Public Input No. 207-NFPA 70-2019 [Global Input]

"no less than"
change to
"not less than"

Statement of Problem and Substantiation for Public Input

The term "no less than" is used approximately 6 times in the NEC.
The term "not less than" is used approximately 881 times in the NEC.

Reason for the global change is for consistency, and to comply with the style manual. The "no less than's" can be found in:

Definitions, Overcurrent Protective Device, Branch-Circuit.
240.21(B)(4)(9)
430.109(F)
600.32(A)(4) [appears twice in this section]
691.1

Submitter Information Verification

Submitter Full Name: Nick Sasso
Organization: Clark County Building and Fire
Street Address:
City:
State:
Zip:
Submittal Date: Thu Dec 26 19:34:36 EST 2019
Committee: NEC-P01

Copyright Assignment

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Public Input No. 259-NFPA 70-2020 [Global Input]

"unless permitted by..." or "unless permitted by Article..."
change to
"unless permitted in..."

Statement of Problem and Substantiation for Public Input

Basically this is just clean up language, and to be in accordance with section 4.1.2 of the style manual. Let's pick one or the other. I believe that the correct language should be "unless permitted in..."

The unless permitted by's are located in:

300.13(A)

348.20(A)

356.20(A)

411.5(B)

625.46

626.26

725.136(A)

760.136(A)

The unless permitted in's are located in

225.30

230.2

348.20

356.20

411.5(B)

625.46

626.26

725.136(A)

760.136(A)

Submitter Information Verification

Submitter Full Name: Nick Sasso
Organization: Clark County Building and Fire
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 08 14:31:09 EST 2020
Committee: NEC-P01

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Public Input No. 276-NFPA 70-2020 [Global Input]

(capable of being) locked in the open position

to

(capable of being) lockable open

Statement of Problem and Substantiation for Public Input

There are approximately 21 references to, "capable of being locked in the open position..."
and
there are approximately 26 references to, "capable of being lockable open..."

Let's pick one. Reason for change is consistency throughout NEC

Submitter Information Verification

Submitter Full Name: Nick Sasso
Organization: Clark County Building and Fire
Street Address:
City:
State:
Zip:
Submittal Date: Sat Jan 11 17:27:37 EST 2020
Committee: NEC-P01

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Public Input No. 277-NFPA 70-2020 [Global Input]

(capable of being) lockable open

change to

(capable of being) locked in the open position

Statement of Problem and Substantiation for Public Input

There are approximately 26 references to, "capable of being lockable open..."

and

there are approximately 21 references to, "capable of being locked in the open position..."

Let's pick one. Reason for change is consistency throughout NEC. Personally, I prefer "capable of being locked in the open position."

Submitter Information Verification

Submitter Full Name: Nick Sasso
Organization: Clark County Building and Fire
Street Address:
City:
State:
Zip:
Submittal Date: Sat Jan 11 17:33:21 EST 2020
Committee: NEC-P01

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Public Input No. 368-NFPA 70-2020 [Global Input]

Please provide page headers with the appropriate identifiers to make use of the code less confusing.

Example 1:	Chapter 1 Article 100 - Definitions - PART III - Haz Locs
Example 2:	110.31 Article 110 - Reqs for Electrical Installations -Part III - OVER 1000 VOLTS nom
Example 3:	Annex C- Tables Informative Annex C - Table C-3 (FMC) cont.

Statement of Problem and Substantiation for Public Input

Earlier versions of the document included shorthand page headers that greatly improved user ease of finding the correct code sections. As written now the document is confusing with important distinctions hard to ferret out. For example the sections that are limited in application to certain voltages or locations may run for pages but the transition to that distinction is hard to find, and any page after the initial distinguishing information is not notated in any way to indicate that a limitation of scope applies.. Identifiers such as Part III Over 1000 volts is not prominently distinguished in the body of the text and is not reflected in the page heading on latter pages, leading to much confusion when using the document in the field. (Earlier versions also had the PART III or similar transitions prominently bold to make finding them easier.) Please accept my apology if this is submitted in the incorrect format or to the incorrect panel or group. This would appear to be a style request more than a code request but I did not find any public input option for style or page headers.

Submitter Information Verification

Submitter Full Name: Joe Kunkel
Organization: NU Electric Co
Street Address:
City:
State:
Zip:
Submittal Date: Sun Jan 26 12:24:46 EST 2020
Committee: NEC-P01

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Public Input No. 454-NFPA 70-2020 [Global Input]

Type your content here: I would like to see one of the two things I have listed happen; either put all definitions in article 100 no matter how many times the term is used throughout the NEC or keep the NEC at the current format limiting article 100 for definitions of terms used more than twice in the NEC and using xxx.2 for definitions that are only used in that particular article. Do not use xxx.2 for anything besides definitions. Currently if an article does not contain any definitions, xxx.2 is used for anything. Example; 90.2 SCOPE, 110.2 APPROVAL, 200.2 GENERAL, plus many other articles, although this change would not in essence save lifes, it would add consistincey to the NEC, ...

Statement of Problem and Substantiation for Public Input

This would add consistency to the NEC,

Submitter Information Verification

Submitter Full Name: Ray Pritchett
Organization: NJATC
Affiliation: Evansville Electrical Training Center IBEW Local 16
Street Address:
City:
State:
Zip:
Submittal Date: Sun Feb 09 22:55:07 EST 2020
Committee: NEC-P01

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Public Input No. 2989-NFPA 70-2020 [Global Input]

Regarding the division of NEC Articles into “Parts”;

Where "Parts" are used to sub-divide NEC Articles by topic, it is proposed to amend the Part description text with a set of brackets that enclose the span of paragraph numbers that is encompassed by the respective Part category.

For example, NEC Chapter 2, Article 210, Part III.

This "Part" text string is represented as;

Part III. Over 1000 Volts

The proposal is to revise this "Part" text string to;

Part III. Over 1000 Volts (210.50-.70)

And, to do the same for all "Parts" of all NEC Articles.

Statement of Problem and Substantiation for Public Input

BASIS FOR CODE REVISION: to facilitate quicker more efficient code searches by providing a context clue via association of the paragraphs that are correlated to the "Part" sub-category. Page-by-page code searches that miss seeing the keyword "Part" somewhere on the page, could now be less prone to such erroneous mis-associations

Submitter Information Verification

Submitter Full Name: John Blissett
Organization: Bernhard TME
Street Address:
City:
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Submittal Date: Thu Sep 03 19:32:38 EDT 2020
Committee: NEC-P01

Copyright Assignment

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Public Input No. 3013-NFPA 70-2020 [Global Input]

Move all definitions in the code to Article 100, arrange them in alphabetical order and without any subdivisions.

Statement of Problem and Substantiation for Public Input

The National Electrical Code has definitions in multiple parts in Article 100 and many definitions scattered through out the code many of them in the .2 section of the articles.
Most of the other standards under NFPA have their definitions in one location and this will allow the NEC the same requirement. The Revisions to the NEC Style require all the definitions to be moved to Article 100.

Submitter Information Verification

Submitter Full Name: David Williams
Organization: Delta Charter Township
Street Address:
City:
State:
Zip:
Submittal Date: Thu Sep 03 21:41:22 EDT 2020
Committee: NEC-P01

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Public Input No. 3141-NFPA 70-2020 [Global Input]

Move all definitions in current (2020) NEC text to Article 100. Insert those definitions in alphabetical order. For definitions that apply in only one article, the article number in parentheses shall follow the definition. The CMP responsible for the definition shall be identified in parentheses at the end of the definition following any extract or article information.

Type your content here ...

Statement of Problem and Substantiation for Public Input

This revision provides a more usable code by providing a uniform process to find definitions. Users are currently required to look in multiple locations to determine if a term is defined. Other NFPA codes and standards utilize a single location for all definitions.

Submitter Information Verification

Submitter Full Name: Donald Cook
Organization: Shelby County Department of De
Affiliation: Self
Street Address:
City:
State:
Zip:
Submittal Date: Sat Sep 05 15:11:40 EDT 2020
Committee: NEC-P01

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Public Input No. 3327-NFPA 70-2020 [Global Input]

Review the revisions to the new NEC Style Manual and make changes to comply with the Style Manual.

Statement of Problem and Substantiation for Public Input

The NEC Style Manual has been revised and every code making panel needs to review the manual and make changes to their code articles to comply with the Style Manual revisions.

Submitter Information Verification

Submitter Full Name: David Williams
Organization: Delta Charter Township
Street Address:
City:
State:
Zip:
Submittal Date: Tue Sep 08 07:31:11 EDT 2020
Committee: NEC-P01

Public Input No. 3328-NFPA 70-2020 [Global Input]

Review the Articles with multiple parts to comply with the revisions made to the NEC Style Manual. Make changes based on the Style Manual revisions.

Statement of Problem and Substantiation for Public Input

Section 2.1.4 was revised by adding the last two sentences. Where an article contains multiple parts and includes general installation requirements, such requirements shall be located in the first part titled “Part I. General”. Part titles shall be descriptive and as concise as possible.

Submitter Information Verification

Submitter Full Name: David Williams
Organization: Delta Charter Township
Street Address:
City:
State:
Zip:
Submittal Date: Tue Sep 08 07:34:42 EDT 2020
Committee: NEC-P01

Public Input No. 3329-NFPA 70-2020 [Global Input]

Revise the Definition Title Structure to comply with the NEC Style Manual.

Statement of Problem and Substantiation for Public Input

Review the Style Manual Revisions in 2.2.2.3 Definition Title Structure. Definitions that have sub-parts shall be listed alphabetically by the base term, with a comma and then the modifying descriptor.

Submitter Information Verification

Submitter Full Name: David Williams
Organization: Delta Charter Township
Street Address:
City:
State:
Zip:
Submittal Date: Tue Sep 08 07:36:42 EDT 2020
Committee: NEC-P01

Public Input No. 3330-NFPA 70-2020 [Global Input]

Verify that all exceptions are written in completed sentences.

Statement of Problem and Substantiation for Public Input

The NEC Style Manual requires that all exceptions are written as complete sentences in accordance with 3.1.4.1.

Submitter Information Verification

Submitter Full Name: David Williams
Organization: Delta Charter Township
Street Address:
City:
State:
Zip:
Submittal Date: Tue Sep 08 07:40:56 EDT 2020
Committee: NEC-P01

Public Input No. 3331-NFPA 70-2020 [Global Input]

Revise the definitions in Article 100 to include an acronym, as desired, for subsequent use in the NEC without having to state the term.

Statement of Problem and Substantiation for Public Input

The permitted use of acronyms in the NEC has changed with the Style Manual revisions in 3.2.3. When a term is defined in Article 100 and includes an acronym, that acronym is permitted to be used elsewhere through out the code.

Submitter Information Verification

Submitter Full Name: David Williams
Organization: Delta Charter Township
Street Address:
City:
State:
Zip:
Submittal Date: Tue Sep 08 07:43:12 EDT 2020
Committee: NEC-P01

Public Input No. 3332-NFPA 70-2020 [Global Input]

Review the structure of all Informational Notes to comply with the revised NEC Style Manual.

Statement of Problem and Substantiation for Public Input

Sections 3.1.3.1 and 4.1.3 of the revised NEC Style Manual includes designed structure for references in Informational Notes.

Submitter Information Verification

Submitter Full Name: David Williams
Organization: Delta Charter Township
Street Address:
City:
State:
Zip:
Submittal Date: Tue Sep 08 07:48:58 EDT 2020
Committee: NEC-P01

Public Input No. 3333-NFPA 70-2020 [Global Input]

Review all references to articles or parts of articles to comply with the Style Manual.

Statement of Problem and Substantiation for Public Input

Section 4.1.4 References to a Part Within an Article. Except for Article 100, references shall not be made to an entire article. References to parts within articles shall be permitted.

Submitter Information Verification

Submitter Full Name: David Williams
Organization: Delta Charter Township
Street Address:
City:
State:
Zip:
Submittal Date: Tue Sep 08 07:50:17 EDT 2020
Committee: NEC-P01

Public Input No. 3335-NFPA 70-2020 [Global Input]

Review the use of Parts within an article and the section number for parts of an article.

Statement of Problem and Substantiation for Public Input

The code panels need to review the sections under their purview to comply with the revisions made to the NEC Style Manual. 2.4.2.1 Parts. If an article is subdivided into parts, it is recommended that the section numbering within each part start with the next decade as a minimum to allow for future growth. New or significantly reorganized articles shall follow this numbering convention. Where an article has multiple parts, Part I. shall be titled “General”.

Submitter Information Verification

Submitter Full Name: David Williams
Organization: Delta Charter Township
Street Address:
City:
State:
Zip:
Submittal Date: Tue Sep 08 08:02:00 EDT 2020
Committee: NEC-P01

Public Input No. 3336-NFPA 70-2020 [Global Input]

More than one informational note in a section or subdivision shall be consectutively numbered.

Statement of Problem and Substantiation for Public Input

The numbering of informational notes need to comply with the changes made to the revised Style Manual.
2.4.3. Numbering Informational Notes. If there are two or more informational notes in a definition, section or subdivision, consecutive numbering of the informational notes shall only occur in that definition, section or subdivision.

