwritten signature

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

**Array.**

A mechanically and electrically integrated grouping of 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)

## Statement of Problem and Substantiation for Public Input

This proposed change to use the phrase "mounting system" instead of "support structure' is intended to improve the application of this Code to all PV system installations. While it is true that some arrays could include structural elements such as beams or poles, it is equally true that some arrays rely on buildings or other types of structures for their foundations. Since UL 2703 uses the term "Mounting Systems" in the title, and 690.43(A) already uses "Mounting Systems" when referring to mandatory requirements involving metallic PV module frames and bonding devices used with mounting systems, this term is the correct term to use when referring to an element of a PV array. Though 690.43(B) does use the term "support structure", these are permissive statements that would not apply to all PV array installations, so this phrase is not in conflict here. That said, this section does use the term PV system improperly so there is a related PI to correct that. Finally, the term "mounting system" is also being proposed to add to 690.47(B). Allowing an GEC to connect to an array mounting system in addition to the PV module frame only makes sense. Note that the existing use of the term PV array in that section is used distinctly separate from "support structure", which further justifies this change in the definition of array.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 3836-NFPA 70-2023 [Section No. 690.43(B)] | |
| Public Input No. 3837-NFPA 70-2023 [Section No. 690.47(B)] | |

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**Submittal Date:** Tue Sep 05 18:12:02 EDT 2023
**Committee:** NEC-P04

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

**Interactive ~~Mode~~ 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.

## Statement of Problem and Substantiation for Public Input

Adding the alternate term "Interactive" to this definition clarifies that where the term is used without "mode", which is common, a user is clearly guided to this definition for clarity.

Change equipment to sources to be more consistent with similar references in this Code including 705.1.

---

The Solar and Storage Industry Forum (SSIF) is a coalition of individuals and organizations convened by the Solar Energy Industry Association (SEIA) to organize, support, and mentor renewable energy industry professionals in codes and standards development. Our objective is to submit industry consensus-based recommendations for changes to the National Electrical Code. We believe that this effort improves the Code-making process by consolidating multiple industry member's points of view into fewer, common proposals.
SSIF members are dedicated to continually improving the installation safety of PV and storage systems in the U.S. A list of members can be found here:
https://www.seia.org/industry-forum

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 4167-NFPA 70-2023 [Definition: Power Production Equipment.] | Term change |
| Public Input No. 4167-NFPA 70-2023 [Definition: Power Production Equipment.] | |

## Submitter Information Verification

| | |
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| **Submittal Date:** | Wed Sep 06 20:27:37 EDT 2023 |
| **Committee:** | NEC-P04 |

# Public Input No. 2514-NFPA 70-2023 [ Definition: Island Mode. ]

**Island Mode.**

The operating mode for power production equipment 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).

Informational Note No. 1: The island mode electrical boundary does not extend into the electrical power systems under the exclusive control of the serving utility. 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 Specification of Microgrid Controllers* ; IEEE 2030.8, *IEEE Standard for Detecting Microgrid Controllers* ; and UL1008B, *Outline for Source Interconnection* , for additional information about island mode.

## Statement of Problem and Substantiation for Public Input

The Island Mode definition does not convey understanding that the microgrid electrical power system area could involve facilities under the exclusive control of entities (e.g., electric utilities) and subject to requirements separate from NFPA 70. The boundary and jurisdiction clarifications ensure development of microgrid systems are in accordance with all applicable requirements (e.g., DOE, IEEE 1547, IEEE 2030.7).

## Submitter Information Verification

| | |
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| **Committee:** | NEC-P04 |

# Public Input No. 4265-NFPA 70-2023 [ 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)

## Statement of Problem and Substantiation for Public Input

Term "equipment" is changed to "sources" to be more consistent with similar references in this Code including 705.1.
Note defined term change in related PI.

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The Solar and Storage Industry Forum (SSIF) is a coalition of individuals and organizations convened by the Solar Energy Industry Association (SEIA) to organize, support, and mentor renewable energy industry professionals in codes and standards development. Our objective is to submit industry consensus-based recommendations for changes to the National Electrical Code. We believe that this effort improves the Code-making process by consolidating multiple industry member's points of view into fewer, common proposals.
SSIF members are dedicated to continually improving the installation safety of PV and storage systems in the U.S. A list of members can be found here:
https://www.seia.org/industry-forum

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 4167-NFPA 70-2023 [Definition: Power Production Equipment.] | Change in defined term |
| Public Input No. 4167-NFPA 70-2023 [Definition: Power Production Equipment.] | |

## Submitter Information Verification


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**Submittal Date:** Thu Sep 07 08:56:36 EDT 2023
**Committee:** NEC-P04

## Public Input No. 4363-NFPA 70-2023 [ Definition: Island Mode. ]

**Island Mode.**

The operating mode for power production equipment 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.~~ allows standby power to loads. (CMP-4)

### Statement of Problem and Substantiation for Public Input

The definition is revised to simplify and add clarity for sources and systems which provide power to loads when disconnected from the primary source.

### Submitter Information Verification


| | |
|---|---|
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| **Submittal Date:** | Thu Sep 07 12:53:55 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 3039-NFPA 70-2023 [ Definition: Microgrid Interconnect Device (MID). ]

**Equipment, Interconnection. (Interconnection Equipment), ( Microgrid Interconnect Device), (MID).**

~~A device~~ Equipment that enables ~~a microgrid system~~ sources to separate from and reconnect to an interconnected primary power source. (CMP-4)

### Statement of Problem and Substantiation for Public Input

The term "Interconnection Equipment" better reflects the broad range of applications where this equipment is essential for safety and aligns with current product standards. DER systems and Standby systems are applications that may include this equipment. The term "Microgrid Interconnect Device" and acronym "MID" are retained for use with microgrid requirements and ease of electronic search within the code.

### Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 3043-NFPA 70-2023 [Section No. 700.10(A)] | |

### Submitter Information Verification

| | |
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| **Submittal Date:** | Tue Aug 29 08:00:02 EDT 2023 |
| **Committee:** | NEC-P04 |

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

**Microgrid.**

An electric power system capable of operating in island mode and capable of being interconnected to an electric 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. (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 Switches* , 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. See UL 9741 Outline of Investigation for Bidirectional Electric Vehicle Charging System Equipment.

## Statement of Problem and Substantiation for Public Input

UL 1008B is not the standard for Microgrid product, just the switch (part of the transfer switch series that also includes solid state switches, etc.). Ideally UL product references would be located in Annex A.1(a) or (b) as appropriate. Article 705 Annex A.1(a) already refers to UL 1741. UL 9741 is under development and not yet referenced by 705, but is by 625.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 1803-NFPA 70-2023 [Section No. 625.60] | |

## Submitter Information Verification

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| **Submittal Date:** | Sat Jul 29 19:18:12 EDT 2023 |
| **Committee:** | NEC-P04 |

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

**Microgrid.**

An interactive electric power ~~system capable of operating in island mode and capable of being interconnected to an electric power production and distribution network or other primary source while operating in interactive mode, which includes~~ source and distribution network with the ability to disconnect ~~from and reconnect to a~~ from a primary source and operate in island mode. (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.

## Statement of Problem and Substantiation for Public Input

The previous definition included redundant language that did not provide clarity. Short, simple declarative sentences should be used in accordance with the style manual.

## Submitter Information Verification


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**Submittal Date:** Wed Sep 06 11:22:51 EDT 2023
**Committee:** NEC-P04

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

**Microgrid.**

An electric power system ~~capable of~~ consisting of two or more power sources capable of operating in island mode and capable of being interconnected to an electric power production and distribution network or other primary source while operating in interactive mode~~, which includes the~~ . These systems include the ability to disconnect from and reconnect to a primary source ~~and operate in island mode~~ . (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.

## Statement of Problem and Substantiation for Public Input

The current definition is confusing, references "operation in island mode" twice, and because of the lengthy sentence seems to redefine interactive mode in a way that differs from the existing definition of interactive mode. Splitting this into two sentences and deleting the second reference to island mode aids in clarity without changing the meaning. Adding a reference to two or more power sources helps to further differentiate these systems from other standby or small standalone systems.

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The Solar and Storage Industry Forum (SSIF) is a coalition of individuals and organizations convened by the Solar Energy Industry Association (SEIA) to organize, support, and mentor renewable energy industry professionals in codes and standards development. Our objective is to submit industry consensus-based recommendations for changes to the National Electrical Code. We believe that this effort improves the Code-making process by consolidating multiple industry member's points of view into fewer, common proposals.

SSIF members are dedicated to continually improving the installation safety of PV and storage systems in the U.S. A list of members can be found here:
https://www.seia.org/industry-forum

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| **Submittal Date:** | Wed Sep 06 18:51:15 EDT 2023 |
| **Committee:** | NEC-P04 |

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

**Microgrid.**

An electric power system capable of operating in island mode and capable of being interconnected to an electric 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. (CMP-4)

Informational Note No. 1: See UL 3001 Standard for Distributed Energy Resource Systems, UL 3010 Standard for Single Site Energy Systems for evaluating microgrids, 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*; and 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.

## Statement of Problem and Substantiation for Public Input

UL 3001 and 3010 were developed to address hazards not covered by existing standards for microgrid systems. Both standards cover microgrids consisting of more than one distributed energy source (generation or storage) and capable of operating islanded, either permanently (stand-alone systems) or temporarily (island mode for a grid-tied system).

Hazards not addressed by existing standards include, but are not limited to, protection of generators from backfeeding power, islanded power quality (voltage, frequency and harmonics), as well as interaction between sources during all modes of operation.

UL 1008B covers one possible component of a microgrid and does not provide additional information on microgrid systems as mentioned in the Informational Note.

## Related Public Inputs for This Document

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

## Submitter Information Verification


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**Submittal Date:** Thu Sep 07 13:11:00 EDT 2023
**Committee:** NEC-P04

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

**Solar Cell ( Photovoltaic Cell ~~(~~ . PV ~~). (Solar~~ Cell).**

The basic photovoltaic device that generates dc electricity when exposed to light. (CMP-4)

## Statement of Problem and Substantiation for Public Input

The term "Photovoltaic cell" is not used in the NEC, nor is "PV cell"; "Solar cell" is.

## Submitter Information Verification


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**Submittal Date:** Tue Jul 11 17:50:51 EDT 2023
**Committee:** NEC-P04

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

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

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

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

## Statement of Problem and Substantiation for Public Input

This change is proposed to add more consistency and clarity to this Code. This existing term is used in this Code as a way to refer to any power source other than a utility source. While it uses the term "equipment", its current use in the Code is more general to refer to an entire system, not a discrete piece of equipment. Additionally there are multiple locations where "Power Source" is used, yet is undefined. In fact, the phrase "electric power production sources" is used in the scope of 705 (705.1). While both phrases ("power production equipment" and "power production equipment") are used in this Code, the defined term would more accurately be that of the source, since any use of the term equipment, would be a subset of the power source system.
In the informational note, adding wind to generators as well as energy storage systems improves accuracy. A fuel cell is only one type of energy storage system (per NFPA-855 and UL 9540) and not using the full ESS term could imply that other ESS do not fall under this definition. These changes would add clarity and ensure that for bidirectional equipment such as battery-based energy storage systems, the requirements in this Code would be correctly applied. The existing term is only used in Articles 705, and 710 as well as three other definitions in 100 also under the purview of CMP-4.
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SSIF members are dedicated to continually improving the installation safety of PV and storage systems in the U.S. A list of members can be found here:
https://www.seia.org/industry-forum

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 4265-NFPA 70-2023 [Definition: Island Mode.] | Use of term |
| Public Input No. 4189-NFPA 70-2023 [Definition: Interactive Mode.] | Use of term |
| Public Input No. 4268-NFPA 70-2023 [Section No. 705.40] | Use of term |
| Public Input No. 4189-NFPA 70-2023 [Definition: Interactive Mode.] | |
| Public Input No. 4265-NFPA 70-2023 [Definition: Island Mode.] | |
| Public Input No. 4268-NFPA 70-2023 [Section No. 705.40] | |

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| **Submittal Date:** | Wed Sep 06 19:15:06 EDT 2023 |
| **Committee:** | NEC-P04 |

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

**Power Production Equipment.**

Electrical generating equipment ~~supplied by any source other than~~ that is not a utility service, up to the source system disconnecting means. (CMP-4)

Informational Note: Examples of power production equipment include such items as generators, solar photovoltaic systems, and fuel cell systems.

## Statement of Problem and Substantiation for Public Input

How can a source be supplied by a source? That is like saying that something has a starting point before its starting point.

## Submitter Information Verification


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# Public Input No. 196-NFPA 70-2023 [ Definitions (100): Microgrid.... to Microgrid I... ]

**Definitions (100): Microgrid.... to Microgrid I...**

**~~Microgrid~~ Hybrid Power System .**

An electric power system capable of operating in island mode and capable of being interconnected to an electric 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. (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.

**~~Microgrid,~~ Health Care ~~(Health Care Microgrid System). (Health Care Microgrid)~~ Hybrid Power System**

A group of interconnected loads and distributed energy resources within clearly defined boundaries that acts as a single controllable entity with respect to the utility. [**99:**3.3.75] (517) (CMP-15)

**~~Microgrid~~ Hybrid Power Control System (MCS).**

A structured control system that manages microgrid operations, functionalities for utility interoperability, islanded operations, and transitions. (CMP-4)

Informational Note: MCS differ from multiple standby generators or uninterruptible power supplies that are evaluated and rated to operate as a single source of backup power upon loss of the primary power source. MCS functions include coordination, transitions, and interoperability between multiple power sources.

**~~Microgrid~~ Hybrid Power System Interconnect Device (~~MID~~ HPID ).**

A device that enables a microgrid system to separate from and reconnect to an interconnected primary power source. (CMP-4)

## Statement of Problem and Substantiation for Public Input

There's multiple definitions for "microgrid." However, as an extension of the term "grid" it best is thought of as a system with diversity, such as multiple power sources, multiple voltages, and multiple buildings. Why support such a dubious definition, which considers anyone who has standalone capability for their small rooftop solar installation as the owner of a microgrid? The Department Of Energy defines a microgrid as “a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode." This does not sound like the individual who just installed solar panels with a battery backup and islanding capability, on their house.

See Wikipedia definition of the term "Grid" which doesn't in any sense bring to mind the people who have islanding capable solar on their house:
https://en.wikipedia.org/wiki/Electrical_grid

See references to DOE microgrid definition:
https://emilms.fema.gov/IS0815/groups/32.html
https://www.naseo.org/issues/electricity/microgrids
https://www.researchgate.net/figure/Microgrid-Concept-A-microgrid-is-a-group-of-interconnected-loads-and-distributed-energy_fig1_332984667
https://sustainablesolutions.duke-energy.com/resources/three-types-of-microgrids/

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## Public Input No. 4489-NFPA 70-2023 [ New Definition after Definition: Array. ]

**Array Boundary**

An area of 305 mm (1 ft) from the array in all directions.

## Statement of Problem and Substantiation for Public Input

The term array boundary is used in 690.12 for rapid shutdown of PV systems on buildings. The proposed text is from 690.12(B) where it defines the array boundary in the requirement. This proposed definition will enhance usability for Code Users.

## Submitter Information Verification


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**Committee:** NEC-P04

# Public Input No. 4258-NFPA 70-2023 [ New Definition after Definition: Purpose-Built. ]

**PV Applied Bifacial Stress Irradiance (aBSI).**

Reference conditions used to define a short-circuit current rating of bifacial modules under irradiance conditions corresponding to the combination of 1000 W/m $^{2}$ on the front side and the value that is greater of 300 W/m $^{2}$ or the manufacturer's claimed irradiance value for the rear side of the module. (690) (CMP-4)

**PV Bifacial Module (Bifacial Module).**

A photovoltaic module that can generate electric power by converting light received on both front and rear sides by means of the photovoltaic effect.(690) (CMP-4)

Informational Note: See UL 61730 for more information on PV bifacial modules

**PV Monofacial Module (Monofacial Module).**

A photovoltaic module that can generate electric power by converting light received on one side by means of the photovoltaic effect.((690) CMP-4)

## Statement of Problem and Substantiation for Public Input

New definitions are proposed for Article 100 because they are used in proposed changes to 690.8 to support the addition of clarifications and requirements for bifacial modules. The 2023 NEC did not have any direct reference to bifacial PV modules. The term “bifacial” is widely used in the PV industry, and has been for at least a decade. An informational note in 690.8 referred only to “…modules that can produce electricity when exposed to light on multiple surfaces…”, but with no reference to the term “bifacial”. As a result a word search of the NEC for the term “bifacial” would yield no results.

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SSIF members are dedicated to continually improving the installation safety of PV and storage systems in the U.S. A list of members can be found here:

https://www.seia.org/industry-forum

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 4254-NFPA 70-2023 [Section No. 690.8(A)] | Uses these terms |
| Public Input No. 4254-NFPA 70-2023 [Section No. 690.8(A)] | |

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| **Committee:** | NEC-P04 |

# Public Input No. 4256-NFPA 70-2023 [ New Definition after Definition: PV Module (Module). ]

**PV Standard Test Conditions (STC)**

Reference conditions used to define photovoltaic module ratings in standardized conditions consisting of in-plane irradiance 1000 W/m$^2$ on the front side of the module, a module temperature of 25 °C (77 °F), and an air mass of 1.5. (690) (CMP-4)

## Statement of Problem and Substantiation for Public Input

New definitions are proposed for Article 100 because these terms are used in proposed changes to 690.8 to support the addition of clarifications and requirements for bifacial modules. This requires differentiating between standard test conditions (STC), where light is only applied to the front of the module, from bifacial ratings, which are based on light hitting both the front and rear of the module.

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https://www.seia.org/industry-forum

## Related Public Inputs for This Document

| Related Input | Relationship |
| --- | --- |
| Public Input No. 4254-NFPA 70-2023 [Section No. 690.8(A)] | Uses this term |
| Public Input No. 4254-NFPA 70-2023 [Section No. 690.8(A)] | |

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**Committee:** NEC-P04

# Public Input No. 1340-NFPA 70-2023 [ Article 690 ]

## Article 690 ~~Solar~~ Photovoltaic (PV) Systems

**Part I.** General

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

**690.4** General Requirements.

**(A)** PV Systems.

PV systems shall be permitted to supply a building or other structure in addition to any other electrical supply system(s).

**(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.

**(C)** Qualified Personnel.

The installation of equipment, associated wiring, and interconnections shall be performed only by qualified persons.

**(D)** Multiple PV Systems.

Multiple PV systems shall be permitted to be installed in or on a single building or structure. Where the PV systems are remotely located from each other, a directory in accordance with 705.10 shall be provided at each PV system disconnecting means.

**(E)** Locations Not Permitted.

PV system equipment and disconnecting means shall not be installed in bathrooms.

**(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 areas that are not readily accessible. Disconnecting means shall be installed in accordance with 690.15.

**(G)** PV Equipment Floating on Bodies of Water.

PV equipment floating on or attached to structures floating on bodies of water shall be identified as being suitable for the purpose and shall utilize wiring methods that allow for any expected movement of the equipment.

> Informational Note: PV equipment in these installations are often subject to increased levels of humidity, corrosion, and mechanical and structural stresses. Expected movement of floating PV arrays is often included in the structural design.

**690.6** Alternating-Current (ac) Modules and Systems.

**(A)** Photovoltaic Source Circuits.

The requirements of Article 690 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.

**(B)** Output Circuit.

The output of an ac module or ac module system shall be considered an inverter output circuit.

**Part II.** Circuit Requirements

**690.7** 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 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 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 exceed 600 volts on or in one- and two-family dwellings.

(3) PV system dc 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:

(1) 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 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 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

**690.8** Circuit Sizing and Current.

**(A)** Calculation of Maximum Circuit Current.

The maximum current for the specific circuit shall be calculated in accordance with one of the methods in 690.8(A)(1) or (A)(2).

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

(3) <u>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).</u>

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.

**(2)** Circuits Connected to the Input of Electronic Power Converters.

Where a circuit is protected with an overcurrent device not exceeding the conductor ampacity, the maximum current shall be permitted to be the rated input current of the electronic power converter input to which it is connected.

**(B)** Conductor Ampacity.

Circuit conductors shall have an ampacity not less than the larger of 690.8(B)(1) or (B)(2).

**(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: Circuits containing 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.*

**(2)** With Adjustment and Correction Factors.

The maximum currents calculated in 690.8(A) with adjustment and correction factors.

**(C)** Systems with Multiple Direct-Current Voltages.

For a PV power source that has multiple output circuit voltages and employs a common-return conductor, the ampacity of the common-return conductor shall not be less than the sum of the ampere ratings of the overcurrent devices of the individual output circuits.

**(D)** Multiple PV String Circuits.

Where an overcurrent device is used to protect more than one set of parallel-connected PV string circuits, the ampacity of each conductor protected by the device shall not be less than the sum of the following:

(1) The rating of the overcurrent device

(2) The sum of the maximum currents as calculated in 690.8(A)(1)(a) for the other parallel-connected PV string circuits protected by the overcurrent device

**690.9** Overcurrent Protection.

**(A)** Circuits and Equipment.

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).

**(1)** Circuits Where Overcurrent Protection Not Required.

Overcurrent protective devices shall not be required where both of the following conditions are met:

(1) The conductors have sufficient ampacity for the maximum circuit current.

(2) The currents from all sources do not exceed the maximum overcurrent protective device rating specified for the PV module or electronic power converter.

**(2)** Circuits Where Overcurrent Protection is Required on One End.

A circuit conductor connected at one end to a current-limited supply, where the conductor is rated for the maximum circuit current from that supply, and also connected to sources having an available maximum circuit current greater than the ampacity of the conductor, shall be protected from overcurrent at the point of connection to the higher current source.

Informational Note: Photovoltaic system dc circuits and electronic power converter outputs powered by these circuits are current-limited and in some cases do not need overcurrent protection. Where these circuits are connected to higher current sources, such as parallel-connected PV system dc circuits, energy storage systems, or a utility service, the overcurrent device is often installed at the higher current source end of the circuit conductor.

**(3)** Other Circuits.

Circuits that do not comply with 690.9(A)(1) or (A)(2) shall be protected with one of the following methods:

(1) Conductors not greater than 3 m (10 ft) in length and not in buildings, protected from overcurrent on one end

(2) Conductors not greater than 3 m (10 ft) in length and in buildings, protected from overcurrent on one end and in a raceway or metal clad cable

(3) Conductors protected from overcurrent on both ends

(4) Conductors not installed on or in buildings are permitted to be protected from overcurrent on one end of the circuit where the circuit complies with all of the following conditions:

a. The conductors are installed in metal raceways or metal-clad cables, or installed in enclosed metal cable trays, or underground, or where directly entering pad-mounted enclosures.

b. The conductors for each circuit terminate on one end at a single circuit breaker or a single set of fuses that limit the current to the ampacity of the conductors.

c. The overcurrent device for the conductors is an integral part of a disconnecting means or shall be located within 3 m (10 ft) of conductor length of the disconnecting means.

d. The disconnecting means for the conductors is installed outside of a building, or at a readily accessible location nearest the point of entrance of the conductors inside of a building, including installations complying with 230.6.

**(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.

**(C)** PV System DC Circuits.

A single overcurrent protective device, where required, shall be permitted to protect the PV modules, dc-to-dc converters, and conductors of each circuit. Where single overcurrent protection devices are used to protect circuits, all overcurrent devices shall be placed in the same polarity for all circuits within a PV system. The overcurrent devices shall be accessible but shall not be required to be readily accessible.

Informational Note: Due to improved ground-fault protection required in PV systems by 690.41(B), a single overcurrent protective device in either the positive or negative conductors of a PV system in combination with this ground-fault protection provides adequate overcurrent protection.

**(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.*

**690.11** Arc-Fault Circuit Protection (dc).

Photovoltaic systems with PV system dc circuits operating at 80 volts dc or greater between any two conductors shall be protected by a listed PV arc-fault circuit interrupter or other system components listed to provide equivalent protection. The system shall detect and interrupt arcing faults resulting from a failure in the intended continuity of a conductor, connection, module, or other system component in the PV system dc circuits.

*Exception: PV system dc circuits that utilize metal-clad cables, are installed in metal raceways or enclosed metal cable trays, or are underground shall be permitted without arc-fault circuit protection if the installation complies with at least one of the following:*

*(1) The PV system dc circuits are not installed in or on buildings.*

*(2) The PV system dc circuits are located in or on detached structures whose sole purpose is to support or contain PV system equipment.*

**690.12** Rapid Shutdown of PV Systems on Buildings.

PV system circuits installed on or in buildings shall include a rapid shutdown function to reduce shock hazard for firefighters in accordance with 690.12(A) through (D).

*Exception No. 1: Ground-mounted PV system circuits that enter buildings, of which the sole purpose is to house PV system equipment, shall not be required to comply with 690.12.*

*Exception No. 2: PV equipment and circuits installed on nonenclosed detached structures including but not limited to parking shade structures, carports, ~~solar trellises~~ trellises , and similar structures shall not be required to comply with 690.12.*

Informational Note: Exceptions for rapid shutdown are intended to be consistent with building and fire codes that have limitations as to the types of buildings on which firefighters typically perform rooftop operations.

**(A)** Controlled Conductors.

Requirements for controlled conductors shall apply to the following:

(1) PV system dc circuits

(2) Inverter output circuits originating from inverters located within the array boundary

Informational Note: The rapid shutdown function reduces the risk of electrical shock that dc circuits in a PV system could pose for firefighters. The ac output conductors from PV systems that include inverters will either be de-energized after shutdown initiation or will remain energized by other sources such as a utility service. To prevent PV arrays with attached inverters from having energized ac conductors within the PV array(s), those circuits are also specifically controlled after shutdown initiation.

*Exception: PV system circuits originating within or from arrays not attached to buildings that terminate on the exterior of buildings and PV system circuits installed in accordance with 230.6 shall not be considered controlled conductors for the purposes of 690.12.*

**(B)** Controlled Limits.

The use of the term *array boundary* in this section is defined as 305 mm (1 ft) from the array in all directions. Controlled conductors outside the array boundary shall comply with 690.12(B)(1) and inside the array boundary shall comply with 690.12(B)(2). Equipment and systems shall be permitted to meet the requirements of both inside and outside the array as defined by the manufacturer's instructions included with the listing.

**(1)** Outside the Array Boundary.

Controlled conductors located outside the boundary or more than 1 m (3 ft) from the point of entry inside a building shall be limited to not more than 30 volts within 30 seconds of rapid shutdown initiation. Voltage shall be measured between any two conductors and between any conductor and ground.

**(2)** Inside the Array Boundary.

The PV system shall comply with one of the following:

(1) 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: 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) 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.

**(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.

**(D)** Buildings with Rapid Shutdown.

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~~ “PV SYSTEM IS EQUIPPED WITH RAPID SHUTDOWN” shall have these letters capitalized and having a minimum height of 9.5 mm (⅜ in.). All text shall be legible and contrast the background.

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

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

**(1)** Buildings with More Than One Rapid Shutdown Type.

For buildings that have PV systems with more than one rapid shutdown type or PV systems with no rapid shutdown, a detailed plan view diagram of the roof shall be provided showing each different PV system with a dotted line around areas that remain energized after rapid shutdown is initiated.

**(2)** Rapid Shutdown Switch.

A rapid shutdown switch shall have a label that includes the following wording located on or no more than 1 m (3 ft) from the switch:

RAPID SHUTDOWN SWITCH FOR ~~SOLAR~~ PV SYSTEM

The label shall be reflective, with all letters capitalized and having a minimum height of 9.5 mm (⅜ in.) in white on red background.

**Part III.** Disconnecting Means

**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.

**690.15** Disconnecting Means for Isolating Photovoltaic Equipment.

Disconnecting means of the type required in 690.15(A) shall be provided to disconnect ac PV modules, fuses, dc-to-dc converters, inverters, and charge controllers from all conductors that are not solidly grounded.

**(A)** Type of Disconnecting Means.

Where a disconnect is required to isolate equipment, the disconnecting means shall be one of the following:

(1) An equipment disconnecting means in accordance with 690.15(C)

(2) An isolating device as part of listed equipment where an interlock or similar means prevents the opening of the isolating device under load

(3) For circuits with a maximum circuit current of 30 amperes or less, an isolating device in accordance with 690.15(B)

**(B)** Isolating Device.

An isolating device shall not be required to have an interrupting rating. Where an isolating device is not rated for interrupting the circuit current, it shall be marked “Do Not Disconnect Under Load” or “Not for Current Interrupting.” An isolating device shall not be required to simultaneously disconnect all current-carrying conductors of a circuit. The isolating device shall be one of the following:

(1) A mating connector meeting the requirements of 690.33 and listed and identified for use with specific equipment

(2) A finger-safe fuse holder

(3) An isolating device that requires a tool to place the device in the open (off) position

(4) An isolating device listed for the intended application

**(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).

Equipment disconnecting means, other than those complying with 690.33, shall be marked in accordance with the warning in 690.13(B) 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.

**(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 in accordance with 110.25

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

(5) <u>The disconnecting means and their controls are located within the same equipment.</u>

(6) <u>The disconnecting means is lockable in accordance with 110.25, and the location of the controls are marked on the disconnecting means.</u>

**Part IV.** Wiring Methods and Materials

**690.31** Wiring Methods.

**(A)** Wiring Systems.

**(1)** Serviceability.

Where wiring devices with integral enclosures are used, sufficient length of cable shall be provided to facilitate replacement.

**(2)** Where Readily Accessible.

Where not guarded, PV system dc circuit conductors operating at voltages greater than 30 volts that are readily accessible to unqualified persons shall be installed in Type MC cable, in multiconductor jacketed cable, or in raceway.

**(3)** Conductor Ampacity.

The ampacity of 105°C (221°F) and 125°C (257°F) conductors shall be permitted to be determined by Table 690.31(A)(3)(1). For ambient temperatures greater than 30°C (86°F), the ampacities of these conductors shall be corrected in accordance with Table 690.31(A)(3)(2).

Table 690.31(A)(3)(1) Ampacities of Insulated Conductors Rated Up To and Including 2000 Volts, 105°C Through 125°C (221°F Through 257°F), Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)

| | Types | |
|---|---|---|
| AWG | PVC, CPE, XLPE 105°C | XLPE, EPDM 125°C |
| 18 | 15 | 16 |
| 16 | 19 | 20 |
| 14 | 29 | 31 |
| 12 | 36 | 39 |
| 10 | 46 | 50 |
| 8 | 64 | 69 |
| 6 | 81 | 87 |
| 4 | 109 | 118 |
| 3 | 129 | 139 |
| 2 | 143 | 154 |
| 1 | 168 | 181 |
| 1/0 | 193 | 208 |
| 2/0 | 229 | 247 |
| 3/0 | 263 | 284 |
| 4/0 | 301 | 325 |

Table 690.31(A)(3)(2) Correction Factors

| | Temperature Rating of Conductor | | |
|---|---|---|---|
| Ambient Temperature (°C) | 105°C (221°F) | 125°C (257°F) | Ambient Temperature (°F) |
| 30 | 1 | 1 | 86 |
| 31–35 | 0.97 | 0.97 | 87–95 |
| 36–40 | 0.93 | 0.95 | 96–104 |
| 41–45 | 0.89 | 0.92 | 105–113 |
| 46–50 | 0.86 | 0.89 | 114–122 |
| 51–55 | 0.82 | 0.86 | 123–131 |
| 56–60 | 0.77 | 0.83 | 132–140 |
| 61–65 | 0.73 | 0.79 | 141–149 |
| 66–70 | 0.68 | 0.76 | 150–158 |
| 71–75 | 0.63 | 0.73 | 159–167 |
| 76–80 | 0.58 | 0.69 | 168–176 |
| 81–85 | 0.52 | 0.65 | 177–185 |
| 86–90 | 0.45 | 0.61 | 186–194 |
| 91–95 | 0.37 | 0.56 | 195–203 |

| | - | Temperature Rating of Conductor | - |
|---|---|---|---|
| Ambient Temperature | 105°C | 125°C | Ambient Temperature |
| (°C) | (221°F) | (257°F) | (°F) |
| 96–100 | 0.26 | 0.51 | 204–212 |
| 101–105 | — | 0.46 | 213–221 |
| 106–110 | — | 0.4 | 222–230 |
| 111–115 | — | 0.32 | 231–239 |
| 116–120 | — | 0.23 | 240–248 |

**(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.

**(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.

*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.*

**(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 690.31(B)(2)(a) and (B)(2)(b).

*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.

**(3)** Grouping.

Where ac and dc conductors of PV systems occupy the same junction box, pull box, or wireway, the ac and dc circuit conductors shall be grouped separately by cable ties or similar means at least once and at intervals not to exceed 1.8 m (6 ft).

*Exception: The requirement for grouping shall not apply if the circuit enters from a cable or raceway unique to the circuit that makes the grouping obvious.*

**(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) <u>PV wire or cable</u>

(3) <u>Single-conductor cable marked sunlight resistant and Type USE-2 and Type RHW-2</u>

(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.

**(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).

**(1)** Metal Raceways 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 of the building.*

**(2)** Marking and Labeling.

Unless located and arranged so the purpose is evident, the following wiring methods and enclosures that contain PV system dc circuit conductors shall be marked with the wording PHOTOVOLTAIC POWER SOURCE or SOLAR PV DC CIRCUIT by means of permanently affixed labels or other approved permanent marking:

(1) Exposed raceways, cable trays, and other wiring methods

(2) Covers or enclosures of pull boxes and junction boxes

(3) Conduit bodies in which any of the available conduit openings are unused

The labels or markings shall be visible after installation. All letters shall be capitalized and shall be a minimum height of 9.5 mm (⅜ in.) in white on a red background. Labels shall appear on every section of the wiring system that is separated by enclosures, walls, partitions, ceilings, or floors. Spacing between labels or markings, or between a label and a marking, shall not be more than 3 m (10 ft). Labels required by this section shall be suitable for the environment where they are installed.

**(E)** Bipolar Photovoltaic Systems.

Where the sum, without consideration of polarity, of the voltages of the two monopole circuits exceeds the rating of the conductors and connected equipment, monopole circuits in a bipolar PV system shall be physically separated, and the electrical output circuits from each monopole circuit shall be installed in separate raceways until connected to the inverter. The disconnecting means and overcurrent protective devices for each monopole circuit output shall be in separate enclosures. All conductors from each separate monopole circuit shall be routed in the same raceway. Solidly grounded bipolar PV systems shall be clearly marked with a permanent, legible warning notice indicating that the disconnection of the grounded conductor(s) may result in overvoltage on the equipment.

*Exception: Listed switchgear rated for the maximum voltage between circuits and containing a physical barrier separating the disconnecting means for each monopole circuit shall be permitted to be used instead of disconnecting means in separate enclosures.*

**(F)** Wiring Methods and Mounting Systems.

Roof-mounted PV array mounting systems shall be permitted to be held in place with an approved means other than those required by 110.13 and shall utilize wiring methods that allow any expected movement of the array.

Informational Note: Expected movement of unattached PV arrays is often included in structural calculations.

**(G)** Over 1000 Volts DC.

Equipment and wiring methods containing PV system dc circuits with a maximum voltage greater than 1000 volts shall comply with the following:

(1) Shall not be permitted on or in one- and two-family dwellings.

(2) Shall not be permitted within buildings containing habitable rooms.

(3) Where installed on the exterior of buildings shall be located less than 3 m (10 ft) above grade. Wiring methods containing PV system dc circuits connected to this equipment shall not be permitted to attach to the building greater than 10 m (33 ft) along the building surface from the equipment.

**690.32** Component Interconnections.

Fittings and connectors that are intended to be concealed at the time of on-site assembly, where listed for such use, shall be permitted for on-site interconnection of modules or other array components. Such fittings and connectors shall be equal to the wiring method employed in insulation, temperature rise, and short-circuit current rating, and shall be capable of resisting the effects of the environment in which they are used.

**690.33** Mating Connectors.

Mating connectors, other than connectors covered by 690.32, shall comply with 690.33(A) through (D).

**(A)** Configuration.

The mating connectors shall be polarized and shall have a configuration that is noninterchangeable with receptacles in other electrical systems on the premises.

**(B)** Guarding.

The mating connectors shall be constructed and installed so as to guard against inadvertent contact with live parts by persons.

**(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.

**(D)** Interruption of Circuit.

Mating connectors shall be one of the following:

(1) Rated for interrupting current without hazard to the operator

(2) A type that requires the use of a tool to open and marked "Do Not Disconnect Under Load" or "Not for Current Interrupting"

(3) Supplied as part of listed equipment and used in accordance with instructions provided with the listed connected equipment

> Informational Note: Some listed equipment, such as microinverters, are evaluated to make use of mating connectors as disconnect devices even though the mating connectors are marked as "Do Not Disconnect Under Load" or "Not for Current Interrupting."

**690.34** Access to Boxes.

Junction, pull, and outlet boxes located behind modules or panels shall be so installed that the wiring contained in them can be rendered accessible directly or by displacement of a module(s) or panel(s) secured by removable fasteners and connected by a flexible wiring system.

**Part V.** Grounding and Bonding

**690.41** PV System DC Circuit Grounding and Protection.

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

(4) Ungrounded circuits

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

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

**(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 (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 identified for the combination of the dc-to-dc converter 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: 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.

**690.42** Point of PV System DC Circuit Grounding Connection.

**(A)** Circuits with GFDI Protection.

Circuits protected by GFDI equipment in accordance with 690.41(B) shall have any circuit-to-ground connection made by the GFDI equipment.

**(B)** Solidly Grounded Circuits.

For solidly grounded PV system dc circuits, the grounding connection shall be made from any single point on the PV dc system to a point in the grounding electrode system in 690.47(A).

**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 (D).

**(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 PV modules.

> Informational Note: See UL 2703, *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, *Standard for Solar Trackers*.

**(B)** Equipment Secured to Grounded Metal Supports.

Devices listed, labeled, and identified for bonding and grounding the metal parts of PV systems shall be permitted to bond the equipment to grounded metal supports. 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.

**(C)** Location.

Equipment grounding conductors shall be permitted to be run separately from the PV system conductors within the PV array. Where PV system circuit conductors leave the vicinity of the PV array, equipment grounding conductors shall comply with 250.134.

**(D)** Bonding for Over 250 Volts.

The bonding requirements contained in 250.97 shall apply only to solidly grounded PV system circuits operating over 250 volts to ground.

**690.45** Size of Equipment Grounding Conductors.

Equipment grounding conductors for PV system circuits shall be sized in accordance with 250.122. Where no overcurrent protective device is used in the circuit, an assumed overcurrent device rated in accordance with 690.9(B) shall be used when applying Table 250.122.

Increases in equipment grounding conductor size to address voltage drop considerations shall not be required.

**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).

PV array equipment grounding conductors shall be connected to a grounding electrode system in accordance with Part VII of Article 250. This connection shall be in addition to any other equipment grounding conductor requirements in 690.43(C). 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.

**Part VI.** Source Connections

**690.56** Identification of Power Sources.

Plaques or directories shall be installed in accordance with 705.10.

**690.59** Connection to Other Sources.

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

**690.72** Self-Regulated PV Charge Control.

The PV source circuit shall be considered to comply with the requirements for charge control of a battery without the use of separate charge control equipment if the circuit meets both of the following:

(1) The PV source circuit is matched to the voltage rating and charge current requirements of the interconnected battery cells.

(2) The maximum charging current multiplied by 1 hour is less than 3 percent of the rated battery capacity expressed in ampere-hours or as recommended by the battery manufacturer.

## Statement of Problem and Substantiation for Public Input

The NEC currently recognizes the fact that any light source can be used and not just solar light source to generate energy with photovoltaic panels. This PI aligns with many other locations in the NEC where the term Photovoltaic is used without Solar. A good example of this is in the title of Article 691 which does not have the word “solar” in its title.

the changes in this public input include the following 6 areas found in Article 690. Please note that I am entering this information to specifically identify these locations in Article 690 because TERRA has identified areas of Article 690 that I am not suggesting to change as part of this public input.

The following is impacted by this Public Input:

Article 690 Title
690.1 Scope
690.12 Exception 2
690.12(D)
690.12(D)(2)
690.31(D)(2)

## Submitter Information Verification

**Submitter Full Name:** Thomas Domitrovich
**Organization:** Eaton Corporation
**Street Address:**
**City:**
**State:**
**Zip:**
**Submittal Date:** Sat Jul 08 12:38:32 EDT 2023
**Committee:** NEC-P04

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

**690.2 Listing Requiremets.**

**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.**

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document when general listing requirements are covered within an article. The NEC Style Manual Section 2.2.1 Parallel Numbering Required, states that technical committees shall use the following section numbers for the same purposes within articles. The listing requirements are to be located in the .2 section.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Related Public Inputs for This Document

| Related Input | Relationship |
| --- | --- |
| Public Input No. 2810-NFPA 70-2023 [Section No. 690.4] | Deleted and relocated to the .2 section. |
| Public Input No. 2810-NFPA 70-2023 [Section No. 690.4] | |

## Submitter Information Verification

| | |
| --- | --- |
| **Submitter Full Name:** | Dean Hunter |
| **Organization:** | Minnesota Department of Labor |
| **Street Address:** | |
| **City:** | |
| **State:** | |
| **Zip:** | |
| **Submittal Date:** | Fri Aug 25 13:33:48 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 3827-NFPA 70-2023 [ New Section after 690.1 ]

**690.3 Reconditioned Equipment**

(A) Permitted to be Installed.

Reconditioned equipment shall be listed as reconditioned and comply with 110.21(A)(2).

Reconditioned PV equipment such as Inverters, combiner boxes and PVRSE shall be permitted.

Reconditioned photovoltaic modules and panels with or without integrated electronics such as; AC modules, DC/DC converters, PVRSE and optimizers shall be permitted.

## Statement of Problem and Substantiation for Public Input

This proposal is aligned with 110.21 (A)(2) and clarifies that all reconditioned PV system equipment is permitted. Due to the complexity and safety risks associated with this equipment, it is important that the reconditioned equipment be evaluated by a listing agency to ensure compliance with the product standard.

## Submitter Information Verification


| | |
|---|---|
| **Submitter Full Name:** | Colleen OBrien |
| **Organization:** | UL LLC |
| **Street Address:** | |
| **City:** | |
| **State:** | |
| **Zip:** | |
| **Submittal Date:** | Tue Sep 05 17:56:07 EDT 2023 |
| **Committee:** | NEC-P04 |

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

**690.2 LISTING REQUIRED**

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, charge controllers intended for use in PV systems, shall be listed or be evaluated for the application and have a field label applied.

## Statement of Problem and Substantiation for Public Input

Propose to move 690.4(B) to 690.2 and change name from "Equipment" to "Listing Required". The relocation is in accordance with 2.2.1 of the style manual.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 3839-NFPA 70-2023 [Section No. 690.4(B)] | Changes are also proposed to the content of this section as well as to the new section number and title of this section. |
| Public Input No. 3839-NFPA 70-2023 [Section No. 690.4(B)] | |

## Submitter Information Verification

**Submitter Full Name:** Colleen OBrien
**Organization:** UL LLC
**Street Address:**
**City:**
**State:**
**Zip:**
**Submittal Date:** Tue Sep 05 18:38:58 EDT 2023
**Committee:** NEC-P04

## Public Input No. 1797-NFPA 70-2023 [ 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. 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 Note Figure 690.1 Illustration of PV System DC Circuits and PV System Components in a Typical PV Installation.**

## Additional Proposed Changes

| File Name | Description | Approved |
|---|---|---|
| 20230803_123543.jpg | PV Combiner Box and labeling | |

## Statement of Problem and Substantiation for Public Input

Labeling on info note fig 690.1 needs to distinctively describe supply from the pv array and differentiate the combined power flow towards the inverter of battery storage systems.
For the combiner input side, please consider terms like STRING, Source, or Branch
For the combiner output side ELIMINATE the repetitive term SOURCE and consider using FEEDER or TRUNK.
The lower current INPUT and the combined higher ampacity OUTPUT conductors from the combiner box should be distinctly annotated to clarify the direction of power flow in the system

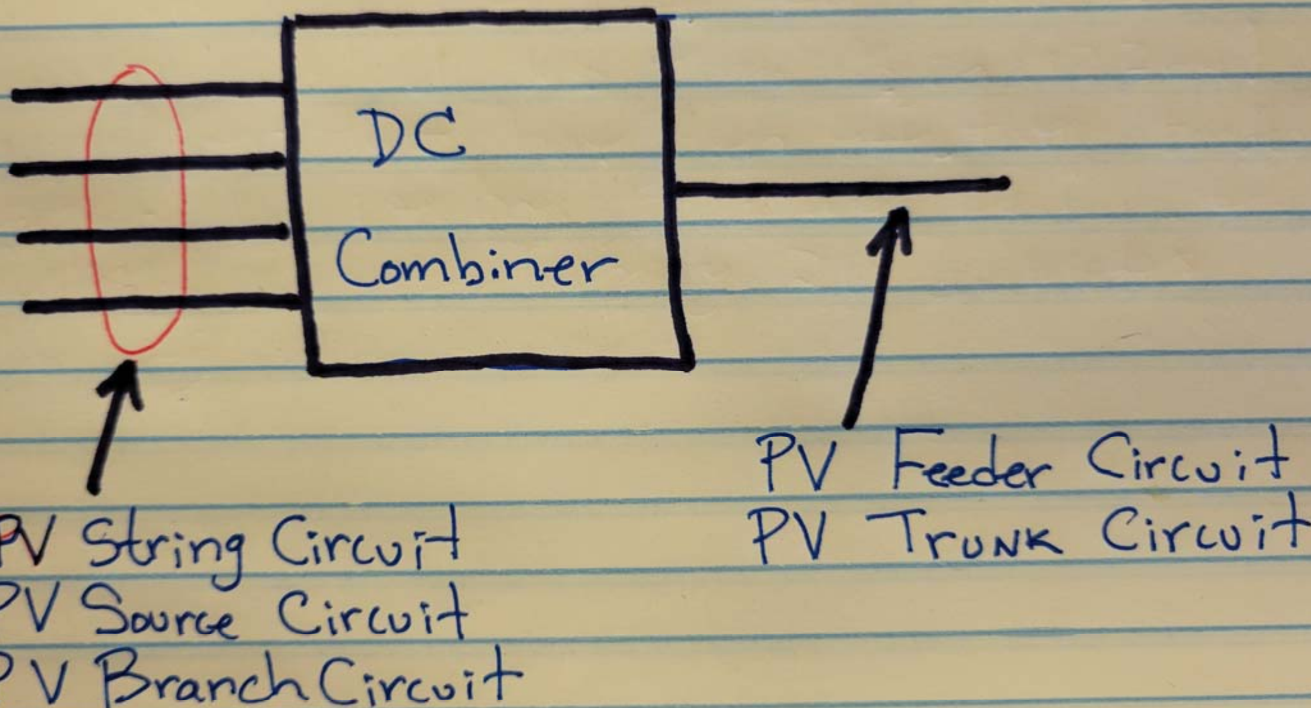
## Submitter Information Verification

**Submitter Full Name:** Andrew Rolfe

**Organization:** Louisville Electrical JATC

| | |
|---|---|
| **Affiliation:** | IBEW LU 369 |
| **Street Address:** | |
| **City:** | |
| **State:** | |
| **Zip:** | |
| **Submittal Date:** | Thu Aug 03 12:29:19 EDT 2023 |
| **Committee:** | NEC-P04 |

Informational Note Figure 690.1



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

**690.1** Scope.

This article applies to solar PV systems, other than those ~~covered by Article 691~~ described in 691.4 , including the array circuit(s), inverter(s), and controller(s) for such systems. 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 Note Figure 690.1 Illustration of PV System DC Circuits and PV System Components in a Typical PV Installation.**

## Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the NEC(r) Style Manual prohibits referencing an entire article other than article 100 or where required for context. In the case of the scope of htis article, it is proposed that we replace the first instance of "Article 691" with the "other than those described in 691.4" since 691.4 gives the specific requirements, including the minimum size of the PV system, in order to be considered a large scale PV system. I'm proposing that the informational note pointing to Article 691 be left as is "for context", though similar changes could be made to the informational note if the panel chooses.

## Submitter Information Verification


**Submitter Full Name:** Richard Holub

**Organization:** The DuPont Company, Inc.

**Street Address:**

**City:**

**State:**

**Zip:**


**Submittal Date:** Thu Aug 31 09:22:53 EDT 2023

| | |
|---|---|
| **Committee:** | NEC-P04 |

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

**690.1** Scope.

This article applies to solar PV systems that exceed 30 volts or 8 amperes , other than those covered by Article 691~~, including the array circuit(s), inverter(s), and controller(s) for such systems~~ . 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 Note Figure 690.1 Illustration of PV System DC Circuits and PV System Components in a Typical PV Installation.**

## Statement of Problem and Substantiation for Public Input

While there has never been a minimum size for a PV system in this Code since this Article's introduction in 1984, there have been many changes in the requirements for PV systems that justify considering one be added. It is a fact that small PV modules are being sold for common uses such as vehicle battery charging etc. Since this article could apply to any PV installation, permanent or temporary, consideration should be given to ensure no unfair burden is placed on installers or owners of small PV systems that do not present shock or fire hazards. Since these proposed limits are below the values required for ground-fault protection, arc-fault protection, and rapid shutdown, it is fair to say that PV systems below these limits do not need to be subjected to all the requirements in this article, as these limits are very low energy and potential. Additionally, several terms are proposed to be struck from this scope as they are not necessary to apply this article, and are incomplete when it comes to describing the systems this article applies to. This is old language that is no longer accurate or even needed when considering the definitions and other clarifications we now have throughout the body of article 100 and 690.

## Submitter Information Verification

**Submitter Full Name:** Jason Fisher

| | |
|---|---|
| **Organization:** | Solar Technical Consulting Llc |
| **Street Address:** | |
| **City:** | |
| **State:** | |
| **Zip:** | |
| **Submittal Date:** | Tue Sep 05 19:44:04 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 1247-NFPA 70-2023 [ New Section after 690.4 ]

**TITLE OF NEW CONTENT**

Type your content here ...

690.5. Cybersecurity

PV Systems that are connected to a communication network and have the capability to be controlled or permit control of any portion of the premises shall comply with either of the following:

(1) The ability to control the system is limited to a direct connection through a local nonnetworked interface.

(2) The PV Sytem is connected through a networked interface complying with both of the following methods:

a. The PV System and associated software are identified as being evaluated for cybersecurity.

b. A cybersecurity assessment is conducted on the connected system to determine vulnerabilities to cyber attacks.

The cybersecurity assessment shall be conducted when the system configuration changes and at not more than 5-year intervals.

Documentation of the evaluation, assessment, identification, and certification shall be made available to those authorized to inspect, operate, and maintain the system.

Informational Note No. 1: See ANSI/ISA 62443, Cybersecurity Standards series; UL 2900, Cybersecurity Standards series; and the NIST Framework for Improving Critical Infrastructure Cybersecurity, Version 1.1, for assessment guidelines.

Informational Note No. 2: Examples of the commissioning certification used to demonstrate the system has been investigated for cybersecurity vulnerabilities could be one of the following:

(1) The ISA Security Compliance Institute (ISCI) conformity assessment program

(2) Certification of compliance by a nationally recognized test laboratory

### Statement of Problem and Substantiation for Public Input

Most of the cybersecurity focus has been on IT systems. There has been very little public discussion about cybersecurity for Operational Technology (OT), but cyber attacks on OT, by both domestic and foreign actors, occur on almost a daily basis. Hackers can easily destroy unprotected equipment and shut down entire unprotected facilities. Our adversaries such as Russia, China, North Korea, and Iran, are continuously mounting cyber attacks. They understand their limits and, so far, prohibit catastrophic attacks on our financial/banking system and electrical grid. In the mean time, they attack our infrastructure, such as the southeast gas pipeline. We have the ability, and obligation, to prevent this type of damage to our infrastructure from malicious cyber attacks. This Public Input is based upon 240.6(D) and 708.7 in the 2023 NEC. Pay particular attention to the word "identified" in (2) a. "Identified" as applied to equipment, is defined in Article 100 as "Recognizable as suitable for the specific purpose, function, use, environment, application, and so forth, where described in a particular Code requirement. Informational Note: Some examples of ways to determine suitability of equipment for a specific purpose, environment, or application include investigations by a qualified testing laboratory (listing and labeling), an inspection agency, or other organization concerned with product evaluation." This Public Input simply requires that a PV System either not be connected to the internet, or if it is connected to the internet, that it be identified for cybersecurity and that an assessment is provided.

### Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Vincent Saporita |
| **Organization:** | Saporita Consulting |
| **Street Address:** | |
| **City:** | |
| **State:** | |
| **Zip:** | |
| **Submittal Date:** | Fri Jun 30 12:45:57 EDT 2023 |
| **Committee:** | NEC-P04 |

# Public Input No. 3866-NFPA 70-2023 [ New Section after 690.4 ]

**Installation shall prevent build up of debris**

The installation of the PV system shall be installed as to prevent build up of materials restricting airflow and creating a risk of fire with combustible products.

## Additional Proposed Changes

| File Name | Description | Approved |
|---|---|---|
| IMG_7687.jpeg | Leaves built up under the skirt | |

## Statement of Problem and Substantiation for Public Input

Currently we are starting the fall season in New England. In this photo one can see leaves building up under the skirt and restricts air flow and causes a build up of combustible material. I am worried that this installation and several more I have seen will get worse as the seasons pass, creating a risk of fire with dry fuel on a structured roof. This will also heat the panels up restricting the airflow.
Dry paper will ignite between 424F and 475F from various sources. I have had a roof In Massachusetts get up to 165 degrees.

## Submitter Information Verification


**Submitter Full Name:** Brian Leary
**Organization:** Town of Walpole
**Street Address:**
**City:**
**State:**
**Zip:**

**Submittal Date:** Tue Sep 05 21:10:54 EDT 2023
**Committee:** NEC-P04

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

**690.4** General Requirements.

**(A)** PV Systems.

PV systems shall be permitted to supply a building or other structure in addition to any other electrical supply system(s).

~~(C)~~

**(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.~~

**Qualified Personnel.**

The installation of equipment, associated wiring, and interconnections shall be performed only by qualified persons.

**(~~D~~ C )** Multiple PV Systems.

Multiple PV systems shall be permitted to be installed in or on a single building or structure. Where the PV systems are remotely located from each other, a directory in accordance with 705.10 shall be provided at each PV system disconnecting means.

**(~~E~~ D )** Locations Not Permitted.

PV system equipment and disconnecting means shall not be installed in bathrooms.

**(~~F~~ E )** 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 areas that are not readily accessible. Disconnecting means shall be installed in accordance with 690.15.

**(~~G~~ F )** PV Equipment Floating on Bodies of Water.

PV equipment floating on or attached to structures floating on bodies of water shall be identified as being suitable for the purpose and shall utilize wiring methods that allow for any expected movement of the equipment.

> Informational Note: PV equipment in these installations are often subject to increased levels of humidity, corrosion, and mechanical and structural stresses. Expected movement of floating PV arrays is often included in the structural design.

### Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document when general listing requirements are covered within an article. The NEC Style Manual Section 2.2.1 Parallel Numbering Required, states that technical committees shall use the following section numbers for the same purposes within articles. The listing requirements are to be located in the .2 section.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

### Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 2809-NFPA 70-2023 [New Section after 690.1] | Deleted and relocated to the .2 section |
| Public Input No. 2809-NFPA 70-2023 [New Section after 690.1] | |

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Dean Hunter |
| **Organization:** | Minnesota Department of Labor |
| **Street Address:** | |
| **City:** | |
| **State:** | |
| **Zip:** | |
| **Submittal Date:** | Fri Aug 25 13:35:32 EDT 2023 |
| **Committee:** | NEC-P04 |

# Public Input No. 1069-NFPA 70-2023 [ Section No. 690.4(B) ]

**(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.

## Statement of Problem and Substantiation for Public Input

See public input number 1068-NFPA 70-2023. The change proposed in this public input is to remove references to PVRSE and PVHCE because they are no longer required. As I said in the original proposal, MLPE are unreliable and have been the cause of rooftop fires. They should not be required by code because they do not improve safety.

Note that PVHCS are still required by code.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 1068-NFPA 70-2023 [Section No. 690.12(B)(2)] | 1068 eleimnates references to both PVRSE and PVHCE (but NOT PVHCS) |

## Submitter Information Verification


**Submitter Full Name:** Charles Ladd
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**Affiliation:** CL Engineering and Architecrture PLLC
**Street Address:**
**City:**
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**Zip:**

**Submittal Date:** Wed Jun 14 09:16:37 EDT 2023
**Committee:** NEC-P04

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

**(B)** Equipment.

The following equipment shall be listed or be evaluated for the application and have a field label applied .

1. Electronic power converters~~, motor generators, PV modules, ac modules and ac module systems, dc combiners,~~

2. Motor generators

3. PV modules

4. Ac modules

5. Ac module systems

6. Dc combiners

7. PV rapid shutdown equipment (PVRSE)~~,~~

8. PV hazard control equipment (PVHCE)~~,~~

9. PV hazard control systems (PVHCS)~~, dc~~

10. 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.~~

11. Charge controllers

## Statement of Problem and Substantiation for Public Input

Section has been reorganized into a list format to improve readability.

## Submitter Information Verification


**Submitter Full Name:** Jason Fisher

**Organization:** Solar Technical Consulting Llc

**Street Address:**

**City:**

**State:**

**Zip:**


**Submittal Date:** Mon Jul 24 11:09:57 EDT 2023

**Committee:** NEC-P04

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

**(B)** Equipment.

(1) 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.

(2) The rated maximum input short-circuit current rating of equipment such as electronic power converters, dc to dc optimizers, PV rapid shutdown equipment and inverters shall not be exceeded.

## Additional Proposed Changes

| File Name | Description | Approved |
|---|---|---|
| Max_Input_Short-Circit_Current_Rating.jpg | Example of the rated maximum short-circuit current rating of equipment. | |

## Statement of Problem and Substantiation for Public Input

Per UL 1741, the maximum input short-circuit current is defined as the absolute maximum prospective short circuit current that a DC port of the device under test is rated to have connected to it. There is a note to this definition that explains; This could be the short circuit from a PV array, battery, or energy storage device. For a PV source it would account for worst-case conditions of ambient temperature, irradiance, etc. For NEC compliant installation, this Maximum Input Short Circuit Current rating equates to 1.25 × Isc of the PV array. This aligns with NEC Section 690.8(A)(1)(a).

There is an industry practice to take this number and multiply it with the same 1.25 multiplier that is required to be applied to the PV module. This is a safety issue as the equipment is now being connected to a circuit with higher short circuit current available than it was tested and rated for.

## Submitter Information Verification


**Submitter Full Name:** Jeffrey Fecteau
**Organization:** UL Solutions
**Street Address:**
**City:**
**State:**
**Zip:**

**Submittal Date:** Thu Aug 17 19:53:27 EDT 2023
**Committee:** NEC-P04

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

**(B)** ~~Equipment.~~ Listing Required

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, and retrofit kits for PV equipment shall be listed or be evaluated for the application and have a field label applied.

Retrofit kits for PV equipment shall include installation instructions for field conversion of the equipment.

## Statement of Problem and Substantiation for Public Input

Listed retrofit kits are now available for power production equipment, that are not considered to be utilization equipment. One example is the field replacement of microinverters on PV AC modules, replacement or removal of a rapid shutdown device as part of a transition from a PVRSS to a PVHCS. Due to the complexity and safety risks associated with PV equipment, it is important that retrofit kits be evaluated by a listing agency to ensure compliance with the product standard. Detailed instructions are critical to the proper installation of these retrofit kits to maintain the performance and safety of the equipment during and following the retrofit procedure.

The change in title of this section from "Equipment" to "Listing Required" is to align with the style manual (2.2.1).

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 3829-NFPA 70-2023 [Definition: Retrofit Kit.] | A modification to the definition of "retrofit kit" is needed to clarify that, in addition to "utilization" equipment, listed retrofit kits are now available for power production equipment. |
| Public Input No. 3843-NFPA 70-2023 [New Section after 690.1] | also propose to change section number from 690.4(B) to 690.2 in accordance with style manual |
| Public Input No. 3829-NFPA 70-2023 [Definition: Retrofit Kit.] | |
| Public Input No. 3843-NFPA 70-2023 [New Section after 690.1] | |

## Submitter Information Verification

**Submitter Full Name:** Colleen OBrien
**Organization:** UL LLC
**Street Address:**
**City:**
**State:**
**Zip:**
**Submittal Date:** Tue Sep 05 18:25:23 EDT 2023

**Committee:** NEC-P04

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

**(B)** Equipment.

Electronic power converters, motor generators, PV modules, ac modules and ac module systems, dc PV circuit overcurrent devices, 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.

## Statement of Problem and Substantiation for Public Input

The requirement for PV source circuit overcurrent protective devices to be listed for use in PV systems should be grouped with the requirements for other equipment and devices found in 690.4(B). This requirement is sometimes overlooked by system designers and installers because it is not in the appropriate location in Article 690.

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The Solar and Storage Industry Forum (SSIF) is a coalition of individuals and organizations convened by the Solar Energy Industry Association (SEIA) to organize, support, and mentor renewable energy industry professionals in codes and standards development. Our objective is to submit industry consensus-based recommendations for changes to the National Electrical Code. We believe that this effort improves the Code-making process by consolidating multiple industry member's points of view into fewer, common proposals.

SSIF members are dedicated to continually improving the installation safety of PV and storage systems in the U.S. A list of members can be found here:

https://www.seia.org/industry-forum

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Evelyn Butler |
| **Organization:** | Solar Energy Industries Assn |
| **Street Address:** | |
| **City:** | |
| **State:** | |
| **Zip:** | |
| **Submittal Date:** | Wed Sep 06 18:57:13 EDT 2023 |
| **Committee:** | NEC-P04 |

# Public Input No. 1817-NFPA 70-2023 [ Section No. 690.4(C) ]

**(C)** Qualified Personnel.

The construction, installation, testing, operation and maintenance of equipment, associated wiring, and interconnections shall be performed only by qualified persons.

## Statement of Problem and Substantiation for Public Input

I agree with keeping the requirements of qualified persons in 690.4 (C) do to the unique hazards presented by these technologies. However, the language should be uniform amongst all articles in emerging technologies. The use and requirement of "qualified persons" is inconsistent from article to article, resulting in the responsibility of the qualified person differing from system to system. Throughout the country, sections and portions of each system are NOT being performed by qualified persons and the argument for those performing the work is based on the language or lack there of total inclusion of all "parts" of the system. Installation by definition is the act of installing and can be broken down into individual components, while construction is the act of constructing a total structure.
This revision will more align with the article 100 definition as referenced and will promote a uniform application of documents as mandated per the style manual, while promoting a more standard formal interpretation of what portion of the work shall be performed by a qualified person.
This change will also conform this language to NFPA 70E and NFPA 70B as referenced throughout this document.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 1818-NFPA 70-2023 [Section No. 691.4] | |
| Public Input No. 1819-NFPA 70-2023 [Section No. 692.4(C)] | |
| Public Input No. 1820-NFPA 70-2023 [Section No. 694.7 [Excluding any Sub-Sections]] | |
| Public Input No. 1821-NFPA 70-2023 [New Part after II.] | |

## Submitter Information Verification

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**Committee:** NEC-P04

## Public Input No. 3880-NFPA 70-2023 [ Section No. 690.4(C) ]

**(C)** ~~Qualified Personnel.~~

~~The installation of equipment, associated wiring, and interconnections shall be performed only by qualified persons~~

**Cooling.** Equipment that depends on the natural circulation of air and convection principals for cooling shall be located and installed so that airflow is not prevented by adjacent installed equipment or other environmental obstructions .

### Statement of Problem and Substantiation for Public Input

PV equipment needs to be installed so that the natural circulation of air is not obstructed by other equipment or the environment that it is installed in. Remove "Qualified Personal" as it is not needed. Remove the informational note.

### Submitter Information Verification


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| **Committee:** | NEC-P04 |

## Public Input No. 4241-NFPA 70-2023 [ 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.

### Statement of Problem and Substantiation for Public Input

Suggest shortening the language. There are many areas inside and outside of a building that are not considered readily accessible. No real need to specifically mention the roof.

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## Public Input No. 4252-NFPA 70-2023 [ 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 ampere, with decimal fractions smaller than 0.5 dropped.

## Statement of Problem and Substantiation for Public Input

This language is based on an existing allowance in 220.5(B), which applies to ampere calculations for branch-circuits, feeders, and services. It extends this allowance for rounding to the nearest whole ampere (and dropping decimal fractions smaller than 0.5) to calculations in Articles 690, 705, and 706, making it clear that this allowance is valid for circuits that are defined and named differently than those covered in Article 220. For Article 690, the allowance would also apply to calculations for voltage, and thus would be located in a new Section 690.4(H), whereas it would reside in existing Sections related to maximum current in Articles 705 and 706.

Currently, there is no standard approach or method outside of inferring that the 220.5(B) applies elsewhere; furthermore, significant digits don't work for current and voltage calculations because of small decimal temperature coefficients. While it may be preferable and more advantageous for this allowance to be in Section 90.9 so as to apply Code-wide, it could instead be addressed in Articles 690, 705, and 706 as proposed here.
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The Solar and Storage Industry Forum (SSIF) is a coalition of individuals and organizations convened by the Solar Energy Industry Association (SEIA) to organize, support, and mentor renewable energy industry professionals in codes and standards development. Our objective is to submit industry consensus-based recommendations for changes to the National Electrical Code. We believe that this effort improves the Code-making process by consolidating multiple industry member's points of view into fewer, common proposals.
SSIF members are dedicated to continually improving the installation safety of PV and storage systems in the U.S. A list of members can be found here:
https://www.seia.org/industry-forum

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 4248-NFPA 70-2023 [Section No. 705.28(A)] | Equivalent language |
| Public Input No. 4250-NFPA 70-2023 [Section No. 706.30(A) [Excluding any Sub-Sections]] | Equivalent language |

## Submitter Information Verification

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## Public Input No. 4468-NFPA 70-2023 [ New Section after 690.4(G) ]

**690.5 Fault response of PV systems utilizing PVRSE or electrical PVHCE. (NEW)**

A PV system utilizing PVRSE or electronic PVHCE shall transition any PVRSE or electronic PVHCE in a faulted PV dc circuit to a controlled state in response to the following faults that require nonautomatic intervention to resume operation.

(1) An arc-fault detection and interruption as required by 690.11

(2) A ground-fault detection and interruption as required by 690.41(B)

(3) Detected faults as required by the equipment listing

Equipment providing this function shall detail this response in the instructions included with the listing.

### Statement of Problem and Substantiation for Public Input

There is no code or standard requirement to coordinate faults in PV systems (arc-faults, ground-faults, and equipment faults), often sensed by inverters, with PVRSE or electronic PVHCE. PVRSE and PVHCE are used to comply with 690.12.

This new section would require that the listed faults in PV systems (arc faults in 690.11, ground-faults in 690.41(B), and equipment faults such as internal inverter failures to additionally transition the PVRSE or electronic PVHCE (if present) to a controlled state in the faulted circuit or system. This reduces the likelihood of an additional fault creating a hazard before the first fault is addressed by using equipment that may already be installed in the system.

### Submitter Information Verification


| | |
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| **Committee:** | NEC-P04 |

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

**(A)** Photovoltaic Source Circuits.

The requirements of ~~Article 690 pertaining~~ this article 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.

### Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the NEC(r) Style Manual prohibit referencing an entire article with the exception of Article 100 or where required for context. As such, it is recommended to revise the language to "this article" to comply. This is merely an editorial change and not intended to change the published 2023 requirement.

### Submitter Information Verification


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**Submittal Date:** Fri Sep 01 09:02:49 EDT 2023

**Committee:** NEC-P04

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

**(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~~ voltages 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 |

## Statement of Problem and Substantiation for Public Input

NOTE that some text shown in the printout as changed, has not been changed.
This PI is a reorganization of two existing phrases into one, plus one suggested technical change.

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

The 100 kW size limit for allowing a licensed professional electrical engineer to use an industry standard method to determine maximum voltage was an arbitrary limit set in a previous Code cycle. Performance modeling software that relies on industry standard methods and many years of historical weather data to calculate maximum voltage are in common use by system designers.

There is no practical difference between (10) identical 10 kW systems and (1) 100kW system. In both cases it is likely that a licensed PE would use software and an industry standard method to calculate maximum voltage and should be allowed to do so. Details of the calculation can always be requested before approval, if needed.

Any installer should be able to build to a stamped and approved plan set. The licensed PE in this case is the qualified person to do this design work. There should be no negative effect on system safety by expanding this allowance to systems of any size, while ensuring that a licensed professional is liable for correctly calculating the value.

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## Public Input No. 3787-NFPA 70-2023 [ Section No. 690.7 [Excluding any Sub-Sections] ]

The maximum voltage shall be used to determine the voltage and voltage to ground of circuits in the application of this *Code*. Maximum voltage values shall be used ~~for conductors, cables, equipment, working space, and other applications where voltage limits and ratings are used~~ where nominal voltage is used elsewhere in this *Code* . 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 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 exceed 600 volts on or in one- and two-family dwellings.

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

### Statement of Problem and Substantiation for Public Input

This text revision does not fundamentally change the application of this section but rather it reduces the text and clarifies that PV system dc circuit maximum voltage is to be used anywhere where the term “nominal voltage” is used across the Code, such as in Chapters 1-3. PV system dc circuits do not typically have an assignable or identifiable nominal voltage value, unlike battery circuits or AC branch circuits and feeders. However many applications of the Code, including even something as basic as choosing what Articles apply, rely on assigning nominal voltage values to a circuit. It is important to make it clear that for these unique circuits, maximum voltage is the referenced value to use in place of “nominal” for PV system dc circuits.

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

**Sections 690.8, 690.9**

**690.8** Circuit Sizing and Current.

**(A)** Calculation of Maximum Circuit Current.

The maximum current for the specific circuit shall be calculated in accordance with one of the methods in 690.8(A)(1) or (A)(2).

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

(3) <u>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).</u>

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.

**(2)** Circuits Connected to the Input of Electronic Power Converters.

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

<u>(a) The circuit is protected at the source of supply with an overcurrent device not exceeding the conductor ampacity .</u>

<u>( b) The circuit maximum current as calculated in 690.8(A)(1) complies with 690.9(A)(1).</u>

**( B)** Conductor Ampacity.

Circuit conductors shall have an ampacity not less than the larger of 690.8(B)(1) or (B)(2).

**(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: Circuits containing 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.*

**(2)** With Adjustment and Correction Factors.

The maximum currents calculated in 690.8(A) with adjustment and correction factors.

**(C)** Systems with Multiple Direct-Current Voltages.

For a PV power source that has multiple output circuit voltages and employs a common-return conductor, the ampacity of the common-return conductor shall not be less than the sum of the ampere ratings of the overcurrent devices of the individual output circuits.

**(D)** Multiple PV String Circuits.

Where an overcurrent device is used to protect more than one set of parallel-connected PV string circuits, the ampacity of each conductor protected by the device shall not be less than the sum of the following:

(1) The rating of the overcurrent device

(2) The sum of the maximum currents as calculated in 690.8(A)(1)(a) for the other parallel-connected PV string circuits protected by the overcurrent device

**690.9** Overcurrent Protection.

**(A)** Circuits and Equipment.

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).

**(1)** Circuits Where Overcurrent Protection Not Required.

Overcurrent protective devices shall not be required where both of the following conditions are met:

(1) The conductors have sufficient ampacity for the maximum circuit current.

(2) The currents from all sources do not exceed the maximum overcurrent protective device rating specified for the PV module or electronic power converter.

**(2)** Circuits Where Overcurrent Protection is Required on One End.

A circuit conductor connected at one end to a current-limited supply, where the conductor is rated for the maximum circuit current from that supply, and also connected to sources having an available maximum circuit current greater than the ampacity of the conductor, shall be protected from overcurrent at the point of connection to the higher current source.

Informational Note: Photovoltaic system dc circuits and electronic power converter outputs powered by these circuits are current-limited and in some cases do not need overcurrent protection. Where these circuits are connected to higher current sources, such as parallel-connected PV system dc circuits, energy storage systems, or a utility service, the overcurrent device is often installed at the higher current source end of the circuit conductor.

**(3)** Other Circuits.

Circuits that do not comply with 690.9(A)(1) or (A)(2) shall be protected with one of the following methods:

(1) Conductors not greater than 3 m (10 ft) in length and not in buildings, protected from overcurrent on one end

(2) Conductors not greater than 3 m (10 ft) in length and in buildings, protected from overcurrent on one end and in a raceway or metal clad cable

(3) Conductors protected from overcurrent on both ends

(4) Conductors not installed on or in buildings are permitted to be protected from overcurrent on one end of the circuit where the circuit complies with all of the following conditions:

a. The conductors are installed in metal raceways or metal-clad cables, or installed in enclosed metal cable trays, or underground, or where directly entering pad-mounted enclosures.

b. The conductors for each circuit terminate on one end at a single circuit breaker or a single set of fuses that limit the current to the ampacity of the conductors.

c. The overcurrent device for the conductors is an integral part of a disconnecting means or shall be located within 3 m (10 ft) of conductor length of the disconnecting means.

d. The disconnecting means for the conductors is installed outside of a building, or at a readily accessible location nearest the point of entrance of the conductors inside of a building, including installations complying with 230.6.

**(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.

**(C)** PV System DC Circuits.

A single overcurrent protective device, where required, shall be permitted to protect the PV modules, dc-to-dc converters, and conductors of each circuit. Where single overcurrent protection devices are used to protect circuits, all overcurrent devices shall be placed in the same polarity for all circuits within a PV system. The overcurrent devices shall be accessible but shall not be required to be readily accessible.

Informational Note: Due to improved ground-fault protection required in PV systems by 690.41(B), a single overcurrent protective device in either the positive or negative conductors of a PV system in combination with this ground-fault protection provides adequate overcurrent protection.

**(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.*

## Additional Proposed Changes

| File Name | Description | Approved |
|---|---|---|
| PDF_version_of_PI.pdf | PDF version of PI due to Terraview making it look like there are changes to .8(A)(1), which in fact there are not. I tried multiple times on three different browsers, and every time Terraview underlines unchanged text in 690.8(A)(1)(a)(1) and (2) | |

## Statement of Problem and Substantiation for Public Input

The allowance to calculate maximum circuit current of a PV or dc-to-dc converter circuit based on the input current limit of the electronic power converter (EPC) it is connected to safely limits the possible sources of overcurrent for that circuit to the power source itself (assuming no backfeed is possible via the EPC).

Utilizing this allowance in 690.8(A)(2) required using an overcurrent device to protect the circuit conductors by limiting current on them to no greater than the ampacity of the conductors. This allowance may result in conductor sizes that have an ampacity less than the current available from the connected power source, in which case an OCPD should indeed be required.

However, in some cases, the circuit conductors will have an ampacity sufficient to carry the maximum circuit current from the connected power source [as calculated in 690.8(A)(1)], even when sized based on the maximum input current level of the connected electronic power converter. In these cases, provided that the EPC cannot backfeed power from a source on the other side of it (such as the grid or a battery), the circuit will comply with the two requirements in 690.9(A)(1); and without a source of overcurrent for properly sized conductors, there is no need for overcurrent protection.

Example:
In this example, the selected 385-amp rated conductor is sufficient for the circuit maximum current based both on the input current limit of the electronic power converter [690.8(A)(2)], and for the maximum current simulated per 690.8(A)(1)(a)(2), illustrating that overcurrent protection is unnecessary for the circuit.

STC Isc 18.47
Circuits in parallel 16

Array Isc x 1.25 = 369.4 A
x 1.25 Min. fuse/ampacity = 461.75 A
Actual fuse = 500 A
Cond. ampacity (Al 90C) = 480 A

690.8(A)(1)(a)(2) Simulated Imax = 349.76 A
x 1.25 Min. fuse/ampacity = 437.2 A
Actual fuse = 450 A
Cond. ampacity (Al 90C) = 425 A

690.8(A)(2) Input current limit = 296.7 A
x 1.25 Min. fuse/ampacity = 370.88 A
Actual fuse = 400 A
Cond. ampacity (Al 90C) = 385 A

However, when an overcurrent protection device is utilized to comply with 690.8(A)(2) it must be located at the source of supply for the conductors, since the supply current may in fact exceed the rating of the conductors in the circuit. That is not currently a clear requirement, thus the addition of the language in 2023 690.8(A)(2) is necessary. While locating the OCPD at the source of supply is in keeping with the general requirement in 240.21, it is often the case in PV systems that overcurrent protection is located not at the current-limited source of supply (the PV array), but rather where the circuit is connected in parallel with other, higher current sources (such as in a combiner box), as required in 690.9(A)(2). A circuit complying with the 2023 690.8(A)(2) text could be subject to catastrophic failure in the event of line-to-line fault if overcurrent protection was located at the termination of the circuit. adding text to clarify the location of overcurrent protection in 690.8(A)(2) ensures it protects the circuit from the short-circuit current of the source to which it is connected regardless of fault location. Furthermore, Section 690.9(A) already provides requirements about locations of overcurrent protection for specific circuits and situations, so adding this detail to 690.8(A)(2) maintains some consistency across the Sections.

## Submitter Information Verification

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**Submittal Date:** Tue Aug 29 18:12:12 EDT 2023
**Committee:** NEC-P04

690.8 Circuit Sizing and Current

**(A) Calculation of Maximum Circuit Current.**

…

**(2) Circuits Connected to the Input of Electronic Power Converters.**
Where a circuit is connected to the input of an electronic power converter ~~protected with an overcurrent device not exceeding the conductor ampacity~~, the maximum current shall be permitted to be the rated input current of the electronic power converter input to which it is connected, provided one of the following conditions is met:

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

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

690.9 Overcurrent Protection.

**(A) Circuits and Equipment.**
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).

Substantiation:
The allowance to calculate maximum circuit current of a PV or dc-to-dc converter circuit based on the input current limit of the electronic power converter (EPC) it is connected to safely limits the possible sources of overcurrent for that circuit to the power source itself (assuming no backfeed is possible via the EPC).

Utilizing this allowance in 690.8(A)(2) required using an overcurrent device to protect the circuit conductors by limiting current on them to no greater than the ampacity of the conductors. This allowance may result in conductor sizes that have an ampacity less than the current available from the connected power source, in which case an OCPD should indeed be required.

However, in some cases, the circuit conductors will have an ampacity sufficient to carry the maximum circuit current from the connected power source [as calculated in 690.8(A)(1)], even when sized based on the maximum input current level of the connected electronic power converter. In these cases, provided that the EPC cannot backfeed power from a source on the other side of it (such as the grid or a battery), the circuit will comply with the two requirements in 690.9(A)(1); and without a source of overcurrent for properly sized conductors, there is no need for overcurrent protection.

**Example:**
In this example, the selected 385-amp rated conductor is sufficient for the circuit maximum current based both on the input current limit of the electronic power converter [690.8(A)(2)], and for the maximum current simulated per 690.8(A)(1)(a)(2), illustrating that overcurrent protection is unnecessary for the circuit.