Submitter Information Verification

Submitter Full Name: David Williams
Organization: Delta Charter Township
Street Address:
City:
State:
Zip:
Submittal Date: Tue Sep 08 08:10:27 EDT 2020
Committee: NEC-P01

Public Input No. 3490-NFPA 70-2020 [Global Input]

100 Definitions

Defined terminology associated with Manufacture and Construction activities.

1. **The term "Construction" shall be defined as the process of deploying product or installation of a device, material, or item of equipment in accordance to its designated purpose. An owner or owner's agent (e.g. contractor) implements construction at a specific worksite location for either a permanent installation, or a temporary application as permitted by code. Installation shall comply with manufacturer terms and ratings unless permitted otherwise in this code. All code delegated responsibilities for testing, marking, labeling, identification, documentation, etc., which are not the clear accomplished responsibility of the manufacture production process, shall be the due diligence responsibility of those involved with the construction process, unless approved otherwise by the authority having jurisdiction.**

Informational Note: construction applications include, but are not limited to, activities associated with activities involved with: install, field installed, field applied, field tested, field assembled, field evaluation, field wiring, field marking, field conversion, and field labeled.

2. **The term "Fabricated" shall be defined to apply to equipment or an assembly that is neither necessarily listed nor mass-produced. For example, custom equipment, a custom assembly, or equipment that is altered from its original listing. Fabrication may occur in whole or part onsite or offsite. Component parts and materials may be listed, or may be required to be listed by this code or by the authority having jurisdiction. Generally, where fabricated products are permitted by this code, code compliant product qualification shall be by a Field Evaluation Body, where duties typically include: product testing, marking, labeling, identification, standards compliance, product documentation and instructions sufficient for the safe operation appropriate per the application criteria. Fabricated applications also include reconditioned equipment and retrofit equipment, as permitted by this code, wherever equipment is functionally restored to other than conformance to the original manufacturer's equipment ratings and life cycle projections. Fabricated equipment and systems that encompass, in part or whole, any associated construction activities and elements, shall absorb the associated due diligence responsibilities involved, except as approved otherwise by the authority having jurisdiction.**

Informational Note: fabrication applications generally include, but are not limited to, activities associated with pre-fabricated equipment and systems: electrical system assemblies, mechanical system assemblies, and modular building assemblies. Where the assembly is listed as a unit, then the manufacture application responsibilities apply.

3. **The term "Pre-fabricated" shall be defined to apply to those fabricated equipment assembly activities that occur at a site other than the permanent installation location.**

4. **The term "Manufacture" shall be defined as the factory assembly of a product, characteristically mass produced and distributed. Examples include: equipment, wire, devices, material, and compounds. The manufacture process includes production activities including: factory testing, marking, labeling, identification; NRTL Listing where applicable; standards compliance, product document publication for sales and designer specifications including those used for: shipping, install, field**

testing, owner use, and maintenance. By definition, final assembly or other in-field activites of a product at its permanently installed location will not constitute an aspect of manufacture, unless performed by the manufacturer.

Informational Note 1: applications where a product's permanent or temporary installation occurs at a point-of-use location under direct supervision of the manufacturer, the requirement duties of both the manufacture process(es) and associated construction process shall be the responsibility of the manufacturer, except as approved otherwise by the authority having jurisdiction.

Informational Note 2: manufacture applications shall include modular equipment, where an assemblage of different products has been hybridized into a singular unit, when the unitized equipment is listed. Where the unitized equipment is not listed as a unit, then the fabricated application responsibilities apply.

Statement of Problem and Substantiation for Public Input

BASIS FOR CODE REVISION:
The term "construction" is used throughout NEC in reference to code requirements that are aimed at typically different segments of industry, which only occasionally overlap each other's general task sets. Product construction during manufacture is one application, versus product install during site construction. The code text describes both contexts as construction. Where practicable, it would improve functional clarity in code text requirements to employ distinct construction-like terms wherever reasonable and appropriate. The terms and definitions proposed are suggestions; to serve as a basis to move this discussion and consensus forward.
Where code requirements clearly intend compliance fulfillment to be about the product's activities prior to leaving the factory, distinct terminology can communicate this with added clarity. Similarly, where code compliance fulfillment clearly applies to the implementation of a product, as regards its permanent installation, a distinctly defined term for 'construction' will yield improved comprehension as to intended context. A third distinct category can also be established by definition that encompasses fabrication, to serve to encompass custom fabrication assemblies, reconditioned equipment, and retrofits.
Applications where the code responsibility can fall into gray areas for accountability between the three, can be attended to by a default assignment of responsibility. This explicit clarity helps ensure that enforceable code compliance responsibilities are clearly stated. Allowance for an exception, per AHJ acceptance, provides a mechanism to formally transfer an obligation of responsibility.
Where the code speaks to putting an identifying mark, or information, or color onto a cable or item of equipment, it more often refers to those which would intend to be understood as the responsibility of the manufacturer. The following two sets of code citations illustrate where the manufacturer is to provide a mark or color (first set) versus where the installer is to provide a mark or color. The third set of code citations is where it is intuitively apparent that either the manufacturer or installer could either be involved (or both involved) in providing a mark or color on the electrical equipment.
Example requirements for manufacturer marks or color include but are not necessarily limited to; 110.14(D), 110.28, 200.4(B), 200.6, 200.7, 200.9, 200.10(B), 200.10(D), 215.12(A), 215.12(B), 225.30(A)(7), 230.46, 230.66(A), 230.70(B), 230.77, 240.50(C), 240.81, 240.82, 240.83(A&B), 240.83(D), 240.85, 250.28(B), 250.110 Ex3, 250.119, 250.119(A), 250.119(B), 250.119(C), 250.126, 250.28(B), 250.112, 250.114, 250.119, 250.126, 300.11(B)(1), 300.11(B)(2), 310.3(D), Table 310.4(A), 310.6(ABC), 310.8(C)&(D), 310.10(C), 310.10(D), 311.14, 311.16(A), 311.16(B)(1&2)), 311.16(B4&C), 311.32, 314.16(C)(2), 322.56(B), 322.120(C), 336.120, 338.120, 368.12(E), 386.70, 388.70, 406.3(D), 406.3(E), 406.10(B), 406.13 (A-D), 409.110, 430.52(C)(5), 500.8, 501.5, 501.17, 501.105(B)(1), 501.130(A)(1, 502.6, 502.130(B)(1), 502.130(B)(2), 503.130(A), 504.80(C), 505.8, 505.20(B&C), 505.22, 505.26, 506.9(C)(1), 506.9(C)(2), 506.9(D), 517.18(A), 517.19(A), 517.61(C)(2), 530.21(B), 530.22(B), 545.22(A), 551.77(A), 552.10(B)(3), 552.10(E)(2), 555.8, 555.33(B)(2), 600.23(F), 600.33(A)(3), 600.33(A)(4), 690.12(C), 690.51, 694.22(A), 700.10(A), 705.12(D), 705.20, 706.15(C), 708.10(A)(2), 712.37, 725.3(P), 725.179, 760.3(O), 760.30, 760.176(G), 760.179(G)(1), 770.179, 800.182, 805.179, 820.179, 830.90(A)(2), 830.179(C&D), 840.170(B), and 840.170(E).
Example requirements for the installer to do the marks or color indications include but are not necessarily limited to; 200.4(B), 200.6, 210.5(C)(1), 210.5(C)(2), 210.12, 215.12(A), 215.12(C)(1), 215.12(C)(2), 225.30(B), 225.38(C), 225.52(D&E), 230.72(A), 300.5(D)(3), Table 300.50, 310.6(ABC), 311.14, 406.3(E),

406.10(B), 408.3(E)(2), 408.3(F)(1), 408.3(F)(2), 408.3(F)(3), 408.3(F)(4), 408.3(F)(5), 517.18(A), 517.19(A), 517.160(A)(5), 530.21(B), 530.22(B), 547.9(A)(10, 550.33(A), 552.43(C), 620.53, 620.55, 647.4(C), 647.7(A)(4), 668.21(C), 690.54, 690.55, 700.10(A), 712.25, 712.55, 725.124, 760.30, and 770.179(F).

Example requirements for either the manufacturer and/or the installer to do the marks or color indications include but are not necessarily limited to; 230.56, 250.21(C), 250.167(C), 408.3(E)(1), 409.102(B), 430.97(B), 430.109(A)(6), 430.109(E), 517.31(C)(1), 517.31(E), 517.42(E), 520.44(C)(3), 520.54(C), 520.54(J)(1), 520.54(K), 530.21(B), 530.22(B), 550.10(I), 690.1, 690.31(B)(1), 690.31(D)(2), 770.179(G), 805.90(A)(2), and 805.170(A).

As regards reconditioned equipment and retrofit equipment, the code is in its developing infancy as regards code requirements for marks, as they are few, yet likely to grow in upcoming code cycles. Having distinct groups for manufacture, installation, and fabrication also serves to help make obvious, the places in code that similar code requirements between them may be missing but warranted.

Similar to the topic above for equipment marks between manufacture, installation, and fabrication, are topics for labels and signage which are beyond marks.

In NEC Chapter 3,4 and 7 the term “manufacture specifications” can substituted for “construction specifications”. And in NEC Chapter 5 and 6, where specifications have other terminology variations based on product qualities, “manufacture specifications” can be used with such term descriptors for NEC consistency to augment transparency when a code specification is intended to apply to manufacture apart from installation criterion.

Another example benefit from having a distinction between manufacture, installation, and fabrication are for the code required documentation and whom is to provide it. Such as; instructions for shipping, install, or maintenance, versus installer instructions for operation sequence, equipment ratings guidance or site-specific diagnostic protocols.

Where an entity assumes multiple roles of manufacture, installation, and/or fabrication, they are intended to assume the respective responsibilities. And, what those responsibilities are will have improved certainty, when there are improvements to distinctions of terminology and nomenclature. Inspections and commissioning processes will similarly be improved for the same basis of improved enforceable clarity.

SIDEBAR: a supplemental suggestion, in the earnest of minimizing code text where practicable, is to utilize a letter or symbol icon, for use in NEC margins, that correlates to each of the three definitions for, manufacture, versus fabricated, versus construction. For example, a symbol icon for manufacturer (e.g. Hex Note enclosing an 'M'), versus those affiliated with the product install construction process (e.g. Hex Note with 'C'), versus the symbol for the fabrication process (e.g. Hex Note with 'F'). One example of benefit of deploying a symbolic nomenclature is the topic of labels, signage, and markings; which are often able to be grouped by: manufacturer, fabricated, or installer. Each instance in code for label, mark, or sign can include one or more of these three symbols in the margin alongside the code text without adding pages to the code. A raised bar of label and signage compliance is likely the result, plus an improved ease and capacity for enforcement by way of inspection or commissioning.

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Public Input No. 4390-NFPA 70-2020 [Global Input]

When an Article has Parts the revised Style Manual requires the following in 2.1.4.

Part titles shall be descriptive and as concise as possible.

Example:

Part I. General

Part II. Installation

Part III. Construction

Statement of Problem and Substantiation for Public Input

The revised Style Manual requires Article Part titles to be descriptive and concise as possible and provides examples for the code panels to use.

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Public Input No. 4707-NFPA 70-2020 [Global Input]

Globally revise the use of term "Listed", and revise use of the term "Labeled"

To distinguish the NRTL (testing lab) context for the term "labeled" and "listed" from other NEC context uses of these words in all their forms; label, labels, labeling and labeled, it recommended to apply capitalization to the word "Labeled" and "Listed" when intended for this particular context of a testing organization. Capitalization as proper nouns will make this context more readily recognizable.

For additional distinctive clarity for this context of these terms 'listed' and "labeled", apply them with their "NRTL" modifier; and deploy "NRTL Listed" and "NRTL Labeled" throughout the Code text. Of course, all variants formed for grammatical correctness would also be amended and capitalized, such as "NRTL Listing" and "NRTL Label" etc.

In the definitions, it is appropriate to associate NRTL to "Nationally Recognized Testing Laboratory", which is generally the type of testing agency. Any other testing agency, where approved by an AHJ, is allowed. It is also appropriate to include a reference to the industry standard organization that acknowledged to govern this industry acceptance standard for each NRTL, the Occupational Safety and Health Administration (OSHA). With OSHA acknowledged as the official agency, it becomes a Code-legitimized reference, able to facilitate any follow-up enquiries regarding code compliance. To help facilitate back-checks has never been more suitable than in this age of ever-increasing pirating of product and other pretenders to suitability.

Wherever the term 'Labeled' is used as part of 'NRTL Listed and Labeled', it shall refer to the equipment mounted labeling that is pertinent to all of the equipment item's application-specific Listing(s) and shall include the equipment ratings.

Wherever the term 'Marked' is used as part of 'NRTL Listed and Marked' or 'NRTL Listed and Labeled and Marked', 'marked' shall refer to the marking or labeling that is associated with the Listing and shall include the specific qualification of use mentioned in code. E.g. listed and labeled and marked as being suitable for use as service equipment.