STC Isc 18.47
Circuits in parallel 16

Array Isc x 1.25 = 369.4 A
x 1.25 Min. fuse/ampacity = 461.75 A
Actual fuse = 500 A
Cond. ampacity (Al 90C) = 480 A

690.8(A)(1)(a)(2) Simulated Imax = 349.76 A
x 1.25 Min. fuse/ampacity = 437.2 A
Actual fuse = 450 A
Cond. ampacity (Al 90C) = 425 A

690.8(A)(2) Input current limit = 296.7 A
x 1.25 Min. fuse/ampacity = 370.88 A
Actual fuse = 400 A
Cond. ampacity (Al 90C) = 385 A

However, when an overcurrent protection device is utilized to comply with 690.8(A)(2) it must be located at the source of supply for the conductors, since the supply current may in fact exceed the rating of the conductors in the circuit. That is not currently a clear requirement, thus the addition of the language in 2023 690.8(A)(2) is necessary. While locating the OCPD at the source of supply is in keeping with the general requirement in 240.21, it is often the case in PV systems that overcurrent protection is located not at the current-limited source of supply (the PV array), but rather where the circuit is connected in parallel with other, higher current sources (such as in a combiner box), as required in 690.9(A)(2). A circuit complying with the 2023 690.8(A)(2) text could be subject to catastrophic failure in the event of line-to-line fault if overcurrent protection was located at the termination of the circuit. adding text to clarify the location of overcurrent protection in 690.8(A)(2) ensures it protects the circuit from the short-circuit current of the source to which it is connected regardless of fault location. Furthermore, Section 690.9(A) already provides requirements about locations of overcurrent protection for specific circuits and situations, so adding this detail to 690.8(A)(2) maintains some consistency across the Sections.

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

**(A)** Calculation of Maximum Circuit Current.

The maximum current for the specific circuit shall be calculated in accordance with one of the methods in 690.8(A)(1) ~~or~~ through (A)(~~2~~ 4 ).

**(1)** – _ _ PV ~~System~~ Source Circuit Circuits.~~-~~ ~~The maximum current shall be as calculated in accordance with~~

~~690.8(A)(1) (a) through (A)(1)(c).~~ ~~*Photovoltaic Source Circuit Currents*~~ ~~The maximum current shall be as calculated in either of the following:The maximum current shall be the sum of the~~

one of the following methods:

(a) Monofacial Modules. The sum of the short-circuit current ratings at STC of the PV modules connected in parallel multiplied by 125 percent.

(b) Bifacial Modules . The sum of the bifacial short-circuit current ratings of the PV modules connected in parallel multiplied by

~~125 percent.~~
125 percent. The bifacial short circuit current rating shall be based on either the aBSI rating, or a value not less than the short-circuit current at STC if recommended in the manufacturer's instructions for a specific installation configuration.

Informational Note: Bifacial modules are commonly labeled with multiple short-circuit current ratings based on varying levels of light reaching the back of the module, which is dependent upon specific installation conditions. Additional guidance is provided in the instructions included with the listing.

(c) Any Modules. 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.

**(2) 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.

**(3) 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.~~

~~(2)~~

**(4) Circuits Connected to the Input of Electronic Power Converters.**

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

## Additional Proposed Changes

| File Name | Description | Approved |
|---|---|---|
| SSIF_bifacial_max_circuit_current_690_8A_for_attachment.pdf | Clean copy showing actual changes | |

## Statement of Problem and Substantiation for Public Input

NOTE THAT NOT ALL CHANGES SHOWN ARE ACCURATE. PLEASE SEE ATTACHMENT FOR A CLEAN COPY.

The informational note in 690.8(A)(1)(a) states that [bifacial] modules “are labeled with applicable short-circuit currents. Additional guidance is provided in the instructions included with the listing”. This is problematic because bifacial modules are labeled with multiple short-circuit ratings such as at aBSI and STC (see related proposed definitions for 100). This results in a lack of clarity on which rating should be used.

This proposed change clarifies which bifacial short-circuit rating should be used, and also allows a different rating if specified in the manufacturer’s instructions for specific configurations. However the bifacial current should not be less than the current at STC; that is, it should not be less than the maximum current assumed for monofacial modules that generate no electricity due to light exposure on the rear side of the module.

690.8 has also been reorganized. The original organization of this section contained four section subdivisions, since the fourth level of original text did not meet the NEC Style Manual requirements for a list per section 2.1.8.2. This new organization now structures this section into 3 subdivisions, which meets the allowance in section 2.1.6.3.1 of the NEC Style Manual. The title of the original section (A)(1) has been changed during this reorganization to correctly describe the type of circuits the reorganized and new requirements will apply to. Previous items (b) and (c) have been moved to a second level subdivision, with no change to their original requirements.

Per above, 690.8(A)(1)(a)(1) has been changed to section 690.8(A)(1)(a). Additionally, it has been modified to clarify that the short circuit current that was referenced is based on STC conditions (per the new definition), and that it is applicable to monofacial modules (also a new definition).

A new item 690.8(A)(1)(b) is a new section to specify which bifacial short-circuit current rating is used to calculate the maximum continuous current. The proposed change would specify that for bifacial modules, the short-circuit rating at applied bifacial stress irradiance (“aBSI”), a new defined term, shall be used with the standard 1.25 high irradiance factor, or a lower value not less than the rating at STC, if recommended in the instructions for specific configurations. This recommendation is aligned the data from Sandia National Laboratories summarized in the report “Bifacial Photovoltaic Modules and Systems: Experience and Results from International Research and Pilot Applications”, 2021, published by the International Energy Agency, Photovoltaic Power Systems Programme, under Task 13: Performance, Operation and Reliability of Photovoltaic Systems. Table 9 and Table 11 in the report summarizes Sandia’s measurements of 5 system configurations in three climates, including 3-hour averages of total irradiance (front and rear of modules). In a subsequent correspondence with Dr. Josh Stein, an author of the Sandia bifacial study, a breakdown of front and rear irradiance values were provided as shown in the attachment.

As shown in the tables in the attachment, the 3-hour average of rear irradiance exceeds 300 W/m2 in several locations and is not considered overly conservative, but a reasonable compromise. The additional 1.25 high irradiance factor would account for the potential for higher rear side irradiance as well as front side irradiance (note that the maximum measured total irradiance was 1566 W/m2 (front and rear), which would yield a maximum continuous current that is very close to the proposed Isc value at aBSI, which is 1000 on the front and 300 on the rear, when multiplied by the 1.25 factor (1.25*1300 = 1625 W/m2).

690.8(A)(1)(b) also address the fact that while Isc at aBSI is a reasonable generic assumption that can cover a wide range of geographic location, ground reflectivity and module orientation, it may be overly conservative for certain configurations, particularly roof-mounted systems where modules are mounted close to the roof. For this reason, the module manufacturer’s instructions may be relied upon to support the use of a lower short-circuit current rating, but not less than the Isc at STC, since the lowest value used for Isc for a bifacial module should not be less than used for a monofacial module.

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The Solar and Storage Industry Forum (SSIF) is a coalition of individuals and organizations convened

by the Solar Energy Industry Association (SEIA) to organize, support, and mentor renewable energy industry professionals in codes and standards development. Our objective is to submit industry consensus-based recommendations for changes to the National Electrical Code. We believe that this effort improves the Code-making process by consolidating multiple industry member's points of view into fewer, common proposals.
SSIF members are dedicated to continually improving the installation safety of PV and storage systems in the U.S. A list of members can be found here:
https://www.seia.org/industry-forum

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 4256-NFPA 70-2023 [New Definition after Definition: PV Module (Module).] | new definitions |
| Public Input No. 4258-NFPA 70-2023 [New Definition after Definition: Purpose-Built.] | new definitions |
| Public Input No. 4256-NFPA 70-2023 [New Definition after Definition: PV Module (Module).] | |
| Public Input No. 4258-NFPA 70-2023 [New Definition after Definition: Purpose-Built.] | |

## Submitter Information Verification


| | |
|---|---|
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| **Organization:** | Solar Energy Industries Assn |
| **Street Address:** | |
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| **Zip:** | |
| **Submittal Date:** | Thu Sep 07 07:59:36 EDT 2023 |
| **Committee:** | NEC-P04 |

**Legislative Text**

**690.8 (A) Calculation of Maximum Circuit Current.**

The maximum current for the specific circuit shall be calculated in accordance with one of the methods in 690.8(A)(1) ~~or~~ through (A)(~~2~~)(4).

(1) ~~PV System Circuits.~~ PV Source Circuit Currents

~~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 accordance with one ~~either~~ of the following methods:

> ~~(1)~~ (a) Monofacial Modules. The ~~maximum current shall be the~~ sum of the short-circuit current ratings at STC of the PV modules connected in parallel multiplied by 125 percent.
>
> ~~(2)~~ (b) Bifacial Modules. The sum of the bifacial short-circuit current ratings of the PV modules connected in parallel multiplied by 125 percent. The bifacial short circuit current rating shall be based on either the aBSI rating, or a value not less than the short-circuit current at STC if recommended in the manufacturer's instructions for a specific installation configuration.
>
> Informational Note: Bifacial modules are commonly labeled with multiple short-circuit current ratings based on varying levels of light reaching the back of the module, which is dependent upon specific installation conditions. Additional guidance is provided in the instructions included with the listing.
>
> (c) Any Modules. 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.<br><br>~~(b~~)(2) 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.<br><br>~~(c)~~(3) Inverter Output Circuit Current. The maximum current shall be the inverter continuous output current rating.<br><br>~~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.~~<br><br>~~(2)~~ (4) Circuits Connected to the Input of Electronic Power Converters.<br><br>Where a circuit is protected with an overcurrent device not exceeding the conductor ampacity, the maximum current shall be permitted to be the rated input current of the electronic power converter input to which it is connected. |
| **Clean Text** | **690.8 (A) Calculation of Maximum Circuit Current.**<br>The maximum current for the specific circuit shall be calculated in accordance with one of the methods in 690.8(A)(1) through (A)(4).<br><br>(1) PV Source Circuit Currents<br><br>The maximum current shall be as calculated in accordance with one of the following methods:<br><br>(a) Monofacial Modules. The sum of the short-circuit current ratings at STC of the PV modules connected in parallel multiplied by 125 percent.<br><br>(b) Bifacial Modules. The sum of the bifacial short-circuit current ratings of the PV modules connected in parallel multiplied by 125 percent. The bifacial short circuit current rating shall be based on either the aBSI rating, or a value not less than the short-circuit current |

| | |
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| | at STC if recommended in the manufacturer's instructions for a specific installation configuration.<br><br>Informational Note: Bifacial modules are commonly labeled with multiple short-circuit current ratings based on varying levels of light reaching the back of the module, which is dependent upon specific installation conditions. Additional guidance is provided in the instructions included with the listing.<br><br>(c) Any Modules. 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).<br><br>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.<br><br>(2) 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.<br><br>(3) Inverter Output Circuit Current. The maximum current shall be the inverter continuous output current rating.<br><br>(4) Circuits Connected to the Input of Electronic Power Converters.<br><br>Where a circuit is protected with an overcurrent device not exceeding the conductor ampacity, the maximum current shall be permitted to be the rated input current of the electronic power converter input to which it is connected. |

| Substantiation | The informational note in 690.8(A)(1)(a) states that [bifacial] modules "are labeled with applicable short-circuit currents. Additional guidance is provided in the instructions included with the listing". This is problematic because bifacial modules are labeled with multiple short-circuit ratings such as at aBSI and STC (see related proposed definitions for 100). This results in a lack of clarity on which rating should be used.<br><br>This proposed change clarifies which bifacial short-circuit rating should be used, and also allows a different rating if specified in the manufacturer's instructions for specific configurations. However the bifacial current should not be less than the current at STC; that is, it should not be less than the maximum current assumed for monofacial modules that generate no electricity due to light exposure on the rear side of the module.<br><br>690.8 has also been reorganized. The original organization of this section contained four section subdivisions, since the fourth level of original text did not meet the NEC Style Manual requirements for a list per section 2.1.5.1. This new organization now structures this section into 3 subdivisions, which meets the allowance in section 2.1.5 of the NEC Style Manual. The title of the original section (A)(1) has been changed during this reorganization to correctly describe the type of circuits the reorganized and new requirements will apply to. Previous items (b) and (c) have been moved to a second level subdivision, with no change to their original requirements.<br><br>Per above, 690.8(A)(1)(a)(1) has been changed to section 690.8(A)(1)(a). Additionally, it has been modified to clarify that the short circuit current that was referenced is based on STC conditions (per the new definition), and that it is applicable to monofacial modules (also a new definition).<br><br>A new item 690.8(A)(1)(b) is a new section to specify which bifacial short-circuit current rating is used to calculate the maximum continuous current. The proposed change would specify that for bifacial modules, the short-circuit rating at applied bifacial stress irradiance ("aBSI"), a new defined term, shall be used with the standard 1.25 high irradiance factor, or a lower value not less than the rating at STC, if recommended in the instructions for specific configurations. This recommendation is aligned the data from Sandia National Laboratories summarized in the report "Bifacial Photovoltaic Modules and Systems: Experience and Results from International Research and Pilot Applications", 2021, published by the International Energy Agency, Photovoltaic Power Systems Programme, under Task 13: Performance, |
|---|---|

Operation and Reliability of Photovoltaic Systems. Table 9 and Table 11 in the report summarizes Sandia's measurements of 5 system configurations in three climates, including 3-hour averages of total irradiance (front and rear of modules). In a subsequent correspondence with Dr. Josh Stein, an author of the Sandia bifacial study, a breakdown of front and rear irradiance values were provided as shown below.

3-hour averages of front and rear irradiance

| System | NM | | | NV | | | V | |
|---|---|---|---|---|---|---|---|---|
| | Front | Rear | Total | Front | Rear | Total | Front | Rear |
| 1 | 1088.5 | 431.6 | 1520 | 1022 | 203 | 1225 | 978 | |
| 2 | 1135 | 430.5 | 1566 | 1061.5 | 192.2 | 1254 | 1049 | |
| 3 | 1108 | 168 | 1276 | 1105.5 | 132.5 | 1238 | 1034 | |
| 4 | 1008 | 130 | 1138 | 919.6 | 92.2 | 1012 | 1142 | |
| 5 | 773.4 | 235.3 | 1009 | 860.5 | 118.8 | 979 | 920 | |

Table 9 in the report summarizes the system configurations that were studied, and the duration of the measurements

**Table 9: Summary of site and experimental data.**

| | Albuquerque, New Mexico | Henderson, Nevada | Burlington, Vermont |
|---|---|---|---|
| Data Start Date | 2016-02-16 | 2016-12-24 | 2017-03-29 |
| Data End Date | 2020-07-01 | 2020-07-01 | 2019-04-01 |
| Number of observations | 2,218,361 | 1,850,648 | 869,540 |
| Natural Albedo | 0.22 | 0.2 | 0.18-0.22 (depends on grass condition) |
| Enhanced Albedo | 0.6 | 0.3 | 0.25 |
| System 1 | West-facing, 15° tilt, high albedo | West-facing, 15° tilt, high albedo | West-facing, 30° tilt, high albedo |
| System 2 | South-facing, 15° tilt, high albedo | South-facing, 15° tilt, high albedo | South-facing, 30° tilt, high albedo |
| System 3 | South-facing, 30° tilt, natural albedo | South-facing, 30° tilt, natural albedo | South-facing, 30° tilt, natural albedo |
| System 4 | South-facing, 90° tilt | South-facing, 90° tilt | South-facing, 90° tilt |
| System 5 | West-facing, 90° tilt | West-facing, 90° tilt | West-facing, 90° tilt |

As shown above, the 3-hour average of rear irradiance exceeds 300 W/m2 in several locations and is not considered overly conservative, but a reasonable compromise. The additional 1.25 high irradiance factor would account for the potential for higher rear side irradiance as well as front side irradiance (note that the maximum measured total irradiance was 1566 W/m2 (front and rear), which would yield a maximum continuous current that is very close to

| | |
|---|---|
| | the proposed Isc value at aBSI, which is 1000 on the front and 300 on the rear, when multiplied by the 1.25 factor (1.25*1300 = 1625 W/m2).<br><br>690.8(A)(1)(b) also address the fact that while Isc at aBSI is a reasonable generic assumption that can cover a wide range of geographic location, ground reflectivity and module orientation, it may be overly conservative for certain configurations, particularly roof-mounted systems where modules are mounted close to the roof. For this reason, the module manufacturer's instructions may be relied upon to support the use of a lower short-circuit current rating, but not less than the Isc at STC, since the lowest value used for Isc for a bifacial module should not be less than used for a monofacial module. |

## Public Input No. 4345-NFPA 70-2023 [ Section No. 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.

~~For PV systems with an inverter generating capacity of 100 kW or greater, a~~

(1) 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.

(c) *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.

(d) *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.

### Statement of Problem and Substantiation for Public Input

Note not all text shown as changed has been changed.
The only change is the removal of the phrase "For PV systems with an inverter generating capacity of 100 kW or greater,"

The 100 kW size limit for allowing a licensed professional electrical engineer to use an industry standard method to determine maximum current was an arbitrary limit set in a previous Code cycle. Performance modeling software that relies on industry standard methods and many years of historical weather data to calculate maximum currents are in common use by system designers.

There is no practical difference between (10) identical 10 kW systems and (1) 100kW system. In both cases it is likely that a licensed PE would use software and an industry standard method to calculate maximum currents and should be allowed to do so. Details of the calculation can always be requested before approval, if needed.

Any installer should be able to build to a stamped and approved plan set. The licensed PE in this case is the qualified person to do this design work. There should be no negative effect on system safety by expanding this allowance to systems of any size, while ensuring that a licensed professional is liable for correctly calculating the value.

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Jason Fisher |
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| **Street Address:** | |
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| **State:** | |
| **Zip:** | |
| **Submittal Date:** | Thu Sep 07 12:15:22 EDT 2023 |
| **Committee:** | NEC-P04 |

# Public Input No. 3490-NFPA 70-2023 [ 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), 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).*

## Statement of Problem and Substantiation for Public Input

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).

## Submitter Information Verification


**Submitter Full Name:** Brian Mehalic
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**Affiliation:** Solar Energy International
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**Submittal Date:** Mon Sep 04 14:31:56 EDT 2023
**Committee:** NEC-P04

## Public Input No. 381-NFPA 70-2023 [ 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: 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.*

## Statement of Problem and Substantiation for Public Input

Clarify that in the case a circuit has no overcurrent devices, e.g. as allowed under 690.9(A)(1), the exception may still be used as long as the rest of the equipment in the circuit is listed for continuous operation at 100 percent of its rating.

## Submitter Information Verification

**Submitter Full Name:** Wayne Whitney
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**Street Address:**
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**State:**
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**Submittal Date:** Wed Mar 01 18:20:09 EST 2023
**Committee:** NEC-P04

## Public Input No. 4202-NFPA 70-2023 [ Section No. 690.8(D) ]

**(D)** Multiple PV String Circuits.

Where an overcurrent device is used to protect more than one set of parallel-connected PV string circuits, the ampacity of each conductor protected by the device shall not be less than the ~~sum~~ larger of the following:

(1) The rating of the overcurrent device

(2) The sum of the maximum currents as calculated in 690.8(A)(1)(a) for the other parallel-connected PV string circuits protected by the overcurrent device

## Statement of Problem and Substantiation for Public Input

The word "sum" under 690.8(D) appears to be a typo in the current language of the code. If the word "sum" were to remain then it would essentially require both the calculations of item #1 and #2 be added together and the conductors would always have an ampacity larger that the rating of the overcurrent protective device. In fact, in some cases the conductors would have more than double the ampacity of the overcurrent protective device rating. This section should be clarified to specify the larger of either item #1 or #2 for the minimum ampacity of the conductor in relation to an overcurrent protective device.

## Submitter Information Verification


**Submitter Full Name:** Douglas Smith

**Organization:** West Coast Code Consultants (WC-3)

**Street Address:**

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**State:**

**Zip:**


**Submittal Date:** Wed Sep 06 21:25:33 EDT 2023

**Committee:** NEC-P04

## Public Input No. 3010-NFPA 70-2023 [ 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.*~~

### Statement of Problem and Substantiation for Public Input

Article 705 is the applicable location for interconnection of PV systems to the utility grid or other primary sources. 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)would increase clarity and aid in enforcement for the inspection community. The panel retained the 690.9(D) language for 2023 only to provide a pointer to the new 705.30(F).

### Submitter Information Verification


**Submitter Full Name:** Larry Sherwood
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**Submittal Date:** Mon Aug 28 16:46:53 EDT 2023
**Committee:** NEC-P04

## Public Input No. 499-NFPA 70-2023 [ 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.*~~

### Statement of Problem and Substantiation for Public Input

Overcurrent on the secondary side of a transformer when viewed from utility is governed by 240.21(C) and 240.4(F). Those are placed in there for the protection of secondary conductors due to fault. Placing an inverter on the secondary side of a transformer does not alleviate this hazard. This is a similar hazard to the 2020 705.11(C) 10 and 16 feet allowance of supply side conductors inside structures that was removed.

### Submitter Information Verification


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**Organization:** City of Dallas

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**City:**

**State:**

**Zip:**


**Submittal Date:** Tue Mar 21 14:56:24 EDT 2023

**Committee:** NEC-P04

# Public Input No. 894-NFPA 70-2023 [ 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.*~~

## Statement of Problem and Substantiation for Public Input

The IAEI Public Input for the 2023 NEC was to eliminate this language and address the transformer requirements in Article 705. The panel agreed but wanted to retain the 690.9(D) language for one more cycle to provide a "pointer" to 705. Please see the original 2023 substantiation below:

The current language at 690.9(D) was established in the 1984 NEC with the following substantiation:

This requirement is necessary to ensure that proper overcurrent protection is provided for power transformers where sources of supply are connected to both sides.

705.30 (C) addresses the requirements for transformers used with interconnected electric power production sources.

The primary and secondary windings of a transformer are required to be identified by the manufacturer through the UL product standard XQNX - Power and General-purpose Transformers, Dry Type. Step-up and step-down transformers are available and some manufacturers permit transformers to be reverse connected within certain operational limitations in accordance with installation instructions.

The current language requires “one side, then the other side” of the transformer to be considered the primary for application of 450.3 (primary over-current protection). The secondary over-current protection rules of 450.3(B) are not addressed. Nor are the transformer secondary feeder conductor over-current protection requirements of NEC 240.21(C). 690.9(D) does not modify or eliminate 240.21(C). If we are to consider each side of the transformer as the primary are we also to consider the opposite side as the secondary and therefore apply 240.21 (C) to each side in turn?

Deletion of the current language from 690 combined with the revised transformer requirements for 705.30 (see companion PI) would increase clarity and aid in enforcement for the inspection community.

## Submitter Information Verification


| | |
|---|---|
| **Submitter Full Name:** | Peter Jackson |
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| **Street Address:** | |
| **City:** | |
| **State:** | |
| **Zip:** | |
| **Submittal Date:** | Thu May 25 13:12:39 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 3611-NFPA 70-2023 [ New Section after 690.12 ]

690.12 (E) Buildings with PV Hazard Control

Buildings other than one- and two-family dwellings with PV Hazard Control Systems with controlled conductors above 165Vdc after the initiation of rapid shutdown shall have permanent labels indicating the maximum array voltage after rapid shutdown has been initiated.

(1) Located at each service equipment location to which the PV systems are connected or at an approved readily visible location and shall include a simple diagram of a building with a roof and shall include the following words:

SOLAR PV SYSTEM IS EQUIPPED WITH PV HAZARD CONTROL. AFTER RAPID SHUTDOWN INITIATION, MAXIMUM VOLTAGE INSIDE THE ARRAY BOUNDARY IS ________V

Warning signs(s) or label(s) shall have a minimum letter height of 9.5mm(3/8 In)

(2) Located at each array boundary perimeter at 10 meter (33 ft.) intervals and shall include the following words:

PV HAZARD CONTROL SYSTEM. AFTER RAPID SHUTDOWN INITIATION, MAXIMUM VOLTAGE INSIDE THE ARRAY IS ________V

Warning signs(s) or label(s) shall have a minimum letter height of 17.5mm(11/16 In)

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

Informational note: describing diagram similar to figure 690.12(D)

### Statement of Problem and Substantiation for Public Input

With the adoption of PVHC inside the array there are new approaches to compliance with 690.12 that bring a variety of innovative solutions at varying voltage levels. While PVHC systems have been evaluated to UL 3741, the voltage levels within the system are not clearly marked at the site level for emergency responders or qualified persons who will have access to these components which may or may not remain energized. Confusion exists over what the remaining array voltage is after rapid shutdown has been initiated. Personnel simply do not know what voltage level they are dealing with after rapid shutdown initiation due to the variety of possible systems from 0-1000V allowed under UL 3741. Field observable information about these new systems is needed to safeguard persons and property. NEC required field warning signs with system level information would address this problem.
UL 3741 evaluated systems may be comprised of a multitude of components from various manufactures evaluated by various NRTLs assembled to form a complete or partial safety system whose characteristics will differ from project to project. However, there is no system level nameplate with electrical information included in the system listing to indicate the resulting field assembled system characteristics.
Some Listed systems utilize wiring management, separation, and barriers to critically route conductors that remain energized up to 1000Vdc after rapid shutdown initiation. There are no system level markings to indicate to emergency responders or qualified persons that these conductors and other components remain energized and that their location is critical to maintain the listing and compliance of the hazard control system.
System level information is needed to inform all qualified personnel of hazardous voltages at various stages of the system's service life such as initial construction, normal operations and maintenance, firefighting, and post fire-fighting overhaul. Overhaul procedures are often performed with little knowledge of the PV array characteristics or maximum voltage levels and involve increased fire fighter interactions with the array.

The proposed voltage threshold of 165Vdc is referenced from UL 3741 annex F which concludes that no further protective measures are required for voltages at or below this level when FF PPE is used, thus reducing the need for field warnings and labels for voltages below this threshold. This voltage was chosen based on logic in the standard, however, a higher threshold may be suitable upon future substantiation.
Proposed section E(2) uses ANSI Z535.2 recommended letter height for unfavorable reading conditions at 8ft.
Proponents: Bill Brooks (Brooks Engineering), John Berdner (Enphase), Tony Granato (Energy Response Solutions LLC)

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 3627-NFPA 70-2023 [New Section after 690.12] | |

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Jason Bobruk |
| **Organization:** | SolarEdge Technologies Inc |
| **Affiliation:** | SolarEdge Technologies Inc |
| **Street Address:** | |
| **City:** | |
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| **Zip:** | |
| **Submittal Date:** | Tue Sep 05 07:47:58 EDT 2023 |
| **Committee:** | NEC-P04 |

# Public Input No. 3627-NFPA 70-2023 [ New Section after 690.12 ]

690.12 (F) Engineering verification of higher voltage PVHCS

PVHCS installations on buildings other than one- and two-family dwellings, with controlled conductors which remain above 165Vdc after the initiation of rapid shutdown, shall be field verified by the licensed professional electrical engineer of record. Documentation that the installation matches the certified PVHCS configuration shall be provided in a stamped engineering report, available to the AHJ, verifying all required components of the PVHCS are installed in compliance with the PVHCS listing.

## Statement of Problem and Substantiation for Public Input

With the adoption of PVHC inside the array there are new approaches to compliance with 690.12 that bring a variety of innovative solutions, component choices, and physical arrangements provided by multiple vendors evaluated by one or more NRTLs to form a complete PVHCS . Systems may be comprised of passive mechanical systems, voltage control systems, or a combination of various means. Arrays may be segmented into lower voltage sections or remain and maximum string voltage. The precise placement of all PVHC components, inverters, PVRSE, as well as wire routing and management becomes critical to the success and effectiveness of the entire safety system final assembly for each specific project site. UL 3741 required instructions included in the listing and labeling of PVHCE and PVHCS are not adequate to cover the entirety of the final system for each individual project site which can vary widely. At higher voltage levels this may be problematic as the intended safety of the PVHCS is dependent upon proper installation of the components. AHJs may lack sufficient project information at the planning or enforcement phases to adequately assess that all critical components are installed such that they form a listed PVHC system for each unique project. Utilizing an engineering report for the installation will help to close this gap in the construction process. Project plan sets often include project specific details for racking attachments, ballast, and hardware that is project specific for structural engineering evaluation. Including this level of detail for the assembly of a listed safety system comprised of a multitude of individual critical components is no different than methods in use today for PV system planning and inspection. Leaving out or improperly installing even small components can render the final assembly non-compliant with NEC or the PVHCS listing and pose a risk to fire fighters.

PVHC solutions that do not employ voltage control are not evaluated to UL 1741 PVRSE/PVRSS and are not required to have a system self-check and electronic fail-safe feature which can detect improperly installed PVRSE/PVRSS. This puts the entire responsibility of a properly functioning PVHC system on the installer and the AHJ. Implementing an engineering verification process as proposed will provide critical precise system level information to all parties to ensure that the final safety system is deployed properly.

The proposed voltage threshold of 165Vdc is referenced from UL 3741 annex F which concludes that no further protective measures are required for voltages at or below this level when FF PPE is used. This voltage was chosen based on logic in the standard, however, a higher threshold may be suitable upon future substantiation. The reduced voltage is accomplished by the use of listed PVRSS/PVRSE with required self-check and fail-safe features, thus reducing the need for engineering inspections below this threshold.

3741 may also be revised in parallel to include additional documentation to support this proposal.

Proponents: Bill Brooks (Brooks Engineering), John Berdner (Enphase)

## Related Public Inputs for This Document

| Related Input | Relationship |
| --- | --- |
| Public Input No. 3611-NFPA 70-2023 [New Section after 690.12] | PVHC |

## Submitter Information Verification

| | |
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| **Submittal Date:** | Tue Sep 05 10:31:09 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 4204-NFPA 70-2023 [ Section No. 690.12 ]

~~**690.12** Rapid Shutdown of PV Systems on Buildings.~~

~~PV system circuits installed on or in buildings shall include a rapid shutdown function to reduce shock hazard for firefighters in accordance with 690.12 (A) through (D).~~

~~*Exception No. 1: Ground-mounted PV system circuits that enter buildings, of which the sole purpose is to house PV system equipment, shall not be required to comply with 690.12 .*~~

~~*Exception No. 2: PV equipment and circuits installed on nonenclosed detached structures including but not limited to parking shade structures, carports, solar trellises, and similar structures shall not be required to comply with 690.12 .*~~

> ~~Informational Note: Exceptions for rapid shutdown are intended to be consistent with building and fire codes that have limitations as to the types of buildings on which firefighters typically perform rooftop operations.~~

~~**(A)** Controlled Conductors.~~

~~Requirements for controlled conductors shall apply to the following:~~

(1) ~~PV system dc circuits~~

(2) ~~Inverter output circuits originating from inverters located within the array boundary~~

> ~~Informational Note: The rapid shutdown function reduces the risk of electrical shock that dc circuits in a PV system could pose for firefighters. The ac output conductors from PV systems that include inverters will either be de-energized after shutdown initiation or will remain energized by other sources such as a utility service. To prevent PV arrays with attached inverters from having energized ac conductors within the PV array(s), those circuits are also specifically controlled after shutdown initiation.~~

~~*Exception: PV system circuits originating within or from arrays not attached to buildings that terminate on the exterior of buildings and PV system circuits installed in accordance with 230.6 shall not be considered controlled conductors for the purposes of 690.12 .*~~

~~**(B)** Controlled Limits.~~

~~The use of the term *array boundary* in this section is defined as 305 mm (1 ft) from the array in all directions. Controlled conductors outside the array boundary shall comply with 690.12(B)(1) and inside the array boundary shall comply with 690.12(B)(2) . Equipment and systems shall be permitted to meet the requirements of both inside and outside the array as defined by the manufacturer's instructions included with the listing.~~

~~**(1)** Outside the Array Boundary.~~

~~Controlled conductors located outside the boundary or more than 1 m (3 ft) from the point of entry inside a building shall be limited to not more than 30 volts within 30 seconds of rapid shutdown initiation. Voltage shall be measured between any two conductors and between any conductor and ground.~~

~~**(2)** Inside the Array Boundary.~~

~~The PV system shall comply with one of the following:~~

(1) ~~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: 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) ~~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.~~

~~**(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.~~

~~**(D)** Buildings with Rapid Shutdown.~~

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

~~**(1)** Buildings with More Than One Rapid Shutdown Type.~~

~~For buildings that have PV systems with more than one rapid shutdown type or PV systems with no rapid shutdown, a detailed plan view diagram of the roof shall be provided showing each different PV system with a dotted line around areas that remain energized after rapid shutdown is initiated.~~

~~**(2)** Rapid Shutdown Switch.~~

~~A rapid shutdown switch shall have a label that includes the following wording located on or no more than 1 m (3 ft) from the switch:~~

~~RAPID SHUTDOWN SWITCH FOR SOLAR PV SYSTEM~~

~~The label shall be reflective, with all letters capitalized and having a minimum height of 9.5 mm ( 3/8 in.) in white on red background.~~

## Additional Proposed Changes

| File Name | Description | Approved |
|---|---|---|
| NEC_changes.pdf | Reasons to eliminate need for RSD devices | |

## Statement of Problem and Substantiation for Public Input

Rapid Shutdown Devices are starting to have too many failures and associated problems from devices causing arc faults, failures and melting.

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Peter Greenberg |
| **Organization:** | Energy Wise Services |
| **Affiliation:** | My input represents my company and the Albany and Corvallis, Oregon Fire Marshalls office. |
| **Street Address:** | |
| **City:** | |
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| **Zip:** | |
| **Submittal Date:** | Wed Sep 06 22:21:30 EDT 2023 |
| **Committee:** | NEC-P04 |

It has been a few years since the requirement for electronics behind solar modules has been in place for most of the country. I propose to eliminate 690.12(B)(2) and explain why in this letter.

There appears to be little public data of solar system problems both before or after the 2017 code change. This is due to a lack of reporting through the National Fire database, Non-Disclosure Agreements, confidential insurance payouts, apparently very few solar fires and expert testimony that is confidential. I have not found significant data showing that adding more electronics has made solar safer or if we had many problems before the 2017 code was introduced. Certainly, there were and will be problems and even fires as there are with most electronics. One of the few studies I have seen is from Germany where they looked at 17 years of data with 30 gigawatts of solar and found about 200 fires (20% of which were due to thin film solar panels which we also had issues within the U.S.). The U.S. Is one of very few countries in the world to require Rapid Shut Down devices (RSD) as one of the paths prescribed in code for solar systems. Australia went thru a similar process when their code mandated DC Isolators which caused hundreds of fires in solar systems. They took this out of the code years later and still have problems to this day with these devices.

In my experience with being a professional and volunteer firefighter/paramedic for 11 years and owning a solar installation company for the last 13 years, I have installed hundreds of solar systems with over 40,000 panels. Many before the 2017 code changes and many after. I have concerns with the 2017 codes. We had a fire in a solar system early in June 2023, and are currently awaiting forensic results. After the fire we went to other sites and found (RSD) units with signs of failing including internal heat bubbles and cracking in the housing.

My preference is to use string inverters in solar systems as they can be replaced by any manufacturer of these if they fail or a company goes out of business. Currently one must use RSD if one is to use string inverters (this was not so in the past) on occupied buildings. We should not exclude string inverters which have been used safely for the last few decades in solar systems. Ideally the least amount of electronics behind a solar panel is best. Outdoors behind a solar panel is a harsh environment where the equipment should last for the life of the solar panels. Solar panel manufacturers use many different brands of connectors, the RSD and other module level electronics use Staubli (MC4) connectors. Adding RSD almost always requires 4 additional connectors. Studies have shown connectors are the #1 point of failure.

With RSD we have seen failures in our installed systems in 3 different brands, not including a very high failure rate with Generac systems and their resulting lawsuits. I have heard from other installers who have had failures in RSD.

Other than failures in RSD whether they are installed perfectly or not, failures are very difficult to find. One must check all of the strings safety voltage with the inverter off, onsite (this cannot be done remotely.) Next all of the strings must be taken off the inverter and tested individually within the first 5 minutes of the inverter starting. This must be repeated over and over again for every string. If there is a difference in voltage, every connection and every device in the string needs to be checked. On a sloped roof one can't get to the equipment to check these connections without removing the panels from the roof.

It appears that with multiple units from multiple companies failing within the first few years, lab testing standards are not adequate. The devices are not hardy enough, they require excessive connections, and these are all pathways to failures, one would think this will only get worse as equipment ages.

The 1 ft. from the boundary maximum to the inverter appears arbitrary. An AC disconnect is located close to the electric meter. The DC wires from the solar system, whether in 1 foot or 20 feet of conduit are insignificantly more or less safe. Every firefighter realizes the dangers of being on a roof and regardless of what safety devices are on solar panels they should not be relied upon to work in a fire. No firefighter should be within 1 foot of any solar system on fire, rather they need to be 15 or 20 feet away and better yet on a snorkel or ladder truck with a fog stream putting the fire out. After a fire, a solar professional should be called to make sure the DC is safe and ideally use the unique product PV Stop to spray on solar panels to stop the flow of electricity. This has just been introduced into the US.

UL 3741 is a newly used path for solar (first proposed and accepted thru UL by Sollega racking and SMA inverters) , this is a systems approach where mainly the inverter is within 1 foot of the solar array and the DC wire is isolated from the solar panels by various methods, mostly using nylon wire ties in the case of Sollega racking to create a gap between the solar panel and the DC wire.

Requiring an inverter to be within 1 foot of the array boundary in UL 3741 helps in some circumstances with commercial buildings but does not help with string inverters on houses. This is due to the passive cooling of most string inverters and them not being able to be installed vertically on a typical house roof. With millions of these RSD devices on solar panels, it is only a matter of time before more fail. We need to make it easy to remove them without adding more electronics.

In larger systems with 1 ft. boundaries on both sides of 2 arrays on a roof, this allows for 2 feet of space between the arrays. In solar systems over 150 feet long, there is a required 3-foot path for firefighters. 2 feet isn't 3 feet, so multiple smaller inverters need to be used with larger systems. This 1 ft. boundary should be eliminated so RSD's can be removed and still have a pathway for fire fighters.

Eliminating 690,12(B)(2) and allowing longer DC runs to the DC inverter (in the case of houses) typically on the side wall near the meter, would bring us back to seemingly safer times with less electronics, less jumpers and less problems.

Sincerely,

Peter Greenberg nrgwiseservice@gmail.com Albany, Oregon

Peter Greenberg 9/7/2023

Lora Ratcliff, City of Albany Oregon Fire Dept Fire Marshal lora.ratcliff@cityofalbany.net

9-7-2023

Jason Dennis, Deputy Fire Marshall, Corvallis Oregon Fire Dept. jason.dennis@corvallisoregon.gov

Jason Dennis 9/7/2023

# Public Input No. 1068-NFPA 70-2023 [ Section No. 690.12(B)(2) ]

**(2)** Inside the Array Boundary.

The PV system shall ~~comply with one of the following: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: 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* .

- ~~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.~~

## Statement of Problem and Substantiation for Public Input

Module level power electronics are unreliable and have caused many fires on buildings. Other jurisdictions like Australia have made MLPE optional because of this. Firefighters (including CAL Fire) have told us that they treat PV systems on roofs the same whether or not a rapid shutdown system is present. For these reasons the common belief is that MLPE cause more problems without actually solving any problems. My proposal is to eliminate Module level power electronics as an acceptable method for providing firefighter safety inside the array boundary.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 1069-NFPA 70-2023 [Section No. 690.4(B)] | |

## Submitter Information Verification


**Submitter Full Name:** Charles Ladd
**Organization:** Greenskies Clean Energy LLC
**Affiliation:** CL Engineering and Architecture PLLC
**Street Address:**
**City:**
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**Submittal Date:** Wed Jun 14 09:00:45 EDT 2023
**Committee:** NEC-P04

# Public Input No. 3226-NFPA 70-2023 [ Section No. 690.12(B)(2) ]

**(2)** Inside the Array Boundary.

The PV system shall comply with one of the following:

(1) 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: 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*.

<u>Informational Note No. 2: Installation instructions for listed or field-labeled PVHCS include checklists to ensure all PVHCE is present and correctly installed. Review of these checklists is one method which may be used to determine compliance with this section.</u>

(2) 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.

## Statement of Problem and Substantiation for Public Input

UL 3741 is the relevant Standard for PV Hazard Control Equipment (PVHCE) and PV Hazard Control Systems (PVHCS). The Standard relies heavily on manufacturer's instructions to reduce PV hazards. In some cases the PVHCS is made up of PVHCE from multiple suppliers and proper installation of all the PVHCE is necessary to create a properly functioning PVHCS. There have been multiple examples of confusion in the field over which manufacturer's instructions to follow, i.e. PVHCE or PVHCS, which has resulted in systems being installed improperly or without all the necessary PVHCE. The proposal would provide additional guidance on what documentation should be supplied with a PVCHS and provide one possible mechanism for AHJ's to verify correct installation of the PVHCS.

The change is being submitted in coordination with proposals currently being made to the UL 3741 Technical Comittee which would require the manufacturer's instructions for the PVHCS to include an installer checklist. Manufacturer's instructions are part of the PVHCS and are controlled by the Nationally Recognized Testing Labratory providing the PVHCS Listing. The proposed new checklist would require indentification of any required PVHCE and installer verification that the PVHCE was properly installed. The UL 3741 Standard is presently open for revision and the proposal has been reviewed, and is supported by, several members of the UL 3741 Technical Comittee.

Proposal Submitted to UL 3741 Technical Committee:

18.# The PVHC system installation instructions shall include a separate installer checklist(s) which identifies all required equipment and installation steps necessary to ensure proper functionality of the PVHC System. Where the PVHC System relies on coordination of PVHC functions between multiple suppliers of PVHCE, the installation checklist shall identify make and model number of all required PHCE or shall clearly identify which PVHC functions are to supplied by other Listed PVHCE. Installer checklist(s) shall be marked “INSTALLATION CHECKLIST for Authority Having Jurisdiction”

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | John Berdner |
| **Organization:** | Enphase energy |
| **Street Address:** | |
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| **Zip:** | |
| **Submittal Date:** | Wed Aug 30 13:37:02 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 1399-NFPA 70-2023 [ Section No. 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) 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) <u>Emergency disconnect</u>

(3) PV system disconnecting means

(4) 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.

### Statement of Problem and Substantiation for Public Input

Emergency disconnects should be added to the itemized list of initiation devices as they are required to be located for ready access and quick operation for firefighters and provide the functionality of an initiation device for interactive inverters.

### Submitter Information Verification


**Submitter Full Name:** Chris Papp

**Organization:** [ Not Specified ]

**Street Address:**

**City:**

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**Submittal Date:** Thu Jul 13 12:53:40 EDT 2023

**Committee:** NEC-P04

## Public Input No. 3986-NFPA 70-2023 [ Section No. 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) 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. <u>Multiple initiation devices shall be grouped.</u>

### Statement of Problem and Substantiation for Public Input

Rapid shutdown initiation devices should be grouped for first responders and firefighters.

### Submitter Information Verification


**Submitter Full Name:** Peter Diamond
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**City:**
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**Submittal Date:** Wed Sep 06 12:16:18 EDT 2023
**Committee:** NEC-P04

# Public Input No. 4062-NFPA 70-2023 [ Section No. 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) 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

(4) **<u>ESS disconnecting means</u>**

(5) **<u>If a PV system would not initiate rapid shutdown on service disconnection due to presence of the ESS, means shall be provided to simultaneously disconnect the ESS and PV system from all wiring systems in accordance with 706.15</u>**

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.

## Statement of Problem and Substantiation for Public Input

As the Morgan Solar Energy Blind will most likely be installed as a part of an Energy Storage System (ESS), the PV system and ESS system may both share a disconnecting means that is independent of service disconnection. In situations of weather-related grid outages (which function like a service disconnection), a building may want to switch to power from local PV and ESS. This use case is not currently covered in the existing code. The proposed change also adds an additional layer of safety for first responders as they would be able to disconnect an ESS and PV system simultaneously with one disconnecting means where such systems are found. In the case of a grid outage, the PV system and ESS could retain functionality.

MSI proposes an ESS disconnecting means to be sufficient to meet the requirements of an Initiation Device required for a rapid shutdown of PV systems.

## Submitter Information Verification

**Submitter Full Name:** Joel Slonetsky
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**Submittal Date:** Wed Sep 06 15:18:36 EDT 2023

**Committee:** NEC-P04

# Public Input No. 4180-NFPA 70-2023 [ Section No. 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)~~ device meeting the requirements in 690.12(C)(1) through (3) shall be provided ~~and shall initiate~~ to initiate the rapid shutdown function.

**(1) Type and Location.** The initiation device shall be readily accessible and shall consist of one or more of the following:

(a) Service disconnecting means

(b) PV system disconnecting means

(c) A listed switch or emergency stop device

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

**(2) Operation.** 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~~

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.

~~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~~

**(3) More than One System.** Where multiple PV systems are installed with rapid shutdown functions on a single service, ~~the~~ initiation ~~device(s) shall~~ devices 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.

## Additional Proposed Changes

| File Name | Description | Approved |
|---|---|---|
| SSIF_690.12_C_PI_copy_for_attachment.pdf | Clean copy in case the changes don't come through clearly. | |

## Statement of Problem and Substantiation for Public Input

Reorganization of this section into subdivisions is proposed 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 around the use of listed switches in (3) is simplified and “listed” is added to reinforce that the devices used should be suitable for the application and conditions of use. Emergency stop devices are added as an important example of a suitable initiation device. Since listings for E-stop devices do not require that “Off” and “On” markings are attached to these devices, and since their operation is so widely understood, the marking requirement has been deleted.

Language specifically allowing additional means of initiation is 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 is done to improve ease of use and to clarify that the acceptable devices are those as identified in (C)(1).
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The Solar and Storage Industry Forum (SSIF) is a coalition of individuals and organizations convened by the Solar Energy Industry Association (SEIA) to organize, support, and mentor renewable energy industry professionals in codes and standards development. Our objective is to submit industry consensus-based recommendations for changes to the National Electrical Code. We believe that this effort improves the Code-making process by consolidating multiple industry member's points of view into fewer, common proposals.
SSIF members are dedicated to continually improving the installation safety of PV and storage systems in the U.S. A list of members can be found here:
https://www.seia.org/industry-forum

## Submitter Information Verification


| | |
|---|---|
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| **City:** | |
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| **Zip:** | |
| **Submittal Date:** | Wed Sep 06 19:39:12 EDT 2023 |
| **Committee:** | NEC-P04 |

| | |
|---|---|
| **Legislative Text** | **690.12 (C) Initiation Device.**<br>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 (3) shall be provided ~~and shall~~to initiate the rapid shutdown function.<br><br>**(1) Type and Location.** The initiation device shall be readily accessible and shall consist of one or more of the following:<br>(a) Service disconnecting means<br>(b) PV system disconnecting means<br>(c) ~~Switch that plainly indicates whether it is in the “off” or “on” position~~A listed switch or emergency stop device<br>For one-and two-family dwellings, ~~an~~ initiation device~~(s)~~, where required, shall be located at an ~~readily accessible~~ outdoor location.<br><br>**(2) Operation.** The device’s “off” position shall indicate that the rapid shutdown function has been initiated 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. ~~Devices shall consist of at least one or more of the following:~~<br>~~(1) Service disconnecting means~~<br>~~(2) PV system disconnecting means~~<br>~~(3) Readily accessible switch that plainly indicates whether it is in the “off” or “on” position~~<br><br>**(3) More than One System.** Where multiple PV systems are installed with rapid shutdown functions on a single service, ~~the~~ initiation devices~~(s)~~ shall consist of not more than six devices meeting the requirements in 690.12(C)(1) grouped together~~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)~~ whose combined operation shall initiate the rapid shutdown of all PV systems with rapid shutdown functions on that service. |
| **Clean Text** | **690.12 (C) Initiation Device.**<br>Where circuits identified in 690.12(A) are required to meet the requirements in 690.12(B), an initiation device meeting the requirements in 690.12(C)(1) through (3) shall be provided to initiate the rapid shutdown function.<br><br>**(1) Type and Location.** The initiation device shall be readily accessible and shall |

| | |
|---|---|
| | consist of one or more of the following:<br>(a) Service disconnecting means<br>(b) PV system disconnecting means<br>(c) A listed switch or emergency stop device<br>For one-and two-family dwellings, initiation devices, where required, shall be located at an outdoor location.<br><br>**(2) Operation.** The device's "off" position shall indicate that the rapid shutdown function has been initiated 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.<br><br>**(3) More than One System.** Where multiple PV systems are installed with rapid shutdown functions on a single service, initiation devices shall consist of not more than six 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. |

# Public Input No. 2472-NFPA 70-2023 [ Section No. 690.12(D) ]

**(D)** Buildings with Rapid Shutdown

**(1) Marking .**

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~~ (a) The label shall be all capitalized letters having a minimum height of 9. ~~5 mm~~ 5 mm ( 3⁄/ 8 in.). All ~~text~~ letters shall be ~~legible and contrast the background.~~ in white on a red background and legible.

(b) Diagram sections in red shall signify sections of the PV system that are not shut down when the rapid shutdown switch is operated. Diagram sections in green shall signify sections of the PV system that are shut down when the rapid shutdown switch is operated.

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

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

**(~~1~~ 2 )** Buildings with More Than One Rapid Shutdown Type.

For buildings that have PV systems with more than one rapid shutdown type, or ~~PV systems with~~ a rapid shutdown type and a PV system with no rapid shutdown, a detailed plan view diagram of the roof shall be provided showing ~~each different PV system~~ each PV system with a dotted line around areas that remain energized after rapid shutdown is ~~initiated~~ operated .

(~~2~~ 3 ) Rapid Shutdown Switch.

~~A~~ The rapid shutdown switch shall have a permanent label ~~that includes the following wording located~~ located at a readily visible location on or no more than 1 m (3 ft) from the switch that inludes the following words :

RAPID SHUTDOWN SWITCH FOR SOLAR PV SYSTEM

The label shall be reflective, with all letters capitalized and having a minimum height of 9.5 mm (3⁄8 in.) in white on red background.

## Statement of Problem and Substantiation for Public Input

These proposed changes will align with NFPA 1. As currently written, there are significant differences of the label requirements of NFPA 1 such as the NEC only requires the label to be contrasting in color whereas NFPA 1, Section 11.12.2.1.1 has a specific color scheme to identify what remains energized (RED) and what is shutdown (GREEN) when the rapid shutdown switch is operated. Since these requirements are intended for firefighters, the requirements in the NEC should match those in NFPA 1. An alternative would be to extract these requirements directly from NFPA 1.

## Submitter Information Verification


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**Submittal Date:** Thu Aug 17 19:15:41 EDT 2023
**Committee:** NEC-P04

# Public Input No. 3008-NFPA 70-2023 [ Section No. 690.12(D)(2) ]

**(2)** Rapid Shutdown ~~Switch~~ Initiation Device .

A rapid shutdown ~~switch~~ initiation device shall have a label that includes the following wording located on or no more than 1 m (3 ft) from the ~~switch~~ indicator :

RAPID SHUTDOWN ~~SWITCH~~ INITIATION DEVICE FOR SOLAR PV SYSTEM

The label shall be reflective, with all letters capitalized and having a minimum height of 9.5 mm (⅜ in.) in white on red background.

## Statement of Problem and Substantiation for Public Input

Three different devices are permitted to be used as initiators; the service disconnecting means, the PV system disconnecting means, or a switch. See 690.12(C). The label requirement of 690.12(D)(2) is only in reference to a "switch". Is this label requirement intended to also apply to service & PV system disconnecting means? If so, should "initiator" be used instead of "switch". The device used as the initiator should be clearly marked. The most common device used as an initiator for dwellings is the PV system disconnecting means (circuit breaker) in a panelboard. There is not enough space within a residential panelboard dead front to label a branch circuit breaker with the specified font size.

## Submitter Information Verification


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**Submittal Date:** Mon Aug 28 16:40:32 EDT 2023

**Committee:** NEC-P04

## Public Input No. 347-NFPA 70-2023 [ Section No. 690.12(D)(2) ]

**(2)** Rapid Shutdown ~~Switch~~ Initiator .

A rapid shutdown switch shall have a label that includes the following wording located on or no more than 1 m (3 ft) from the ~~switch~~ initiator :

RAPID SHUTDOWN SWITCH FOR SOLAR PV SYSTEM

The label shall be reflective, with all letters capitalized and having a minimum height of 9.5 mm (3⁄8 in.) in white on red background.

### Statement of Problem and Substantiation for Public Input

Three different devices are permitted to be used as initiators; the service disconnecting means, the PV system disconnecting means, or a switch. See 690.12(C). The label requirement of 690.12(D)(2) is only in reference to a "switch". Is this label requirement intended to also apply to service & PV system disconnecting means? If so, should "initiator" be used instead of "switch". The device used as the initiator should be clearly marked. The most common device used as an initiator for dwellings is the PV system disconnecting means (circuit breaker) in a panelboard. There is not enough space within a residential panelboard dead front to label a branch circuit breaker with the specified font size.

### Submitter Information Verification

**Submitter Full Name:** Peter Jackson
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**Submittal Date:** Fri Feb 17 10:36:50 EST 2023
**Committee:** NEC-P04

# Public Input No. 458-NFPA 70-2023 [ 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.

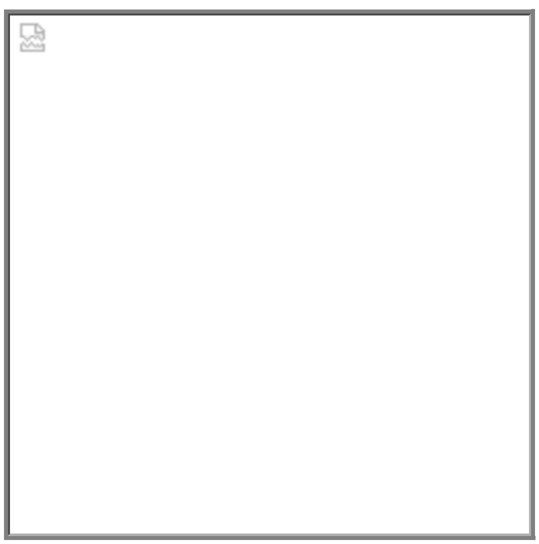
TURN RAPID SHUTDOWN SWITCH TO THE "OFF" POSITION TO SHUT DOWN

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 (⅜ in.). All text shall be legible and contrast the background.

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

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



## Statement of Problem and Substantiation for Public Input

The word "is" is not in Figure 690.12(D).

## Submitter Information Verification

| | |
|---|---|
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| **Submittal Date:** | Wed Mar 15 07:26:20 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 2473-NFPA 70-2023 [ Section No. 690.12 [Excluding any Sub-Sections] ]

PV system circuits installed on or in buildings shall include a rapid shutdown function to reduce shock hazard for firefighters in accordance with 690.12(A) through (D).

<u>The PV rapid shutdown function shall be performance tested when first installed on site. This testing shall be conducted by a qualified person(s) using a test process approved by the authority having jurisdiction and in accordance with instructions that are provided with the PV rapid shutdown equipment.</u>

*Exception No. 1: Ground-mounted PV system circuits that enter buildings, of which the sole purpose is to house PV system equipment, shall not be required to comply with 690.12.*

*Exception No. 2: PV equipment and circuits installed on nonenclosed detached structures including but not limited to parking shade structures, carports, solar trellises, and similar structures shall not be required to comply with 690.12.*

Informational Note: Exceptions for rapid shutdown are intended to be consistent with building and fire codes that have limitations as to the types of buildings on which firefighters typically perform rooftop operations.

### Statement of Problem and Substantiation for Public Input

Fire fighters blindly rely on the PV rapid shutdown requirement to reduce the potential for shock. Both UL 1741 for PV rapid shutdown equipment (PVRSE) and PV rapid shutdown systems (PVRSS) as well as UL 3741 for PV hazard control equipment (PVHCE) and PV hazard control systems (PVHCS) have functional safety requirements. Without an onsite functional performance test, compliance with the performance requirements on Section 690.12(B) cannot be verified and approved. Onsite functional performance testing would also provide firefighters reasonable assurance that the PV rapid shutdown functions properly when initiated.

Onsite functional safety performance testing is not new to the NEC. Examples are in 230.95(C), 240.67(C), 240.87(C), 517.17(D) and 708.8(D).

### Submitter Information Verification


| | |
|---|---|
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| **Submittal Date:** | Thu Aug 17 19:46:39 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 3388-NFPA 70-2023 [ Section No. 690.12 [Excluding any Sub-Sections] ]

PV system circuits installed on or in buildings shall include a rapid shutdown function to reduce shock hazard for firefighters in accordance with 690.12(A) through (D).

*Exception No. 1: Ground-mounted PV system circuits that enter buildings, of which the sole purpose is to house PV system equipment, shall not be required to comply with 690.12.*

*Exception No. 2: PV equipment and circuits installed on nonenclosed detached structures including but not limited to parking shade structures, carports, solar trellises, and similar structures shall not be required to comply with 690.12.*

*Exception No. 3: Rapid shutdown shall not be required where a PV system has a disconnecting means for isolating photovoltaic equipment meeting 690.15(A)(1) installed at the array boundary, does not exceed 20% of the roof area and does not exceed any of the following:*

*(a) 144 Square Feet in area.*

*(b) 2000 Watts DC.*

*(c) 300 Volts Open Circuit Voltage.*

*This exception shall be limited to one PV system per building.*

Informational Note: Exceptions for rapid shutdown are intended to be consistent with building and fire codes that have limitations as to the types of buildings on which firefighters typically perform rooftop operations.

## Statement of Problem and Substantiation for Public Input

Small small PV systems are not the types of systems that have caused problems for firefighters. An exception should be added to allow these systems to be serviced or installed without rapid shutdown. In developing the UL3741 standard (product category QIJR), Sandia National labs along with UL conducted extensive analyses of all aspects of firefighter operations, including what types of personal protective equipment (PPE) the firefighters wear, the fire-retardant chemicals that they use, and how they put out fires. The UL3741 standard allows firefighters to come into contact well over 80 Volts. After a review of the recent literature on the subject it appears that small PV systems that are small in area and power are no different than other common rooftop obstructions found on buildings such as Heating, ventilation, and air-conditioning (HVAC) systems, generators and energy storage systems. By having a limited area of the system and requiring a disconnecting means similar to an HVAC system these small systems will be easy to avoid and pose little to no risk to firefighters.

The following literature is the technical basis for this proposal:

Jack Flicker 1 , Olga Lavrova1 , Jimmy Quiroz1 , Tim Zgonena2 , Hai Jiang 2 , Kent Whitfield2 , Kenneth Boyce2 ,
Paul Courtney 2 , John Carr2 , and Paul Brazis "Hazard Analysis of Firefighter Interactions with Photovoltaic Arrays"
Flicker, Jack, and Jay Johnson. "Photovoltaic ground fault detection recommendations for array safety and operation." Solar Energy 140 (2016): 34-50.

Flicker, Jack David, and Jay Johnson. Photovoltaic ground fault and blind spot electrical simulations. No. SAND2013-3459. Sandia National Lab.(SNL-NM), Albuquerque, NM (United States), 2013.
Flicker J, Johnson J, Albers M, Ball G. Recommendations for CSM and R iso ground fault detector trip

thresholds. In2014 IEEE 40th Photovoltaic Specialist Conference (PVSC) 2014 Jun 8 (pp. 3391-3397). IEEE.
Ball, G., B. Brooks, J. Flicker, J. Johnson, A. Rosenthal, J. C. Wiles, and L. Sherwood. "Inverter ground-fault detection ‘blind spot’and mitigation methods." Solar American Board for Codes and Standards 674 (2013): 1-42.

## Submitter Information Verification

| | |
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| **Submittal Date:** | Fri Sep 01 19:27:41 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 3413-NFPA 70-2023 [ Section No. 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

**(F)** DC Surge Protection.

PV system dc circuits shall have SPDs marked as "PV SPD" installed at the dc combiners, electronic power converters, or dc PV system disconnecting means.

**(G)** AC Surge Protection.

Electric power production and distribution network equipment supplied by a PV system shall be provided with an SPD.

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

## Statement of Problem and Substantiation for Public Input

This public input will add surge protection to solar PV systems that are highly susceptible to transient voltages and surge currents from direct or nearby lightning strikes. This protection will reduce the potential for fire and damage to the solar PV system, premises wiring system, interconnected utilities or other on-site power sources, and the building or structure supporting the solar PV system. Protection from overvoltage requirements for both roof-mounted and ground-mounted solar arrays can also be found in the NFPA 780, Standard for the Installation of Lightning Protection Systems.

Part (F) mandates protection of the “dc” side of the PV system with UL 1449 listed PV SPDs.

Part (G) mandates protection on the “ac” side of the PV system with UL 1449 listed SPDs in accordance with Part II. of Article 242. Adding overvoltage protection to PV systems will improve the safety and reliability of these systems.

## Submitter Information Verification

**Submitter Full Name:** Megan Hayes

**Organization:** NEMA

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**Zip:**

**Submittal Date:** Sat Sep 02 17:47:54 EDT 2023

**Committee:** NEC-P04

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

**690.13** Photovoltaic System Disconnecting Means.

~~(B~~

~~Means~~

PV system disconnecting 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.~~

installed in accordance with Article 705.20. In addition to the types of disconnects identified in 705.20 (C), a connector meeting the requirements of 690.33(D)(1) or (D)(3) shall also be permitted.

*Exception: PV system circuits operating at 30V or below shall not require locked or tooled access to enclosures and disconnecting means that expose live parts.*

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

**(A )** 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.~~

## Additional Proposed Changes

| File Name | Description | Approved |
|---|---|---|
| PI_for_Submission_-_690.13_Tesla.docx | 690.13 PI GBall - Tesla | |

## Statement of Problem and Substantiation for Public Input

This PI accompanies PI 4469 and attempts to solidify 705.20 as the go to reference point for the individual power source articles, including 480, 445, 690, 692, and 694. Progress on disconnecting means requirements is made incrementally and inconsistently among the various articles, and that inconsistency shows itself especially as there are growing trends of multiple power sources being used on the same premises. It is hoped that this approach will allow the other articles to reduce duplicative content and focus only on salient requirement differences.

The content proposed to be removed from 690.13 is largely covered in the proposed 705.20 changes, albeit with more generic language, and salient differences are left in 690.13. It is hoped that if the proposal has merit it could help instigate a correlating task group to identify changes in the other articles.

## Related Public Inputs for This Document

| Related Input | Relationship |
| --- | --- |
| Public Input No. 4469-NFPA 70-2023 [Section No. 705.20] | References changes to 705.20 |

## Submitter Information Verification


**Submitter Full Name:** Greg Ball

**Organization:** Tesla

**Street Address:**

**City:**

**State:**

**Zip:**


**Submittal Date:** Thu Sep 07 16:16:46 EDT 2023

**Committee:** NEC-P04

| NEC Section | | STATUS |
| --- | --- | --- |
| 690.13 | | |

**Legislative Text**

**690.13 Photovoltaic System Disconnecting Means.**
PV system disconnecting means shall be installed in accordance with Article 705.20. In addition to the types of disconnects identified in 705.20 (C), a connector meeting the requirements of 690.33(D)(1) or (D)(3) shall also be permitted.

*Exception: PV system circuits operating at 30V or below shall not require locked or tooled access to enclosures and disconnecting means that expose live parts.*

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

~~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~~A) 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~~B) 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.<br><br>**Informational Note:**<br>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. |
| **Clean Text** | |
| **Substantiation** | This PI accompanies PI 4469 and attempts to solidify 705.20 as the go to reference point for the individual power source articles, including 480, 445, 690, 692, and 694. Progress on disconnecting means requirements is made incrementally and inconsistently among the various articles, and that inconsistency shows itself especially as there are growing trends of multiple power sources being used on the same premises. It is hoped that this approach will allow the other articles to reduce duplicative content and focus only on salient requirement differences.<br>The content proposed to be removed from 690.13 is largely covered in the proposed 705.20 changes, albeit with more generic language, and salient differences are left in 690.13 |

Submitter: Greg Ball, Tesla

Additional Contributors (if desired):

# Public Input No. 2008-NFPA 70-2023 [ Section No. 690.13(A)(1) ]

**(1)** Readily Accessible.

The PV system disconnecting means shall be installed at a readily accessible location. For one- and two-family dwellings, the PV system disconnecting means shall be located at a readily accessible location outside the building. For other buildings, the PV system disconnecting means shall be installed at a readily accessible location either outside of a building or structure or inside nearest the point of entrance of the power source output conductors.

## Statement of Problem and Substantiation for Public Input

Similar to the requirements in 230.85, adding the requirement for an outside disconnect for one- and two-family dwellings in article 690 brings a parallel requirement for first responders to have a means to disconnect all sources of power outside a dwelling so they may enter the building knowing all power is disconnected. In other buildings have the disconnect outside or nearest the point of entrance is similar to services in 230.70(A)(1)

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 3178-NFPA 70-2023 [Section No. 705.20] | Similar requirement |

## Submitter Information Verification

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**Submittal Date:** Fri Aug 11 06:12:57 EDT 2023
**Committee:** NEC-P04

# Public Input No. 2349-NFPA 70-2023 [ Section No. 690.13(A)(1) ]

**(1)** Readily Accessible.

The PV system disconnecting means shall be installed at a readily accessible location and shall meet the working space requirements of 110 .26(A).

## Statement of Problem and Substantiation for Public Input

Adding same language of 440.14 to 690.13(A) because it relieves the AHJ from interpreting that the PV system disconnecting means must have the required working space in 110.26(A). This increases safety for the safe operation and maintenance of such equipment.

## Submitter Information Verification


| | |
|---|---|
| **Submitter Full Name:** | Mike Holt |
| **Organization:** | Mike Holt Enterprises Inc |
| **Street Address:** | |
| **City:** | |
| **State:** | |
| **Zip:** | |
| **Submittal Date:** | Wed Aug 16 13:56:56 EDT 2023 |
| **Committee:** | NEC-P04 |

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

~~**(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.~~

## Statement of Problem and Substantiation for Public Input

How is a PV system disconnect switch that exposes live parts with the enclosure door open any more dangerous than any other disconnect that also exposes live parts with the enclosure door open, such as an HVAC disconnect? The general requirements of 404.30 should apply to all disconnect switches regardless of the power source supplying the device. For disconnecting means containing fuses, there is no technical justification to modify the general requirements in Section 240.24(A). Based on the Article 100 definition of readily accessible, the use of a tool would make access to the fuses not readily accessible, so this 690.13(A)(2) requirement would conflict, while not specifically identifying those sections. Additionally, since there is no definition of what a locked cover is in this Code, this section has created confusion and there have been reports of switches being locked in the closed position in the field.

## Submitter Information Verification


**Submitter Full Name:** Larry Sherwood

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**Submittal Date:** Mon Aug 28 16:44:32 EDT 2023

**Committee:** NEC-P04

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

**(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).

## Statement of Problem and Substantiation for Public Input

Since the code is a permissive code, additional language is not necessary to permit other markings unless they are prohibited elsewhere.

## Submitter Information Verification

**Submitter Full Name:** Stephen Schmiechen
**Organization:** [ Not Specified ]
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**Submittal Date:** Fri Sep 01 22:24:41 EDT 2023
**Committee:** NEC-P04

# Public Input No. 3394-NFPA 70-2023 [ Section No. 690.13(B) ]

**(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 and include the code year that is in effect . 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).

## Statement of Problem and Substantiation for Public Input

As the NEC requirements change from cycle to cycle it is important to know which code cycle a PV system was installed under. Adding the code year to the disconnect will assist code users with service and maintenance of existing systems.

## Submitter Information Verification

**Submitter Full Name:** Stephen Schmiechen
**Organization:** [ Not Specified ]
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**Submittal Date:** Fri Sep 01 22:26:58 EDT 2023
**Committee:** NEC-P04

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

**(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~~ 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.

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document when a disconnecting means is required to be lockable open elsewhere in the code. The text is revised to comply with the NEC Style Manual. The NEC Style Manual Section 3.2.5 Consistent Application of Terms, 3.2.5.3 Lockable Open. Where a requirement specifies that a disconnecting means be capable of being locked in the open position, the phrase lockable open in accordance with 110.25 shall be used.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | David Williams |
| **Organization:** | Delta Charter Township |
| **Street Address:** | |
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| **Zip:** | |
| **Submittal Date:** | Sun Aug 20 07:08:34 EDT 2023 |
| **Committee:** | NEC-P04 |

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

**(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~~ The following devices listed or approved for the intended application:

(a) Fused disconnects, unless otherwise marked, shall be considered suitable for backfeed.

(b) 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

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

## Statement of Problem and Substantiation for Public Input

Revised text for list (5) with “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.” Was a 100% extraction from 705.30(D). Too add clarity for Code users it is always great when NEC rules are consistent between articles.

## Submitter Information Verification

**Submitter Full Name:** Mike Holt
**Organization:** Mike Holt Enterprises Inc
**Street Address:**
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**Submittal Date:** Tue Aug 29 11:29:50 EDT 2023
**Committee:** NEC-P04

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

**(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~~ are not ~~be~~ suitable for backfeed or reverse current.

## Statement of Problem and Substantiation for Public Input

Omitting the “line” and “load” markings are the means by which circuit breakers are identified for suitability of backfeeding applications. No other rating or marking is provided on circuit breakers to identify suitability for this application. A circuit breaker which is marked “line” and “load” is not suitable for backfeeding and utilizing such a circuit breaker for this application would not comply with Section 110.3(B).

## Related Public Inputs for This Document

| Related Input | Relationship |
| --- | --- |
| Public Input No. 4014-NFPA 70-2023 [Section No. 705.30(D)] | |
| Public Input No. 4014-NFPA 70-2023 [Section No. 705.30(D)] | |

## Submitter Information Verification


**Submitter Full Name:** Danish Zia

**Organization:** UL Solutions

**Street Address:**

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**Submittal Date:** Wed Sep 06 14:06:44 EDT 2023

**Committee:** NEC-P04

# Public Input No. 4063-NFPA 70-2023 [ Section No. 690.15(B) ]

**(B)** Isolating Device.

An isolating device shall not be required to have an interrupting rating. Where an isolating device is not rated for interrupting the circuit current, it shall be marked “Do Not Disconnect Under Load” or “Not for Current Interrupting.” An isolating device shall not be required to simultaneously disconnect all current-carrying conductors of a circuit. The isolating device shall be one of the following:

(1) A mating connector meeting the requirements of 690.33 and listed and identified for use with specific equipment

(2) A finger-safe fuse holder

(3) An isolating device that requires a tool to place the device in the open (off) position

(4) An isolating device listed for the intended application

(5) **A solid state device provided that it has ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals and is default 'open' unless powered closed by a control system.**

## Statement of Problem and Substantiation for Public Input

An isolating device as defined in 690.15(B) may be used as a disconnecting means. Solar monitoring and management equipment may contain solid state devices with appropriate electrical ratings that would meet the requirements of an isolating device. Morgan Solar proposes adding an additional requirement of such a solid state device that in the event of a service failure the device default to an ‘open switch’ condition (must be energized to be closed). With such a requirement this device could then be added to the list of allowable isolating devices. An electronic solid state device could respond to a service disconnect and initiate PV system shut down.

## Submitter Information Verification

**Submitter Full Name:** Joel Slonetsky
**Organization:** Morgan Solar
**Street Address:**
**City:**
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**Submittal Date:** Wed Sep 06 15:23:43 EDT 2023
**Committee:** NEC-P04

## Public Input No. 2545-NFPA 70-2023 [ Section No. 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~~ lockable open in accordance with 110.25.

(4) Be one of the types 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) 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.

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document when a disconnecting means is required to be lockable open elsewhere in the code. The text is revised to comply with the NEC Style Manual. The NEC Style Manual Section 3.2.5 Consistent Application of Terms, 3.2.5.3 Lockable Open. Where a requirement specifies that a disconnecting means be capable of being locked in the open position, the phrase lockable open in accordance with 110.25 shall be used.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Submitter Information Verification

**Submitter Full Name:** David Williams
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**Street Address:**
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**Submittal Date:** Sun Aug 20 07:09:58 EDT 2023
**Committee:** NEC-P04

# Public Input No. 2546-NFPA 70-2023 [ Section No. 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) Provided with remote controls to activate the disconnecting means where the remote controls comply with one of the following:

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

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

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document when a disconnecting means is required to be lockable open elsewhere in the code. The text is revised to comply with the NEC Style Manual. The NEC Style Manual Section 3.2.5 Consistent Application of Terms, 3.2.5.3 Lockable Open. Where a requirement specifies that a disconnecting means be capable of being locked in the open position, the phrase lockable open in accordance with 110.25 shall be used.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

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**Submittal Date:** Sun Aug 20 07:10:57 EDT 2023
**Committee:** NEC-P04

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

**(4)** Special Equipment.

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

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

## Statement of Problem and Substantiation for Public Input

How do you "specifically list" something? Equipment either complies with a product standrad or it does not.

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Ryan Jackson |
| **Organization:** | Self-employed |
| **Street Address:** | |
| **City:** | |
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| **Zip:** | |
| **Submittal Date:** | Mon Apr 10 13:53:24 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 3810-NFPA 70-2023 [ Section No. 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 installed in accordance with one or more of the following:

(1) The PV system dc circuits are separated from all other circuits by a barrier or partition.

~~Exception: Where all conductors~~

(1) The installation of other circuit conductors is permitted by the PV system equipment listing.

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

## Additional Proposed Changes

| File Name | Description | Approved |
|---|---|---|
| ACote_2026_PI-3810.pdf | PI-3810: Proposed Language, Substantiation, and Markup | |

## Statement of Problem and Substantiation for Public Input

The revision turns the current exception into positive code language to improve the clarity and usability of the Code. The revised text maintains the same requirements as the 2023 NEC, but now allows for any combination of four installation options where PV dc circuit conductors can be installed in the same wiring method, like a metal wireway, where other circuit conductors like inverter output circuits or other circuits, branch circuits and feeders could be present.

Energy management and power control system circuit conductors are added to the permitted circuits in (4), in addition to breaking out remote control and signaling circuits in 300.26 from Article 724 Class 1 power limited remote-control and signaling circuits to correlate with the work of CMP-3 last cycle.

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Andrew Cote |
| **Organization:** | Generac Power Systems, Inc |
| **Street Address:** | |
| **City:** | |
| **State:** | |
| **Zip:** | |
| **Submittal Date:** | Tue Sep 05 17:32:07 EDT 2023 |
| **Committee:** | NEC-P04 |

# 2026 Public Input Form

| **Name:** Andrew Cote<br><br>**Email:** andrew.cote@generac.com | **2023 NEC Section Number:**<br><br>690.31(B)(1) | **Proposed NEW Section Number:**<br><br>690.31(B)(1) |
|---|---|---|

**Type of Change:** *(New, revision, etc.)*
Revision of existing *Code* language

**Proposed Code Language:**

**(1) Conductors of Different Systems**.
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 installed in accordance with one or more of the following:

(1) The PV system dc circuits are separated from all other circuits by a barrier or partition.
(2) The installation of other circuit conductors is permitted by the PV system 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) Multiconductor jacketed cables for energy management systems, power control systems, remote control and signaling circuits, or Class 1 power-limited remote-control and signaling circuits shall be permitted within the same wiring enclosure, cable, or raceway as PV system dc circuits where all circuits serve the PV system.

**Substantiation for Change:**

The revision turns the current exception into positive code language to improve the clarity and usability of the *Code*. The revised text maintains the same requirements as the 2023 NEC, but now allows for any combination of four installation options where PV dc circuit conductors can be installed in the same wiring method, like a metal wireway, where other circuit conductors like inverter output circuits or other circuits, branch circuits and feeders could be present.

Energy management and power control system circuit conductors are added to the permitted circuits in (4), in addition to breaking out remote control and signaling circuits in 300.26 from Article 724 Class 1 power limited remote-control and signaling circuits to correlate with the work of CMP-3 last cycle.

**Notes:**

**(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:

~~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.~~

(1) The PV system dc circuits are separated from all other circuits by a barrier or partition.
(2) The installation of other circuit conductors is permitted by the PV system 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) Multiconductor jacketed cables for energy management systems, power control systems, remote control and signaling circuits, or Class 1 power-limited remote-control and signaling circuits shall be permitted within the same wiring enclosure, cable, or raceway as PV system dc circuits where all circuits serve the PV system.

# Public Input No. 2058-NFPA 70-2023 [ 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~~ 210 . ~~31~~ 5 ( ~~B)(2)(a) and (B)(2)(b)~~ C) .

*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 .~~

## Statement of Problem and Substantiation for Public Input

This public input is being submitted on behalf of the Minnesota Department of Labor and Industry. Currently, the Department's inspection staff includes 14-office/field staff, 12-state field inspectors, 2-virtual inspectors and 50 plus contract electrical inspectors that complete over 170,000 electrical inspections annually.

Understanding that these conductors are not branch circuits and are considered PV source circuits. For consistency and usability of the NEC, a simple reference to 210.5(C)(2) for branch circuits would promote consistency when determining identification requirements for DC conductors.

## Submitter Information Verification


**Submitter Full Name:** Dean Hunter

**Organization:** Minnesota Department of Labor

**Street Address:**

**City:**

**State:**

**Zip:**


**Submittal Date:** Fri Aug 11 13:28:17 EDT 2023

**Committee:** NEC-P04

## Public Input No. 571-NFPA 70-2023 [ Section No. 690.31(B)(2) ]

**(2)** Identification.

PV system dc circuit conductors shall be ~~identified~~ marked at all termination, connection, and splice points by color coding, marking tape, tagging, or other approved means in accordance with 690.31(B)(2)(a) and (B)(2)(b).

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

(a) Conductors that rely on other than color coding for polarity ~~identification~~ indication shall be ~~identified by an approved permanent marking~~ permanently marked by 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.

### Statement of Problem and Substantiation for Public Input

There editorial revisions are made to avoid misuse of the defined term "identified," which does not mean marking.

### Submitter Information Verification

**Submitter Full Name:** Ryan Jackson
**Organization:** Self-employed
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**Submittal Date:** Mon Apr 10 13:50:18 EDT 2023
**Committee:** NEC-P04

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

**(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.

## Statement of Problem and Substantiation for Public Input

Note that the only change actually made here is the deletion of the one sentence in (b), that is proposed to be moved to the main charging paragraph through the separate PI.
See PI-4159 for substantiation.

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SSIF members are dedicated to continually improving the installation safety of PV and storage systems in the U.S. A list of members can be found here:
https://www.seia.org/industry-forum

## Related Public Inputs for This Document

| Related Input | Relationship |
| --- | --- |
| Public Input No. 4159-NFPA 70-2023 [Section No. 690.31(C) [Excluding any Sub-Sections]] | Location moved to |
| Public Input No. 4159-NFPA 70-2023 [Section No. 690.31(C) [Excluding any Sub-Sections]] | |

## Submitter Information Verification

**Submitter Full Name:** Evelyn Butler
**Organization:** Solar Energy Industries Assn
**Street Address:**
**City:**
**State:**
**Zip:**
**Submittal Date:** Wed Sep 06 19:09:08 EDT 2023
**Committee:** NEC-P04

## Public Input No. 440-NFPA 70-2023 [ Section No. 690.31(C)(1) ]

**(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~~ support devices , including straps, hangers, or similar fittings listed and identified for securement and support in outdoor locations. Devices shall be installed using manufacturers specified tools and equipment. 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.*

*Note: Cable ties can be authorized as a supporting device, but need to be listed for outdoor use and installed using manufacturer approved tools.*

(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.