Statement of Problem and Substantiation for Public Input

BASIS FOR CODE REVISION:

The term 'Listing' and 'Listed' will be capitalized and treated as a proper noun; short for 'NRLT Listing' and 'NRTL Listed'. The term 'Labeled' will also be capitalized as a proper noun when used to indicate 'NRTL Labeled' or 'Manufacturer Labeled' as regards the manufacturer's terms of use for the equipment. NFPA codes does not capitalize these three terms generally so they are indistinguishable from the other contexts for a list or label. Manufacturer terms of use regarding labeling can include ratings, Listing types, or other declarations of compliance to particular industry standards.

There Code text of NEC 110.3, Part (C) may have intended for equipment generally to be Listed, but technically it is not ever stated. All that is stated is the terms for who will do the testing and evaluation as regards a Listing.

The Occupational Safety and Health Administration (OSHA) is the official agency that recognizes qualified testing laboratories, of which there are 23 approved labs to date. OSHA confirms that NEC's "electrical" sub-distinction of labs in NEC 110.3, Part (C) doesn't formally exist as an industry recognized group. The 'electrical' testing laboratory distinction is an obscure reference used in two other places in the NEC [90.7,

490.48(A)], but not in the NEC's other (14) references of a testing laboratory. Underwriter Laboratories (UL) is the only distinct NRTL lab whose standards are cited in the NEC and there are hundreds of UL citations (see. NEC Informative Annex A). One relevant ATS example is cited in NEC; UL1008 for transfer switches up to 600V. And one relevant ATS example is not cited in NEC; UL1008A for 750V-46kV ATSs. Whether another NRTL lab other than UL may qualify NEC's intent as an "electrical lab" is unknown. The NEC requirements are functional without the "electrical" sub-distinction, and so this likely warrants deletion of "electrical" in an upcoming NEC code revision.

Though these code articles infer an expectation that an ATS shall be used, an ATS is not overtly mandated as required. Only when an ATS is used, then definitive code requirements apply, like a Listing for emergency use.

NEC Article 705 applies to Interconnected Power Production Sources that parallel with the normal source, which is typically the utility supplied power source. There is an incongruence of code due to what NEC 705 allows. That is whenever the 705 code language is interpreted as an absolute permission due to the omission of disallowances of use as an essential-class power system. The code requirement variance compared to similar applications is a risk, because it then grants an emergency power distribution topology absolution because the code language allows it. NEC Article 705 has no requirements for equipment to be Listed for any aspect.

NEC 705 applies to distribution gear that interconnects normal power (e.g. utility) with an alternate source of power (e.g. generator). The 705 distribution gear may serve in place of an automatic transfer switch because the code does not disallow that use. Yet code does not require it be listed for emergency use, nor does it even require the automated switching mechanisms to be electrically operated and mechanically held. The NEC 705 gear has latitude to have more than two sources and more than one load. The function of NEC 705 gear may be no less critical but it is more susceptible to dysfunction than an ATS. It is arguably more important even than any single automatic transfer switch as it can perform the duty of multiple transfer switches or be the power source to many ATSs. It is like using a string to support a chain. This example illustrates how language of one NEC article (705) can permit use of a power distribution topology that is inconsistent to all other instances of code text regarding transfer switching of emergency power, which would otherwise be fairly consistent.

Application Specific Code Requirements

A summary of code findings on power source selection for emergency applications is as follows;

1. FOR ALL CODIFIED POWER SYSTEM TYPES OTHER THAN NORMAL: An ATS shall be NRTL Listed for Emergency Use (and also identified for Standby Use). Exceptions are:

A. Optional Standby Power System (NEC 702; other Listing requirements may apply)

B. Fire Pump (NEC 695; other Listing applies)

C. Interconnected Power Production Sources (NEC 705)

D. Medium Voltage (see caveats below)

2. MEDIUM VOLTAGE CAVEATS:

A. NFPA 99 indicates an ATS <600V must be Listed for the purpose. No mention of requirements for other voltages >600V. Allowance for ATS >600V to not be Listed is one logical inference.

B. NFPA 110 states MV transfer of central plant or mechanical equipment is allowed using electrically interlocked medium voltage circuit breakers; but the equipment branch MV transfer switch is not to include life safety (LS), emergency (RE), or critical branch (CR) loads. By mention of critical branch this code regards healthcare but is not correlated by any healthcare code; neither by NFPA 99 nor by NEC 517. Allowance by Listing omission may be logically inferred for power system types not mentioned; SEPSS (NFPA 111), RSPSS (NEC 701), EQ (NEC 517), FPPSS (NEC 695), FCPSS (NEC 692), and EPSS (NFPA 110). Note that an MV transfer equipment is not disallowed for LS, RE, or CR if the MV switch is separated from mechanical loads. Also, there is no disallowance to separate loads if the MV ATS is Listed.

C. NFPA 70 (NEC) does not mandate a Listing requirement specific to distribution gear generally, including medium voltage (MV) equipment. NEC makes no mention of MV ATSs, nor provides any specific exemption for an MV ATS. That paralleling gear has no Listing requirement at all would apparently extend to MV types of paralleling gear.

3. FOR FIRE PUMP APPLICATIONS: A fire pump's local ATS and/or controller shall be NRTL Listed for electric motor-driven fire pump service. Other transfer equipment upstream of a fire pump ATS does not qualify it as a fire pump ATS also; so only the lower level ATS must meet these 'Fire Pump ATS' requirements.

4. GENERAL REQUIREMENTS: NRTL Listing types compound for each condition of use that applies; 'emergency', 'wet location', etc; whenever the NRTL Listed Use is an available product offering. An ATS must be NRTL Listed for all of the load types to be served. Field labeling by a Field Evaluation Body is an alternate compliance path for a Listing requirement generally, except where a Listing is overtly stated as the only compliance path such as for an ATS and select other NEC applications.

5. OPTIONAL STANDBY APPLICATIONS: Transfer equipment shall be NRTL 'Listed as Transfer Equipment' wherever supplemental circuit protection devices (CPD) are integral to the transfer equipment. No other Listing requirements apply for Optional Standby transfer equipment.

6. INTERCONNECTED POWER PRODUCTION SOURCES are a recognized transfer switch application apart from an ATS. NEC 705 scope only applies to multiple sources if the normal source (e.g. utility) is one of the sources. Where field labeling is provided, the NEC does not mandate any requirement for a Listing of any kind. Even if it is Listed, NEC doesn't require the gear to be NRTL 'Listed as Transfer Equipment' (as CPD optional standby transfer equipment must do), nor 'Listed for Emergency Use' (as all other emergency power transfer equipment must do). Where NEC 705 is applied to critical grade topologies, NEC suffers a glaring omission for any code-required NRTL type validation for a failsafe style of integrity, suitable for essential-class loads.

7. PARALLELING GEAR for automatic transfer switching of multiple sources (apart from an Article 705 type system) has no code article that governs its performance requirements. Only if the paralleling gear is connected to a normal (utility) source must it then comply with NEC 705. But even then the 705 requirements are not up to the usual code standards for critical or emergency gear and so it does not impose any failsafe standard for integrity including associated Listings.

Ironically, NEC 110.3(B) does state (by omission) that only the Listed or Labeled equipment needs to be used in accordance with the equipment manufacturer's instructions. Because the NEC makes no similar requirement of equipment that is not Listed nor Labeled, this equipment category escapes the stipulation to comply with the manufacturer's terms of use. This however is recognizable as nonsense, and an intonation of NEC intent must be interpolated.

NEC 110.3, Part (C) fails to identify that multiple Listings may be required for a product, and that one Listing may not be adequate. An individual separate Listing for each specific category of use is required whenever such Listing categories apply to the conditions of the equipment use.

NEC 110.3, Part (C) also fails to identify NEC's own exemptions for its general requirement that everything be Listed, and whether there are terms for when these exceptions are permitted or disallowed. One category is custom fabricated equipment, of which certain field assemblies may qualify as hybrid sub-category. One other category is equipment that has been reconditioned, refurbished or remanufactured. One final category is non-Listed equipment where NEC has outlined the specific terms of permitted use based on application. The problems arising from potential distinctions of allowances for non-Listed equipment is much more pronounced when the inconsistencies of Listing requirements by specific application are attempted to be put into a proper context (more on this in Chapter 8).

A best practice default for equipment selection is to choose a Listed product whenever one is available, and include each Listing application type that applies. Only when a Listed product cannot meet the design requirement should an alternative be considered; such as a custom fabricated product. Even then, such non-Listed applications shall be responsibly managed to best show coherence to all other code intent toward trustworthy integrity of; the components, the assembly work, and the resultant functionality. And where NEC outlines terms for use specific to "non-Listed" equipment (as done in Chapter 8), it shall be considered an acceptable form of compliance.

The NEC variations of terminology for Listed and for Labeled is diverse but the reason for this inconsistency is not always evident. The numeral in parenthesis is the number of occurrences found for each term in the NEC.

SIDEBAR: As the deadline for 2020 Public Comment is impending, the values and citations from here forward were not back-checked to 2020 NEC from the v2017 they were derived from .

1. Listed (1715), Listing (247), List (9)
2. Approved (473), Approving (2), Approval (44)
3. Labeled (65), Labeling (30), Labels (57), Label (55), Field Labeled (3), clearly Labeled (1)
4. Identified (2), Identifying (35), Identify (41)
5. Marked (647), Marking (555), Mark (31), Marks (3)
6. " Listed for" (332)
7. "Listed and Labeled" (21)
8. "Listed and Labeled for" (2)
9. "Listed or Labeled" (6)
10. "Listed, Labeled, and identified" (18)
11. "Listed, Labeled, or identified" (1)
12. "Prominently Labeled" (2)
13. "Listed, Labeled, and marked" (1)
14. "Listed and Labeled or field identified" (1)

Situation specific NEC requirements for equipment to be "Listed" vary case-by-case, whether by code article, or by site application type, or by equipment category. The way the requirements varied indicate that either code intent is not always consistent, or that the manner in which NEC requirements are written are a mixed bag of inconsistencies. In actuality, it is both.

The code citations below are selected to indicate general requirements and the requirements specific to switch transfer of emergency power sources. Other unrelated code citations are included to illustrate how the code may show consistency and how it shows inconsistency.

1. Listing Requirements by NEC Article

Every material item used for Trailer Parks (NEC 552), RVs (NEC 551), and mobile homes (NEC 550) must be Listed. But not a thing is mandated as needing to be Listed for hospitals (NEC 517), floating buildings (NEC 553), and certain other applications in NEC such as; Cablebus (370), Multioutlet Assemblies (380), Underfloor Raceways (390), Concealed Knob and Tube Wiring (394), Open Wiring on Insulators (398), Outdoor Overhead Conductors Over 1000V (399), Flexible Cords and Flexible Cables (400; though only nearly nil), Fixture Wires (402), Industrial Control Panels (409), Fixed Industrial Heating Equipment (455), Capacitors (460), Resistors and Reactors (470), Equipment Over 1000V (490), Integrated Electrical Systems (685), Interconnected Power Production Sources (705; aka paralleling gear), Circuits and Equipment Under 50V (720), and Energy Management Systems (750).

2. Listing Requirements by Equipment Category

For other NEC articles, the requirements for Listed equipment amounts to an honorable mention of oddities in bits and pieces; not because those bits are especially significant, or associated with criticality. NEC will

mention a Listing requirement for the parenthetically consequential 1% and miss the more essential 99%. Switchgear (408) requires that insulated conductors are Listed, but NEC invokes no other requirements of anything else to do with switchgear to be Listed. There are times that NEC chapters or paragraphs only apply technically for any equipment which is Unlisted.

Most all raceways and cabling, but one, are required to be Listed from the 300 series articles of NEC. But at many points amongst the other code articles, only the fittings are indicated as needing to be Listed. The singular 300-series article for cablebus that was inadvertently skipped, is likely an oversight.

3. Listing Requirements by Application Type

Some aspects of Listings are meant to apply categorically, like a Wet Location Listing for any equipment in wet locations; but NEC consistency is sporadic and omissions prolific where they should apply. This inconsistency is similar to the requirements mentioned for sun exposure considerations.

At some points of code there are common applications with common importance factors but they are treated with uncommon requirements.

4. Observations of Inconsistent and Irrelevant Text

The terminologies for similar types of Listings has aspects of inconsistency, such as the five different terms used for an ATS to be Listed for Emergency Use. The verbiage variations could infer that these refined differences in text vary for good reason (with potentially varying requirements), but under scrutiny they do not.

There are code sentences that are superfluous because the Listing requirement for a subcomponent item being mentioned was already imposed generally at some other NEC article prior. Such as for particular conduit fittings to be Listed. To make matters worse, the requirements at one location in code doesn't always match the other location.

Other code text is a waste of language as the statement is redundant unto itself. Such as stating that use of equipment is okay if the Listing says it's okay. Or employing a double-negative to state that equipment is not to be used in a way that the Listing doesn't say is okay. As a side issue, such statements infer that there are "Listing Instructions" to follow for each Listing type. That such instructions exist and are published respective to Listing types is not affirmed to be an industry accepted understanding. How is it proposed that such reference materials are to be captured with consistent integrity by electrical system designers?

At times one or two specifications or features of the Listing itself, are mentioned with the NEC code text. But the exclusion of the other Listing features beckons follow-up questions as to why a partial redundant mention is relevant for some features of the Listing but not the others.

Some NEC text has inferences that a Listing requirement exists without an actual requirement of a Listing ever being stated overtly, only as an inference that the requirement already exists. Conditional statements employing logical grouping sometimes miss clear meaning due to commas missing at relevant points of the sentence.

The benefit that the above comments hope to achieve is in universal applications of Listing requirements as a categorical default wherever practicable, with caveats to follow as to exceptions or specialty additions, such that taken together, the Code edits would amount to less text and simpler forms of clarity. It would be an aide, perhaps suited to Chapter 9 indexes if nowhere else, to have a running list of all potential types of Listings that may be suited to electrical applications governed by NEC. Of course, such a reference list would be subject to on-going updates, but to see them all is perhaps the opportune way to know them.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 4586-NFPA 70-2020 [Definition: Labeled.]	similar topic
Public Input No. 4591-NFPA 70-2020 [Definition: Listed.]	similar topic

Public Input No. 4619-NFPA 70-2020 [Section No. 110.3(B)]	similar topic
Public Input No. 4624-NFPA 70-2020 [Section No. 110.3(C)]	similar topic

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Public Input No. 2766-NFPA 70-2020 [Global Input]

Clarify terminology of power system types and power supply system types.

For NFPA 70, 99, 110, and 111 taken together, there are seven (7) or more codified power distribution system types and seven (7) or more codified power supply system types that would benefit from a consistently applied pattern in their terminology. It is proposed that wherever there is a particular codified type of power system, apply uniform terminology in the definition.

For distinctive codified types of power distribution, include either "Power System" or "Power Distribution System" in the defining terminology, with examples as follows;

A. Essential Electrical System of NFPA 70 Article 517 and NFPA 99; revise to "Essential Power System."

B. Fire pump circuits of Article 695; revise to "Fire Pump Power System."

C. Emergency Systems of Article 700; revise to "Required Emergency Power System."

D. Legally Required Standby System of Article 701; revise to "Required Standby Power System."

E. Optional Standby System of Article 702; revise to "Optional Standby Power System."

F. Critical Operations Power System of Article 708 remains unchanged.

G. And for references to normal power; revise code text to "Normal Power System." And, codify it in NEC Article 100 with a proper definition.

For distinctive codified types of a power source, include "Power Supply System" in the defining terminology. Also, preface with the term "Essential" wherever the Power Supply System must comply to an elevated class of resilience due to load criticality, "Essential Power Supply System". Examples are as follows;

A. Emergency Power Supply System of NFPA 110; revise to "Engine Driven Essential Power Supply System". The "Engine Driven" term is added to distinguish this essential power system distinctly apart from all other types of essential power systems; "Stored Energy Essential Power Supply System" and "Fuel Cell Essential Power Supply System." It used to be that NFPA 110 sources encompassed all those sources that NFPA 111 did not; however, with the advent of fuel cells into the foray of permitted essential power sources, this is no longer the case. *Although at the time of this writing, it is not yet clear what code standard for fuel cells measures up to the system resilience robustness intent of NFPA 110 and 111.*

SIDEBAR: these three essential power systems together share a unique characterization of supplying emergency, critical, and essential power systems. If another new distinctive definition were to be coined to describe the group of these essential power system sources; it would be dutiful to consider the inclusion or exclusion of unitized batteries with that category, or else derive a more functional other category.

B. Stored Energy Emergency Power Supply System (SEPSS) in accordance with NFPA 111; revise to "Stored Energy Essential Power Supply System." Swapping the term 'essential' for 'emergency' accomplishes three things.

1. By not using the term 'emergency', it affirms that there are more types of code required alternate power system types beyond just the 'emergency' type (of NEC Article 700) that this

standard should also apply to.

2. The term 'essential' can function to associate this as one of the few select sources approved for similar applications.
3. The importance factor of "essential" can maintain distinction of this power source supply system as an elevated class of resilience apart from the power source supply system of NEC Article 706, Energy Storage Systems.

C. Solar Photovoltaic (PV) Systems in accordance with Article 690; revise to "Solar Photovoltaic (PV) Power Supply System."

D. Large-Scale Photovoltaic (PV) Electric Power Production Facility Systems in accordance with Article 691; revise to "Large Scale Solar Photovoltaic (PV) Power Supply System."

E. Fuel Cell Power Systems in accordance with Article 692; revise to "Fuel Cell Power Supply System."

a. Where used for supplying required alternate power (e.g. Article 517 and NFPA 99 where permitted to supply the Essential Electrical System), another terminology should be employed to cite whatever code standard is intended to outline compliance with those particular code requirements; "Fuel Cell Essential Power Supply System."

F. Wind Electric Systems in accordance with Article 694; "Wind Power Supply System."

G. Energy Storage Systems in accordance with Article 706; " Energy Storage Power Supply System."

Statement of Problem and Substantiation for Public Input

BASIS FOR CODE REVISION:
1) The word "emergency" is defined as a serious, unexpected, often dangerous situation requiring immediate action. Even within NEC, "emergency" is used in both power and non-power applications; emergency stop, emergency disconnect, emergency conditions, emergency battery-powered lighting (allowable to be used for non-emergency applications), emergency generator (allowable to be used for non-emergency applications), emergency purposes, emergency management, emergency communications, emergency use, emergency operations, emergency room, emergency treatment areas, emergency egress, and other NFPA standards offer other emergency systems that are outside the application of power distribution.
To help mitigate inadvertent misappropriation of the term "emergency" or "emergency systems" by users of the NEC and other NFPA codes, it would be prudent to use discreet terminology to clarify when the application strictly regards power systems. The key to optimal clarity is to uniquely distinguish applications of power from each other. And too, make them more easily distinguishable from all other possible interpretations of "emergency" or "emergency system."
NEC Article 700 use of the term "nonemergency" and "non-emergency" should be standardized to a single term. They are intended to apply to any source other than those of Article 700, but may be construed otherwise due to other types of use for the term "emergency." Refer to the last sentence of 70012(H), where after non-emergency is discussed, the code text juxtaposes "normal supply" with that of the "emergency standby system," which could easily confuse this paragraph's intent and be interpreted as either Article 700 power or Article 701 power or both.
2) Power system type categorization can be accomplished by building upon two base level characterizations, "Power System" types (or "Power Distribution System" types) and "Power Supply System" types. This intuitively functions in two ways;
a. For each individual type, the grouping illustrates their association to each other. The common defining term 'power' shows that one of their principal characteristics is shared with each other.
b. Then to distinguish between the (6) code recognized types of power systems and (7) code recognized types of power supply systems, strategic modifier terminology is selected based on their principal distinctions between each other. To do this with the with the most simply stated yet most recognizable principal characteristic would help ensure that definitions are understood most clearly and easily.
The intuitive comprehension aide that this yields to NEC would similarly extend as a benefit throughout the

other NFPA codes, by readily distinguishing these power terms and applications from other kinds of use of the terms "emergency" and "emergency systems." Thus, also helping improve intuitive understandings for those NFPA references outside of NEC, which are potentially being referenced by disciplines not especially versed in electrical, and could benefit from these intuitive clues.
These two base level characterizations may be suited to get their own defined terminologies for particular power group type categories. This may be implemented to simplify general references in code text meant to address one or another entire category; "Power Systems" (where normal power and optional standby power are encompassed with all others) versus "Essential Power Systems" (only those which are code required alternate power sources). And similarly, "Power Supply Systems" versus "Essential Power Supply Systems".
3) The term "emergency" is used frequently throughout the NFPA (refer to NFPA 2018 Glossary) with many diverse meanings and applications of criticality. Distinctions in the differentiation of the terminology itself are especially important in clarifying intent for matters of code requirements. Without obvious clear distinctions in terminology, unintended cross-correlations of requirements may be inadvertently interpreted. For code reference examples, see;
a. "Emergency" in NFPA: 59A, 130, 424, 450, 502, 1006 & 1221
b. "Emergency Power Supply" and "Emergency Power Supply System" in NFPA: 110 & 111
4) The term "emergency system" is used in multiple instances of NFPA codes and is near identical to the pluralized version of the term "emergency systems" used in Article 700 of the NEC (NFPA 70). Some examples from NFPA outside of NEC are;
• "Emergency Systems" from NFPA: 3 & 4. The set of NFPA 3 & 4 definitions for required alternate power system types is an open-ended generalized approximation that makes reference to; COPS (NEC 708), EPS (NFPA 110), EPSS (NFPA 110), Emergency Systems (NEC 700), and Legally Required Standby Systems (NEC 701). The NFPA: 3 & 4 definition fails to reference the following: NFPA 111; the essential electrical systems of NEC 517 and NFPA 99 with its sub-branches; any power system type that could be derived to strictly serve fire pumps; and fuel cells when used as a required alternate power source.
• "Emergency Alarm System" from NFPA: 318 & 5000
• "Emergency Communication System" from NFPA: 72 & 130
• "Emergency Services System" from NFPA: 1250
• "Emergency Shutdown System" from NFPA: 160
• "Emergency Power Supply System" from NFPA: 110
5) The risk of users inadvertently crossing code requirements inappropriately based on the potential for terminology confusion is twofold.
a. The first is that code text applications which may not intend to correlate, based on the term "emergency", could be interpreted to correlate inappropriately. At least until supplemental review and research of code text is exercised diligently within the time permitted to validate clarification otherwise.
b. The second is that applications meant to apply to Article 700, and reference Article 700, should also be referencing other types of essential, critical, life safety, which are not being stated explicitly because the term "emergency" or "emergency system" was believed adequate to cover intent. The types of other such power system types, depending on the application, may include the following;
i. Emergency Power Supply System circuit in accordance with NFPA 110
ii. Stored Energy Power Supply System circuit in accordance with NFPA 111
iii. Essential Electrical System circuits in accordance with Article 517 and NFPA 99, or any of its sub-system branches as follows;
1. Life Safety Branch
2. Critical Branch
3. Equipment Branch
a. Equipment Branch A
b. Equipment Branch B
iv. Emergency system circuit in accordance with Article 700.
v. Legally required standby system circuit in accordance with Article 701.
vi. Optional standby system circuit in accordance with Article 702.
vii. Critical Operations Power system circuit in accordance with Article 708
viii. Fuel cell power supply system circuit, when used as a power source for power system type (3) through (7) above.
ix. A multi-source power system type derived to strictly serve fire pumps in accordance with Article 695. With its alternate source, as permitted from a power source type (1) through (8) above, or derived from an alternate normal power service to satisfy the reliability requirements.
6) Examples of potentially misinterpreted terminology within the NEC are:
a. 230.85 Emergency Disconnects.
b. Emergency Lighting [646.16 & 17]; may be interpreted to be unequivocally associated with Article

700. But, such fault resistant lighting requirements may potentially apply also to;
i. Life Safety Branch AND/OR Critical Branch of Essential Electrical System circuits in accordance with Article 517 and NFPA 99.
ii. Critical Operations Power system circuit in accordance with Article 708
c. Emergency shutoff [680.41]; this use of 'emergency' is of a different character to Article 700. Although there could be an "emergency shutoff" system for the source of an "emergency (power) system" where the term 'emergency' in each vernacular has disparate intonations.
7) Terminology revision can also standardize power type definitions and Article titles around the use of pluralization of power system types; where each definition uses the singular version of the word "system" rather than having the varied usage of both plural and no-plural versions; such as the word "systems" as in Article 700. An exception could be developed for titles of NFPA standards 110 and 111, which might perhaps be best suited to the plural version of system, "systems."
8) It may be prudent to clarify in code definitions of power system types, and power supply system types, and any definitions for the groups of such power types, that in practice, users may also use their own terminology. Users may be explicitly permitted describe or label the power system types on their premises. For example, a power system named after an equipment type; e.g. elevator, imaging equipment, etc. However, it should also be explicitly disallowed for a power system to be unclear, as to which of the (7) codified "power system" types or (7) codified "power supply system" types that any power distribution system is being held in compliance to. Nor should it be permitted to be unclear at which points in the power distribution, that one type of power system converts to another. It may behoove any capacity for inspection, commissioning, service, and consistency within a facility to require specific labeling and/or diagramming that details what all types of power systems are present, and at which specific points of named equipment within the power distribution that power system types convert from one type to another type. In other words, make clear the origination point of each power system type. Grammatical protocol for defined power systems types should uniformly reference them as proper nouns by always using the full term and by employing capitalized letters, so to prevent confusion when the same words are used for other purposes.
9) For consistency across NFPA standards, other subsequent edits would also be submitted as Public Input for NFPA revisions that would correlate to those uses of terminology outlined above, so to maximize the benefits that consistency adds to clarity if done similarly throughout the NFPA standards. Examples of such edits include;
a. The revisions to power system terminologies outlined above, which are associated with NEC Article 517, would also to apply to NFPA 99.
b. The title of NFPA 110 "Emergency and Standby Power Systems" revised to "Engine Driven Essential Power Supply Systems."
d. The title of NFPA 111 " Stored Electrical Energy Emergency and Standby Power Systems" revised to "Stored Energy Essential Power Supply Systems."
d. And perhaps some NFPA standard of the same resiliency caliber as NFPA 110 & 111, but instead structured to address fuel cell based essential power supplies, "Fuel Cell Essential Power Supply Systems."