### Statement of Problem and Substantiation for Public Input

Cable ties have become a big issue in PV installations. Commercial sites have reported, even using listed ties, cable ties failing within first 1-5 years. Most cable ties are not designed with a 10-30 year lifespan and installing them outdoors makes the concept of use even more difficult.

When installed properly, the cable ties can still fail if animals, wind or other outside forces stress the wire and cables. Stock home center cable ties are often the go to for uneducated PV installers and will usually fail within first year of install. Listed devices are better, but still fail after short intervals in field. Commercial PV owners have it on regular schedules to verify cable ties and replace on regular intervals. This is a poor substitute for proper wire and cable support.

When cable ties are installed using hands or unauthorized tools such as pliers, the ties can be over tightened, causing insulation failure, ground faults and arcing. There are several sites that have experienced fires due to improperly installed cable ties. We have data showing arc faults and insulation failure leading to energized metal parts.

I suggest the code be changed with a call to utilize listed supporting devices and ensure they are installed to manufacturer specifications, using authorized tools. There are new devices being developed in the PV industry that will hopefully make cable ties obsolete.

### Submitter Information Verification

**Submitter Full Name:** Bill Sekulic

| | |
|---|---|
| **Organization:** | National Renewable Energy Laboratory |
| **Street Address:** | |
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| **Submittal Date:** | Thu Mar 09 12:30:42 EST 2023 |
| **Committee:** | NEC-P04 |

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

**(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.

## Additional Proposed Changes

| File Name | Description | Approved |
|---|---|---|
| Wire_mesh_cable_tray.jpg | Wire mesh cable tray | |

## Statement of Problem and Substantiation for Public Input

The 2023 revisions made in this section provide an allowance for "ladder ventilated trough" cable trays. The 2020 public input behind the new language specifically addressed “ladder OR ventilated trough cable trays” but the final code language left out the word "or".

Additionally, Wire mesh cable trays are often used in rooftop PV cable installations as in the attached image. Is there a reason wire mesh cable trays are not included in these requirements?

## Submitter Information Verification

**Submitter Full Name:** Jeffrey Simpson
**Organization:** ElectricalLicenseRenewal.com
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**Submittal Date:** Thu Sep 07 05:36:18 EDT 2023
**Committee:** NEC-P04

The adjustment factors for 1/0 AWG single conductor cable in 392.80(A)(2) is permitted to be used for single-conductor PV wire **smaller than** 1/0 AWG installed in ***uncovered*** cable trays

# 2023 NEC 690.31(C)(2)

The following applies to single-conductor PV wire smaller than 1/0 AWG installed in ***ladder or ventilated trough cable trays***:

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

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

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

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

**(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 |

## Statement of Problem and Substantiation for Public Input

The MCM designation was changed to kcmil, in the Code, quite some time ago. Some manufacturers still have MCM on their websites, but it makes sense for the Code to be consistent with itself.

## Submitter Information Verification


**Submitter Full Name:** Eric Stromberg
**Organization:** Los Alamos National Laboratory
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**Submittal Date:** Sat Mar 04 09:42:38 EST 2023
**Committee:** NEC-P04

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

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.

### Statement of Problem and Substantiation for Public Input

In the 2023 second draft (see link to SR 8336), a mis-numbered section (C)(1)(d) stating "PV wire or cable shall be permitted in all locations where RHW-2 is permitted" [duplicatively labeled as Section "(c)" though correctly referred to as "(d)" in the first sentence of 690.31(C)(1)] was deleted in favor of keeping the exact same language as the last sentence of (C)(1)(b). Unfortunately, (C)(1)(b) is specifically for conductors 8 AWG and smaller; this removed the allowance (PV wire in the same locations where RHW-2 is permitted) for conductors greater than 8 AWG [in (C)(1)(c)], whereas the previous location of the statement made it apply to both. "PV wire or cable shall be permitted in all locations where RHW-2 is permitted" should be removed from (b) where it only applies to 8 AWG and smaller conductors and be located in the charging paragraph of 690.31(C) to clarify that this applies regardless of wire gauge.

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SSIF members are dedicated to continually improving the installation safety of PV and storage systems in the U.S. A list of members can be found here:

https://www.seia.org/industry-forum

### Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 4161-NFPA 70-2023 [Section No. 690.31(C)(1)] | Location moved from |
| Public Input No. 4161-NFPA 70-2023 [Section No. 690.31(C)(1)] | |

### Submitter Information Verification


**Submitter Full Name:** Evelyn Butler

**Organization:** Solar Energy Industries Assn

**Street Address:**

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**Submittal Date:** Wed Sep 06 19:06:47 EDT 2023

**Committee:** NEC-P04

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

**(1)** Metal Raceways 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 ~~of the building~~ , and in the interior spaces, of buildings .*

### Statement of Problem and Substantiation for Public Input

The current text is unclear - does it mean just at the point of penetration, or also after that point? Since the Section 690.31(D)(1) title and requirement is for "metal raceways and enclosures" “where inside buildings," the exception should be clearly applicable both at the point of penetration of the surface of a building as well as inside that building.

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SSIF members are dedicated to continually improving the installation safety of PV and storage systems in the U.S. A list of members can be found here:
https://www.seia.org/industry-forum

### Submitter Information Verification


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| **Submitter Full Name:** | Evelyn Butler |
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| **Submittal Date:** | Wed Sep 06 18:59:56 EDT 2023 |
| **Committee:** | NEC-P04 |

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

**(1)** Metal Raceways 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~~ raceways or 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 of the building.*

## Statement of Problem and Substantiation for Public Input

The title of this section or the contents of it need to be revised for consistency. Type MC cable is not a raceway. If the intent is that we use raceways, as indicated in the title of the section, then we need to remove allowance for MC. If we want to allow MC then we need to change the title from "raceways" to "wiring methods."

## Submitter Information Verification


| | |
|---|---|
| **Submitter Full Name:** | Ryan Jackson |
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| **Affiliation:** | Steel Tube Institute |
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| **Submittal Date:** | Mon Apr 10 12:46:34 EDT 2023 |
| **Committee:** | NEC-P04 |

# Public Input No. 373-NFPA 70-2023 [ New Section after 690.31(D)(2) ]

**Marking Micro-Inverter AC PV Circuits**

**Unless located and arranged so the purpose is evident, the following wiring methods used in micro-inverter installations that contain AC system circuit conductors shall be marked with the wording AC PHOTOVOLTAIC POWER SOURCE by means of permanently affixed labels or other approved permanent marking: (1) Exposed raceways, cable trays, and other wiring methods. (2) Covers or enclosures of pull boxes and junction boxes (3) Conduit bodies in which any of the available conduit openings are unused. The labels or markings shall be visible after installation. All letters shall be capitalized and shall be a minimum height of 9.5mm (3/8 in.) in block on yellow background. Labels shall appear on every section of the wiring system that is separated by enclosures, walls, partitions, ceilings or floors. Spacing between labels shall not be more than 3 m (10 ft). Labels required by this section shall be suitable for the environment where they are installed.**

## Statement of Problem and Substantiation for Public Input

A large number of local AHJ's are creating their own labeling requirements for micro-inverter or Enphase installations. The primary requirement has been to mark the AC circuit of the micro-inverter. This is causing confusion because the NEC does not require AC circuits be marked, yet they are insisting it be done anyway, by local code, for safety reasons. Perhaps it is a valid safety concern that needs to be addressed.

## Submitter Information Verification


| | |
|---|---|
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| **Organization:** | HellermannTyton |
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| **Zip:** | |
| **Submittal Date:** | Thu Feb 23 13:50:26 EST 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 4182-NFPA 70-2023 [ 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~~ manufacturers' instructions.

## Statement of Problem and Substantiation for Public Input

The current language regarding connectors that are not of the identical type or brand allows for a unilateral listing and identification for intermatability from one of the two manufacturers; the proposed change would ensure that both of the manufacturers list and identify their respective connectors as intermatable with the other. This will ensure true compatibility: one big risk with the current language that could arise is if one of the manufactures changes something about their connector; the other manufacturer may be unaware of this, and it could render the components no longer intermatable. With both manufacturers required to be involved for connectors to be intermatable it means that changes to one would either mean they are no longer listed for intermatability, or the other manufacturer would have to either make changes, or at least retest, to ensure continued intermatability.

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SSIF members are dedicated to continually improving the installation safety of PV and storage systems in the U.S. A list of members can be found here:

https://www.seia.org/industry-forum

## Submitter Information Verification


| | |
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| **Submitter Full Name:** | Evelyn Butler |
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| **Submittal Date:** | Wed Sep 06 20:04:54 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 3390-NFPA 70-2023 [ 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) Circuits not isolated from the grounded inverter output circuit

(4) Ungrounded circuits

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

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

### Statement of Problem and Substantiation for Public Input

PV system DC configurations should be classified as grounded, ungrounded or functionally grounded. UL standards should follow the NEC not the other way around. Having another possible undefined configuration just opens up the possibility for confusion.

### Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Stephen Schmiechen |
| **Organization:** | [ Not Specified ] |
| **Street Address:** | |
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| **Submittal Date:** | Fri Sep 01 20:50:56 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 3391-NFPA 70-2023 [ 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) Circuits not isolated from the grounded inverter output circuit

(4) Ungrounded circuits

(5) Solidly grounded circuits ~~as permitted in 690.41(B)~~

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

## Statement of Problem and Substantiation for Public Input

Solidly grounded DC circuit are not prohibited in other parts of the code (see 90.3), this wording is not adding to or modifying other parts of the code. 690.41(B) stands alone and does not need to be referenced here.

## Submitter Information Verification

**Submitter Full Name:** Stephen Schmiechen
**Organization:** [ Not Specified ]
**Street Address:**
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**State:**
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**Submittal Date:** Fri Sep 01 20:57:16 EDT 2023
**Committee:** NEC-P04

## Public Input No. 3392-NFPA 70-2023 [ 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~~
~~Bipolar circuits according to 690.7(C) with a functional ground reference (center tap)~~

(2) Functionally grounded circuits

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

(4) Ungrounded circuits

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

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

### Statement of Problem and Substantiation for Public Input

Clarify bipolar (3 wire) circuits can be used in all systems. 3 wire grounded and ungrounded DC systems have been in use for over a century. This section should deal with the types of DC circuit configurations. 690.7(C) is sufficient.

### Submitter Information Verification


**Submitter Full Name:** Stephen Schmiechen
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**Submittal Date:** Fri Sep 01 21:05:18 EDT 2023
**Committee:** NEC-P04

# Public Input No. 360-NFPA 70-2023 [ 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~~ through (B)(~~2~~ 3 ) ~~to~~ 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 identified for the combination of the dc-to-dc converter 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: 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.

## Statement of Problem and Substantiation for Public Input

(B)(3) was added in the 2020 Edition, but it should be made clear that this requirement has to be fulfilled as well.

## Submitter Information Verification

**Submitter Full Name:** Christian Eder

**Organization:** Fronius USA LLC

**Street Address:**

**City:**

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| | |
|---|---|
| **Zip:** | |
| **Submittal Date:** | Tue Feb 21 10:52:55 EST 2023 |
| **Committee:** | NEC-P04 |

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

**(1)** Ground-Fault Detection.

The GFDI device or system shall be listed, and detect ground fault(s) in the PV system dc circuits, including any functionally grounded conductors~~, and be listed for providing GFDI protection.~~ . Where GFDI is required and the GFDI device is not integral to a listed dc-to-dc converter, PV optimizer or rapid shutdown equipment, the GFDI shall be listed and identified for use with the combination of dc-to-dc converter, PV optimizer and/or rapid shutdown equipment in the same circuit. For dc-to-dc converters not listed as providing GFDI protection, where required, listed GFDI protection equipment identified for the combination of the dc-to-dc converter and the GFDI device shall be installed to protect the circuit.

Informational Note: Most often the GFDI functionality is within the PV inverter. 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.

## Statement of Problem and Substantiation for Public Input

Substantiation - It is critical that inverters and other PV equipment with the PV GFDI functionality, be evaluated and listed to operate as intended when used with other PV system equipment such as dc-to-dc converters, pv optimizers and PV rapid shutdown equipment. There have been situations where PV system equipment has blinded PV GFDI equipment from detecting PV array ground faults. Evaluating, testing and Listing these multi-function systems together will confirm the system operates as intended and provides the necessary ground fault protection.

## Submitter Information Verification


**Submitter Full Name:** Colleen OBrien

**Organization:** UL LLC

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**City:**

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**Submittal Date:** Tue Sep 05 17:46:23 EDT 2023

**Committee:** NEC-P04

## Public Input No. 2593-NFPA 70-2023 [ Section No. 690.43(A) ]

**(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 PV modules. Electrical connections using dissimilar metals shall be environmentally sealed (as air-tight and water-tight) against the effects of corrosion or otherwise protected using materials listed for the purpose .

Informational Note: See UL 2703, *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, *Standard for Solar Trackers*.

### Additional Proposed Changes

| File Name | Description | Approved |
|---|---|---|
| PI_2493_Attachment_C_.pdf | | |

### Statement of Problem and Substantiation for Public Input

Secure grounding and bonding connections are essential to a safe electrical system. Grounding is essential to ensure a safe return path for electrical current. Bonding ensures that all metal parts of electrical equipment have the same electrical potential, reducing the risk of shock hazard and damage. Both grounding and bonding are necessary for an electrical system to ensure safety, reliability, performance, and to prevent equipment damage.

The effects of corrosion on grounding and bonding connections, especially outdoors or in humid or corrosive environments are significant. Humidity causes metals to corrode and can accelerate the galvanic action caused by using dissimilar metals used to bond electrical equipment. Corrosive atmospheres, such as in a swimming pool equipment room can quickly corrode grounding and bonding connections, rendering them unsafe.
Galvanic corrosion is an electrochemical process in which one metal corrodes preferentially when it is in electrical contact with another, in the presence of an electrolyte, such as water. By keeping the electrolyte away from the connection, corrosion can be significantly reduced.

Connections using dissimilar metals will quickly corrode when exposed to weather or corrosive conditions, causing failure of the bonding pathway. Corrosion is a major problem for electrical connections, as it can lead to increased resistance and heating. Corrosion can lead to connections becoming oxidized, creating a high resistance contact, and can ultimately lead to the failure of the connection. Poor grounding and bonding connections can result in an electrical potential on exposed metal parts, which may result in property damage, injury, or death.

Corrosion is a natural phenomenon which occurs under certain moisture, temperature and atmospheric conditions; it cannot be avoided, only mitigated. Corrosion weakens products therefore affecting their function and integrity.

Corrosion is a large problem. A 2002 study by the National Association of Corrosion Engineers, backed by the Federal Highway Administration, estimated corroding metals in various industries, infrastructure and manufacturing cost $276 billion annually.

For example, the United States Consumer Product Safety Commission (CPSC) ordered a recall of 1.3 million grounding lugs due to corrosion issues in 2014. Although no deaths were attributed to the recall, the cost to replace the lugs was significant.

In another case, a recent article illustrated significant lightning damage to Orange County Florida's public emergency communications equipment. 1 The damage was caused by lightning strikes and corrosion of bonding connections on lightning protection conductors. These damages were between one and two million dollars over a ten-year period.

According to the CPSC, approximately 90 people are electrocuted annually in the United States due to appliances or wiring issues. There are also at least 30,000 non-fatal shock incidents per year in the United States. Each year, approximately 5% of all burn unit admissions in the United States occur because of electrical injuries.

Preventing corrosion of grounding and bonding connections in wet, damp, or corrosive atmospheres can be challenging. Equipment located in these conditions are exposed to the elements, which can result in atypical situations where the usual practices for bonding may not perform as intended. For example, many listed grounding lugs are not designed to be installed outdoors; using a lug that is not rated for outdoor use can lead to premature failures in the intended path for fault current, impairing the functionality of overcurrent and ground-fault protection devices. Other issues include corrosion of bonding connections due to galvanic action.

Grounding lugs can damage the protective anodized coating on aluminum module frames and rails. For example, some manufacturers suggest scraping, cutting, or scuffing the anodized coating. Unless the connection is sealed (as air-tight and water-tight) from the elements, the aluminum becomes exposed to the environment which increases the rate of oxidation and galvanic corrosion. Corrosion at the connection will cause an increase in the connection's resistance, and eventual failure of the bond. However, some equipment manufacturers do not permit removal of the protective anodized coating, such as galvanization, to make electrical contact. This is because removal of the coating will facilitate corrosion.

Tests conducted on a variety of bonding connections indicated that most typical connections failed quickly when exposed to deteriorating agents. Damp-heat resistances were relatively unchanged over a 20-week period. However, most samples corroded in just a few weeks for the salt-mist tests. Samples using an antioxidant lasted slightly longer before failing. Lay-in lugs with washers and grounding clips and compound lasted more than 20 weeks in the salt mist condition, but still failed. 2

Using connection hardware that is environmentally sealed (as air-tight and water-tight) against the effects of corrosion will not only make installations safer but will reduce costs for the owner/operator.

Using an environmentally sealed electrical bonding device and bonding fastener with environmental seals creates an air-tight and water-tight seal around the teeth which make the electrical bonding connection and protect it from corrosion. As the nut and bolt are tightened the twisted teeth bite into the facing surfaces of the frames to penetrate any surface corrosion or coating and create a solid electrical connection that is air-tight and water-tight sealed against the elements and the effects of corrosion. Please refer to Attachments 1-4 for photographs of environmentally sealed washers. As can be seen in Attachments 3 and 4, the washer clearly provided good contact with the aluminum surface, while the silicone protects the connection from corrosion.

Environmentally sealed hardware creates more secure electrical connections by providing 360-degree protection against corrosion and degradation. This is achieved by embedding the washer in an air and watertight silicone layer. The silicone layer prevents moisture and other contaminants from coming into contact with the washer and mating surface, which can help to prevent corrosion and degradation of the electrical connection.

As a result of these benefits, environmentally sealed hardware can help to create more secure electrical connections that are less likely to fail. This is important for safety, as it can help to prevent electrical fires and other hazards. Environmentally sealed hardware is also important for reliability, as they can help to ensure that electrical connections remain functional for longer periods of time.

Here are some of the specific benefits of using environmentally sealed connections:

- Increased resistance to corrosion
- Reduced risk of electrical fires and shock hazards
- Improved reliability
- Longer lifespan

Notes:
1. All-Copper Grounding Systems End Million Dollar Losses at Emergency Response System. [West, Donnelly, Sorley, 2016]
2. Accelerated Aging Tests on PV Grounding Connections [Wang et al., 2011]

## Submitter Information Verification


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| **Submittal Date:** | Wed Aug 23 16:04:10 EDT 2023 |
| **Committee:** | NEC-P04 |

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

**(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, *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, *Standard for Solar Trackers*.

## Statement of Problem and Substantiation for Public Input

The existing language of 690.43 (A) is misleading because it implies that the listing of a bonding device with a PV module frame means that the bonding device has been evaluated and listed for use with any and all PV module frames. However, the dimensions, geometry, material and coating specifications of PV module frames are known to impact the electrical resistance in the bonding path between the frame and the bonding devices. Therefore the bonding device must be listed, labeled and identified for use with specific modules.

## Submitter Information Verification

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| **Submittal Date:** | Tue Sep 05 19:33:06 EDT 2023 |
| **Committee:** | NEC-P04 |

# Public Input No. 2592-NFPA 70-2023 [ Section No. 690.43(B) ]

**(B)** Equipment Secured to Grounded Metal Supports.

Devices listed, labeled, and identified for bonding and grounding the metal parts of PV systems shall be permitted to bond the equipment to grounded metal supports. 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. Electrical connections using dissimilar metals shall be environmentally sealed (as air-tight and water-tight) against the effects of corrosion or otherwise protected using materials listed for the purpose .

## Additional Proposed Changes

| File Name | Description | Approved |
|---|---|---|
| PI_2492_Attachment_C_.pdf | | |

## Statement of Problem and Substantiation for Public Input

Secure grounding and bonding connections are essential to a safe electrical system. Grounding is essential to ensure a safe return path for electrical current. Bonding ensures that all metal parts of electrical equipment have the same electrical potential, reducing the risk of shock hazard and damage. Both grounding and bonding are necessary for an electrical system to ensure safety, reliability, performance, and to prevent equipment damage.

The effects of corrosion on grounding and bonding connections, especially outdoors or in humid or corrosive environments are significant. Humidity causes metals to corrode and can accelerate the galvanic action caused by using dissimilar metals used to bond electrical equipment. Corrosive atmospheres, such as in a swimming pool equipment room can quickly corrode grounding and bonding connections, rendering them unsafe.
Galvanic corrosion is an electrochemical process in which one metal corrodes preferentially when it is in electrical contact with another, in the presence of an electrolyte, such as water. By keeping the electrolyte away from the connection, corrosion can be significantly reduced.

Connections using dissimilar metals will quickly corrode when exposed to weather or corrosive conditions, causing failure of the bonding pathway. Corrosion is a major problem for electrical connections, as it can lead to increased resistance and heating. Corrosion can lead to connections becoming oxidized, creating a high resistance contact, and can ultimately lead to the failure of the connection. Poor grounding and bonding connections can result in an electrical potential on exposed metal parts, which may result in property damage, injury, or death.

Corrosion is a natural phenomenon which occurs under certain moisture, temperature and atmospheric conditions; it cannot be avoided, only mitigated. Corrosion weakens products therefore affecting their function and integrity.

Corrosion is a large problem. A 2002 study by the National Association of Corrosion Engineers, backed by the Federal Highway Administration, estimated corroding metals in various industries, infrastructure and manufacturing cost $276 billion annually.

For example, the United States Consumer Product Safety Commission (CPSC) ordered a recall of 1.3 million grounding lugs due to corrosion issues in 2014. Although no deaths were attributed to the recall, the cost to replace the lugs was significant.

In another case, a recent article illustrated significant lightning damage to Orange County Florida's public emergency communications equipment. 1 The damage was caused by lightning strikes and corrosion of bonding connections on lightning protection conductors. These damages were between one and two million dollars over a ten-year period.

According to the CPSC, approximately 90 people are electrocuted annually in the United States due to appliances or wiring issues. There are also at least 30,000 non-fatal shock incidents per year in the United States. Each year, approximately 5% of all burn unit admissions in the United States occur because of electrical injuries.

Preventing corrosion of grounding and bonding connections in wet, damp, or corrosive atmospheres can be challenging. Equipment located in these conditions are exposed to the elements, which can result in atypical situations where the usual practices for bonding may not perform as intended. For example, many listed grounding lugs are not designed to be installed outdoors; using a lug that is not rated for outdoor use can lead to premature failures in the intended path for fault current, impairing the functionality of overcurrent and ground-fault protection devices. Other issues include corrosion of bonding connections due to galvanic action.

Grounding lugs can damage the protective anodized coating on aluminum module frames and rails. For example, some manufacturers suggest scraping, cutting, or scuffing the anodized coating. Unless the connection is sealed (as air-tight and water-tight) from the elements, the aluminum becomes exposed to the environment which increases the rate of oxidation and galvanic corrosion. Corrosion at the connection will cause an increase in the connection’s resistance, and eventual failure of the bond. However, some equipment manufacturers do not permit removal of the protective anodized coating, such as galvanization, to make electrical contact. This is because removal of the coating will facilitate corrosion.

Tests conducted on a variety of bonding connections indicated that most typical connections failed quickly when exposed to deteriorating agents. Damp-heat resistances were relatively unchanged over a 20-week period. However, most samples corroded in just a few weeks for the salt-mist tests. Samples using an antioxidant lasted slightly longer before failing. Lay-in lugs with washers and grounding clips and compound lasted more than 20 weeks in the salt mist condition, but still failed. 2

Using connection hardware that is environmentally sealed (as air-tight and water-tight) against the effects of corrosion will not only make installations safer but will reduce costs for the owner/operator.

Using an environmentally sealed electrical bonding device and bonding fastener with environmental seals creates an air-tight and water-tight seal around the teeth which make the electrical bonding connection and protect it from corrosion. As the nut and bolt are tightened the twisted teeth bite into the facing surfaces of the frames to penetrate any surface corrosion or coating and create a solid electrical connection that is air-tight and water-tight sealed against the elements and the effects of corrosion. Please refer to Attachments 1-4 for photographs of environmentally sealed washers. As can be seen in Attachments 3 and 4, the washer clearly provided good contact with the aluminum surface, while the silicone protects the connection from corrosion.

Environmentally sealed hardware creates more secure electrical connections by providing 360-degree protection against corrosion and degradation. This is achieved by embedding the washer in an air and watertight silicone layer. The silicone layer prevents moisture and other contaminants from coming into contact with the washer and mating surface, which can help to prevent corrosion and degradation of the electrical connection.

As a result of these benefits, environmentally sealed hardware can help to create more secure electrical connections that are less likely to fail. This is important for safety, as it can help to prevent electrical fires and other hazards. Environmentally sealed hardware is also important for reliability, as they can help to ensure that electrical connections remain functional for longer periods of time.

Here are some of the specific benefits of using environmentally sealed connections:

- Increased resistance to corrosion
- Reduced risk of electrical fires and shock hazards
- Improved reliability
- Longer lifespan

Notes:
1. All-Copper Grounding Systems End Million Dollar Losses at Emergency Response System. [West, Donnelly, Sorley, 2016]
2. Accelerated Aging Tests on PV Grounding Connections [Wang et al., 2011]

## Submitter Information Verification

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| **Submittal Date:** | Wed Aug 23 15:55:27 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 3093-NFPA 70-2023 [ 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 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.

### Statement of Problem and Substantiation for Public Input

Adding “support structure” to be consistent in the language used in 250.136.

### Submitter Information Verification


| | |
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| **Organization:** | Mike Holt Enterprises Inc |
| **Street Address:** | |
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| **Submittal Date:** | Tue Aug 29 11:32:54 EDT 2023 |
| **Committee:** | NEC-P04 |

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

**(B)** Equipment Secured to Grounded Metal Supports.

Devices listed, labeled, and identified for bonding and grounding the metal parts of PV ~~systems shall~~ arrays shall be permitted to bond the equipment to grounded metal supports. 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.

## Statement of Problem and Substantiation for Public Input

This section uses the term PV system improperly. The only component of a PV system that is applicable to this section is the PV array. This change will add clarity to the application of this section.

## Related Public Inputs for This Document

| Related Input | Relationship |
| --- | --- |
| Public Input No. 3834-NFPA 70-2023 [Definition: Array.] | Includes "mounting system" in array. Removes "support structure". |
| Public Input No. 3837-NFPA 70-2023 [Section No. 690.47(B)] | |
| Public Input No. 3834-NFPA 70-2023 [Definition: Array.] | |
| Public Input No. 3837-NFPA 70-2023 [Section No. 690.47(B)] | |

## Submitter Information Verification

**Submitter Full Name:** Jason Fisher
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**Submittal Date:** Tue Sep 05 18:17:41 EDT 2023
**Committee:** NEC-P04

# Public Input No. 247-NFPA 70-2023 [ New Section after 690.43(D) ]

**690.43(D) W ire Type Equipment Grounding Conductor**

Where equipment is installed outdoors on a roof, an equipment grounding conductor of the wire type shall be installed in outdoor portions of metallic raceway systems that use compression-type fittings.

## Statement of Problem and Substantiation for Public Input

This is the same text from 440.9. See the NFPA 70 Handbook for 440.9 commentary text relating to justification.

The same justification that applies to 440.9 is relevant to solar rooftop installations using EMT. The solar industry uses lots of EMT compression-type fittings on roof and solar maintenance electricians are enouncing the same problem identified in 440.9, namely that effective ground fault path may be compromised in service.

Thank you for your service.

## Submitter Information Verification


| | |
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| **Submittal Date:** | Sun Jan 29 22:11:27 EST 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 3919-NFPA 70-2023 [ 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 equipment grounding conductors shall comply with one of the following 690.43(E)(1) through 690.43(E)(3)

(1) Flexible cords and flexible cables 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.

(2) Flexible braided equipment grounding conductors and identified as suitable for the application

(3) 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 690.43(E)** .

Table 690.43(E) Minimum PV Wire Strands

| PV Wire AWG | Minimum Strands |
|---|---|
| 14–10 | 19 |
| 8–4 | 49 |
| 2 | 130 |
| 1 AWG–1000 MCM | 259 |

### Statement of Problem and Substantiation for Public Input

The requirement for flexible conductors to connect with movable PV arrays is covered in 690.31(C)(4) but there has not been a corresponding requirement for equipment grounding conductors to be flexible, and I have seen single conductor #6 being used. This proposal would add that requirement for EGCs and make the NEC more consistent on the subject of conductors connected to movable PV arrays.

### Submitter Information Verification

**Submitter Full Name:** Marvin Hamon
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**Submittal Date:** Wed Sep 06 10:29:58 EDT 2023
**Committee:** NEC-P04

## Public Input No. 3247-NFPA 70-2023 [ 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) .~~

~~PV array equipment grounding conductors shall be connected to a grounding electrode system in accordance with Part VII of Article 250. This connection shall be in addition to any other equipment grounding conductor requirements in 690.43(C) . The PV array equipment grounding conductors shall be sized in accordance with 690.45 .~~

~~Interconnected with Other Power Production Systems. PV systems that are interconnected with other electric power production sources as permitted by 705.11, shall be grounded in accoradnce with 705.11(E).~~

~~(B) Stand-Alone Systems. Stand-alone systems shall be grounded in accordance with 710.15~~

(C) Grounding Configurations. 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~~ D )** Auxiliary 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~~ Auxiliary grounding electrode(s) meeting the requirements of 250. ~~52. PV arrays mounted to buildings~~ 54 shall be permitted ~~to use the metal structural frame of the building if the requirements of 250.68(C)(2) are met.~~ for PV systems.

### Statement of Problem and Substantiation for Public Input

The new text “(A) Interconnected with Other Power Production Systems” is necessary to make it clear that PV systems that are interconnected with other electric power production sources as permitted by 705.11, must be bonding and grounding in accordance with 705.11(E).
Next text for (B) is to coordinate with another PI submitted for 710.15.

Delete the rules about a grounding electrode system since these are already addressed in other sections of the NEC.
The revision to (C) is permit the use of an Auxiliary Electrode, and all of the other text needs to be deleted.

## Submitter Information Verification


**Submitter Full Name:** Mike Holt

**Organization:** Mike Holt Enterprises Inc

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**Submittal Date:** Wed Aug 30 17:22:41 EDT 2023

**Committee:** NEC-P04

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

**(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).

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 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.

### Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document. The text is revised to to comply with the NEC Style Manual Section 4.1.4, regarding the use of Parts.
4.1.4 References to an Entire Article. References shall not be made to an entire article, except for the Article 100 or where referenced to provide the necessary context. References to specific parts within articles shall be permitted. References to all parts of an article shall not be permitted. The article number shall precede the part number.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

### Submitter Information Verification

**Submitter Full Name:** David Williams
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**City:**
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**Submittal Date:** Mon Aug 28 12:18:26 EDT 2023
**Committee:** NEC-P04

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

**(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)~~ ~~.~~ Part III of Article 250.

PV array equipment grounding conductors shall be connected to a grounding electrode system in accordance with Part VII of Article 250. This connection shall be in addition to any other equipment grounding conductor requirements in 690.43(C). 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.

## Statement of Problem and Substantiation for Public Input

When the proposed changes to 690.47(B) were rejected in the 2023 NEC code cycle, it was proposed that the language be reverted to the 2020 NEC. When this was done, the change in 690.47(A), that was changed for the proposed revision, was not reverted to the 2020 NEC language in the first sentence. This PI simply reverts the reference 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.
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The Solar and Storage Industry Forum (SSIF) is a coalition of individuals and organizations convened by the Solar Energy Industry Association (SEIA) to organize, support, and mentor renewable energy industry professionals in codes and standards development. Our objective is to submit industry consensus-based recommendations for changes to the National Electrical Code. We believe that this effort improves the Code-making process by consolidating multiple industry member's points of view into fewer, common proposals.
SSIF members are dedicated to continually improving the installation safety of PV and storage systems in the U.S. A list of members can be found here:
https://www.seia.org/industry-forum

## Submitter Information Verification

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| **Zip:** | |
| **Submittal Date:** | Wed Sep 06 19:11:37 EDT 2023 |
| **Committee:** | NEC-P04 |

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

~~**(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.~~

## Statement of Problem and Substantiation for Public Input

Per 90.3 all parts of article 250 already apply to article 690, this subsection should be deleted as it is not modifying the requirements in article 250, nor is it adding additional requirements.

## Submitter Information Verification

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**Submittal Date:** Fri Sep 01 19:15:51 EDT 2023
**Committee:** NEC-P04

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

**(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), mounting system, 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.

## Statement of Problem and Substantiation for Public Input

Allowing an GEC to connect to an array mounting system in addition to a PV module frame only makes sense.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 3834-NFPA 70-2023 [Definition: Array.] | |
| Public Input No. 3836-NFPA 70-2023 [Section No. 690.43(B)] | |
| Public Input No. 3834-NFPA 70-2023 [Definition: Array.] | |
| Public Input No. 3836-NFPA 70-2023 [Section No. 690.43(B)] | |

## Submitter Information Verification


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**Zip:**

**Submittal Date:** Tue Sep 05 18:23:13 EDT 2023
**Committee:** NEC-P04

## Public Input No. 2930-NFPA 70-2023 [ 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~~ .

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document. The text is revised to to comply with the NEC Style Manual Section 4.1.4, regarding the use of Parts.
4.1.4 References to an Entire Article. References shall not be made to an entire article, except for the Article 100 or where referenced to provide the necessary context. References to specific parts within articles shall be permitted. References to all parts of an article shall not be permitted. The article number shall precede the part number.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | David Williams |
| **Organization:** | Delta Charter Township |
| **Street Address:** | |
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| **State:** | |
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| **Submittal Date:** | Mon Aug 28 12:19:26 EDT 2023 |
| **Committee:** | NEC-P04 |

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

**691.2 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 691.2(1) or (2) are not available, by engineering review validating that the electrical equipment is evaluated and tested to relevant standards or industry practice**

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document when general listing requirements are covered within an article. The NEC Style Manual Section 2.2.1 Parallel Numbering Required, states that technical committees shall use the following section numbers for the same purposes within articles. The listing requirements are to be located in the .2 section.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 2811-NFPA 70-2023 [Section No. 691.5] | Deleted and relocated to the .2 section. |
| Public Input No. 2811-NFPA 70-2023 [Section No. 691.5] | |

## Submitter Information Verification


| | |
|---|---|
| **Submitter Full Name:** | Dean Hunter |
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| **City:** | |
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| **Submittal Date:** | Fri Aug 25 13:42:12 EDT 2023 |
| **Committee:** | NEC-P04 |

# Public Input No. 4264-NFPA 70-2023 [ 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.**

## Statement of Problem and Substantiation for Public Input

NEC Staff may already be making the change to the IEEE 2023 National Electrical Safety Code from the 2017 revision throughout the current NEC edition.

## Submitter Information Verification

**Submitter Full Name:** Michael Anthony
**Organization:** Standards Michigan LLC
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**Submittal Date:** Thu Sep 07 08:54:37 EDT 2023
**Committee:** NEC-P04

## Public Input No. 1818-NFPA 70-2023 [ Section No. 691.4 ]

**691.4** Special Requirements for Large-Scale PV Electric Supply Stations.

Large-scale PV electric supply stations shall be accessible only to authorized personnel and comply with the following:

(1) ~~Electrical circuits and equipment shall be maintained and operated~~ The construction, installation, testing, operation and maintenance of equipment, associated wiring and interconnections shall be performed only by qualified persons.

Informational Note No. 1: See NFPA *70E*-2021, *Standard for Electrical Safety in the Workplace*, for electrical safety requirements.

(2) Access to PV electric supply stations shall be restricted in accordance with 110.31. Field-applied hazard markings shall be applied in accordance with 110.21(B).

(3) The connection between the PV electric supply station and the system operated by a utility for the transfer of electrical energy shall be through medium- or high-voltage switch gear, substation, switch yard, or similar methods whose sole purpose shall be to interconnect the two systems.

(4) The electrical loads within the PV electric supply station shall only be used to power auxiliary equipment for the generation of the PV power.

(5) Large-scale PV electric supply stations shall not be installed on buildings.

(6) The station shall be monitored from a central command center.

(7) The station shall have an inverter generating capacity of at least 5000 kW.

Informational Note No. 2: Some individual sites with capacities less than 5000 kW are operated as part of a group of facilities with a total generating capacity exceeding 5000 kW.

### Statement of Problem and Substantiation for Public Input

I agree with keeping the requirements of qualified persons in 691.4 (1) do to the unique hazards presented by these technologies. However, the language should be uniform amongst all articles in emerging technologies. The use and requirement of "qualified persons" is inconsistent from article to article, resulting in the responsibility of the qualified person differing from system to system. Throughout the country, sections and portions of each system are NOT being performed by qualified persons and the argument for those performing the work is based on the language or lack there of total inclusion of all "parts" of the system. Installation by definition is the act of installing and can be broken down into individual components, while construction is the act of constructing a total structure.
This revision will more align with the article 100 definition as referenced and will promote a uniform application of documents as mandated per the style manual, while promoting a more standard formal interpretation of what portion of the work shall be performed by a qualified person.
This change will also conform this language to NFPA 70E and NFPA 70B as referenced throughout this document.

### Related Public Inputs for This Document

| Related Input | Relationship |
| --- | --- |
| Public Input No. 1817-NFPA 70-2023 [Section No. 690.4(C)] | |
| Public Input No. 1819-NFPA 70-2023 [Section No. 692.4(C)] | |

Public Input No. 1820-NFPA 70-2023 [Section No. 694.7 [Excluding any Sub-Sections]]

Public Input No. 1821-NFPA 70-2023 [New Part after II.]

## Submitter Information Verification


| | |
|---|---|
| **Submitter Full Name:** | George Mostardini |
| **Organization:** | IBEW Local 134 |
| **Street Address:** | |
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| **State:** | |
| **Zip:** | |
| **Submittal Date:** | Sat Aug 05 13:40:59 EDT 2023 |
| **Committee:** | NEC-P04 |

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

~~**691.5** Equipment.~~

~~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(1) or (2) are not available, by engineering review validating that the electrical equipment is evaluated and tested to relevant standards or industry practice~~

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document when general listing requirements are covered within an article. The NEC Style Manual Section 2.2.1 Parallel Numbering Required, states that technical committees shall use the following section numbers for the same purposes within articles. The listing requirements are to be located in the .2 section.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 2812-NFPA 70-2023 [New Section after 691.1] | Deleted and relocated to the .2 section. |
| Public Input No. 2812-NFPA 70-2023 [New Section after 691.1] | |

## Submitter Information Verification


**Submitter Full Name:** Dean Hunter

**Organization:** Minnesota Department of Labor

**Street Address:**

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**Submittal Date:** Fri Aug 25 13:41:14 EDT 2023

**Committee:** NEC-P04

# Public Input No. 1248-NFPA 70-2023 [ New Section after 691.11 ]

**TITLE OF NEW CONTENT**

Type your content here ...

691.12. Cybersecurity

Large-Scale Photovoltaic (PV) Electric Supply Stations that are connected to a communication network and have the capability to be controlled or permit control of any portion of the premises shall comply with either of the following:

(1) The ability to control the system is limited to a direct connection through a local nonnetworked interface.