Submitter Information Verification

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Submittal Date: Mon Aug 31 12:15:14 EDT 2020
Committee: NEC-P13

Copyright Assignment

I, John Blissett, 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

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☑ By checking this box I affirm that I am John Blissett, 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. 3819-NFPA 70-2020 [Global Input]

See Attached Word Document for Changes

Additional Proposed Changes

File Name	Description	Approved
Article_235_Public_Input_-_Final2.docx	Global PI to Revise Articles 210, 215, 225, and 230, Adding New Article 235.	

Statement of Problem and Substantiation for Public Input

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

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

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

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

All changes to Articles 215, 225, and 230 related to installations over 1000 Vac and 1500 Vdc, along with what seem to be applicable requirements in Article 210, are incorporated into proposed Article 235. This is submitted as a Global Input, and includes deleted text that is relocated from Articles 215, 225, and 230. Below is a summary of those changes:

Add a new Article 235 “Services, Feeders, & Branch Circuits Over 1000 VAC, 1500 VDC, Nominal”
- Add a new Part I titled Scope and General to new Article 235
- Add a new section 235.1 with suggested scope of the Article

Branch Circuits – Part II
- Add a new Part II titled Branch Circuits to new Article 235
- Add a new 235.105 titled Identification for Branch Circuits with first level subdivisions for grounded

conductors, equipment grounding conductors, and ungrounded conductors to mirror the requirements in Article 210 for branch circuits under 1000 volts.
o Add a new 235.106 titled Branch Circuit Voltage Limitations Over 1,000 volts Between Conductors to mirror the requirements in Article 210 for branch circuits under 1000 volts.
o Add a new 235.111 titled Branch Circuits Required with first level subdivision for the number of circuits and distribution of the loads to mirror the requirements in Article 210 for branch circuits under 1000 volts.
o Add a new 235.118 title Branch Circuit Rating to address the rating of the circuit and mirror the requirement in Article 210 for branch circuits under 1000 volts.
o Add a new 235.119 titled Conductors-Minimum Ampacity and Size with second level subdivision for the general and supervised installations to mirror the requirements in Article 210 for branch circuits under 1000 volts.
o Add a new 235.120 titled Overcurrent Protection with first level subdivisions for continuous and noncontinuous loads, conductor protection, and equipment protection to mirror the requirements in Article 210 for branch circuits under 1000 volts.

Feeders – Part III
o Add a new Part III titled Feeders to new Article 235.
o Delete 215.2 (B) and renumber accordingly.
o Add a new 235.202 titled Minimum Rating and Size with three first level subdivisions feeders supplying transformers, feeders supplying transformers and utilization equipment, and supervised installations with the text deleted from 215.2 (B) for feeders over 1000 volts.
o Add a new 235.203 titled Overcurrent Protection to mirror Article 215 for feeders under 1000 volts.
o Add a new 235.205 titled Diagrams of Feeders to mirror Article 215 for feeders under 1000 volts.
o Add a new 235.206 titled Feeder Equipment Grounding Conductor to mirror Article 215 for feeders under 1000 volts.
o Add a new 235.212 titled Identification for Feeders with first level subdivisions for grounded conductors, equipment grounding conductors, and ungrounded conductors to mirror Article 215 for feeders under 1000 volts.

Outside Branch Circuits & Feeders – Part IV
o Add a new Part IV titled Outside Branch Circuits & Feeders to Article 235
o Delete current Part III from Article 225 and relocate that text to new Article 235 with the following minor edits for formatting and numbering in new Article 235:
- Add a new 235.301 titled Scope which describes the requirements of Article 235 Part IV
- Add a new 235.306 titled Conductor Size and Support with modified text from 225.06
- Add a new 235.310 titled Wiring on Buildings (or Other Structures) with modified text from 225.10
- Add a new 235.314 titled Open-Conductor Spacings with modified text rom 225.14
- Add a new 235.339 titled Rating of Disconnect with modified text from 225.39
- Add a new 235.350, relocated from 225.50
- Add a new 235.351, relocated from 225.51
- Add a new 235.352, relocated from 225.52
- Add a new 235.353, relocated from 225.53
- Add a new 235.354, relocated from 225.54
- Add a new 235.355, relocated from 225.55
- Add a new 235.356, relocated from 225.56
- Add a new 235.357, relocated from 225.57
- Add a new 235.358, relocated from 225.58
- Add a new 235.359, relocated from 225.59
- Add a new 235.360, relocated from 225.60
- Add a new 235.361, relocated from 225.61

Services – Part V
o Add a new Part V titled Services to new Article 235.
o Delete current Part VII from Article 230 and relocate that text to new Article 235 with the following minor edits for formatting and numbering in new Article 235:
- Add a new 235.400 titled General includes text previously located in 230.200.
- Add a new 235.402 titled Service –Entrance Conductors with two first level subdivisions and include the text previously located in 230.202.
- Add a new 235.404 titled Isolating Switches with four first level subdivisions and include the text previously located in 230.204.
- Add a new 235.405 titled Disconnecting Means with three first level subdivisions and include the text

previously located in 230.205.

Add a new 235.406 titled Overcurrent Devices as Disconnecting Means and include the text previously located in 230.206.

Add a new 235.408 titled Protection Requirements with two first level subdivisions and include the text previously located in 230.208.

Add a new 235.409 titled Surge Arresters and include the text previously located in 230.209.

Add a new 235.410 titled Service Equipment and include the text previously located in 230.210.

Add a new 235.411 titled Switchgear and include the text previously located in 230.211.

Add a new 235.412 titled Over 35,000 Volts and include the text previously located in 230.212.

Note: There are other Public Inputs being submitted that address restructuring, and these are identified as “Companion Public Inputs”. Other Article or Section references may be impacted due restructuring activities by those companion Public Inputs; however, changes to references outside of Articles 210, 215, 225 and 230 are not shown in this Public Input.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3728-NFPA 70-2020 [Global Input]	Companion Public Input (Articles 245 and 495)
Public Input No. 3765-NFPA 70-2020 [New Section after 250.194(B)]	Companion Public Input (Article 255)
Public Input No. 3772-NFPA 70-2020 [New Section after 110.79]	Companion Public Input (Article 115)
Public Input No. 3815-NFPA 70-2020 [New Section after 200.11]	Companion Public Input (Article 205)
Public Input No. 3827-NFPA 70-2020 [Global Input]	Companion Public Input (Article 305)
Public Input No. 3838-NFPA 70-2020 [Section No. 690.31(A)]	Companion Public Input (Section 690.31(A))
Public Input No. 3846-NFPA 70-2020 [Section No. 694.30(A)]	Companion Public Input (Section 694.30(A))
Public Input No. 3849-NFPA 70-2020 [New Part after IV.]	Companion Public Input (Section 706.30)

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Submittal Date: Wed Sep 09 13:35:57 EDT 2020
Committee: NEC-P04

Substantiation:

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

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Add a new Article 235 "Services, Feeders, & Branch Circuits Over 1000 VAC, 1500 VDC, Nominal"

- Add a new Part I titled Scope and General to new Article 235
- Add a new section 235.1 with suggested scope of the Article

Branch Circuits – Part II

- Add a new Part II titled Branch Circuits to new Article 235

- Add a new 235.105 titled Identification for Branch Circuits with first level subdivisions for grounded conductors, equipment grounding conductors, and ungrounded conductors to mirror the requirements in Article 210 for branch circuits under 1000 volts.
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- Add a new 235.111 titled Branch Circuits Required with first level subdivision for the number of circuits and distribution of the loads to mirror the requirements in Article 210 for branch circuits under 1000 volts.
- Add a new 235.118 title Branch Circuit Rating to address the rating of the circuit and mirror the requirement in Article 210 for branch circuits under 1000 volts.
- Add a new 235.119 titled Conductors-Minimum Ampacity and Size with second level subdivision for the general and supervised installations to mirror the requirements in Article 210 for branch circuits under 1000 volts.
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Feeders – Part III

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- Add a new 235.205 titled Diagrams of Feeders to mirror Article 215 for feeders under 1000 volts.
- Add a new 235.206 titled Feeder Equipment Grounding Conductor to mirror Article 215 for feeders under 1000 volts.
- Add a new 235.212 titled Identification for Feeders with first level subdivisions for grounded conductors, equipment grounding conductors, and ungrounded conductors to mirror Article 215 for feeders under 1000 volts.

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Services – Part V

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  - Add a new 235.402 titled Service –Entrance Conductors with two first level subdivisions and include the text previously located in 230.202.
  - Add a new 235.404 titled Isolating Switches with four first level subdivisions and include the text previously located in 230.204.
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  - Add a new 235.410 titled Service Equipment and include the text previously located in 230.210.
  - Add a new 235.411 titled Switchgear and include the text previously located in 230.211.
  - Add a new 235.412 titled Over 35,000 Volts and include the text previously located in 230.212.

Note: There are other Public Inputs being submitted that address restructuring, and these are identified as “Companion Public Inputs”. Other Article or Section references may be impacted

due restructuring activities by those companion Public Inputs; however, changes to references outside of Articles 210, 215, 225 and 230 are not shown in this Public Input.

ADD NEW ARTICLE 235

Article 235 Services, Feeders, & Branch Circuits Over 1000 VAC, 1500 VDC, Nominal

PART I. Scope and General.

235.1 Scope. This Article includes modified general requirements for installations for branch circuits, feeders, and services over 1,000 volts, nominal.

235.3 Other Articles. General requirements of 210, 215, 225, and 230 apply unless modified by this article.

Part II. Branch Circuits

235.105 Identification for Branch Circuits.

235.105(A) Grounded Conductor.
The grounded conductor of a branch circuit shall be identified in accordance with 200.6.

235.105(B) Equipment Grounding Conductor.
The equipment grounding conductor shall be identified in accordance with 250.119.

235.105(C) Identification of Ungrounded Conductors.
Where the premises wiring system has branch circuits supplied from more than one nominal voltage system, each ungrounded conductor of a branch circuit shall be identified by phase or line and by system voltage class at all termination, connection, and splice points in compliance with 235.105 (C) (a) and (b). Different systems within the same premises that have the same system voltage class shall be permitted to use the same identification.

(a) *Means of Identification.* The means of identification shall be permitted to be by separate color coding, marking tape, tagging, or other approved means.

(b) *Posting of Identification Means.* The method utilized for conductors originating within each branch-circuit panelboard or similar branch-circuit distribution equipment shall be documented in a manner that is readily available or shall be permanently posted at each branch-circuit panelboard or similar branch-circuit distribution equipment. The label shall be of sufficient durability to withstand the environment involved and shall not be handwritten.

Exception: In existing installations where a voltage system(s) already exists and a different voltage system is being added, it shall be permissible to mark only the new system voltage. Existing unidentified systems shall not be required to be identified at each termination, connection, and splice point in compliance with 235.105 (C) (1) (a) and (b) . *Labeling shall be required at each voltage system distribution equipment to identify that only one voltage system has been marked for a new system(s). The new system label(s) shall include the words "other unidentified systems exist on the premises."*

235.106 Branch-Circuit Voltage Limitations Over 1,000 Volts Between Conductors.

Circuits exceeding 1,000 volts, nominal, between conductors shall be permitted to supply utilization equipment in installations where conditions of maintenance and supervision ensure that only qualified persons service the installation.

235.111 Branch Circuits Required. Branch circuits for equipment operating above 1,000 volts shall be provided for loads as specified in 235.11 (A) and (B).

235.111(A) Number of Branch Circuits.
The minimum number of branch circuits shall be determined from the total calculated load and the size or rating of the circuits used. In all installations, the number of circuits shall be sufficient to supply the load served.

235.111(B) Load Evenly Proportioned Among Branch Circuits.
Where the load is calculated, the wiring system up to and including the branch-circuit overcurrent device(s) shall be provided to serve not less than the calculated load. Branch-circuit overcurrent devices and circuits shall be required to be installed only to serve the connected load.

235.118 Branch-Circuit Rating.
Branch circuits recognized by this article shall be rated in accordance with the maximum permitted ampere rating or setting of the overcurrent device. Where conductors of higher ampacity are used for any reason, the ampere rating or setting of the specified overcurrent device shall determine the circuit rating.

235.119 Conductors — Minimum Ampacity and Size.

The ampacity of conductors shall be in accordance with 310.14 or 311.60, as applicable. Branch-circuit conductors over 1,000 volts shall be sized in accordance with 235.119(B)(1) or (B)(2).

235.119(A) General.
The ampacity of branch-circuit conductors shall not be less than 125 percent of the designed potential load of utilization equipment that will be operated simultaneously.

235.119(B) Supervised Installations.
For supervised installations, branch-circuit conductor sizing shall be permitted to be determined by qualified persons under engineering supervision. Supervised installations are defined as those portions of a facility where both of the following conditions are met:

(1) Conditions of design and installation are provided under engineering supervision.
(2) Qualified persons with documented training and experience in over1000 volt systems provide maintenance, monitoring, and servicing of the system.