(2) The Large-Scale Photovoltaic (PV) Electric Supply Station is connected through a networked interface complying with both of the following methods:

a. The Large-Scale Photovoltaic (PV) Electric Supply Station and associated software are identified as being evaluated for cybersecurity.

b. A cybersecurity assessment is conducted on the connected system to determine vulnerabilities to cyber attacks.

The cybersecurity assessment shall be conducted when the system configuration changes and at not more than 5-year intervals.

Documentation of the evaluation, assessment, identification, and certification shall be made available to those authorized to inspect, operate, and maintain the system.

Informational Note No. 1: See ANSI/ISA 62443, Cybersecurity Standards series; UL 2900, Cybersecurity Standards series; and the NIST Framework for Improving Critical Infrastructure Cybersecurity, Version 1.1, for assessment guidelines.

Informational Note No. 2: Examples of the commissioning certification used to demonstrate the system has been investigated for cybersecurity vulnerabilities could be one of the following:

(1) The ISA Security Compliance Institute (ISCI) conformity assessment program

(2) Certification of compliance by a nationally recognized test laboratory

## Statement of Problem and Substantiation for Public Input

Most of the cybersecurity focus has been on IT systems. There has been very little public discussion about cybersecurity for Operational Technology (OT), but cyber attacks on OT, by both domestic and foreign actors, occur on almost a daily basis. Hackers can easily destroy unprotected equipment and shut down entire unprotected facilities. Our adversaries such as Russia, China, North Korea, and Iran, are continuously mounting cyber attacks. They understand their limits and, so far, prohibit catastrophic attacks on our financial/banking system and electrical grid. In the mean time, they attack our infrastructure, such as the southeast gas pipeline. We have the ability, and obligation, to prevent this type of damage to our infrastructure from malicious cyber attacks. This Public Input is based upon 240.6(D) and 708.7 in the 2023 NEC. Pay particular attention to the word "identified" in (2) a. "Identified" as applied to equipment, is defined in Article 100 as "Recognizable as suitable for the specific purpose, function, use, environment, application, and so forth, where described in a particular Code requirement. Informational Note: Some examples of ways to determine suitability of equipment for a specific purpose, environment, or application include investigations by a qualified testing

laboratory (listing and labeling), an inspection agency, or other organization concerned with product evaluation." This Public Input simply requires that a Large-Scale Photovoltaic (PV) Electric Supply Station either not be connected to the internet, or if it is connected to the internet, that it be identified for cybersecurity and that an assessment is provided.

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Vincent Saporita |
| **Organization:** | Saporita Consulting |
| **Street Address:** | |
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| **Submittal Date:** | Fri Jun 30 14:10:31 EDT 2023 |
| **Committee:** | NEC-P04 |

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

**691.11** ~~Fence~~ Bonding and Grounding.

(A) Grounding Electrode System

PV Systems that do not comply with the requirements of 690.47 shall include details of the grounding electrode system 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.

## Statement of Problem and Substantiation for Public Input

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.

The requirements of 690.47 are both too simplistic and too prescriptive to insure the safety of these large-scale PV plant grounding systems. For example, the allowance in 690.47(B) that 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 does not acknowledge the fact that many thousands of metal pilings are installed at these large-scale sites which do not typically meet the precise requirements of any of the (8) permitted electrodes. Whether and how these pilings must be bonded together or to the rest of the racking structure is not sufficiently addressed by the NEC because of the lack of clarity on whether these pilings are considered grounding electrodes. However, the answer to this question is nearly irrelevant, because the engineered grounding network system design will provide the clarity needed to install a system safe from both personnel and equipment grounding hazards.

This proposal is intended to clarify that grounding systems for large-scale PV electric supply stations will be site-specific engineered designs which may or may not align completely with Article 690 and Article 250 terminology and requirements.

## Submitter Information Verification

**Submitter Full Name:** Rebekah Hren
**Organization:** IPPNC LLC
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| **Zip:** | |
| **Submittal Date:** | Wed Sep 06 12:08:49 EDT 2023 |
| **Committee:** | NEC-P04 |

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

**692.2 Listing Requirements.**

**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**

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document when general listing requirements are covered within an article. The NEC Style Manual Section 2.2.1 Parallel Numbering Required, states that technical committees shall use the following section numbers for the same purposes within articles. The listing requirements are to be located in the .2 section.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 2814-NFPA 70-2023 [Section No. 692.6] | Deleted and relocated to the .2 section. |
| Public Input No. 2814-NFPA 70-2023 [Section No. 692.6] | |

## Submitter Information Verification

**Submitter Full Name:** Dean Hunter
**Organization:** Minnesota Department of Labor
**Street Address:**
**City:**
**State:**
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**Submittal Date:** Fri Aug 25 13:46:45 EDT 2023
**Committee:** NEC-P04

# Public Input No. 634-NFPA 70-2023 [ New Section after 692.1 ]

**692.2 Reconditioned Equipment**

Fuel Cell systems shall not be reconditioned.

## Statement of Problem and Substantiation for Public Input

These items are not permitted to be reconditioned per the NEMA Technical Position on Reconditioned Equipment (NEMA CS 100-2020, Appendix B.1)

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 628-NFPA 70-2023 [New Section after 630.1] | Reconditioned Equipment |
| Public Input No. 629-NFPA 70-2023 [New Section after 455.1] | Reconditioned Equipment |
| Public Input No. 630-NFPA 70-2023 [New Section after 460.1] | Reconditioned Equipment |
| Public Input No. 631-NFPA 70-2023 [New Section after 450.14] | Reconditioned Equipment |
| Public Input No. 632-NFPA 70-2023 [New Section after 625.1] | Reconditioned Equipment |
| Public Input No. 633-NFPA 70-2023 [New Section after 706.1] | Reconditioned Equipment |

## Submitter Information Verification

**Submitter Full Name:** Russ Leblanc
**Organization:** Leblanc Consulting Services
**Street Address:**
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**Submittal Date:** Sun Apr 16 09:48:32 EDT 2023
**Committee:** NEC-P04

## Public Input No. 1819-NFPA 70-2023 [ Section No. 692.4(C) ]

**(C)** System Installation.

The construction ~~and operation of equipment~~ , installation, testing, operation and maintenance of equipment , associated wiring, and interconnections shall be performed only by qualified persons.

Informational Note: See Article 100 for the definition of *qualified person*.

## Statement of Problem and Substantiation for Public Input

I agree with keeping the requirements of qualified persons in 692.4 (C) do to the unique hazards presented by these technologies. However, the language should be uniform amongst all articles in emerging technologies. The use and requirement of "qualified persons" is inconsistent from article to article, resulting in the responsibility of the qualified person differing from system to system.
Throughout the country, sections and portions of each system are NOT being performed by qualified persons and the argument for those performing the work is based on the language or lack there of total inclusion of all "parts" of the system. Installation by definition is the act of installing and can be broken down into individual components, while construction is the act of constructing a total structure.
This revision will more align with the article 100 definition as referenced and will promote a uniform application of documents as mandated per the style manual, while promoting a more standard formal interpretation of what portion of the work shall be performed by a qualified person.
This change will also conform this language to NFPA 70E and NFPA 70B as referenced throughout this document.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 1817-NFPA 70-2023 [Section No. 690.4(C)] | |
| Public Input No. 1818-NFPA 70-2023 [Section No. 691.4] | |
| Public Input No. 1820-NFPA 70-2023 [Section No. 694.7 [Excluding any Sub-Sections]] | |
| Public Input No. 1821-NFPA 70-2023 [New Part after II.] | |

## Submitter Information Verification


**Submitter Full Name:** George Mostardini
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**City:**
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**Submittal Date:** Sat Aug 05 13:45:20 EDT 2023
**Committee:** NEC-P04

## Public Input No. 1249-NFPA 70-2023 [ New Section after 692.6 ]

**TITLE OF NEW CONTENT**

Type your content here ...

692.7. Cybersecurity

Fuel Cell Systems that are connected to a communication network and have the capability to be controlled or permit control of any portion of the premises shall comply with either of the following:

(1) The ability to control the system is limited to a direct connection through a local nonnetworked interface.

(2) The Fuel Cell System is connected through a networked interface complying with both of the following methods:

a. The Fuel Cell System and associated software are identified as being evaluated for cybersecurity.

b. A cybersecurity assessment is conducted on the connected system to determine vulnerabilities to cyber attacks.

The cybersecurity assessment shall be conducted when the system configuration changes and at not more than 5-year intervals.

Documentation of the evaluation, assessment, identification, and certification shall be made available to those authorized to inspect, operate, and maintain the system.

Informational Note No. 1: See ANSI/ISA 62443, Cybersecurity Standards series; UL 2900, Cybersecurity Standards series; and the NIST Framework for Improving Critical Infrastructure Cybersecurity, Version 1.1, for assessment guidelines.

Informational Note No. 2: Examples of the commissioning certification used to demonstrate the system has been investigated for cybersecurity vulnerabilities could be one of the following:

(1) The ISA Security Compliance Institute (ISCI) conformity assessment program

(2) Certification of compliance by a nationally recognized test laboratory

## Statement of Problem and Substantiation for Public Input

Most of the cybersecurity focus has been on IT systems. There has been very little public discussion about cybersecurity for Operational Technology (OT), but cyber attacks on OT, by both domestic and foreign actors, occur on almost a daily basis. Hackers can easily destroy unprotected equipment and shut down entire unprotected facilities. Our adversaries such as Russia, China, North Korea, and Iran, are continuously mounting cyber attacks. They understand their limits and, so far, prohibit catastrophic attacks on our financial/banking system and electrical grid. In the mean time, they attack our infrastructure, such as the southeast gas pipeline. We have the ability, and obligation, to prevent this type of damage to our infrastructure from malicious cyber attacks. This Public Input is based upon 240.6(D) and 708.7 in the 2023 NEC. Pay particular attention to the word "identified" in (2) a. "Identified" as applied to equipment, is defined in Article 100 as "Recognizable as suitable for the specific purpose, function, use, environment, application, and so forth, where described in a particular Code requirement. Informational Note: Some examples of ways to determine suitability of equipment for a specific purpose, environment, or application include investigations by a qualified testing

laboratory (listing and labeling), an inspection agency, or other organization concerned with product evaluation." This Public Input simply requires that a Fuel Cell System either not be connected to the internet, or if it is connected to the internet, that it be identified for cybersecurity and that an assessment is provided.

## Submitter Information Verification


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| **Submitter Full Name:** | Vincent Saporita |
| **Organization:** | Saporita Consulting |
| **Street Address:** | |
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| **Zip:** | |
| **Submittal Date:** | Fri Jun 30 14:27:00 EDT 2023 |
| **Committee:** | NEC-P04 |

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

~~**692.6** 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~~

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document when general listing requirements are covered within an article. The NEC Style Manual Section 2.2.1 Parallel Numbering Required, states that technical committees shall use the following section numbers for the same purposes within articles. The listing requirements are to be located in the .2 section.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 2813-NFPA 70-2023 [New Section after 692.1] | Deleted and relocated to the .2 section. |
| Public Input No. 2813-NFPA 70-2023 [New Section after 692.1] | |

## Submitter Information Verification

**Submitter Full Name:** Dean Hunter
**Organization:** Minnesota Department of Labor
**Street Address:**
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**Submittal Date:** Fri Aug 25 13:48:37 EDT 2023
**Committee:** NEC-P04

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

**692.6** Listing ~~Requirement~~ .

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

- ~~Be listed for the application~~

~~Be evaluated for the application and have a field label applied~~ systems shall be listed or field labeled

## Statement of Problem and Substantiation for Public Input

This simple requirement is found in multiple articles of the NEC, none of which make it this difficult.

## Submitter Information Verification


**Submitter Full Name:** Ryan Jackson
**Organization:** Self-employed
**Street Address:**
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**Submittal Date:** Mon Apr 10 13:02:27 EDT 2023
**Committee:** NEC-P04

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

**692.13** ~~All Conductors~~ 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 Article 705.20.

## Statement of Problem and Substantiation for Public Input

This PI accompanies PI 4469 and attempts to solidify 705.20 as the go to reference point for the individual power source articles, including 480, 445, 690, 692, and 694. Progress on disconnecting means requirements is made incrementally and inconsistently among the various articles, and that inconsistency shows itself especially as there are growing trends of multiple power sources being used on the same premises. It is hoped that this approach will allow the other articles to reduce duplicative content and focus only on salient requirement differences.

This proposal replaces the existing text in 692.13 with a pointer to 705.20. An accompanying proposal deletes 692.17 as 705.20 covers that as well. It is hoped that if the proposal has merit it could help instigate a correlating task group to identify changes in the other articles

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 4469-NFPA 70-2023 [Section No. 705.20] | Proposed language references new proposed 705.20 |
| Public Input No. 4528-NFPA 70-2023 [Section No. 692.17] | |

## Submitter Information Verification


**Submitter Full Name:** Greg Ball
**Organization:** Tesla
**Street Address:**
**City:**
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**Submittal Date:** Thu Sep 07 16:30:00 EDT 2023
**Committee:** NEC-P04

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

~~**692.17** Switch or Circuit Breaker.~~

~~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) .~~

## Statement of Problem and Substantiation for Public Input

This PI accompanies PI 4469 and PI 4494 and attempts to solidify 705.20 as the go to reference point for the individual power source articles, including 480, 445, 690, 692, and 694. Progress on disconnecting means requirements is made incrementally and inconsistently among the various articles, and that inconsistency shows itself especially as there are growing trends of multiple power sources being used on the same premises. It is hoped that this approach will allow the other articles to reduce duplicative content and focus only on salient requirement differences.

This proposal deletes 692.17 entirely as the pointer to 705.20 in 692.13 (PI 4494) covers the requirements of both 692.13 and 692.17.

## Related Public Inputs for This Document

| Related Input | Relationship |
| --- | --- |
| Public Input No. 4469-NFPA 70-2023 [Section No. 705.20] | References proposed new 705.20 |
| Public Input No. 4494-NFPA 70-2023 [Section No. 692.13] | Relies on proposed change to 692.13 |

## Submitter Information Verification


**Submitter Full Name:** Greg Ball

**Organization:** Tesla

**Street Address:**

**City:**

**State:**

**Zip:**


**Submittal Date:** Thu Sep 07 17:06:24 EDT 2023

**Committee:** NEC-P04

# Public Input No. 2931-NFPA 70-2023 [ 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~~ .

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document. The text is revised to to comply with the NEC Style Manual Section 4.1.4, regarding the use of Parts.
4.1.4 References to an Entire Article. References shall not be made to an entire article, except for the Article 100 or where referenced to provide the necessary context. References to specific parts within articles shall be permitted. References to all parts of an article shall not be permitted. The article number shall precede the part number.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Submitter Information Verification

**Submitter Full Name:** David Williams
**Organization:** Delta Charter Township
**Street Address:**
**City:**
**State:**
**Zip:**
**Submittal Date:** Mon Aug 28 12:20:14 EDT 2023
**Committee:** NEC-P04

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

**Sections 692.60, 692.61**

~~**692.60** Connection to Other Systems.~~

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

~~**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.~~

### Statement of Problem and Substantiation for Public Input

Section 692.60 is unnecessary since it does not modify requirements in Article 705. It is therefore a redundant requirement. The 2023 NEC Style Manual section 4.1.1 states that the use of redundant references shall be avoided.

Section 692.61 uses jargon terms and lacks sufficient clarity to ensure the uniform application of this section. Its presence also raises questions as to if this language modifies or overrides requirements in other articles including 700, 701, 702, and 705, though none of those are mentioned. This section is no longer needed since the requirements applying to the connection of these systems to other premises or service wiring is governed by the other articles in this Code, depending on application.

### Submitter Information Verification


| | |
|---|---|
| **Submitter Full Name:** | Larry Sherwood |
| **Organization:** | Sustainable Energy Action Comm |
| **Street Address:** | |
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| **Submittal Date:** | Mon Aug 28 16:50:07 EDT 2023 |
| **Committee:** | NEC-P04 |

# Public Input No. 1250-NFPA 70-2023 [ New Section after 694.1 ]

**TITLE OF NEW CONTENT**

Type your content here ...

694.5. Cybersecurity

Wind Electric Systems that are connected to a communication network and have the capability to be controlled or permit control of any portion of the premises shall comply with either of the following:

(1) The ability to control the system is limited to a direct connection through a local nonnetworked interface.

(2) The Wind Electric System is connected through a networked interface complying with both of the following methods:

a. The Wind Electric System and associated software are identified as being evaluated for cybersecurity.

b. A cybersecurity assessment is conducted on the connected system to determine vulnerabilities to cyber attacks.

The cybersecurity assessment shall be conducted when the system configuration changes and at not more than 5-year intervals.

Documentation of the evaluation, assessment, identification, and certification shall be made available to those authorized to inspect, operate, and maintain the system.

Informational Note No. 1: See ANSI/ISA 62443, Cybersecurity Standards series; UL 2900, Cybersecurity Standards series; and the NIST Framework for Improving Critical Infrastructure Cybersecurity, Version 1.1, for assessment guidelines.

Informational Note No. 2: Examples of the commissioning certification used to demonstrate the system has been investigated for cybersecurity vulnerabilities could be one of the following:

(1) The ISA Security Compliance Institute (ISCI) conformity assessment program

(2) Certification of compliance by a nationally recognized test laboratory

## Statement of Problem and Substantiation for Public Input

Most of the cybersecurity focus has been on IT systems. There has been very little public discussion about cybersecurity for Operational Technology (OT), but cyber attacks on OT, by both domestic and foreign actors, occur on almost a daily basis. Hackers can easily destroy unprotected equipment and shut down entire unprotected facilities. Our adversaries such as Russia, China, North Korea, and Iran, are continuously mounting cyber attacks. They understand their limits and, so far, prohibit catastrophic attacks on our financial/banking system and electrical grid. In the mean time, they attack our infrastructure, such as the southeast gas pipeline. We have the ability, and obligation, to prevent this type of damage to our infrastructure from malicious cyber attacks. This Public Input is based upon 240.6(D) and 708.7 in the 2023 NEC. Pay particular attention to the word "identified" in (2) a. "Identified" as applied to equipment, is defined in Article 100 as "Recognizable as suitable for the specific purpose, function, use, environment, application, and so forth, where described in a particular Code requirement. Informational Note: Some examples of ways to determine suitability of equipment for a specific purpose, environment, or application include investigations by a qualified testing

laboratory (listing and labeling), an inspection agency, or other organization concerned with product evaluation." This Public Input simply requires that a Wind Electric System either not be connected to the internet, or if it is connected to the internet, that it be identified for cybersecurity and that an assessment is provided.

## Submitter Information Verification


| | |
|---|---|
| **Submitter Full Name:** | Vincent Saporita |
| **Organization:** | Saporita Consulting |
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| **Submittal Date:** | Fri Jun 30 14:34:47 EDT 2023 |
| **Committee:** | NEC-P04 |

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

**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, *Standard for Wind Turbines Permitting Entry of Personnel*, and UL 6142, *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.**

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document when general listing requirements are covered within an article. The NEC Style Manual Section 2.2.1 Parallel Numbering Required, states that technical committees shall use the following section numbers for the same purposes within articles. The listing requirements are to be located in the .2 section.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 2815-NFPA 70-2023 [Section No. 694.7] | Deleted and relocated to the .2 section. |
| Public Input No. 2815-NFPA 70-2023 [Section No. 694.7] | |

## Submitter Information Verification


**Submitter Full Name:** Dean Hunter

**Organization:** Minnesota Department of Labor

**Street Address:**

**City:**

**State:**

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**Submittal Date:** Fri Aug 25 13:54:00 EDT 2023

**Committee:** NEC-P04

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

**694.7** Construction and Maintenance.

The construction and maintenance, associated wiring, and interconnections shall be performed only by qualified persons.

Informational Note: See Article 100 for the definition of *qualified person*.

**(A)** Wind Electric Systems.

A wind electric system(s) shall be permitted to supply a building or other structure in addition to other sources of supply. These requirements apply to both onshore and offshore installations.

~~(C)~~

**(B)**

~~Equipment.~~

~~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, *Standard for Wind Turbines Permitting Entry of Personnel*, and UL 6142, *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.~~

~~**Diversion Load Controllers.**~~

~~A wind electric system employing a diversion load controller as the primary means of regulating the speed of a wind turbine rotor shall be equipped with an additional, independent, reliable means to prevent over-speed operation. An interconnected utility service shall not be considered to be a reliable diversion load.~~

~~(~~

~~D~~

~~C )~~ ~~Overvoltage 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 .~~

~~(~~

~~E~~

~~D )~~ ~~Receptacles.~~

~~A receptacle shall be permitted to be supplied by a wind electric system branch or feeder circuit for maintenance or data acquisition use. Receptacles shall be protected with an overcurrent device with a rating not to exceed the current rating of the receptacle. In addition to the requirements in 210.8 , all 125-volt, single-phase, 15- and 20-ampere receptacles installed for maintenance of the wind turbine shall have ground-fault circuit-interrupter protection for personnel.~~

~~(~~

~~F~~

~~E )~~ ~~Poles or Towers Supporting Wind Turbines Used as a Raceway.~~

~~A pole or tower shall be permitted to be used as a raceway if approved in accordance with one of the following:~~

(1) ~~Be evaluated as part of the listing for the wind turbine~~

(2) ~~Be listed for the application~~

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

~~(~~

~~G~~

~~**F )** 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 nominal.~~

~~Table 694.7(~~

~~G~~

~~**F ) 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~~ | ~~900 mm (3 ft)~~ | ~~1.0 m (3 ft 6 in.)~~ | ~~1.2 m (4 ft)~~ |

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document when general listing requirements are covered within an article. The NEC Style Manual Section 2.2.1 Parallel Numbering Required, states that technical committees shall use the following section numbers for the same purposes within articles. The listing requirements are to be located in the .2 section.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 2816-NFPA 70-2023 [New Section after 694.1] | Deleted and relocated to the .2 section. |
| Public Input No. 2816-NFPA 70-2023 [New Section after 694.1] | |

## Submitter Information Verification

**Submitter Full Name:** Dean Hunter
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**Submittal Date:** Fri Aug 25 13:51:40 EDT 2023
**Committee:** NEC-P04

## Public Input No. 2932-NFPA 70-2023 [ Section No. 694.7(D) ]

**(D)** Overvoltage 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 , Part II .

### Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document. The text is revised to to comply with the NEC Style Manual Section 4.1.4, regarding the use of Parts.
4.1.4 References to an Entire Article. References shall not be made to an entire article, except for the Article 100 or where referenced to provide the necessary context. References to specific parts within articles shall be permitted. References to all parts of an article shall not be permitted. The article number shall precede the part number.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

### Submitter Information Verification


| | |
|---|---|
| **Submitter Full Name:** | David Williams |
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| **Street Address:** | |
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| **Submittal Date:** | Mon Aug 28 12:21:25 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 3416-NFPA 70-2023 [ 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.~~

### Statement of Problem and Substantiation for Public Input

This public input replaces the term “overvoltage” with “surge” to keep this rule consistent with the title of all other sections of the code covering surge protection. This includes but is not limited to sections 215.18, 225.42, 230.67, 409.70, 501.35, 502.35, 620.51(E), 645.18, 695.15, 700.8, and 708.20(D). The last sentence of the rule is deleted as 90.3 already tells the code user that Article 242 applies generally to all installations of SPDs required elsewhere in the code.

### Submitter Information Verification


**Submitter Full Name:** Megan Hayes

**Organization:** NEMA

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**Submittal Date:** Sat Sep 02 18:07:04 EDT 2023

**Committee:** NEC-P04

# Public Input No. 2432-NFPA 70-2023 [ 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) |

## Statement of Problem and Substantiation for Public Input

This Public Input is submitted on behalf of a Correlating Committee Task Group consisting of Robert Osborne (Chair), Paul Barnhart, Lou Grahor, Donny Cook, Scott Higgins, Mike Querry, Roger McDaniel, Dave Burns, Rod Belisle, Kevin Rogers, Tony Ricciuti, Paul Knapp, Paul Sullivan, George Smith, Eric Simmon, Kevin Arnold, Larry Wildermuth, and Kyle Krueger.

The voltage limitation for work spaces should be based on the peak voltage of the system. Peak voltage of a 1000 vac (rms) circuit is 1414 volts. If the overvoltage permitted by electric utilities is taken into consideration, the voltage for a 1000 vac system would be 1,060 volts ac. The corresponding dc voltage is 1,499 volts It is recognized that a nominal range with DC may result in higher values; however, the requirement indicates “nominal”, and is not a limit for accepted overvoltages.

## Submitter Information Verification


**Submitter Full Name:** Robert Osborne
**Organization:** UL Solutions
**Street Address:**
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**Submittal Date:** Thu Aug 17 09:50:10 EDT 2023
**Committee:** NEC-P04

## Public Input No. 1820-NFPA 70-2023 [ Section No. 694.7 [Excluding any Sub-Sections] ]

The construction ~~and maintenance~~ , installation, testing, operation and maintenance of equipment , associated wiring, and interconnections shall be performed only by qualified persons.

Informational Note: See Article 100 for the definition of *qualified person*.

### Statement of Problem and Substantiation for Public Input

I agree with keeping the requirements of qualified persons in 694.7 do to the unique hazards presented by these technologies. However, the language should be uniform amongst all articles in emerging technologies. The use and requirement of "qualified persons" is inconsistent from article to article, resulting in the responsibility of the qualified person differing from system to system. Throughout the country, sections and portions of each system are NOT being performed by qualified persons and the argument for those performing the work is based on the language or lack there of total inclusion of all "parts" of the system. Installation by definition is the act of installing and can be broken down into individual components, while construction is the act of constructing a total structure.
This revision will more align with the article 100 definition as referenced and will promote a uniform application of documents as mandated per the style manual, while promoting a more standard formal interpretation of what portion of the work shall be performed by a qualified person.
This change will also conform this language to NFPA 70E and NFPA 70B as referenced throughout this document.

### Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 1817-NFPA 70-2023 [Section No. 690.4(C)] | |
| Public Input No. 1818-NFPA 70-2023 [Section No. 691.4] | |
| Public Input No. 1819-NFPA 70-2023 [Section No. 692.4(C)] | |
| Public Input No. 1821-NFPA 70-2023 [New Part after II.] | |

### Submitter Information Verification


**Submitter Full Name:** George Mostardini
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**Submittal Date:** Sat Aug 05 13:49:27 EDT 2023
**Committee:** NEC-P04

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

**(B)** ~~Power~~ Transformers.

~~Overcurrent protection for a transformer~~ (1) For the purpose of overcurrent protection, the primary side of transformers 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.~~

connected to the largest source of available fault current.

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

## Statement of Problem and Substantiation for Public Input

The revised text aligns the transformer requirements with Articles 690 & 705.

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Peter Jackson |
| **Organization:** | City Of Bakersfield, Californi |
| **Street Address:** | |
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| **Submittal Date:** | Thu Feb 02 17:26:43 EST 2023 |
| **Committee:** | NEC-P04 |

## 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.~~

~~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 purposes 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)..

### Statement of Problem and Substantiation for Public Input

The revised text aligns the transformer requirements with Articles 690 & 705.

### Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Larry Sherwood |
| **Organization:** | Sustainable Energy Action Comm |
| **Street Address:** | |
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| **Submittal Date:** | Mon Aug 28 16:52:24 EDT 2023 |
| **Committee:** | NEC-P04 |

# Public Input No. 3324-NFPA 70-2023 [ Section No. 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~~ 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 and shall comply with Table 400.4. 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).

## Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the NEC(r) Style Manual prohibits referencing an entire article with the exception of Article 100 or where required for context. In this text, it appears that we should be referring the user to the required constructions found in Table 400.4 instead of referencing the entire article. This is intended to be an editorial fix and not intended to change the overall requirement of the section.

## Submitter Information Verification


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**Submittal Date:** Fri Sep 01 09:06:46 EDT 2023

**Committee:** NEC-P04

# Public Input No. 2933-NFPA 70-2023 [ 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~~ .

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document. The text is revised to to comply with the NEC Style Manual Section 4.1.4, regarding the use of Parts.
4.1.4 References to an Entire Article. References shall not be made to an entire article, except for the Article 100 or where referenced to provide the necessary context. References to specific parts within articles shall be permitted. References to all parts of an article shall not be permitted. The article number shall precede the part number.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Submitter Information Verification


| | |
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| **Submitter Full Name:** | David Williams |
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| **Submittal Date:** | Mon Aug 28 12:22:14 EDT 2023 |
| **Committee:** | NEC-P04 |

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

**705.2 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, *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.**

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document when general listing requirements are covered within an article. The NEC Style Manual Section 2.2.1 Parallel Numbering Required, states that technical committees shall use the following section numbers for the same purposes within articles. The listing requirements are to be located in the .2 section.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 2826-NFPA 70-2023 [Section No. 705.6] | Deleted and relocated to the .2 section. |
| Public Input No. 2826-NFPA 70-2023 [Section No. 705.6] | |

## Submitter Information Verification


| | |
|---|---|
| **Submitter Full Name:** | Dean Hunter |
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| **Street Address:** | |
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| **Zip:** | |
| **Submittal Date:** | Fri Aug 25 14:14:20 EDT 2023 |
| **Committee:** | NEC-P04 |

# Public Input No. 3264-NFPA 70-2023 [ Section No. 705.1 ]

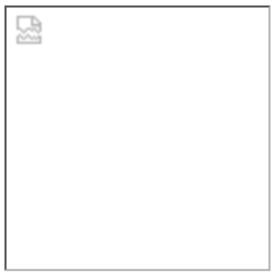
**705.1** Scope.

This article covers installation of one or more electric power production sources operating in parallel with other electric power production sources and/or a primary source(s) of electricity.

Informational Note No. 1: Examples of the types of primary sources include a utility supply or an on-site electric power source(s).

Informational Note No. 2: See Informational Note Figure 705.1.

**Figure Informational Note Figure 705.1 Identification of Power Source Components in Common Configurations**



## Statement of Problem and Substantiation for Public Input

Today the production and storage of electrical energy has gotten very creative. There are installations where a PV system is interconnected with an energy storage system to operate as a microgrid in island mode in accordance with Article 710. This change to the scope make it clear that Article 705 is required to be complied with, even if the interconnected power production sources are not in parallel with to the primary source of power (utility).

## Submitter Information Verification

**Submitter Full Name:** Mike Holt
**Organization:** Mike Holt Enterprises Inc
**Street Address:**
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**Submittal Date:** Wed Aug 30 20:33:40 EDT 2023
**Committee:** NEC-P04

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

~~**705.6** Equipment Approval.~~

~~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, *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.~~

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document when general listing requirements are covered within an article. The NEC Style Manual Section 2.2.1 Parallel Numbering Required, states that technical committees shall use the following section numbers for the same purposes within articles. The listing requirements are to be located in the .2 section.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 2824-NFPA 70-2023 [New Section after 705.1] | Deleted and relocated to the .2 section. |
| Public Input No. 2824-NFPA 70-2023 [New Section after 705.1] | |

## Submitter Information Verification


| | |
|---|---|
| **Submitter Full Name:** | Dean Hunter |
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| **Street Address:** | |
| **City:** | |
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| **Zip:** | |
| **Submittal Date:** | Fri Aug 25 14:15:48 EDT 2023 |
| **Committee:** | NEC-P04 |

# Public Input No. 4400-NFPA 70-2023 [ 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, *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.

Informational Note No. 3: See UL 3001, Standard for Distributed Energy Resource Systems and UL 3010, Standard for Single Site Energy Systems for evaluating microgrid systems. Microgrid systems listed using the requirements in these standards provide voltage and frequency control as required in 705.81.

## Statement of Problem and Substantiation for Public Input

The requirements in 705.6 should be located in 705.2 per the NEC Style Manual 2.2.1. Additionally, the title should be changed to "Listing Requirements."

A new informational note was added due to the development of UL 3001 and UL 3010. Prior to these two standards, there was no identified means to determine whether the voltage and frequency supplied are within the limits compatible with the connected loads (705.81), or what those limits are.

Both standards provide and verify limits equivalent to the safety provided by a typical utility as well as other safety considerations.

## Related Public Inputs for This Document

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

## Submitter Information Verification

**Submitter Full Name:** Jason Hopkins
**Organization:** UL Solutions
**Street Address:**
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**Submittal Date:** Thu Sep 07 14:20:25 EDT 2023
**Committee:** NEC-P04

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

**705.~~11~~** ~~Source~~ 11 Power S ource Connections to a Service.

**(A)** Service Connections.

An electric power production source shall be permitted to be connected to a service by one of the following methods:

(1) To a new service in accordance with 230.2(A)

(2) To the supply side of the service disconnecting means in accordance with 230.82(6)

(3) ~~To an additional set of service entrance conductors in accordance with 230.40 , Exception No. 5~~

~~These connections shall comply with 705.11(B) through (F).~~

~~**(B)**~~ (B) Service Conductors.

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

~~**(F)** Overcurrent Protection.~~

~~The power production source service~~

(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 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 service conductors to which the power production sources are connected shall not be less than that required in 705.11(B).

~~**(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 .~~

(1) Service conductor taps to existing service equipment located within a building shall be protected in accordance with one of the following methods:

(2) With an overcurrent device located within 3 m (10 ft) of conductor length in a dwelling units and 5 m (16.5 ft)in other than dwelling units from the point of connection to the service.

(3) In other than dwelling units, with an overcurrent device located within 20 m (71 ft) of conductor length from the point of connection to the service, provided that cable limiters installed in all ungrounded conductors are located within 5 m (16.5 ft) of conductor length from the point of connection to the service.

**(C)** Overcurrent Protection

(1) The power source output 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 source service disconnecting means shall be used to determine if ground-fault protection of equipment is required~~
705.30.

(2) Ground-fault protection shall be provided in accordance with 230.95 .

## Additional Proposed Changes

| File Name | Description | Approved |
| --- | --- | --- |
| 705.11_ballot_comment.docx | Substantiation | |

## Statement of Problem and Substantiation for Public Input

The revised 2023 text includes broad restatement of existing Chapter 1-4 requirements without modification. All referenced rules are already in effect in accordance with 90.3. General requirements contained in Chapters 1 through 4 shall not be repeated in other articles of the document in accordance with 4.1.1 of the 2020 NEC Style Manual.

The substantiation provided indicated that the redundancy is necessary because users are not aware of the general requirements of Articles 230 and 250, nor the correct use of the NEC in accordance with 90.3. That has not been my experience. Additional services or supply-side connections to existing services are not new nor unique to interconnected systems.

Much of the new or revised text is too broad to be useful, unnecessarily redundant, and a violation of Section 4.1.1 of the 2020 NEC Style Manual:

• 705.11(A)(3) – the referenced exception only exists to facilitate (A)(2) above. This is not another permitted method in addition to (A)(2) as the structure would suggest, but rather, an integral component of the method referenced by (A)(2). See the language of the 230.40 Exception 5.

• 705.11(C)(1) - Unnecessarily redundant language. These requirements are applicable unless modified in accordance with 90.3.

• 705.11(C)(2) – A general requirement of 110.3 that is applicable to all equipment installed under the authority of NFPA-70.

• 705.11(C)(3) – A true but unnecessary statement. The NEC does not cover utility owned equipment. See NEC 90.2(5).

• 705.11(D) – The requirements of and for a service disconnecting means are already referenced through 230.2(A)(5) and 230.82(6).

• 705.11(E) – The reference to "Parts II through V and VIII of Article 250" is too broad to be of any practical use. References to entire Articles are not permitted in accordance with the Style Manual and this reference, though not to the entire Article 250, comes quite close. Article 250 applies unless modified and there are no modifications presented here. Article 230 (Services) does not even contain this language. See Article 230 Informational Note Figure 230.1.

• 705.11(F) - The requirements of and for service conductor overcurrent protection as specified in Article 230 Part VII are already referenced through 230.2(A)(5) and 230.82(6).

• The cable limiter provisions of 705.11 (C) (1) & (2) were eliminated without any discussion by Panel 4.

There has been a tendency recently for panels to repeat Chapter 1-4 requirements when presented with evidence that those rules are not being followed. And after adding the redundant pointers, if the rules are still being violated, then that becomes evidence that even more redundancy is required. The reality is that those who do not know, or desire to follow the NEC requirements, will not do so regardless of additional redundancy. We will never be able to produce code language that enforces itself. Competent enforcement is always required.

Unqualified NEC users are a problem, but not one solved through redundant references to Chapters 1-4. This approach only makes the problem worse and creates the very confusion that the panels are attempting to address. When users see Chapter 1-4 references throughout Chapters 5-7 that indicates to the user that the references are necessary. Training for NEC users is the appropriate solution. The NEC is not intended as an instruction manual for untrained persons (90.1).

## Submitter Information Verification


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**Submittal Date:** Mon Jan 30 16:19:59 EST 2023

**Committee:** NEC-P04

The revised 2023 text includes broad restatement of existing Chapter 1-4 requirements without modification. All referenced rules are already in effect in accordance with 90.3. General requirements contained in Chapters 1 through 4 shall not be repeated in other articles of the document in accordance with 4.1.1 of the 2020 NEC Style Manual.

The substantiation provided indicated that the redundancy is necessary because users are not aware of the general requirements of Articles 230 and 250, nor the correct use of the NEC in accordance with 90.3. That has not been my experience. Additional services or supply-side connections to existing services are not new nor unique to interconnected systems.

Much of the new or revised text is too broad to be useful, unnecessarily redundant, and a violation of Section 4.1.1 of the 2020 NEC Style Manual:

- 705.11(A)(3) – the referenced exception only exists to facilitate (A)(2) above. This is not another permitted method in addition to (A)(2) as the structure would suggest, but rather, an integral component of the method referenced by (A)(2). See the language of the 230.40 Exception 5.

- 705.11(C)(1) - Unnecessarily redundant language. These requirements are applicable unless modified in accordance with 90.3.

- 705.11(C)(2) – A general requirement of 110.3 that is applicable to all equipment installed under the authority of NFPA-70.

- 705.11(C)(3) – A true but unnecessary statement. The NEC does not cover utility owned equipment. See NEC 90.2(5).

- 705.11(D) – The requirements of and for a service disconnecting means are already referenced through 230.2(A)(5) and 230.82(6).

- 705.11(E) – The reference to “Parts II through V and VIII of Article 250” is too broad to be of any practical use. References to entire Articles are not permitted in accordance with the Style Manual and this reference, though not to the entire Article 250, comes quite close. Article 250 applies unless modified and there are no modifications presented here. Article 230 (Services) does not even contain this language. See Article 230 Informational Note Figure 230.1.

- 705.11(F) - The requirements of and for service conductor overcurrent protection as specified in Article 230 Part VII are already referenced through 230.2(A)(5) and 230.82(6).

- The cable limiter provisions of 705.11 (C) (1) & (2) were eliminated without any discussion by Panel 4.

There has been a tendency recently for panels to repeat Chapter 1-4 requirements when presented with evidence that those rules are not being followed. And after adding the redundant pointers, if the rules are still being violated, then that becomes evidence that even more redundancy is required. The reality is that those who do not know, or desire to follow the NEC requirements, will not do so regardless of additional redundancy. We will never be able to produce code language that enforces itself. Competent enforcement is always required.

Unqualified NEC users are a problem, but not one solved through redundant references to Chapters 1-4. This approach only makes the problem worse and creates the very confusion that the panels are attempting to address. When users see Chapter 1-4 references throughout Chapters 5-7 that indicates to the user that the references are necessary. Training for NEC users is the appropriate solution.  The NEC is not intended as an instruction manual for untrained persons (90.1).

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

**(B)** Conductors.

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 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 service conductors ~~to which~~ between the power production sources ~~are connected shall~~ and service shall not be less than that required in 705.11(B).

## Statement of Problem and Substantiation for Public Input

There can be a number of parallel service conductors in the system supplying loads, as allowed in 230.40, that are tapped off of a single main service entrance conductor from the service. These conductors will be sized based on the load and OCPD they serve, not the size of the service. Adding a additional parallel service entrance conductor connected to a power production source will not impact the size of these other service entrance conductors supplying loads. The way (3) is currently written it could be interpreted to require that all parallel service entrance conductors connected to the power production source be sized to the current form the power production source. This is not necessary for a safe installation and would be an unnecessary impedance to adding a power production source.
I modified (3) to target it at the main service entrance conductor that the power production source service entrance conductor would be connected to in order to send current back to the service.

## Submitter Information Verification


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**Submittal Date:** Tue Jan 31 17:24:30 EST 2023

**Committee:** NEC-P04

# Public Input No. 2941-NFPA 70-2023 [ Section No. 705.11(D) ]

**(D)** Service Disconnecting Means.

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

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document. The text is revised to to comply with the NEC Style Manual Section 4.1.4, regarding the use of Parts.
4.1.4 References to an Entire Article. References shall not be made to an entire article, except for the Article 100 or where referenced to provide the necessary context. References to specific parts within articles shall be permitted. References to all parts of an article shall not be permitted. The article number shall precede the part number.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Submitter Information Verification


| | |
|---|---|
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| **Committee:** | NEC-P04 |

## Public Input No. 567-NFPA 70-2023 [ Section No. 705.11(D) ]

**(D)** Service Disconnecting Means.

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

### Statement of Problem and Substantiation for Public Input

It seems that reference to Part V should have been included. My apologies if that was not the intent.

### Submitter Information Verification


| | |
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| **Submittal Date:** | Mon Apr 10 13:42:30 EDT 2023 |
| **Committee:** | NEC-P04 |

# Public Input No. 757-NFPA 70-2023 [ Section No. 705.11(E) ]

**(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.

Informational Note: An additional grounding electrode connection is not required for production equipment bonded to existing service equipment connected to a grounding electrode system in accordance with Article 250.

## Statement of Problem and Substantiation for Public Input

The problem is that confusion continues to exist regarding the recent code changes for supply-side connected equipment. This informational note would help reinforce and clarify those changes.

## Submitter Information Verification

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**Submittal Date:** Mon May 01 09:07:52 EDT 2023
**Committee:** NEC-P04

## Public Input No. 1716-NFPA 70-2023 [ Section No. 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 source service disconnecting means shall be used to determine if ground-fault protection of equipment is required in accordance with 230.95.

<u>Where the power source output circuit conductors make their connection to the service inside a building, they shall be protected with one of the following methods:</u>

<u>(1) With an overcurrent device located within 3 m (10 ft) of conductor length in dwelling units and 5 m (16.5 ft) in other than dwelling units from the point of connection to the service</u>

<u>(2) In other than a dwelling unit, with an overcurrent device located within 20 m (71 ft)of conductor length from the point of connection to the service, provided that cable limiters installed in all ungrounded conductors are located within 5 m (16.5 ft) of conductor length from the point of connection to the service</u>

### Statement of Problem and Substantiation for Public Input

This language was first inserted into the NEC in the 2014 edition and provided guidance to installers and enforcers alike and enhanced the safety of these installations. This language was removed with no technical substantiation for its removal and no documented evidence that the language as it was written was creating problems for installers or enforcers. This language is necessary especially for enforcers when they are inspecting these installations.

### Submitter Information Verification

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**Committee:** NEC-P04

# Public Input No. 1952-NFPA 70-2023 [ Section No. 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, Part VII . 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.

Where the power source output circuit conductors make their connection to the service inside a building, they shall be protected with one of the following methods:

(1) With an overcurrent device located within 3 m (10 ft) of conductor length in dwelling units and 5 m (16.5 ft) in other than dwelling units from the point of connection to the service

(2) In other than a dwelling unit, with an overcurrent device located within 20 m (71 ft)of conductor length from the point of connection to the service, provided that cable limiters installed in all ungrounded conductors are located within 5 m (16.5 ft) of conductor length from the point of connection to the service

## Statement of Problem and Substantiation for Public Input

This language was first inserted into the NEC in the 2014 edition and provided guidance to installers and
enforcers alike and enhanced the safety of these installations. This language was removed with no technical substantiation for its removal and no documented evidence that the language as it was written
was creating problems for installers or enforcers. This language is necessary especially for enforcers when
they are inspecting these installations.

## Submitter Information Verification


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**Submittal Date:** Tue Aug 08 14:01:58 EDT 2023

**Committee:** NEC-P04

# Public Input No. 2517-NFPA 70-2023 [ Section No. 705.12 ]

**705.12** Load-Side Source Connections.

The output of an interconnected electric power source shall be permitted to be connected to the load side of the service disconnecting means of the other source(s) at any distribution equipment on the premises. Where distribution equipment or feeders are fed simultaneously by a primary source of electricity and one or more other power source(s), the feeders or distribution equipment shall comply with relevant sections of 705.12(A) and (B). Currents from power source connections to feeders or busbars shall be based on the maximum circuit currents calculated in 705.28(A). The ampacity of feeders and taps shall comply with 705.12(A), and the ampere ratings of busbars shall comply with 705.12(B).

**(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 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.

**(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.

*Exception to (A)(1), (A)(2)(a), (B)(1), (B)(2), and (B)(4): Where a power source(s) output circuit is protected by an overcurrent device in accordance with 705.30(B) Exception, the rating of the overcurrent device may be used instead of 125 percent of the power source(s) output circuit current.*

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.

## Statement of Problem and Substantiation for Public Input

Every other section in the NEC that utilizes a 125% continuous use factor has an exception for the case of 100% rated overcurrent devices, and Article 705 itself does in 705.30(B). Therefore it is appropriate that 705.12 have such an allowance as well.

As an example, compare 408.36 Exception #1, which allows a panelboard of up to 42 spaces to be protected by two overcurrent devices, with 705.12(B)(1), which also has an allowance to protect a panelboard busbar by two overcurrent devices. 408.36 Exception #1 uses the sum of the two overcurrent device ratings, while 705.12(B)(1) uses the rating of the overcurrent device protecting the busbar plus 125% of the power source(s) output circuit current. For the case of a 100% rated breaker of a rating equal to the power source(s) output circuit current, as allowed by 705.30(B) Exception, this difference in approach makes 705.12(B)(1) more stringent than 408.36 Exception #1. That makes little sense and is surely not the intent.

Lastly, please note that up through the 2011 NEC, this was not an issue, as 705.12 referred to "the ampere ratings of overcurrent devices". The 2014 NEC switch to "125 percent of the power source(s) output circuit current" covered the case of typical (80% rated) breakers well, increasing flexibility when that computation does not necessarily correspond to a standard breaker size, while overlooking the case of 100% rated breakers.

## Submitter Information Verification

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**Committee:** NEC-P04

## Public Input No. 192-NFPA 70-2023 [ 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 greater~~ ampacity 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.

### Statement of Problem and Substantiation for Public Input

705.12(A)(1) does not contain enforceable language (shall be), it simply provides a statement (is).

### Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Ryan Jackson |
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| **City:** | |
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| **Zip:** | |
| **Submittal Date:** | Wed Jan 18 17:20:30 EST 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 3799-NFPA 70-2023 [ 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.

## Statement of Problem and Substantiation for Public Input

Substantiation – The present verbiage is confusing for a compliance requirement. Changing “is” to “shall be” corrects the sentence and is consistent with formatting of mandatory rules as specified in 3.1.1 of the NEC Style Manual.

## Submitter Information Verification


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**Submittal Date:** Tue Sep 05 17:05:28 EDT 2023

**Committee:** NEC-P04

## Public Input No. 4243-NFPA 70-2023 [ 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.

### Statement of Problem and Substantiation for Public Input

Replace "is" with "shall be" to align with the style manual.

### Submitter Information Verification

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**Committee:** NEC-P04

## Public Input No. 2061-NFPA 70-2023 [ Section No. 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, surge protection devices, and any solar related loads of 10 amps of less 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~~

, EXCLUDING THE OVERCURRENT PROTECTION FOR THE MAIN DISCONNECT, SURGE PROTECTION DEVICES, AND LIMITED SOLAR ASSOCIATED LOADS 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.

## Statement of Problem and Substantiation for Public Input

This public input is being submitted on behalf of the Minnesota Department of Labor and Industry. Currently, the Department's inspection staff includes 14-office/field staff, 12-state field inspectors, 2-virtual inspectors and 50 plus contract electrical inspectors that complete over 170,000 electrical inspections annually.

Some solar installations use panelboards as AC combiners. Occasionally, installers have the need to add overcurrent devices for SPDs in these combiner panelboards, and SPDs utilize minimal power. In addition, at these panelboards, there may be a need for minimal power auxiliary loads associated with the solar system. Limited load profiles for associated circuits such as communication systems and the like, do not add significant load. In addition, excluding the overcurrent device protecting the busbar, the overcurrent devices for SPDs and small auxiliary solar-related loads limited to 10 amps will still be a safe installation.

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Dean Hunter |
| **Organization:** | Minnesota Department of Labor |
| **Street Address:** | |
| **City:** | |
| **State:** | |
| **Zip:** | |
| **Submittal Date:** | Fri Aug 11 13:35:32 EDT 2023 |
| **Committee:** | NEC-P04 |

# Public Input No. 3352-NFPA 70-2023 [ Section No. 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.

## Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the NEC(r) Style Manual prohibits referencing an entire article, with the exception of Article 100 or where required for context. Furthermore, Section 90.3 makes it clear that Chapters 1 through 4 apply generally except as modified by Chapters 5 through 7. As such, Article 220 is most certainly enforceable for the load calculations covered by this section without making an unnecessary reference back to the entire article. Alternatively, if the panel would like to specify a specific part (or parts) of Article 220 without specifying all of the parts, that too would be an acceptable alternative.

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Richard Holub |
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| **Street Address:** | |
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| **State:** | |
| **Zip:** | |
| **Submittal Date:** | Fri Sep 01 14:18:40 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 3807-NFPA 70-2023 [ Section No. 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~~

THE SUM OF ALL

~~OVERCURRENT DEVICES~~

LOAD AND SOURCE OVERCURRENT DEVICE RATINGS, 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.

## Statement of Problem and Substantiation for Public Input

Substantiation – The intent of the requirement is detailed in the ROP from the 2014 Edition of the NEC (Reference 4-391, Log #66 NEC-P04), which is copied below. While the CMP accepted this concept and marking, the marking is confusing and does not provide the reader with the same level of detail that is in the requirement. The modified text provides context and clarification and ensures that the reader of the requirement will have the necessary information to maintain compliance with the Code.

ROP from the 2014 Edition of the NEC (Reference 4-391, Log #66 NEC-P04):
705.12(D)(2)(d). The sum of the ampere ratings of all overcurrent devices on panelboards, both load and supply devices, excluding the main supply overcurrent device, shall not exceed the ampacity of the busbar. The ampere rating of the main supply overcurrent device shall not exceed the rating of the busbar. Permanent warning labels shall be applied to distribution equipment with the following or equivalent wording: WARNING THIS EQUIPMENT FED BY MULTIPLE SOURCES TOTAL RATING OF ALL OVERCURRENT DEVICES, EXCLUDINGMAIN SUPPLY OVERCURRENT DEVICE, SHALL NOT EXCEED AMPACITY OF BUSBAR.
This new requirement is based on the simple fact that as long as the sum of the ratings of all OCPD in panelboad, not counting the main breaker, do not exceed the rating of the busbar in the panelboard, then it is not possible to overload the panelboard. This requirement will be used to combine the ac outputs of several utility-interactive inverters in a single panelboard and not have the panelboard rated excessively high due to the general requirement.
If we had a panelboard with six 50 amp breakers from utility-interactive inverters connected to the bus bar and a 300 amp main breaker, 705.12(D)(2)(a) would require the panelboard to be rated at 600 amps (6 x 50 + 300 = 600). If we assume no load breakers, the panel board busbar would be asked to handle no more than 300 amps and that 300 amps should be the rating. If the total of load and supply breakers (excluding the main breaker) does not exceed the panel busbar rating, then there is no positioning of load and PV breakers that can result in overloading the panel. In all cases the main breaker would be rated no higher than the busbar rating.
Another extreme example would be a 400-amp panel with a 400 amp main. 300 amps of load breakers are located near the bottom of the panel and this requirement would limit any installed source breaker to 100 amps. Under full the full load of 300 amps, the busbar between the main breaker and the source breaker would see the 300 amps load current, well within its 400- amp rating. Note that this requirement would primarily apply to new panels used for combining the outputs of PV utility interactive inverters since existing panels are typically loaded (sum of the ratings of load breakers) above the bus bar rating.

## Submitter Information Verification

**Submitter Full Name:** Colleen OBrien
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| | |
|---|---|
| **Submittal Date:** | Tue Sep 05 17:25:47 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 4120-NFPA 70-2023 [ Section No. 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~~ in switchgear, switchboards, and 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.

## Statement of Problem and Substantiation for Public Input

In the context of this requirement, there is electrically no difference between panelboards, switchgear, and switchboards. Thus, the language in 705.12(B)(3) should include Switchgear and Switchboards (larger ampacity sizes). Including switchgear and switchboards will also provide flexibility to owners and designers when implementing interconnected power sources in support of renewable energy alternatives.

## Submitter Information Verification

**Submitter Full Name:** Steve Chutka
**Organization:** Siemens
**Street Address:**
**City:**
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**Submittal Date:** Wed Sep 06 17:09:40 EDT 2023
**Committee:** NEC-P04

# Public Input No. 4212-NFPA 70-2023 [ Section No. 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).

Informational Note: When applying this method to 705.12(B)(3), an overcurrent protective device(s) protecting a power source output circuit(s) that is located on another busbar shall be included in the calculation, as a supply device, as if it was located on the busbar for which the calculation is being made.

(1) 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.

## Statement of Problem and Substantiation for Public Input

When the busbar calculation method using feed-through lugs is utilized with 705.12(B)(3), it makes no difference which end of the feed-through conductors the OCPD is installed. However, 705.12(B)(3) and 705.12(B)(5) do not currently address this common application. An OCPD in a downstream enclosure should be considered the same as an OCPD directly on the busbar for the purposes of this calculation.

Additionally, given the above proposed change, consideration should be given to the wording of the WARNING message under 705.12(B)(3).

## Submitter Information Verification


| | |
|---|---|
| **Submitter Full Name:** | Clint Frederick |
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| **City:** | |
| **State:** | |
| **Zip:** | |
| **Submittal Date:** | Wed Sep 06 22:58:40 EDT 2023 |
| **Committee:** | NEC-P04 |

# Public Input No. 474-NFPA 70-2023 [ Section No. 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.

(7) Where a busbar has only three connections to it, counting the primary power source, each connection shall be protected by an overcurrent device whose rating does exceed the busbar ampere rating. Where the distribution equipment has provisions for a fourth connection, a permanent warning label shall be applied that displays the following or equivalent wording:

WARNING:

EQUIPMENT FED BY MULTIPLE SOURCES. DO NOT MAKE ADDITIONAL CONNECTIONS TO BUSBAR.

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.

## Statement of Problem and Substantiation for Public Input

Under the conditions specified in the proposed text, it is impossible to overload the busbar: By Kirchhoff's Current Law, current in must equal current out. So if two of the three connections are acting as power sources (current in), the other must be acting as the sole load (current out), and the current out is suitably limited by its overcurrent device. While if only one of the connections is acting as a power source, the current in is limited as usual.

Also, please note that the second sentence of 2020 NEC 705.12 began "Where distribution equipment or feeders are fed simultaneously by a primary source of electricity and one or more other power source and are capable of supplying multiple branch circuits or feeders, or both." This wording limits the scope of the rest of 705.12 to equipment capable of at least 4 connections: at least two for the power sources, and at least two for the multiple branch circuits/feeders.

However, in the 2023 NEC and the corresponding sentence in 705.12, the qualifier "and are capable of supplying multiple branch circuits or feeders, or both" was omitted. This removed the exemption for equipment only capable of 3 connections.

Therefore, this proposed addition restores the longstanding allowance for equipment capable of only 3 connections. It also extends the allowance to equipment capable of more than 3 connections, so long as a suitable warning is posted, in accordance with the other items in this section.

## Submitter Information Verification

**Submitter Full Name:** Wayne Whitney

**Organization:** [ Not Specified ]

**Street Address:**

**City:**

**State:**

**Zip:**

**Submittal Date:** Wed Mar 15 15:25:27 EDT 2023

**Committee:** NEC-P04

# Public Input No. 956-NFPA 70-2023 [ Section No. 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 made at ~~either~~ the opposite end of the primary power source connection on 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. 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.

(1) 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).

(2) 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.

## Statement of Problem and Substantiation for Public Input

Editorial changes would provide better clarity for the end user and eliminate possible confusion as to where the power source connection can to be made.  This will alleviate possible busbar "hotspots", as the current text does not specifically mandate the sources be located opposite each other and the permanent warning label would further assure the power source back fed breaker not be relocated inadvertently by those qualified persons in the panel who may not be well versed with the interconnection of electric power production sources.

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Chris Papp |
| **Organization:** | [ Not Specified ] |
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| **City:** | |
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| **Zip:** | |
| **Submittal Date:** | Mon Jun 05 18:36:18 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 2060-NFPA 70-2023 [ Section No. 705.12 [Excluding any Sub-Sections] ]

The output of an interconnected electric power source shall be permitted to be connected to the load side of the service disconnecting means of the other source(s) at any distribution equipment on the premises. Where distribution equipment or feeders are fed simultaneously by a primary source of electricity and one or more other power source(s), the feeders or distribution equipment shall comply with relevant sections of 705.12(A) and (B). Currents from power source connections to feeders, busbars, or ~~busbars shall~~ terminals shall be based on the maximum circuit currents calculated in 705.28(A). The ampacity of feeders and taps shall comply with 705.12(A), and the ampere ratings of busbars shall comply with 705.12(B).

## Statement of Problem and Substantiation for Public Input

This public input is being submitted on behalf of the Minnesota Department of Labor and Industry. Currently, the Department's inspection staff includes 14-office/field staff, 12-state field inspectors, 2-virtual inspectors and 50 plus contract electrical inspectors that complete over 170,000 electrical inspections annually.

It is common to have terminals on the load side of an overcurrent device that are not considered busbars. By including terminals, it will clarify that the rated ampacity of these terminations shall be considered in the calculations.

## Submitter Information Verification


**Submitter Full Name:** Dean Hunter

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**Submittal Date:** Fri Aug 11 13:33:17 EDT 2023

**Committee:** NEC-P04

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

**705.~~13~~** ~~Energy~~ 13 Power Circuit Management ~~Systems~~ ( ~~EMS~~ PCM ) .

~~An EMS~~ PCM in accordance with 750.30 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: A listed power control system (PCS) is a type of ~~EMS~~ PCM that is capable of monitoring multiple power sources and controlling the current on busbars and conductors to prevent overloading. See ~~UL 1741,~~ UL 3141, Power Circuit Management (PCM), and UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources*, ~~and UL 916,~~ ~~*Energy Management Equipment,*~~ ~~for~~ for information on PCS and ~~EMS~~ PCM .

## Statement of Problem and Substantiation for Public Input

Activities, such as the electrification of the transportation sector and replacement of gas-fired appliance with all electric appliances, coupled with widespread adoption of on-site storage and generation, will place significant new demands on the premises wiring systems covered by the NEC. These activities are complicated by the need to facilitate this shift in energy generation, storage, and use, with an existing (and aging) infrastructure.

An emerging trend is to leverage the technology offered by “Energy Management Systems” to manage these complex electrical systems in a way that prevents overloading of the premises wiring system. These types of systems require functional reliability in order to prevent overloading of the premises wiring, as well as utility owned assets serving the facility. Energy management systems (EMS) historically have not been evaluated for functional reliability to address electrical overload.

While other PI’s may address this need for a more robust “Energy Management System”, this must co-exist with the realization that there is still a place for the traditional Energy Management devices that are not being relied upon for these functions and should not be mandated to meet functional safety requirements.

Recognizing that these existing products will continue to exist in the marketplace, a new term is needed to differentiate between the historic EMS application of energy optimization for appliance control versus electrical overload and/or grid interconnection applications where safety is paramount. With this in mind, this PI focuses on introducing the term Power Circuit Management (PCM) where functional reliability has been applied.

This PI utilizes the new term that is proposed in a Related PI (refer to “Related PI’s”) to mark the distinction between “Energy Management” and “PCM”. As described above, the requirement for this section should reflect the more robust requirements for “PCM”. The informative note has also been updated to reference the new UL standard UL 3141 for Power Circuit Management (PCM) as well as removed UL 916 for EMS as PCS and PCM are only addressed in UL 1741 and UL 3141.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 4331-NFPA 70-2023 [New Definition after Definition: Powder Filling “q”.] | Related due to addition of new PCM definition / term |
| Public Input No. 4332-NFPA 70-2023 [Definition: Energy Management System (EMS).] | Related due to addition of new PCM definition / term |

| | |
|---|---|
| Public Input No. 4335-NFPA 70-2023 [Section No. 750.30] | Related due to addition of new PCM definition / term |
| Public Input No. 4357-NFPA 70-2023 [Section No. 220.70] | Related due to addition of new PCM definition / term |
| Public Input No. 4360-NFPA 70-2023 [Section No. 625.42(A)] | Related due to addition of new PCM definition / term |
| Public Input No. 4362-NFPA 70-2023 [Section No. 700.4(B)] | Related due to addition of new PCM definition / term |
| Public Input No. 4364-NFPA 70-2023 [Section No. 701.4(C)] | Related due to addition of new PCM definition / term |
| Public Input No. 4366-NFPA 70-2023 [Section No. 702.4(A)(2)] | Related due to addition of new PCM definition / term |
| Public Input No. 4372-NFPA 70-2023 [Section No. 750.6] | Related due to addition of new PCM definition / term |
| Public Input No. 4332-NFPA 70-2023 [Definition: Energy Management System (EMS).] | |
| Public Input No. 4335-NFPA 70-2023 [Section No. 750.30] | |
| Public Input No. 4357-NFPA 70-2023 [Section No. 220.70] | |
| Public Input No. 4360-NFPA 70-2023 [Section No. 625.42(A)] | |
| Public Input No. 4362-NFPA 70-2023 [Section No. 700.4(B)] | |
| Public Input No. 4364-NFPA 70-2023 [Section No. 701.4(C)] | |
| Public Input No. 4366-NFPA 70-2023 [Section No. 702.4(A)(2)] | |
| Public Input No. 4372-NFPA 70-2023 [Section No. 750.6] | |

## Submitter Information Verification

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**Submittal Date:** Thu Sep 07 13:04:01 EDT 2023
**Committee:** NEC-P04

## Public Input No. 1812-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, 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 with provisions to visually verify that all blades of the disconnecting devices are fully open :

(2) _ A manually operable switch or drawout-type 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. Wherever possible, with provisions to visually verify that all blades of the disconnecting devices are fully open or that drawout-type circuit breakers are withdrawn to the fully disconnected 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.

## Statement of Problem and Substantiation for Public Input

NFPA 70E-2024 Article 120.6, Process for Establishing and Verifying an Electrically Safe Work Condition, item (3) states “Wherever possible, visually verify that all blades of the disconnecting devices are fully open or that drawout-type circuit breakers are withdrawn to the fully disconnected position."

NFPA 70-2023, Article 705.20(1) & (2) should be revised to require means to visually verify that all blades of the disconnecting devices are fully open or that drawout-type circuit breakers are withdrawn to the fully disconnected position.

Relationship of OSHA and NFPA 70E: The Origin and Development section to NFPA 70E states the Committee on Electrical Safety Requirements for Employee Workplaces was formed to assist OSHA in preparing an electrical safety standard that would serve OSHA's needs and assist in complying with the requirements of Section 6(b) of the Occupational Safety and Health Act. In other words, OSHA looks to NFPA 70E to fill out the performance-based requirements included within the OSHA regulations, especially since NFPA 70E is the American National Standard on the subject and sets the bar for safe work practices.

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Jeffrey Kriner |
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| **Submittal Date:** | Fri Aug 04 17:02:13 EDT 2023 |
| **Committee:** | NEC-P04 |

# 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, ~~Part II of~~ Article 445 , ~~Part III of~~ Part II, Article 690 , ~~Part IIIof~~ Part III, Article 692 , ~~Part IIIof~~ Part III, Article 694 , Part III, and ~~Part II of~~ Article 706 ~~for~~ , Part II 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.

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document. The text is revised to to comply with the NEC Style Manual Section 4.1.4, regarding the use of Parts.
4.1.4 References to an Entire Article. References shall not be made to an entire article, except for the Article 100 or where referenced to provide the necessary context. References to specific parts within

articles shall be permitted. References to all parts of an article shall not be permitted. The article number shall precede the part number.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Submitter Information Verification

| | |
|---|---|
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| **Submittal Date:** | Mon Aug 28 12:31:24 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 3178-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, 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. For one- and two-family dwellings, the disconnecting means shall be located outside the building.

(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.

## Statement of Problem and Substantiation for Public Input

Similar to the requirements in 230.85, adding the requirement for an outside disconnect for one- and two-family dwellings in article 705 brings a parallel requirement for first responders to have a means to disconnect all sources of power outside a dwelling so they may enter the building knowing all power is disconnected.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 2008-NFPA 70-2023 [Section No. 690.13(A)(1)] | |

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Peter Diamond |
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| **Submittal Date:** | Wed Aug 30 06:23:03 EDT 2023 |
| **Committee:** | NEC-P04 |

# Public Input No. 3847-NFPA 70-2023 [ Section No. 705.20 ]

**705.20** Interactive Source ~~Disconnecting Means~~ Isolation Means .

**(A) General.** Means shall be provided to

~~disconnect power source~~
isolate interactive system output conductors

~~of electric power production equipment~~
from the conductors of

~~other systems~~
the normal power supply . A single

~~disconnecting~~
isolation means shall be permitted to

~~disconnect~~
isolate the interactive output of multiple interconnected power sources operating together as a microgrid system from the conductors of

~~other systems.~~
the normal power supply. The isolation means shall be labeled as the "Interactive System Isolation Means" and the label shall meet the requirements of 110.21(B).

Informational Note:

~~See~~

See 480.7 , Part II of Article 445 , Part III of Article 690 ,

~~Part IIIof~~

Part III of Article 692 ,

~~Part IIIof~~

Part III of Article 694 , and Part II of Article 706 for specific source disconnecting means requirements.

~~The disconnecting~~
**(B) Isolation Means** . The isolation 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~~

(7) open all ungrounded conductors of the interactive output circuit

(8) Located where readily accessible

(9) Externally operable without exposed live parts

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

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

(12) 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~~

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

**(C) Multimode Systems** . If the isolation means required in 705.20(A) permits interconnected power production sources to continue to operate in Island Mode while in the OPEN position, the disconnecting means shall be labeled with the following:

**WARNING**

**INTERCONNECTED POWER PRODUCTION SOURCES**

**WILL CONTINUE TO OPERATE IN ISLAND MODE**

**IN THE OPEN POSITION**

The label shall meet the requirements of 110.21(B).

## Additional Proposed Changes

| File Name | Description | Approved |
|---|---|---|
| ACote_2026_PI-3847.pdf | PI-3847: Proposed Language, Substantiation, and Markup | |

## Statement of Problem and Substantiation for Public Input

Every power source Article in the NEC requires disconnecting means for that power source, so an additional requirement for a power source disconnect in 705.20 is redundant and adds confusion to the Code. Article 705.20 covers the interconnection of production sources and the equipment covered under 705.20 should focus on the isolation of the interactive system connection to the normal power supply, and not on the disconnection or shutting down of a power source or sources. The term “isolation means” is appropriate since it is a means to isolate one system from another, whereas a disconnecting means in the NEC and NFPA 70E shuts a power source down to create an electrically safe working condition.

A new (C) is added to address multimode systems and that the sources continue to function in island mode when they become isolated from the normal power supply. Too many of these 705.20 “disconnecting means” on multimode systems are mislabeled in the field as “PV System Disconnects”, “PV Rapid Shutdown Switch”, or “ESS Disconnect”. The opening of a mislabeled device creates the false illusion that the production source has been shut down and exposes persons to electrical hazards because the source is now operating in Island Mode.

## Submitter Information Verification

**Submitter Full Name:** Andrew Cote
**Organization:** Generac Power Systems, Inc
**Street Address:**

| | |
|---|---|
| **City:** | |
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| **Zip:** | |
| **Submittal Date:** | Tue Sep 05 18:48:40 EDT 2023 |
| **Committee:** | NEC-P04 |

# 2026 Public Input Form

| Name: Andrew Cote | 2023 NEC Section Number: 705.20 | Proposed NEW Section Number: 705.20 (A), 705.20 (B), 705.20 (C) |
| --- | --- | --- |
| Email: | | |

**Type of Change:** *(New, revision, etc.)*
Revision of existing *Code* language including new content for multimode systems.

**Proposed Code Language:**

**705.20 Interactive System Isolation Means**.
**(A) General.** Means shall be provided to isolate interactive system output conductors from the conductors of the normal power supply. A single isolation means shall be permitted to isolate the interactive output of multiple interconnected power sources operating together as a microgrid system from the conductors of the normal power supply. The isolation means shall be labeled as the "Interactive System Isolation Means" and the label shall meet the requirements of 110.21(B).

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

**(B) Isolation Means**. The isolation means shall comply with the following:

1. Be one of the following types:
   a) A manually operable switch or circuit breaker
   b) A load-break-rated pull-out switch
   c) A power-operated or remote-controlled switch or circuit breaker that is manually operable locally and opens automatically when control power is interrupted
   d) A device listed or approved for the intended application
2. Simultaneously open all ungrounded conductors of the interactive output circuit
3. Located where readily accessible
4. Externally operable without exposed live parts
5. 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. 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.

**(C) Multimode Systems**. If the isolation means required in 705.20(A) permits interconnected power production sources to continue to operate in Island Mode while in the OPEN position, the disconnecting means shall be labeled with the following:

**WARNING**
**INTERCONNECTED POWER PRODUCTION SOURCES**
**WILL CONTINUE TO OPERATE IN ISLAND MODE**
**IN THE OPEN POSITION**

The label shall meet the requirements of 110.21(B).

**Substantiation for Change:**

Every power source Article in the NEC requires disconnecting means for that power source, so an additional requirement for a power source disconnect in 705.20 is redundant and adds confusion to the Code. Article 705.20 covers the interconnection of production sources and the equipment covered under 705.20 should focus on the isolation of the interactive system connection to the normal power supply, and not on the disconnection or shutting down of a power source or sources. The term "isolation means" is appropriate since it is a means to isolate one system from another, whereas a disconnecting means in the NEC and NFPA 70E shuts a power source down to create an electrically safe working condition.

A new (C) is added to address multimode systems and that the sources continue to function in island mode when they become isolated from the normal power supply. Too many of these 705.20 "disconnecting means" on multimode systems are mislabeled in the field as "PV System Disconnects", "PV Rapid Shutdown Switch", or "ESS Disconnect". The opening of a mislabeled device creates the false illusion that the production source has been shut down and exposes persons to electrical hazards because the source is now operating in Island Mode.

**Notes:**

**705.20 ~~Source Disconnecting~~ Interactive System Isolation Means**.

**(A) General.** Means shall be provided to ~~disconnect power source electrical power production equipment from conductors other systems~~. isolate interactive system output conductors of the normal power supply. A single isolation means shall be permitted to ~~disconnect multiple power sources from conductors of other systems.~~ isolate the interactive output of multiple interconnected power sources operating together as a microgrid system from the conductors of the normal power supply. The isolation means shall be labeled as the "Interactive System Isolation Means" and the label shall meet the requirements of 110.21(B).

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

**(B) Isolation Means**. The isolation means ~~The disconnecting means~~ shall comply with the following:

1. Be one of the following types:
   a) A manually operable switch or circuit breaker
   b) A load-break-rated pull-out switch
   c) A power-operated or remote-controlled switch or circuit breaker that is manually operable locally and opens automatically when control power is interrupted
   d) A device listed or approved for the intended application
2. Simultaneously open all ungrounded conductors of the interactive output circuit
3. Located where readily accessible
4. Externally operable without exposed live parts
5. 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. 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.

**(C) Multimode Systems**. If the isolation means required in 705.20(A) permits interconnected power production sources to continue to operate in Island Mode while in the OPEN position, the isolating means shall be labeled with the following:

**WARNING**
**INTERCONNECTED POWER PRODUCTION SOURCES**
**WILL CONTINUE TO OPERATE IN ISLAND MODE**
**IN THE OPEN POSITION**

The label shall meet the requirements of 110.21(B).

## Public Input No. 4469-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.~~ all wiring systems including power systems and utilization equipment and its associated premises wiring. . A single disconnecting means shall be permitted to disconnect the combined output of 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.

**(A) Location**

The disconnecting means shall be readily accessible and shall comply with one or more of the following:

~~Be~~

(1) Located within or integral to the electric power production source.

(2) Located within sight and within 3 m (10 ft) from the power production source.

(3) 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. Where remote controls are used and are not located within sight of the power source, the location of the controls shall be marked on the disconnecting means.

**(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 of Disconnect.**

The disconnecting means shall simultaneously disconnect all ungrounded conductors of the circuit and shall be one of the following

~~types~~

:

(1) A manually operable switch or circuit breaker

(2) A

~~load-break-rated~~

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

(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~~

**(D) Identification and Marking of Disconnecting Means.**

Plaques or directories shall be installed in accordance with Article 705.10. 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.

## Additional Proposed Changes

| File Name | Description | Approved |
|---|---|---|
| PI_for_Submission_-_705.20_Tesla.docx | 705.20 Proposal Text - GBall Tesla | |

## Statement of Problem and Substantiation for Public Input

This PI is an attempt to set up 705.20 as the go to reference point for the individual power source articles, including 480, 445, 690, 692, and 694. Progress on disconnecting means requirements is made incrementally and inconsistently among the various articles, and that inconsistency shows itself especially as there are growing trends of multiple power sources being used on the same premises. It is hoped that this approach will allow the other articles to reduce duplicative content and focus only on salient requirement differences.

The 705.20 proposed 705.20 content is largely intact from 2023 language, but is organized into sections to allow easier citation from other articles when there are exceptions or additions. Content changes also include more explicit options for location and locking, and some clarifying language.

Accompanying proposals include one for 690.13, and one for 692.13 & 17. It is hoped that if the proposal has merit it could help instigate a correlating task group to identify changes in the other articles.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 4483-NFPA 70-2023 [Section No. 690.13] | |
| Public Input No. 4494-NFPA 70-2023 [Section No. 692.13] | |
| Public Input No. 4528-NFPA 70-2023 [Section No. 692.17] | |

## Submitter Information Verification


**Submitter Full Name:** Greg Ball

**Organization:** Tesla

**Street Address:**

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**State:**

**Zip:**


**Submittal Date:** Thu Sep 07 16:04:33 EDT 2023

**Committee:** NEC-P04

| NEC Section | | STATUS |
|---|---|---|
| 705.20 | | |

**Legislative Text**

**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~~ all wiring systems including power systems and utilization equipment and its associated premises wiring. A single disconnecting means shall be permitted to disconnect the combined output of multiple power sources from conductors of other systems.

**Informational Note:** See 480.7, Part II of Article 445, Part III of Article 690, Part III of Article 692, Part III of 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:~~

- ~~a) A manually operable switch or circuit breaker~~
- ~~b) A load-break-rated pull-out switch~~
- ~~c) A power-operated or remote-controlled switch or circuit breaker that is manually operable locally and opens automatically when control power is interrupted~~
- ~~d) A device listed or approved for the intended application~~

~~(2) Simultaneously disconnect all ungrounded conductors of the circuit~~

~~(3) Located where readily accessible~~

~~(4) Externally operable without exposed live parts~~

~~(5) 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)~~

**(A) Location**

The disconnecting means shall be readily accessible and shall comply with one or more of the following:

1. Located within or integral to the electric power production source.
2. Located within sight and within 3 m (10 ft) from the power production source.
3. 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. Where remote controls are used and are not located within sight of the power source, the location of the controls shall be marked on the disconnecting means.

**(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.<br><br>**(C) Type of Disconnect.**<br>The disconnecting means shall simultaneously disconnect all ungrounded conductors of the circuit and shall be one of the following types:<br>1. A manually operable switch or circuit breaker<br>2. A pull-out switch with the required interrupting rating<br>3. A power-operated, or remote-controlled, switch or circuit breaker that is manually operable locally and opens automatically when control power is interrupted.<br>4. A device listed or approved for the intended application<br><br>**(D) Identification and Marking**<br>Plaques or directories shall be installed in accordance with Article 705.10. Where the line and load terminals are capable of being energized in the open position, the disconnecting means shall be marked with the following words or equivalent:<br><br>WARNING<br>ELECTRIC SHOCK HAZARD TERMINALS ON THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION.<br><br>**Informational Note:** With interconnected power sources, some equipment, including switches and fuses, is capable of being energized from both directions. |
| **Clean Text** | **705.20 Source Disconnecting Means.**<br>Means shall be provided to disconnect power source output conductors of electric power production equipment from all wiring systems including power systems and utilization equipment and its associated premises wiring. A single disconnecting means shall be permitted to disconnect the combined output of multiple power sources from conductors of other systems.<br><br>**Informational Note:** See 480.7, Part II of Article 445, Part III of Article 690, Part III of Article 692, Part III of Article 694, and Part II of Article 706 for specific source disconnecting means requirements.<br><br>**(A) Location**<br>The disconnecting means shall be readily accessible and shall comply with one or more of the following:<br>4. Located within or integral to the electric power production source.<br>5. Located within sight and within 3 m (10 ft) from the power production source.<br>6. 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. Where remote controls are used and are not located within sight of the power source, the location of the controls shall be marked on the disconnecting means. |

| | |
|---|---|
| | **(B) Ratings**<br>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.<br><br>**(C) Type of Disconnect.**<br>The disconnecting means shall simultaneously disconnect all ungrounded conductors of the circuit and shall be one of the following:<br>5. A manually operable switch or circuit breaker<br>6. A pull-out switch with the required interrupting rating<br>7. A power-operated, or remote-controlled, switch or circuit breaker that is manually operable locally and opens automatically when control power is interrupted.<br>8. A device listed or approved for the intended application<br><br>**(D) Identification and Marking of Disconnecting Means.**<br>Plaques or directories shall be installed in accordance with Article 705.10. Where the line and load terminals are capable of being energized in the open position, be marked with the following words or equivalent:<br><br>WARNING<br>ELECTRIC SHOCK HAZARD TERMINALS ON THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION.<br><br>**Informational Note:** With interconnected power sources, some equipment, including switches and fuses, is capable of being energized from both directions. |
| **Substantiation** | This PI is an attempt to set up 705.20 as the go to reference point for the individual power source articles, including 480, 445, 690, 692, and 694. Progress on disconnecting means requirements is made incrementally and inconsistently among the various articles, and that inconsistency shows itself especially as there are growing trends of multiple power sources being used on the same premises. It is hoped that this approach will allow the other articles to reduce duplicative content and focus only on salient requirement differences.<br>The 705.20 proposed 705.20 content is largely intact from 2023 language, but is organized into sections to allow easier citation from other articles when there are exceptions or additions. Content changes also include more explicit options for location and locking, and some clarifying language.<br><br>Accompanying proposals include one for 690.13, and one for 692.13 & 17. It is hoped that if the proposal has merit it could help instigate a correlating task group to identify changes in the other articles. |

Submitter: Greg Ball, Tesla

Additional Contributors (if desired):

## 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)** 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.

**(D) 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(D) (1) through (D)(3).

(1) Positive Polarity.