235.120 Overcurrent Protection.
Branch-circuit conductors and equipment shall be protected by overcurrent protective devices that have a rating or setting that complies with 235.120 (A) through (C).

235.120(A) Continuous and Noncontinuous Loads.

Where a branch circuit supplies continuous loads or any combination of continuous and noncontinuous loads, the rating of the overcurrent device shall not be less than the noncontinuous load plus 125 percent of the continuous load.

Exception: Where the assembly, including the overcurrent devices protecting the branch circuit(s), is listed for operation at 100 percent of its rating, the ampere rating of the overcurrent device shall be permitted to be not less than the sum of the continuous load plus the noncontinuous load.

235.120(B) Conductor Protection.
Conductors shall be protected in accordance with their ampacities specified in 310.14 or 311.60, as applicable.

235.120(C) Equipment.
The rating or setting of the overcurrent protective device shall not exceed that specified in the applicable articles referenced in Table 240.3for equipment.

Part III. Feeders

235.202 Minimum Rating and Size.

The ampacity of conductors shall be in accordance with 310.14 and 311.60 as applicable. Where installed, the size of the feeder-circuit grounded conductor shall not be smaller than that required by 250.122, except that 250.122(F) shall not apply where grounded conductors are run in parallel. Feeder conductors over 1000 volts shall be sized in accordance with 235.200(A), (B), or (C).

(A) Feeders Supplying Transformers.
The ampacity of feeder conductors shall not be less than the sum of the nameplate ratings of the transformers supplied when only transformers are supplied.

(B) Feeders Supplying Transformers and Utilization Equipment.
The ampacity of feeders supplying a combination of transformers and utilization equipment shall not be less than the sum of the nameplate ratings of the transformers and 125 percent of the designed potential load of the utilization equipment that will be operated simultaneously.

(C) Supervised Installations.
For supervised installations, feeder conductor sizing shall be permitted to be determined by qualified persons under engineering supervision in accordance with 310.14(B) or 311.60(B). Supervised installations are defined as those portions of a facility where all of the following conditions are met:

(1) Conditions of design and installation are provided under engineering supervision.

(2) Qualified persons with documented training and experience in over 1000-volt systems provide maintenance, monitoring, and servicing of the system.

235.203 Overcurrent Protection.
Feeders shall be protected against overcurrent in accordance with Part XI of Article 240.

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

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

235.212 Identification for Feeders.

235.212(A) Grounded Conductor.
The grounded conductor of a feeder, if insulated, shall be identified in accordance with 200.6

235.212(B) Equipment Grounding Conductor.
The equipment grounding conductor shall be identified in accordance with 250.119.

235.212(C) Identification of Ungrounded Conductors.
Ungrounded conductors shall be identified in accordance with 235.212 (C) (1) or 235.212 (C) (2), where supplied from more than one nominal voltage system. Where the premises wiring system has feeders supplied from more than one nominal voltage system, each ungrounded conductor of a feeder shall be identified by phase or line and system at all termination, connection, and splice points in compliance with 235.212(C)(1) and (2).

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

Part IV Outside Branch Circuits and Feeders

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

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

235.306 Conductor Size and Support.

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

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

235.314 Open-Conductor Spacings. Conductors shall comply with the spacings provided in 110.36 and 490.24.

235.339 Rating of Disconnect. The feeder or branch-circuit disconnecting means shall have a rating of not less than the calculated load to be supplied, determined in accordance with Parts I and II of Article 220 for branch circuits, Part III or IV of Article 220 for feeders, or Part V of Article 220 for farm loads. Where the branch circuit or feeder disconnecting means consists of more than one switch or circuit breaker, as permitted by 225.33, combining the ratings of all the switches or circuit breakers for determining the rating of the disconnecting means shall be permitted.

235.350 Sizing of Conductors. The sizing of conductors shall be in accordance with 235.119(A)for branch circuits and 235.200 for feeders.

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

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

235.352 Disconnecting Means.

(A) Location. A building or structure disconnecting means shall be located in accordance with 225.32, or, if not readily accessible, it shall be operable by mechanical linkage from a readily accessible point. For multibuilding industrial installations under single management, it shall be permitted to be electrically operated by a readily accessible, remote-control device in a separate building or structure.

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

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

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

(C) Locking. Disconnecting means shall be lockable open in accordance with 110.25.

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

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

(E) Uniform Position. Where disconnecting means handles are operated vertically, the "up" position of the handle shall be the "on" position.

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

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

235.356 Inspections and Tests.

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

(1) Instrument Transformers. All instrument transformers shall be tested to verify correct polarity and burden.

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

(3) Switching Circuits. Each switching circuit shall be observed to operate the associated equipment being switched.

(4) Control and Signal Circuits. Each control or signal circuit shall be observed to perform its proper control function or produce a correct signal output.

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

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

(7) Relays and Metering Utilizing Phase Differences. All relays and metering that use phase differences for operation shall be verified by measuring phase angles at the relay under actual load conditions after operation commences.

(B) Test Report. A test report covering the results of the tests required in 235.356 ~~225.56~~(A) shall be delivered to the authority having jurisdiction prior to energization.

Informational Note: For an example of acceptance specifications, see ANSI/NETA ATS-2013, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems, published by the InterNational Electrical Testing Association.

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

(A) 22 kV, Nominal, to Ground or Less. The clearances over roadways, walkways, rail, water, and open land for conductors and live parts up to 22 kV, nominal, to ground or less shall be not less than the values shown in Table 235.360~~225.60~~.

(B) Over 22 kV Nominal to Ground. Clearances for the categories shown in Table 235.360 ~~225.60~~ shall be increased by 10 mm (0.4 in.) per kV above 22,000 volts.

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

Informational Note: For additional information, see ANSI/IEEE C2-2017, National Electrical Safety Code.

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

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

235.361 Clearances over Buildings and Other Structures.

(A) 22 kV Nominal to Ground or Less. The clearances over buildings and other structures for conductors and live parts up to 22 kV, nominal, to ground or less shall be not less than the values shown in Table 235.361~~225.61~~.

(B) Over 22 kV Nominal to Ground. Clearances for the categories shown in Table 235.361 ~~225.61~~ shall be increased by 10 mm (0.4 in.) per kV above 22,000 volts.

Informational Note: For additional information, see ANSI/IEEE C2-2017, National Electrical Safety Code.

Table 235.361 Clearances over Buildings and Other Structures

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

Part V. Services

235.400 General.
Service conductors and equipment used on circuits exceeding 1000 volts ac, 1500 volts dc, nominal, shall comply with all the applicable sections of article 230 and with the following Part V sections that supplement or modify article 230. In no case shall the provisions of Part V apply to equipment on the supply side of the service point.

Informational Note: For clearances of conductors of over 1000 volts, nominal, see ANSI/IEEE C2-2017, *National Electrical Safety Code*.

235.402 Service-Entrance Conductors.
Service-entrance conductors to buildings or enclosures shall be installed to conform to 235.402(A) and (B).

235.402 (A) Conductor Size.
Service-entrance conductors shall not be smaller than 6 AWG unless in multiconductor cable. Multiconductor cable shall not be smaller than 8 AWG.

235.402 (B) Wiring Methods.
Service-entrance conductors shall be installed by one of the wiring methods covered in 300.37 and 300.50.

235.404 Isolating Switches.

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

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

(1) Cannot be opened unless the circuit is disconnected

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

235.404 (B) Fuses as Isolating Switch.
Where fuses are of the type that can be operated as a disconnecting switch, a set of such fuses shall be permitted as the isolating switch.

235.404 (C) Accessible to Qualified Persons Only.
The isolating switch shall be accessible to qualified persons only.

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

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

235.405 Disconnecting Means.

235.405 (A) Location.
The service disconnecting means shall be located in accordance with 230.70.

For either overhead or underground primary distribution systems on private property, the service disconnect shall be permitted to be located in a location that is not readily accessible, if the disconnecting means can be operated by mechanical linkage from a readily accessible point, or electronically in accordance with 235.405(C), where applicable.

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

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

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

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

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

Informational Note: See Table 311.60(C)(67) through Table 311.60(C)(86) for ampacities of conductors rated 2001 volts to 35,000 volts.

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

(A) Equipment Type.
Equipment used to protect service-entrance conductors shall meet the requirements of Article 490, Part II.

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

235.409 Surge Arresters.
Surge arresters installed in accordance with the requirements of Article 242 shall be permitted on each ungrounded overhead service conductor.

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

235.410 Service Equipment — General Provisions.
Service equipment, including instrument transformers, shall conform to Article 490, Part I.

235.411 Switchgear.

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

235.412 Over 35,000 Volts.

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

MODIFICATIONS TO ARTICLE 210:

210.1 Scope. This article provides the general requirements for branch circuits.

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

210.6(E) Over 600, But Not Exceeding 1000 Volts Between Conductors. Circuits exceeding 600 volts, nominal, but not exceeding 1000 volts, nominal, between conductors shall be permitted to supply utilization equipment in installations where conditions of maintenance and supervision ensure that only qualified persons service the installation.

MODIFICATIONS TO ARTICLE 215

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

Exception: Feeders for electrolytic cells as covered in 668.3(C)(1) and (C)(4).

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

~~**215.2(B) Feeders over 1000 Volts.**~~
~~The ampacity of conductors shall be in accordance with 310.14 and 311.60 as applicable. Where installed, the size of the feeder-circuit grounded conductor shall not be smaller than that required by 250.122, except that 250.122(F) shall not apply where grounded conductors are run in parallel. Feeder conductors over 1000 volts shall be sized in accordance with 215.2(B)(1), (B)(2), or (B)(3).~~

~~**215.2(B)(1) Feeders Supplying Transformers.**~~
~~The ampacity of feeder conductors shall not be less than the sum of the nameplate ratings of the transformers supplied when only transformers are supplied.~~

~~**215.2(B)(2) Feeders Supplying Transformers and Utilization Equipment.**~~
~~The ampacity of feeders supplying a combination of transformers and utilization equipment shall not be less than the sum of the nameplate ratings of the transformers and 125 percent of the designed potential load of the utilization equipment that will be operated simultaneously.~~

~~**215.2(B)(3) Supervised Installations.**~~
~~For supervised installations, feeder conductor sizing shall be permitted to be determined by qualified persons under engineering supervision in accordance with 310.14(B) or 311.60(B). Supervised installations are defined as those portions of a facility where all of the following conditions are met:~~

~~(1) Conditions of design and installation are provided under engineering supervision.~~

~~(2) Qualified persons with documented training and experience in over 1000 volt systems provide maintenance, monitoring, and servicing of the system.~~

MODIFICATONS TO ARTICLE 225

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

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

Table 225.3 Other Articles

Equipment/Conductors	Article
Branch circuits	210
Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits	725
Communications circuits	805
Community antenna television and radio distribution systems	820
Conductors for general wiring	310
Electrically driven or controlled irrigation machines	675
Electric signs and outline lighting	600
Feeders	215
Fire alarm systems	760
Fixed outdoor electric deicing and snow-melting equipment	426
Floating buildings	553
Grounding and bonding	250
Hazardous (classified) locations	500

Table 225.3 Other Articles

Equipment/Conductors	Article
Hazardous (classified) locations — specific	510
Marinas and boatyards	555
Medium-voltage conductors and cable	311
Messenger-supported wiring	396
Mobile homes, manufactured homes, and mobile home parks	550
Open wiring on insulators	398
Over 1000 volts, general	490
Overcurrent protection	240
Radio and television equipment	810
Services	230
Services, Feeders, & Branch Circuits Over 1000 VAC, 1500 VDC, Nominal	235
Solar photovoltaic systems	690
Swimming pools, fountains, and similar installations	680
Use and identification of grounded conductors	200

225.6 Conductor Size and Support.

(A) Overhead Spans. Open individual conductors shall not be smaller than the following:

(1) For 1000 volts, nominal, or less, 10 AWG copper or 8 AWG aluminum for spans up to 15 m (50 ft) in length, and 8 AWG copper or 6 AWG aluminum for a longer span unless supported by a messenger wire

(2) For over 1000 volts, nominal, meet the requirements of 235.306. ~~6 AWG copper or 4 AWG aluminum where open individual conductors, and 8 AWG copper or 6 AWG aluminum where in cable~~

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

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

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

~~**Part III. Over 1000 Volts.**~~

~~**225.50 Sizing of Conductors.**~~
~~The sizing of conductors over 1000 volts shall be in accordance with 210.19(B) for branch circuits and 215.2(B) for feeders.~~

~~**225.51 Isolating Switches.**~~
~~Where oil switches or air, oil, vacuum, or sulfur hexafluoride circuit breakers constitute a building disconnecting means, an isolating switch with visible break contacts and meeting the requirements of 230.204(B), (C), and (D) shall be installed on the supply side of the disconnecting means and all associated equipment.~~

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

225.52 Disconnecting Means.

225.52(A) Location.
A building or structure disconnecting means shall be located in accordance with 225.32, or, if not readily accessible, it shall be operable by mechanical linkage from a readily accessible point. For multibuilding industrial installations under single management, it shall be permitted to be electrically operated by a readily accessible, remote-control device in a separate building or structure.