Dc positive conductors shall be 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 shall be 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

(a) Dc nonsolidly grounded positive conductors shall have an insulation color other than green, white, or gray.

(b) Dc nonsolidly grounded negative conductors shall have 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 definition of grounded, functionally and grounded, solidly.

**(E) 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.

## Statement of Problem and Substantiation for Public Input

This proposal clarifies the polarity markings and color identification requirements that should be applied for DC and AC power source circuits. In particular, Dc wiring from multiple systems that are nonsolidly functionally grounded and interconnected should have the same identification scheme for safety and consistency.

As defined in Article 100, the two types of system grounding that are most common in PV and energy storage systems are not specific to any one system type.

Grounded, Functionally (Functionally Grounded) : A system that has an electrical ground reference for operational purposes that is not solidly grounded. (CMP-4)

Grounded, Solidly (Solidly Grounded) Connected to ground without inserting any resistor or impedance device.

On a multimode system with storage, the current Code creates a confusing and inconsistent wire identification scheme that should be addressed. PV circuit wiring is covered by 690, but the remaining DC wiring - battery wiring, charge controller output circuits, etc. – falls under 706, 480, and 710, which does not make any specific distinction for functionally or solidly grounded conductor identification. Therefore, our understanding is that the requirements around identification covered in 200.6(A) and (B) and 200.7 would apply. This creates a conflict as non-PV system DC wiring is commonly "nonsolidly grounded" or "functionally grounded" through the exact same ground-fault protective device GFPD as the PV circuits due to the bussing of positive and negative conductors of multiple dc systems. If the code is applied as it stands, you will have two (or more) circuits that have the exact same grounding configuration with wires that are identified differently entering the same device or enclosure. For example: from the PV system, two conductors that cannot be white, green, or gray; and from the storage system, one conductor that cannot be white, green, or gray, and one that must be white or gray.

Having these requirements in Article 705 will harmonize and standardize the marking requirements for all power source circuits. While there are currently polarity and color marking requirements in 690.31(B) for PV systems they do not conflict with these requirements and could be deleted for a future code revision.
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The Solar and Storage Industry Forum (SSIF) is a coalition of individuals and organizations convened by the Solar Energy Industry Association (SEIA) to organize, support, and mentor renewable energy industry professionals in codes and standards development. Our objective is to submit industry consensus-based recommendations for changes to the National Electrical Code. We believe that this effort improves the Code-making process by consolidating multiple industry member's points of view into fewer, common proposals.
SSIF members are dedicated to continually improving the installation safety of PV and storage systems in the U.S. A list of members can be found here:
https://www.seia.org/industry-forum

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| **Committee:** | NEC-P04 |

# Public Input No. 568-NFPA 70-2023 [ Section No. 705.25 ]

~~(B)~~

**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* .~~

**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.

## Statement of Problem and Substantiation for Public Input

Items (A) and (C) are already permitted by 110.8. See 90.3 and 4.1.1 of the Style Manual.

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**Committee:** NEC-P04

# Public Input No. 3096-NFPA 70-2023 [ 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:

(1) The sum of the continuous output current ratings of the power production equipment at the circuit nominal system voltage

(2) For power production equipment controlled by an EMS, the current setpoint of the EMS

(3) Where sources controlled by an EMS are combined with other sources on the same power source output circuit, the sum of 705.28(A)(1) and (A)(2)

## Statement of Problem and Substantiation for Public Input

The term “where not elsewhere required or permitted in this Code” is very vague and unenforceable. In accordance with the NEC Style manual section 3.2.1. “The documents shall not contain references or requirements that use unenforceable or vague terms.”

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**Submittal Date:** Tue Aug 29 11:42:25 EDT 2023
**Committee:** NEC-P04

# Public Input No. 4248-NFPA 70-2023 [ Section No. 705.28(A) ]

**(A)** Power Source Output Maximum Current.

Where not elsewhere required or permitted in this *Code*, the maximum current for power sources shall be calculated using one of the following methods:

(1) The sum of the continuous output current ratings of the power production equipment at the circuit nominal system voltage

(2) For power production equipment controlled by an EMS, the current setpoint of the EMS

(3) Where sources controlled by an EMS are combined with other sources on the same power source output circuit, the sum of 705.28(A)(1) and (A)(2)

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

## Statement of Problem and Substantiation for Public Input

This language is based on an existing allowance in 220.5(B), which applies to ampere calculations for branch-circuits, feeders, and services. It extends this allowance for rounding to the nearest whole ampere (and dropping decimal fractions smaller than 0.5) to calculations in Articles 690, 705, and 706, making it clear that this allowance is valid for circuits that are defined and named differently than those covered in Article 220.

Currently, there is no standard approach or method outside of inferring that the 220.5(B) applies elsewhere; furthermore, significant digits don't work for current and voltage calculations because of small decimal temperature coefficients. While it may be preferable and more advantageous for this allowance to be in Section 90.9 so as to apply Code-wide, it could instead be addressed in Articles 690, 705, and 706 as proposed here.

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The Solar and Storage Industry Forum (SSIF) is a coalition of individuals and organizations convened by the Solar Energy Industry Association (SEIA) to organize, support, and mentor renewable energy industry professionals in codes and standards development. Our objective is to submit industry consensus-based recommendations for changes to the National Electrical Code. We believe that this effort improves the Code-making process by consolidating multiple industry member's points of view into fewer, common proposals.

SSIF members are dedicated to continually improving the installation safety of PV and storage systems in the U.S. A list of members can be found here:
https://www.seia.org/industry-forum

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 4250-NFPA 70-2023 [Section No. 706.30(A) [Excluding any Sub-Sections]] | |
| Public Input No. 4252-NFPA 70-2023 [New Section after 690.4(G)] | |

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| **Committee:** | NEC-P04 |

## Public Input No. 3097-NFPA 70-2023 [ 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

### Statement of Problem and Substantiation for Public Input

The term “where not elsewhere required or permitted in this Code” is very vague and unenforceable. In accordance with the NEC Style manual section 3.2.1. “The documents shall not contain references or requirements that use unenforceable or vague terms.”

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**Committee:** NEC-P04

## Public Input No. 1298-NFPA 70-2023 [ 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 not be considered suitable for backfeed ~~or reverse current if specifically rated~~ .

## Statement of Problem and Substantiation for Public Input

UL 489 requires circuit breakers to be marked “line” and “load” unless specific tests identified are conducted. A circuit breaker that is not marked “line” and “load” must pass specific tests to be suitable for backfeed. A circuit breaker that is not marked ″line″ and ″load″, per UL 489, must have a sample tested with reversed line and load connections. Section 7.1.1.25 of UL 489 includes performance requirements for those breakers not marked “Line” and “Load”.

Circuit breaker marked line and load are not suitable for backfeed conditions per UL 489.

AC current is always bi-directional. Reverse current is not a technically correct term.

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# Public Input No. 4014-NFPA 70-2023 [ 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 not be considered suitable for backfeed. Circuit breakers marked "line" and "load" shall be considered suitable for backfeed or reverse current ~~if specifically rated~~ .

## Statement of Problem and Substantiation for Public Input

Omitting the “line” and “load” markings are the means by which circuit breakers are identified for suitability of backfeeding applications. No other rating or marking is provided on circuit breakers to identify suitability for this application. A circuit breaker which is marked “line” and “load” is not suitable for backfeeding and utilizing such a circuit breaker for this application would not comply with Section 110.3(B).

## Related Public Inputs for This Document

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

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**Committee:** NEC-P04

## Public Input No. 4535-NFPA 70-2023 [ Section No. 705.30(E) ]

~~**(E)** Fastening.~~

~~Listed 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.~~

### Statement of Problem and Substantiation for Public Input

The section removes the requirement for clips securing backfed plugin circuit breakers, as stated in 408.36(D). This requirement was removed based on the fact that when utility power was lost, inverter output would cease. Now, with today's inverters that operate with utility interactive metering that do not cease output upon loss of utility power, the requirement for the clips securing the circuit breakers should be reinstated.

### Submitter Information Verification


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| **Committee:** | NEC-P04 |

# Public Input No. 320-NFPA 70-2023 [ Section No. 705.32 ]

**705.32** Ground-Fault Protection.

~~Where~~

For load-side connections as permitted in 705.12, 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.~~

~~*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.*~~

this *Code* (A), (B), and (C) below shall apply.

**(A) Operation.**

Ground-fault protection of equipment shall be designed so that it operates as intended where there are multiple sources of power. Existing ground-fault protection of equipment shall be modified, if necessary, to operate as intended when an interconnection to power production equipment is added. Such design or modification shall be performed under engineering supervision.

**(B) Performance Testing.**

Ground-fault protection shall be tested to confirm operation as intended in the presence of multiple sources of power. Existing ground-fault protection shall be tested to confirm operation as intended when an interconnection to power production equipment is added. This testing shall be conducted per the requirements of 230.95(C).

**(C) Transfer Tripping.**

Where power production equipment is not required to have ground-fault protection elsewhere in this *Code* , if ground-fault protection of equipment is present at the level of interconnection with other sources of power, such protection shall cause disconnection of or cessation of energization of the power production equipment if such equipment could supply ground-fault current after the ground-fault protection has tripped and does not have automatic cease-to-energize functionality for ground faults. Such functionality shall be designed under engineering supervision.

Informational Note No. 1: Alternative ground-fault current sensor placement and/or interconnection and alternative locations (within the requirements of this *Code* ) for neutral-to-ground bonding are techniques commonly used to implement ground-fault protection that operates as intended in the presence of multiple sources of power.

Informational Note No. 2: An ungrounded power production source in parallel with solidly-grounded power sources will supply current to a ground fault.

## Statement of Problem and Substantiation for Public Input

The original intent of 705.32 was to avoid mis-operation of ground-fault protection of equipment, and the exception was intended allow a means for power production equipment to be connected to the load side of ground-fault protection for equipment. However, the existing wording of the exception allows simply adding ground-fault protection to the power production equipment. This does not mitigate the mis-operation issue for ground-fault protection of equipment, and has led to the unnecessary installation of ground-fault protection of equipment to power production equipment where it was not otherwise required. Further, the reference to 705.11 in the exception is an error, since 705.11 contains requirements for line-side connections, not load-side connections. The changes in this PI would make the requirement for proper operation of ground-fault protection of equipment the basic requirement, rather than prescribing where power production sources should be connected.  The changes would also eliminate any requirement for ground-fault protection for equipment on power production sources unless required by other parts of the NEC.

These changes also address the need for testing of ground-fault protection where multiple sources of power are present, whether for a greenfield installation or for the addition of power production equipment to an existing installation.

A final requirement added by these changes is a consequence of not requiring ground-fault protection for power production sources unless required by other parts of the NEC; there will be cases where such sources are interconnected with other sources of power which do have ground-fault protection and these changes introduce a requirement for transfer tripping of the power production production from such ground-fault protection if the power production equipment could source ground fault current after ground-fault protection of equipment has tripped.  This requirement is added in order to avoid the situation of power production equipment supplying current to the ground fault for an additional amount of time after ground-fault protection has tripped.

## Submitter Information Verification

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| **Committee:** | NEC-P04 |

# Public Input No. 4268-NFPA 70-2023 [ 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 providing~~ 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.

## Statement of Problem and Substantiation for Public Input

Term "equipment" is changed to "sources" in specific locations to be more consistent with similar references in this Code including 705.1.
Note defined term change in related PI.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 4167-NFPA 70-2023 [Definition: Power Production Equipment.] | Change in defined term |
| Public Input No. 4167-NFPA 70-2023 [Definition: Power Production Equipment.] | |

## Submitter Information Verification

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| **Committee:** | NEC-P04 |

# Public Input No. 1255-NFPA 70-2023 [ New Section after 705.45 ]

**TITLE OF NEW CONTENT**

Type your content here ...

705.46. Cybersecurity

Interconnected Electric Power Production Sources that are connected to a communication network and have the capability to be controlled or permit control of any portion of the premises shall comply with either of the following:

(1) The ability to control the system is limited to a direct connection through a local nonnetworked interface.

(2) The Interconnected Electric Power Production Source is connected through a networked interface complying with both of the following methods:

a. The Interconnected Electric Power Production Source and associated software are identified as being evaluated for cybersecurity.

b. A cybersecurity assessment is conducted on the connected system to determine vulnerabilities to cyber attacks.

The cybersecurity assessment shall be conducted when the system configuration changes and at not more than 5-year intervals.

Documentation of the evaluation, assessment, identification, and certification shall be made available to those authorized to inspect, operate, and maintain the system.

Informational Note No. 1: See ANSI/ISA 62443, Cybersecurity Standards series; UL 2900, Cybersecurity Standards series; and the NIST Framework for Improving Critical Infrastructure Cybersecurity, Version 1.1, for assessment guidelines.

Informational Note No. 2: Examples of the commissioning certification used to demonstrate the system has been investigated for cybersecurity vulnerabilities could be one of the following:

(1) The ISA Security Compliance Institute (ISCI) conformity assessment program

(2) Certification of compliance by a nationally recognized test laboratory

## Statement of Problem and Substantiation for Public Input

Most of the cybersecurity focus has been on IT systems. There has been very little public discussion about cybersecurity for Operational Technology (OT), but cyber attacks on OT, by both domestic and foreign actors, occur on almost a daily basis. Hackers can easily destroy unprotected equipment and shut down entire unprotected facilities. Our adversaries such as Russia, China, North Korea, and Iran, are continuously mounting cyber attacks. They understand their limits and, so far, prohibit catastrophic attacks on our financial/banking system and electrical grid. In the mean time, they attack our infrastructure, such as the southeast gas pipeline. We have the ability, and obligation, to prevent this type of damage to our infrastructure from malicious cyber attacks. This Public Input is based upon 240.6(D) and 708.7 in the 2023 NEC. Pay particular attention to the word "identified" in (2) a. "Identified" as applied to equipment, is defined in Article 100 as "Recognizable as suitable for the specific purpose, function, use, environment, application, and so forth, where described in a particular Code requirement. Informational Note: Some examples of ways to determine suitability of equipment for a specific purpose, environment, or application include investigations by a qualified testing

laboratory (listing and labeling), an inspection agency, or other organization concerned with product evaluation." This Public Input simply requires that an Interconnected Electric Power Production Source either not be connected to the internet, or if it is connected to the internet, that it be identified for cybersecurity and that an assessment is provided.

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Vincent Saporita |
| **Organization:** | Saporita Consulting |
| **Street Address:** | |
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| **Zip:** | |
| **Submittal Date:** | Fri Jun 30 15:17:49 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 2917-NFPA 70-2023 [ Section No. 705.45(B) ]

**(B)** ~~Three~~ Poly Phase.

~~Three~~ Poly -phase 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.

## Statement of Problem and Substantiation for Public Input

Three phase, while the most common poly-phase system it is not the only poly phase system in use. This section should also apply to other types of poly phase systems such as 3, 4 or 5-wire two phase.

## Submitter Information Verification


**Submitter Full Name:** Stephen Schmiechen
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**Submittal Date:** Sun Aug 27 17:26:04 EDT 2023
**Committee:** NEC-P04

## Public Input No. 3254-NFPA 70-2023 [ 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 for health care facilities incorporating microgrids.

### Statement of Problem and Substantiation for Public Input

Deletion of informational note #1 since it does not directly relate to the requirements in this section and therefore does not improve usability.

### Submitter Information Verification

**Submitter Full Name:** Jason Fisher
**Organization:** Solar Technical Consulting Llc
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**Zip:**
**Submittal Date:** Wed Aug 30 18:16:04 EDT 2023
**Committee:** NEC-P04

# Public Input No. 3359-NFPA 70-2023 [ 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~~ See 517.30(B)(5) for health care facilities incorporating microgrids.

## Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the NEC(r) Style Manual prohibits referencing an entire article with the exception of Article 100 or where required for context. As health care microgrids are covered in the specified section, it seems more appropriate to be pointing the user to the exact section, though if the panel desired, they could most certainly point to a part (or parts) of the article instead.

## Submitter Information Verification


**Submitter Full Name:** Richard Holub

**Organization:** The DuPont Company, Inc.

**Street Address:**

**City:**

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**Submittal Date:** Fri Sep 01 14:29:16 EDT 2023

**Committee:** NEC-P04

## Public Input No. 4406-NFPA 70-2023 [ 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~~ <u>may</u> include <u>either</u> a single <u>distributed energy</u> source or ~~a compatible interconnection of multiple~~ <u>multiple interconnected distributed energy</u> sources such as engine generators, solar PV, wind, or ESS.

Informational Note No. 2: See Article 517 for health care facilities incorporating microgrids.

### Statement of Problem and Substantiation for Public Input

The proposed change provides clarity that microgrids may consist of a single or multiple distributed energy sources in addition to any primary source of power. The existing text created confusion as to whether the primary source of power was considered a source.

### Submitter Information Verification

**Submitter Full Name:** Jason Hopkins
**Organization:** UL Solutions
**Street Address:**
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**Submittal Date:** Thu Sep 07 14:31:15 EDT 2023
**Committee:** NEC-P04

# Public Input No. 2570-NFPA 70-2023 [ 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.

## Statement of Problem and Substantiation for Public Input

This change cleans up redundant language that is no longer needed. There is no need to reference 705.13 since both 705.11(B) and 705.12 reference 705.28(A), which includes a direct reference to EMS.

## Submitter Information Verification

**Submitter Full Name:** Jason Fisher
**Organization:** Solar Technical Consulting Llc
**Street Address:**
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**Submittal Date:** Tue Aug 22 13:27:39 EDT 2023
**Committee:** NEC-P04

## Public Input No. 3255-NFPA 70-2023 [ 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.~~

## Statement of Problem and Substantiation for Public Input

Deletion of this IN since it does not support the requirements in this section. This IN also appears in 705.70.

## Submitter Information Verification

**Submitter Full Name:** Jason Fisher
**Organization:** Solar Technical Consulting Llc
**Street Address:**
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**Submittal Date:** Wed Aug 30 18:28:06 EDT 2023
**Committee:** NEC-P04

# Public Input No. 4087-NFPA 70-2023 [ Article 710 ]

~~**Article 710** Stand-Alone Systems~~

~~**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.~~

> ~~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.~~

~~**710.6** Equipment Approval.~~

~~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~~

~~**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 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 .~~

~~**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.~~

~~**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.~~

~~**(B)** Sizing and Protection.~~

~~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.~~

## Statement of Problem and Substantiation for Public Input

The requirements for Stand-Alone Systems are removed from Article 710 and moved with modification to a new Part III of Article 225. This revision will provide consistency and alignment for Stand-Alone Systems with Article 225 Part II that provides requirements for Buildings or Other Structures Supplied by a Feeder(s) or Branch Circuit(s).

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 4122-NFPA 70-2023 [New Section after 225.42] | |
| Public Input No. 4122-NFPA 70-2023 [New Section after 225.42] | |

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Chad Kennedy |
| **Organization:** | Schneider Electric |
| **Street Address:** | |
| **City:** | |
| **State:** | |
| **Zip:** | |
| **Submittal Date:** | Wed Sep 06 16:15:54 EDT 2023 |
| **Committee:** | NEC-P04 |

# Public Input No. 2833-NFPA 70-2023 [ New Section 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**

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document when general listing requirements are covered within an article. The NEC Style Manual Section 2.2.1 Parallel Numbering Required, states that technical committees shall use the following section numbers for the same purposes within articles. The listing requirements are to be located in the .2 section.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 2836-NFPA 70-2023 [Section No. 710.6] | Deleted and relocated to the .2 section. |
| Public Input No. 2836-NFPA 70-2023 [Section No. 710.6] | |

## Submitter Information Verification

**Submitter Full Name:** Dean Hunter
**Organization:** Minnesota Department of Labor
**Street Address:**
**City:**
**State:**
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**Submittal Date:** Fri Aug 25 14:23:08 EDT 2023
**Committee:** NEC-P04

## Public Input No. 4092-NFPA 70-2023 [ 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.~~ supply a stand-alone system.

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.

### Statement of Problem and Substantiation for Public Input

The scope of Article 710 was revised to remove confusion around island mode operation and stand-alone systems. The definition of a stand-alone system in Article 100 and this revision align and will improve clarity for users. The first sentence of the informational note was removed to eliminate redundancy and use of the undefined term isolated microgrid. A microgrid system may have source requirements that conflict with the source requirements in this article depending upon the loads served.

### Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 4094-NFPA 70-2023 [Section No. 710.6] | |
| Public Input No. 4097-NFPA 70-2023 [Section No. 710.10] | |
| Public Input No. 4100-NFPA 70-2023 [Section No. 710.12] | |
| Public Input No. 4102-NFPA 70-2023 [Section No. 710.15 [Excluding any Sub-Sections]] | |
| Public Input No. 4105-NFPA 70-2023 [Section No. 710.15(A)] | |
| Public Input No. 4110-NFPA 70-2023 [Section No. 710.15(E)] | |
| Public Input No. 4247-NFPA 70-2023 [Section No. 710.15(C)] | |
| Public Input No. 4249-NFPA 70-2023 [Section No. 710.15(D)] | |

### Submitter Information Verification

**Submitter Full Name:** Chad Kennedy
**Organization:** Schneider Electric
**Street Address:**
**City:**
**State:**
**Zip:**
**Submittal Date:** Wed Sep 06 16:23:54 EDT 2023
**Committee:** NEC-P04

## Public Input No. 4253-NFPA 70-2023 [ Section No. 710.1 ]

**710.1** Scope.

This article covers electric power production systems that ~~operate in island mode~~ are not connected to an electric utility or other electric power production and distribution network.

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.

### Statement of Problem and Substantiation for Public Input

This public input aims to complete the work that began last code cycle. This would sever the language artifact (island mode) that still ties 710 to interconnected systems and microgrids that are also connected to a primary power source such as a utility. Including "island mode" leads people to believe that there is a corresponding "interactive mode".

### Submitter Information Verification

**Submitter Full Name:** Charles Picard
**Organization:** Tesla, Inc.
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**Submittal Date:** Thu Sep 07 07:57:47 EDT 2023
**Committee:** NEC-P04

# Public Input No. 4402-NFPA 70-2023 [ 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.

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.

Stand-Alone Systems shall be permitted to include switchgear necessary to receive supply from a merchant utility contingent upon the service switchgear meeting all Article 230 requirements.

## Statement of Problem and Substantiation for Public Input

This proposal contemplates evolution of the distribution power grid that uses merchant utility sources as backup power. Stand-alone systems are already in use in isolated telecommunication installations and agricultural regions. There are many issues that have to be resolved if stand alone systems can be deployed more widely within densely populated areas -- zoning regulations, fuel supply, continued financial stability of merchant distribution grids, availability of knowledgeable operating expertise, among them. This proposal challenges the one-generator-per-household backup generation regime present in most residential areas of the US.

This proposal is a placeholder for discussion in this and future NEC revision cycles about how use of emergency generators can be shared among two or more detached buildings.

## Submitter Information Verification


**Submitter Full Name:** Michael Anthony

**Organization:** Standards Michigan LLC

**Affiliation:** StandardsMichigan.COM

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**Submittal Date:** Thu Sep 07 14:25:43 EDT 2023

**Committee:** NEC-P04

# Public Input No. 2836-NFPA 70-2023 [ Section No. 710.6 ]

~~**710.6** Equipment Approval.~~

~~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~~

## Statement of Problem and Substantiation for Public Input

This Public Input is being submitted on behalf of the NEC Correlating Committee Usability Task Group in order to provide correlation throughout the document when general listing requirements are covered within an article. The NEC Style Manual Section 2.2.1 Parallel Numbering Required, states that technical committees shall use the following section numbers for the same purposes within articles. The listing requirements are to be located in the .2 section.
The Usability Task Group members are: Derrick Atkins, David Hittinger, Richard Holub, Dean Hunter, Chad Kennedy and David Williams.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 2833-NFPA 70-2023 [New Section after 710.1] | Deleted and relocated to the .2 section. |
| Public Input No. 2833-NFPA 70-2023 [New Section after 710.1] | |

## Submitter Information Verification


**Submitter Full Name:** Dean Hunter

**Organization:** Minnesota Department of Labor

**Street Address:**

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**Zip:**


**Submittal Date:** Fri Aug 25 14:24:50 EDT 2023

**Committee:** NEC-P04

# Public Input No. 4094-NFPA 70-2023 [ Section No. 710.6 ]

**710.6** Equipment Approval.

All power production equipment or systems shall be approved for the intended 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

## Statement of Problem and Substantiation for Public Input

The requirements of this section were revised to remove confusion around the term “island mode” and stand-alone systems. The suitability of a power source to supply a stand-alone system is addressed in the listing or field evaluation requirements within this section.

## Related Public Inputs for This Document

| Related Input | Relationship |
| --- | --- |
| Public Input No. 4092-NFPA 70-2023 [Section No. 710.1] | |

## Submitter Information Verification

**Submitter Full Name:** Chad Kennedy
**Organization:** Schneider Electric
**Street Address:**
**City:**
**State:**
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**Submittal Date:** Wed Sep 06 16:27:01 EDT 2023
**Committee:** NEC-P04

# Public Input No. 4097-NFPA 70-2023 [ 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.

## Statement of Problem and Substantiation for Public Input

The requirements for identification of power sources was revised for clarity. Inclusion of the article title is redundant and adds confusion to the requirement. The phrase "or be grouped with other plaques or directories for other on-site sources" was removed based on requirement to comply with section 705.10.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 4092-NFPA 70-2023 [Section No. 710.1] | |

## Submitter Information Verification

**Submitter Full Name:** Chad Kennedy
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**State:**
**Zip:**
**Submittal Date:** Wed Sep 06 16:29:49 EDT 2023
**Committee:** NEC-P04

# Public Input No. 4100-NFPA 70-2023 [ 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.~~

## Statement of Problem and Substantiation for Public Input

This section was removed since the article does not contain requirements utilizing the Stand-Alone Inverter Input Current.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 4092-NFPA 70-2023 [Section No. 710.1] | |

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Chad Kennedy |
| **Organization:** | Schneider Electric |
| **Street Address:** | |
| **City:** | |
| **State:** | |
| **Zip:** | |
| **Submittal Date:** | Wed Sep 06 16:38:33 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 1257-NFPA 70-2023 [ New Section after 710.15 ]

**TITLE OF NEW CONTENT**

Type your content here ...

710.16. Cybersecurity

Stand-Alone Systems that are connected to a communication network and have the capability to be controlled or permit control of any portion of the premises shall comply with either of the following:

(1) The ability to control the system is limited to a direct connection through a local nonnetworked interface.

(2) The Stand-Alone Sytem is connected through a networked interface complying with both of the following methods:

a. The Stand-Alone System and associated software are identified as being evaluated for cybersecurity.

b. A cybersecurity assessment is conducted on the connected system to determine vulnerabilities to cyber attacks.

The cybersecurity assessment shall be conducted when the system configuration changes and at not more than 5-year intervals.

Documentation of the evaluation, assessment, identification, and certification shall be made available to those authorized to inspect, operate, and maintain the system.

Informational Note No. 1: See ANSI/ISA 62443, Cybersecurity Standards series; UL 2900, Cybersecurity Standards series; and the NIST Framework for Improving Critical Infrastructure Cybersecurity, Version 1.1, for assessment guidelines.

Informational Note No. 2: Examples of the commissioning certification used to demonstrate the system has been investigated for cybersecurity vulnerabilities could be one of the following:

(1) The ISA Security Compliance Institute (ISCI) conformity assessment program

(2) Certification of compliance by a nationally recognized test laboratory

### Statement of Problem and Substantiation for Public Input

Most of the cybersecurity focus has been on IT systems. There has been very little public discussion about cybersecurity for Operational Technology (OT), but cyber attacks on OT, by both domestic and foreign actors, occur on almost a daily basis. Hackers can easily destroy unprotected equipment and shut down entire unprotected facilities. Our adversaries such as Russia, China, North Korea, and Iran, are continuously mounting cyber attacks. They understand their limits and, so far, prohibit catastrophic attacks on our financial/banking system and electrical grid. In the mean time, they attack our infrastructure, such as the southeast gas pipeline. We have the ability, and obligation, to prevent this type of damage to our infrastructure from malicious cyber attacks. This Public Input is based upon 240.6(D) and 708.7 in the 2023 NEC. Pay particular attention to the word "identified" in (2) a. "Identified" as applied to equipment, is defined in Article 100 as "Recognizable as suitable for the specific purpose, function, use, environment, application, and so forth, where described in a particular Code requirement. Informational Note: Some examples of ways to determine suitability of equipment for a specific purpose, environment, or application include investigations by a qualified testing

laboratory (listing and labeling), an inspection agency, or other organization concerned with product evaluation." This Public Input simply requires that a Stand-Alone System either not be connected to the internet, or if it is connected to the internet, that it be identified for cybersecurity and that an assessment is provided.

## Submitter Information Verification

| | |
|---|---|
| **Submitter Full Name:** | Vincent Saporita |
| **Organization:** | Saporita Consulting |
| **Street Address:** | |
| **City:** | |
| **State:** | |
| **Zip:** | |
| **Submittal Date:** | Fri Jun 30 15:33:04 EDT 2023 |
| **Committee:** | NEC-P04 |

## Public Input No. 3268-NFPA 70-2023 [ New Section after 710.15 ]

710.1 6 Grounding.

(A) Alternating Current System. Stand-alone AC systems that are required to be grounded in accordance with 250.20, shall have the non-current carrying metal parts connected to a grounding electrode system with a grounding electrode conductor sized to 250.66 installed in accordance with Part III of Article 250.

(B) Direct Current System. Stand-alone DC systems that are required to be grounded in accordance with 250.16 2 , shall have the non-current carrying metal parts connected to a grounding electrode system with a grounding electrode conductor sized to 250.166 installed in accordance with Part III of Article 250.

### Statement of Problem and Substantiation for Public Input

We need rules relating to grounding of sand-alone system in Article 710. These proposed revisions will add clarity for Code users and provide references on how to properly ground stand-alone systems.

### Submitter Information Verification

**Submitter Full Name:** Mike Holt
**Organization:** Mike Holt Enterprises Inc
**Street Address:**
**City:**
**State:**
**Zip:**
**Submittal Date:** Wed Aug 30 20:46:04 EDT 2023
**Committee:** NEC-P04

## Public Input No. 4105-NFPA 70-2023 [ Section No. 710.15(A) ]

**(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~~

a minimum capacity rating based on the largest load intended to be operated at one time. Documentation and marking of the power supply shall comply with all of the following:

(1) The supply capacity shall be marked on the equipment containing the system branch circuit overcurrent protective device(s).

(2) Documentation of the load calculation shall be made available to those authorized to inspect, operate, and maintain the system .

## Statement of Problem and Substantiation for Public Input

The stand-alone system supply output which supplies the premises wiring system was revised to simplify and improve clarity. Documentation and marking requirements were added to provide necessary system information for operation and maintenance. The informational note was removed since the information is provided in other parts of the Code.

## Related Public Inputs for This Document

| Related Input | Relationship |
| --- | --- |
| Public Input No. 4092-NFPA 70-2023 [Section No. 710.1] | |

## Submitter Information Verification


**Submitter Full Name:** Chad Kennedy
**Organization:** Schneider Electric
**Street Address:**
**City:**
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**Zip:**

**Submittal Date:** Wed Sep 06 16:45:07 EDT 2023
**Committee:** NEC-P04

## Public Input No. 1410-NFPA 70-2023 [ Section No. 710.15(C) ]

**(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~~ 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).

### Statement of Problem and Substantiation for Public Input

Service equipment is a defined term that does not apply to stand along systems as they are not connected to a utility.

### Submitter Information Verification

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**Committee:** NEC-P04

# Public Input No. 4247-NFPA 70-2023 [ Section No. 710.15(C) ]

**(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).

## Statement of Problem and Substantiation for Public Input

This revision removed the undefined term isolated microgrid since the definition of stand-alone systems in Article 100 provides the information needed to apply the requirements. An isolated microgrid system may have requirements that conflict with the source requirements in this article depending upon the loads served.

## Related Public Inputs for This Document

| Related Input | Relationship |
| --- | --- |
| Public Input No. 4092-NFPA 70-2023 [Section No. 710.1] | |

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**Committee:** NEC-P04

# Public Input No. 4249-NFPA 70-2023 [ Section No. 710.15(D) ]

**(D)** Three-phase Supply.

Stand-alone ~~and microgrid~~ systems shall be permitted to supply three-phase, 3-wire or 4-wire systems.

## Statement of Problem and Substantiation for Public Input

This revision removed the term microgrid since the definition of stand-alone systems in Article 100 provides the information needed to apply the requirements. An microgrid system may have requirements that conflict with the source requirements in this article depending upon the loads served.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 4092-NFPA 70-2023 [Section No. 710.1] | |

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# Public Input No. 4110-NFPA 70-2023 [ Section No. 710.15(E) ]

~~**(E)** Energy Storage or Backup Power System Requirements.~~

~~Energy storage or backup power supplies shall not be required.~~

## Statement of Problem and Substantiation for Public Input

This section was removed since energy storage or backup power are not required in this article. The need for backup or standby power will depend upon the type of loads served as covered in the applicable code article.

## Related Public Inputs for This Document

| Related Input | Relationship |
| --- | --- |
| Public Input No. 4092-NFPA 70-2023 [Section No. 710.1] | |

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# Public Input No. 4102-NFPA 70-2023 [ Section No. 710.15 [Excluding any Sub-Sections] ]

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~~ E ).

## Statement of Problem and Substantiation for Public Input

This section was revised to correct the section reference since 710.15(G) did not exist and align with a separate public input that removes 710.15(E).

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 4092-NFPA 70-2023 [Section No. 710.1] | |

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# Public Input No. 1457-NFPA 70-2023 [ New Part after 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.

## Statement of Problem and Substantiation for Public Input

Currently there is no maximum dc voltage limit applicable to fuel cell systems in or on buildings. As fuel cell system installations will undoubtedly increase in the next decade, we need to start providing appropriate safety thresholds in Article 692. The voltage limitations in this proposal are 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.

## Related Public Inputs for This Document

| Related Input | Relationship |
|---|---|
| Public Input No. 3491-NFPA 70-2023 [Section No. 625.4] | |
| Public Input No. 3491-NFPA 70-2023 [Section No. 625.4] | |

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**Committee:** NEC-P04

# Public Input No. 197-NFPA 70-2023 [ Part II. ]

**Part II.**– _ _ Inverter Based Microgrid Systems Connected at 1000 Volts AC or less

## Statement of Problem and Substantiation for Public Input

Much of the recent development in article 705 is driven by mass growth of inverter based battery energy and solar power sources. As this section is being developed largely by input from those with exposure to commercial and residential inverter based systems, it would seem appropriate to keep its scope focused on those systems.

This requirement as written would apply to industrial or institutional campuses employing large peak shaving medium voltage generators (or low voltage generators with customer owned medium voltage interconnection) which also have islanding capabilities. These systems employ very well engineered protection methods consisting of multiple complex and well designed protective relays and switching devices incorporating all the necessary protection, but perhaps not being individually listed as a "microgrid interconnect device." It is not believed that this section of article 705 was crafted with these systems in mind. Thus, a limitation on its applicability is proposed.

## Submitter Information Verification

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# Public Input No. 4223-NFPA 70-2023 [ Part II. ]

**Part II.** Microgrid Systems

The blue text under "Part II. Microgrid Systems" in the 2023 NEC Handbook appears to be out of place and would be better served to be directly under the last paragraph of 705.40.

The existing blue text under 705.40 could be moved up between the two informational notes and the last paragraph to provide separation of the referenced blue text topics.

## Statement of Problem and Substantiation for Public Input

Blue text in the 2023 NEC Handbook under 705 Part II. Microgrid Systems appears to be out of place.

## Submitter Information Verification


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**Committee:** NEC-P04

# Public Input No. 3998-NFPA 70-2023 [ Part III. ]

**Part III.** Interconnected Systems Operating in Island Mode

Informational Note No. 1: The Island Mode electrical boundary shall not extend into the electrical system under the exclusive control of the serving utility. 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 Specification of Microgrid Controllers* ; IEEE 2030.8, *IEEE Standard for Detecting Microgrid Controllers* ; and UL1008B, *Outline for Source Interconnection* , for additional information about island mode.

## Statement of Problem and Substantiation for Public Input

The Island Mode definition does not convey understanding that the microgrid electrical power system area could involve facilities under the exclusive control of entities (e.g., electric utilities) and subject to requirements separate from NFPA 70. The boundary and jurisdiction clarifications ensure development of microgrid systems are in accordance with all applicable requirements (e.g., DOE, IEEE 1547, IEEE 2030.7).

## Submitter Information Verification

| | |
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# Public Input No. 1404-NFPA 70-2023 [ Sections Part III., 705.80, 705.81, 705.82 ]

~~**Sections Part III., 705.80, 705.81, 705.82**~~

~~**Part III.** Interconnected Systems Operating in Island Mode~~

~~**705.80** Power Source Capacity.~~

~~For interconnected power production sources that operate in island mode, capacity shall be calculated using the sum of all power source output maximum currents for the connected power production source.~~

~~**705.81** Voltage and Frequency Control.~~

~~Power sources operating in island mode shall be controlled so that voltage and frequency are supplied within limits compatible with the connected loads.~~

~~**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) .~~

## Statement of Problem and Substantiation for Public Input

This section should not be included in article 705. Every requirement in part III deals with circumstances of standby use including source and capacity. Those requirements are laid out in articles 700, 701, 702 and 710 respectively.

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# Public Input No. 1845-NFPA 70-2023 [ 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)

## Statement of Problem and Substantiation for Public Input

Duplicate definition. A definition that is duplicated and applied to only one article should add clarification in the term to aid the user in selecting the appropriate definition.

## Submitter Information Verification


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**Submittal Date:** Sun Aug 06 14:09:57 EDT 2023

**Committee:** NEC-P04

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

**Maximum Output Power.**

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)~~ maximum power delivered at its rated load as determined under specified test conditions.

## Statement of Problem and Substantiation for Public Input

This definition was revised to comply with the NEC Style Manual Section 2.1.2.7 regarding multiple definitions for the same term.

## Submitter Information Verification

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

**(D)** Marking DC PV Circuits.

A permanent ~~readily~~ visible label indicating the highest maximum dc voltage in a PV system, equal to or greater than the value calculated in accordance with 690.7, shall be provided ~~by the installer~~ at the PV system electronic power conversion equipment or at one of the following locations:

(1) ~~DC PV~~ Dc PV system disconnecting means

(2) Dc distribution equipment associated with the PV system

Informational Note No 1: Rounding up to a value greater than the calculated PV dc circuit maximum voltage allows easier standardized labeling.

Informational Note No 2: Equipment manufacturers often provide a permanent visible label at the electronic power conversion equipment

- ~~Distribution equipment associated with the PV system~~

~~indicating this value.~~

## Statement of Problem and Substantiation for Public Input

The voltage marking requirement has been updated from maximum to nominal voltage to harmonize with the new definition of PV system dc circuit nominal voltage. This nominal voltage label gives enforcement a simple indication of the voltage class of the equipment. It gives on-site technicians the information they need to choose the appropriate meters for accurate measurements. It allows standardized printed labels for PV dc circuit voltage.

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The Solar and Storage Industry Forum (SSIF) is a coalition of individuals and organizations convened by the Solar Energy Industry Association (SEIA) to organize, support, and mentor renewable energy industry professionals in codes and standards development. Our objective is to submit industry consensus-based recommendations for changes to the National Electrical Code. We believe that this effort improves the Code-making process by consolidating multiple industry member's points of view into fewer, common proposals.

SSIF members are dedicated to continually improving the installation safety of PV and storage systems in the U.S. A list of members can be found here:

https://www.seia.org/industry-forum

## Submitter Information Verification


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