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

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

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

225.52(C) Locking.
Disconnecting means shall be lockable open in accordance with 110.25.

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

225.52(D) Indicating.
Disconnecting means shall clearly indicate whether they are in the open "off" or closed "on" position.

225.52(E) Uniform Position.
Where disconnecting means handles are operated vertically, the "up" position of the handle shall be the "on" position.

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

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

225.56 Inspections and Tests.

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

225.56(A)(1) Instrument Transformers.
All instrument transformers shall be tested to verify correct polarity and burden.

225.56(A)(2) Protective Relays.
Each protective relay shall be demonstrated to operate by injecting current or voltage, or both, at the associated instrument transformer output terminal and observing that the associated switching and signaling functions occur correctly and in proper time and sequence to accomplish the protective function intended.

225.56(A)(3) Switching Circuits.
Each switching circuit shall be observed to operate the associated equipment being switched.

225.56(A)(4) Control and Signal Circuits.
Each control or signal circuit shall be observed to perform its proper control function or produce a correct signal output.

225.56(A)(5) Metering Circuits.
All metering circuits shall be verified to operate correctly from voltage and current sources in a similar manner to protective relay circuits.

225.56(A)(6) Acceptance Tests.
Complete acceptance tests shall be performed, after the substation installation is completed, on all assemblies, equipment, conductors, and control and protective systems, as applicable, to verify the integrity of all the systems.

225.56(A)(7) Relays and Metering Utilizing Phase Differences.
All relays and metering that use phase differences for operation shall be verified by measuring phase angles at the relay under actual load conditions after operation commences.

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

Informational Note: For an example of acceptance specifications, see ANSI/NETA ATS-2013, *Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems*, published by the InterNational Electrical Testing Association.

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

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

225.60(B) Over 22 kV Nominal to Ground.
Clearances for the categories shown in Table 225.60 shall be increased by 10 mm (0.4 in.) per kV above 22,000 volts.

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

Informational Note: For additional information, see ANSI/IEEE C2 2017, *National Electrical Safety Code*.

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

Location	Clearance	
	m	ft
Open land subject to vehicles, cultivation, or grazing	5.6	18.5

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

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

225.61 Clearances over Buildings and Other Structures.

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

225.61(B) Over 22 kV Nominal to Ground.
Clearances for the categories shown in Table 225.61 shall be increased by 10 mm (0.4 in.) per kV above 22,000 volts.

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

Table 225.61 Clearances over Buildings and Other Structures

Clearance from Conductors or Live Parts from:	Horizontal		Vertical	
	m	ft	m	ft
Building walls, projections, and windows	2.3	7.5	—	—
Balconies, catwalks, and similar areas accessible to people	2.3	7.5	4.1	13.5

Table 225.61 Clearances over Buildings and Other Structures

Clearance from Conductors or Live Parts from:	Horizontal		Vertical	
	m	ft	m	ft
Over or under roofs or projections not readily accessible to people	—	—	3.8	12.5
Over roofs accessible to vehicles but not trucks	—	—	4.1	13.5
Over roofs accessible to trucks	—	—	5.6	18.5
Other structures	2.3	7.5	—	—

MODIFICATIONS TO ARTICLE 230

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

Informational Note No. 1: See Figure 230.1.

Informational Note No. 2: For requirements that supplement or modify this Article for Over 1000 Vac, 1500 Vdc installations, see article 235, Services, Feeders, & Branch Circuits Over 1000 Vac, 1500 Vdc, nominal.

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

~~**230.200 General.**~~
~~Service conductors and equipment used on circuits exceeding 1000 volts, nominal, shall comply with all the applicable preceding sections of this article and with the following sections that supplement or modify the preceding sections. In no case shall the provisions of Part VIII apply to equipment on the supply side of the service point.~~

~~Informational Note: For clearances of conductors of over 1000 volts, nominal, see ANSI/IEEE C2-2017, *National Electrical Safety Code*.~~

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

~~**230.202(A) Conductor Size.**~~
~~Service-entrance conductors shall not be smaller than 6 AWG unless in multiconductor cable. Multiconductor cable shall not be smaller than 8 AWG.~~

~~**230.202(B) Wiring Methods.**~~
~~Service-entrance conductors shall be installed by one of the wiring methods covered in 300.37 and 300.50.~~

~~**230.204 Isolating Switches.**~~

~~**230.204(A) Where Required.**~~
~~Where oil switches or air, oil, vacuum, or sulfur hexafluoride circuit breakers constitute the service disconnecting means, an isolating switch with visible break contacts shall be installed on the supply side of the disconnecting means and all associated service equipment.~~

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

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

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

230.204(B) Fuses as Isolating Switch.
Where fuses are of the type that can be operated as a disconnecting switch, a set of such fuses shall be permitted as the isolating switch.

230.204(C) Accessible to Qualified Persons Only.
The isolating switch shall be accessible to qualified persons only.

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

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

230.205 Disconnecting Means.

230.205(A) Location.
The service disconnecting means shall be located in accordance with 230.70.

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

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

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

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

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

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

Informational Note: See Table 311.60(C)(67) through Table 311.60(C)(86) for ampacities of conductors rated 2001 volts to 35,000 volts.

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

230.208(A) Equipment Type.
Equipment used to protect service-entrance conductors shall meet the requirements of Article 490, Part II.

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

230.209 Surge Arresters.
Surge arresters installed in accordance with the requirements of Article 242 shall be permitted on each ungrounded overhead service conductor.

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

230.210 Service Equipment — General Provisions.
Service equipment, including instrument transformers, shall conform to Article 490, Part I.

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

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

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COMMENTS ON NEC 705.13 FOR THE 2023 CODE CYCLE

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INTRODUCTION

The last two decades has seen the dramatic growth of distributed energy resources (DERs) across the US grid, and this growth is only projected to continue in the years to come. DERs increase the complexity of grid operations, and involve a larger number of active market participants than the traditional model of monopoly utilities who provide power to accounts at the grid-edge from large, centralized plants. Because of this, there is increasing need for control systems that can coordinate both generation and load across discrete busses and circuits from transmission systems down to premises wiring. The adoption of 705.13 in the National Electric Code (NEC or Code) 2020 cycle was a vital recognition of this changing reality. However, this new article, as first adopted, does not adequately reflect the composition, variability, behavior or full capabilities of control systems, and their necessary role in the deployment of DERs.

Control systems can manage all different kinds of equipment, not just electrical equipment; in the electricity sector, they are active at all levels of the electric grid. They can do everything from controlling current in a residential PV system to improving power factor at a high voltage substation. Functionally, we can contemplate the locus of control systems' activity according to the interfaces between major systems in the grid: a) at substations among transmission networks or between transmission and distribution networks; b) at the service point between utility circuits and the premises wiring; and c) at busses or circuits connecting equipment across the premises wiring. Because we are addressing the function of and requirements for control systems as specified in NEC 705.13, our concern will be for the latter, c). However, it should be noted that many of the core considerations discussed here apply equally among distribution and transmission networks, and at the connection of NEC-compliant systems to these networks.

Control systems can manage a wide array of applications, and, indeed, are often central to their design. These applications can operate: a) in time; b) in coordination between different pieces of equipment; c) in reaction to specific monitored conditions; and d) in reaction to signals sent from a higher point of coordination. Electrical equipment can be controlled: a) as a current source; b) as a voltage source; c) if it's an AC system, for its power factor; and/or d) if it's an AC system, for the quality of its power signal against an idealized sine curve. 705.13 specifically deals with limiting current to the busbars or conductors of premises wiring on the basis of monitored conditions for the purpose of protecting this equipment from current overload. This current-limiting function is just one application among many that control systems may be asked to superintend; for example, the same control system which may be limiting current from an energy storage system (ESS) inverter to a sub-panel in a building may also be using the inverter to correct the premises wiring power factor output to the grid across its service point to reduce imaginary power. It is important that the rules and standards required by the NEC are able to grade between this particular application and the broadest set of other control functions, without compromising 705.13's intended safety benefits.

It is not appropriate to think of control systems exclusively as a single, definite type or piece of equipment. Controls can either be ***regulatory***, where they are incorporated into the design and operation of a single

device, or ***supervisory***, where they comprise a computing device and its signaling mechanism to one or more other pieces of equipment with the aim of governing their operations, *together*, as a whole system. In the former, the "control system" is a subordinated feature of a piece of equipment with a specific function, listing requirements, and particularized applicability to different NEC articles. In the latter, the "control system" may have its "brains" associated with a computing device, but it is effectively a set of virtual functions for a *system* embodied by signals coordinating among its constituent parts to govern the behavior of heterogeneous pieces of equipment.

SCENARIOS FOR LIMITING THE CURRENT OF DERS

The current-limiting function authorized, alternately, by 705.11, 705.12 and 705.13 can be realized in three different basic scenarios.

SCENARIO #1. A fuse, breaker, or other switching device can be installed at the point of connection for a single circuit, and will trip automatically when the current at that point exceeds some pre-determined, unchangeable limit. This principle is iterative across the premises wiring and can apply to a circuit feeding a single piece of equipment or a circuit serving an enclosure, such as a sub-panel, that combines other circuits for multiple pieces of equipment. This automatic switching operation can happen in milliseconds, if necessary, or longer.

SCENARIO #2. A power source or an energy storage system can be designed and listed to self-limit or modulate its output or intake of power under the governance of its own regulatory controls at pre-defined, but manually changeable, set-points. Alternately, a load control device can limit or modulate current across a single circuit by reacting to a signal under a pre-defined, but manually changeable, function. The input condition, in both cases, could be a current value registered at one or more circuit anywhere across the premises wiring system, or it could be a function of some other measurable value, like time or power factor (though this is unlikely). The modulating action of regulatory controls for many devices can be designed to activate within milliseconds, or longer, as required.

SCENARIO #3. A supervisory control system can orchestrate the output of one or more source, as well as demand from controllable loads, by interfacing with different devices, acquiring relevant real-time information and giving instructions through communication signals. These sources and loads won't necessarily be installed at the same time or be sourced from the "ecosystem" of a single manufacturer. Supervisory controls depend on components that have changeable set-points or alterable functional behavior and that can receive its signals -- similar to those described in Scenario #2. The difference in Scenario #3 is that these inputs to regulatory controls can change dynamically under the guidance of the supervisory controls, and different devices can be coordinated with respect to one another. The supervisory controls, in turn, could be governed by a person, by an algorithm or by machine learning. Supervisory controls are as adaptable and scalable as they need to be. They usually operate, at their fastest, in a second or two, but may be closer to a ten or fifteen second threshold for certain kinds of equipment configurations.

705.11 and 705.12 are both exclusively concerned with Scenario #1. The connections these two articles describe, on both sides of the service point, can only be served by some combination of switch and overcurrent protection device. Scenario #1 is of no particular interest to 705.13, but, as currently written, 705.13 could theoretically apply both to Scenario #2 and Scenario #3.

The requirements that were included in the introduction of 705.13 to the NEC, in the 2020 Code cycle, entail a few items that are germane to its application in Scenario #2 or Scenario #3:

* The text starts by stating: "A power control system (PCS) shall be listed and evaluated to control the output of one or more power production sources, energy storage system (ESS) and other equipment." So the "PCS" must be specifically listed for its control function.

* This sentence also specifically calls for the "PCS" to limit the current from *sources*, but it leaves the door open for loads to be limited as well. "Other equipment" could mean loads, and ESSs are listed as a separate item here because they can behave as loads; also we could interpret the consumption

of power by a piece of equipment under normal operating conditions to be its "output" or at least part of its "output." Current on a bus or a circuit, therefore, can be limited either by curtailing production, or by curtailing load, or both.

* According to 705.13 (A), the "power control system" has to monitor the current of all controlled equipment or circuits, and may monitor uncontrolled equipment or circuits that feed affected busbars or conductors. In most cases, this monitoring function will require an external, automated signal to which the controls must react.

* The text states in 705.13 (C): "The PCS shall provide overcurrent protection either by overcurrent devices or by the PCS including the functionality as an overcurrent device in the product listing." So the whole scheme of affected busses or circuits must react to current fault conditions that produce an overload condition, not just the switching and curtailment under normal operating conditions enabled by the "PCS" -- whether this be handled by the "PCS" or independently by other devices.

* 705.13 (E) specifies that access to the settings in the controls should be limited to qualified personnel.

Scenario #2 involves equipment whose regulatory controls operate with pre-defined, but manually changeable, set-points. Such equipment can react to a condition on a bus or circuit where the current from multiple sources or to multiple loads exceeds some pre-defined current limit.

Here is a canonical example: let's say in a small commercial building in a strip mall there is a 10 kW inverter for a nominal 12.5 kW DC PV system and it is interconnected at a 200 A main panel with a 200 A main breaker at the service point; if the service and inverter output are single phase, 240 V, the inverter can produce up to ~41.7 A and will need to be protected by a 60 A breaker -- 20 A more than is allowable for this 200 A panel under 705.12 (B) (3) (2) or (4). If the inverter's regulatory controls are able to monitor all of the loads on the main panel, the inverter could proportionally curtail its output when its output and the loads, together, exceed 200 A; under this scheme the PV inverter could still be connected with a 60 A breaker and no modifications would need to be made to the main panel. Presumably, the monitoring scheme would involve devices manufactured by the inverter company and listed for narrow variations of this scenario.

While it is expected that the monitored input signal to these regulatory controls would come from more than one piece of other equipment, there will always be a strong preference to limit the complexity of information meant to serve as input. In other words, Scenario #2 for 705.13 will typically involve measuring simple current values at a single busbar or conductor with power inputs and outputs connected at that point from a manageable number of circuits or pieces of equipment; it is unlikely (though possible) that most regulatory controls would be capable of reacting to situations at more than one busbar or conductor, or under input from some other variable, like time (if equipment utilization is strictly scheduled, for example).

Scenario #3 imagines a "power control system" where the currents of multiple components have to be *coordinated*. Regulatory controls are intrinsic to a single piece of equipment and only will process *input* signals from external (and probably lab tested) devices. In order for a control system to govern more than one piece of equipment, external communication connections are necessary and signals have to be sent, received and acted upon by some equipment that is *extrinsic* to the controls; input signals, moreover, may come from a wide range of sources. Supervisory controls are usually the only option for complex configurations: system with variable inputs, multiple outputs, dynamic information processing. It also may be the only option for certain retrofit projects or where components are sourced from different manufacturers.

In the most straightforward versions of Scenario #3, there will be a computer on site that is connected to different equipment and monitoring devices, and this computer will be the central dispatch for all controlled devices. The computer could be housed in a piece of equipment with some other function, like an inverter, but it is more likely to stand alone as a controller unit. Theoretically, the computing device for the supervisory controls may not necessarily be located on site: supervisory controls could be a software

program stored in a remote server or in the cloud, and could retrieve data and issue instructions to equipment over an internet connection or some other secure network connection.

Here is a distinct Scenario #3 example: in the building next door to our previous example, there is a system with a single phase, 240 V service, a 400 A Eaton panel with smart, load control breakers and a 400 A main breaker, a just-installed 500 kWH Li-ion battery ESS with a Sinexcel inverter that outputs up to 100 A, a PV system installed 5 years ago with an SMA inverter that outputs up to 80 A, and an automatic transfer switch that, when the power goes down, connects to a 20 kW Generac generator, installed 10 years ago. The loads from the building, if everything is running all at once could reach as high as 490 A, but curtailment of a Tesla electric vehicle (EV) charger, which draws up to 100 A, should always bring the total possible load drawn from the main panel below 400 A. The PV and ESS systems together output 100 A too much for the size of the main service panel to which they are connected under the limits from 705.12 (B) (3) (2) or (4). Let's say the building is drawing its maximum load and the PV and ESS systems can output their full capacity; the supervisory control system now has several options: it can a) curtail the PV system; b) make sure the ESS isn't charging or discharging; c) curtail the 100 A EV charger; d) curtail several other loads; e) curtail input current from the 400 A main breaker; or f) do more than one of these things at the same time. All six options will accomplish the same safety aim, but the building owner may want to implement a complex scheme for which option is chosen under different conditions. For example, the EV charger might have priority in the evening and morning when the building owner is charging a company car after a day's use so that it has a full battery next morning, while the PV and/or ESS system are prioritized during the afternoon when the building has a high time-of-use electricity rate and would prefer not to consume energy. Furthermore, in a power outage, supervisory controls could manage the loads to match the capabilities of the backup generator, PV system and ESS system (which would vary over time) without electricians needing to segregate only a small bundle of loads in a protected loads panel. This site configuration could only be managed by a supervisory controls system, and there is no practical way to list a single piece of equipment to do all of these things. Nevertheless, this is not an especially challenging control system for an experienced controls engineer to design and implement.

PROBLEMS WITH 705.13 AS CURRENTLY WRITTEN

1. Incoherence of Treatment in the NEC. The NEC deals with control systems in various ways, largely in chapters 4 and 7; the responsibility for these articles is scattered among the code-making panels, and it shows. Viewed at some remove, the approach is not very coherent. Here is a summary of articles that deal substantively with control systems that govern electrical equipment; a number of other articles have provisions for the electrical installation of control systems that govern non-electrical equipment, and these aren't our main focus.

Article 100, Definitions: This article has several definitions for control components.

Article 430, Motors, Motor Circuits & Controllers: This article deals with motors and motor controllers. 430.32, 430.39 and Parts VI, VII and VIII all address some aspects of motor controllers and their use for protecting motor function against overload and failure.

Article 708, Critical Operation Power Systems (COPS): This article covers requirements for backup power systems deemed "critical." The article has a definition for supervisory controls ("SCADA"), but controls functions are only discussed, briefly, in 708.22 (B). The defined term, SCADA, isn't used anywhere else in the text of 708. Its presence here points to Informative Annex G.

Informative Annex G, Supervisory Control & Data Acquisition (SCADA): This is a short informational annotation at the end of the Code which gives some suggested design parameters for the deployment of SCADA in COPS. This Informative Annex is written, syntactically, as though it were a set of Code requirements, but it is explicitly not part of the Code, and its rules are not obligatory.

Article 725, Class 1, 2 & 3 Remote-Control, Signaling & Power-Limited Circuits: This article details requirements for control circuits that are part of a supervisory controls system or that are necessary for, but auxiliary to, a regulatory controls system.

Article 750, Energy Management Systems: This article gives requirements for "energy management systems," which it defines as: "A system consisting of any of the following: *[sic]* a monitor(s), communications equipment, a controller(s), a timer(s), or other device(s) that monitors and/or controls an electrical load or a power production or storage source." The intent of this article, basically, is to list systems, such as fire alarms, that should *not* be interfered with by a control system that fits this definition.

There doesn't appear to be a uniform approach to dealing with the design of control systems and their components across the NEC. If a new concept of "power control systems", along with a new set of requirements, are being introduced in article 705, they need to be reconciled to the functions of and stipulations upon control systems elsewhere in the Code.

2. Terminology and Definitions. This incoherence is particularly noticeable in defined terms found in articles that touch about upon control systems. Here are some controls-oriented terms and definitions sprinkled across the NEC; note that "general scope" as used here means that the definition is indicated to apply throughout the Code, while "article specific scope" means that the definition is indicated to only apply to that article:

Term	Article	Scope
controller	100	General
controller	430	Article Specific
controller, motion	620	Article Specific
controller, motor	620	Article Specific
controller, operation	620	Article Specific
diversion load controller	694	Article Specific
diversion charge controller	706	Article Specific
control circuit	100	General
remote control circuit	100	General
signaling circuit	100	General
electronically actuated fuse	100	General
motor control center	100	General
industrial control panel	100	General
supervisory control & data acquisition (SCADA)	708	General
control	750	Article Specific
energy management system	750	General
control system	620	Article Specific
monitor	750	Article Specific

This terminology, even taken together, is not comprehensive of control systems' components or their modalities as they apply to electrical installations. In some cases, it isn't even consistent. Note, for instance, the redundancy of "controller" in articles 100 and 430, as well as the presence of specific controller types in article 620 that aren't congruent with the basic definition in article 100.

Article 705.13 also doesn't formally define "power control system," nor is any such definition provided elsewhere in article 705 or in article 100. . Even worse, the definition for an "energy management system" in article 750 (which is noted to apply throughout the Code) is functionally indistinguishable from the

undefined concept of a "power control system" as 705.13 seems to use it.

The problems with defined terms and their definitions allow the requirements adopted in the 2020 cycle to elide some of the complexities discussed here. This is a recipe for confusion.

3. Supervisory and Regulatory Controls. There is no acknowledgement in 705.13 of the difference between regulatory and supervisory controls, or between Scenario #2 and Scenario #3. As discussed, this distinction can have substantial implications for the capabilities, reliability and responsiveness of control systems. It stems not only from a difference in the components, but in the conception of what *constitutes* a "control system." A regulatory control system is part of some discrete piece of equipment that has been engineered, evaluated and listed under a standard, and, when applicable, it is transparently regulated by specialized articles of the NEC. Supervisory controls consist in the virtual functions of a system whose components are governed by these functions to achieve some coordinated, emergent outcome. The variability possible under supervisory controls can be managed in a straightforward way by engineering, but is more difficult to regulate from on high, so to speak. Requirements in 705.13 for "power control systems" have to apply themselves, in one fashion or another, to this particular difference.

4. Load and source. The text of 705.13 should be more explicit that both sources AND loads can be controlled to limit current on busbars and conductors. For example, let's say the bus in a sub-panel is rated for 100 A. If there is only 100 A or less of source power on the bus, from the point of view of the bus, there is no safety problem, regardless of potential loads; similarly, if there is only 100 A or less of load on the bus, there is no safety problem, regardless of source potential. It is only when there is more than 100 A possible of BOTH source power AND load that there can be an overload. A controls system can manipulate the sources OR the loads OR both to curtail the total current on a bus or a circuit. Article 705 was written primarily with the idea of controlling DERs as power sources in premises wiring where the overcurrent protection devices on feeders constrain an effectively infinite grid source. As we see more load control devices and ESSs on the market, the ability, and the need, to control loads and sources on equal footing will become more common, and 705.13 should be more explicit about the means by which it can achieve its ends.

To pursue this line of reasoning further, the amount of possible current on a busbar or conductor is determined by the *lowest* possible current value in EITHER the source OR the load. If there is 100 A of source power from a PV inverter and 100 A available from the feeder breaker, again, on a 100 A sub-panel bus, but only 50 A of breakers for loads, the sub-panel will never see more than 100 A of current. The presence of ESSs complicates this picture further, because they can behave either as a source or as a load; in calculating the worst case of maximum current, each ESS presents two different scenarios, one where it behaves as a source and should be counted with other sources, and one where it behaves as a load and should be counted with other loads. In fact, where we have on-site, interconnected power generation, the service of a premises wiring, or circuits connecting back to the service, *also* can behave as a current source or as a load.

The best systematic method for determining the maximum possible current on a busbar or conductor is to enumerate each possible configuration of sources and loads, noting the *lowest* possible current value between source and load in each scenario, and then to choose the *highest* current value among them. Here is an example: there is a 7.6 kW inverter for a 10 kW DC PV system, a second 3.8 kW inverter for a 25 kWH Li-ion battery ESS, and load control breakers on all of the circuits connected to the main panel. The PV inverter has a 40 A breaker connection and the ESS a 20 A breaker connection. The building has a single phase, 240 V service with a 200 A main breaker in a 200 A main panel. The loads from the building, if everything were running all at once, could reach as high as 250 A. Both the ESS and the main breaker can be sources or loads, while the breakers in the panel are always loads and the PV inverter is always a source. From this we get four different scenarios (where L=load and S=source):

	1	2	3	4
Building loads	L	L	L	L

PV inverter	S	S	S	S
Main breaker	S	S	L	L
ESS	S	L	S	L

Based on our set up we can assign a maximum current value to each category of equipment based on its overcurrent protection device(s) (the numbers represent amps):

	1	2	3	4
Building loads	(L) 250	(L) 250	(L) 250	(L) 250
PV inverter	(S) 40	(S) 40	(S) 40	(S) 40
Main breaker	(S) 200	(S) 200	(L) 200	(L) 200
ESS	(S) 20	(L) 20	(S) 20	(L) 20

Next we can determine the maximum possible current on the bus, in each case, by the lowest possible current value between source and load:

S = 260	**S = 240**	**S = 60**	**S = 40**
L = 250	L = 270	L = 450	L = 470

The lowest value in each scenario is bolded; only the first and second iterations are above 200 A, with #1 being the highest at 250 A. Clearly the bus is undersized for this system. However, under the common method of 705.12 (B) (3) (2) or (4), we would have assumed that the PV and ESS systems would have overloaded by the bus by up to 60 A, whereas, in fact, the overload where both systems acted as sources would only have been 50 A, and no higher in any other scenario. With this method we can more accurately determine the magnitude of potential overload and what devices it may be associated with.

It has to be mentioned here that neither 705.11 nor 705.12 do a great job of dealing with situations where multiple devices can behave as both source and load. The additions in past cycles of 705.12 (B) (3) (1) & (3) (or their equivalent) were a perfectly adequate means of resolving this conundrum when it was expected, mostly, that only service-facing breakers or feeders would behave as both source and load, but with the growth of ESSs and control systems as regular features in premises wiring in all site types, the NEC needs to adopt more sophisticated rules around this issue.

5. Signaling. All control systems rely on signaling to accomplish their ends. Typically, regulatory controls have the advantage of being compact and more testable in their functionality through a standardized listing process. Nevertheless, for most applications of 705.13, they will rely on external signals from CTs or other monitoring devices.

Supervisory controls rely extensively on signals among multiple pieces of equipment integrated in the field in unique configurations. This may involve multiple regulatory control systems and equipment with different functions. These systems are likely to include equipment produced by different manufacturers. Communications protocols may not be identical among this equipment, and communications signals may have to travel relatively long distances. Wireless or power-line communication devices are an option where hardwiring poses practical installation difficulties. Communication can even be mediated through the internet or another network where some key component (probably the supervisory computing device) could be located off-site.

Because 705.13 is fundamentally a set of safety requirements, it should include some rules on the deployment of signaling systems to ensure their reliability. For example, internet connections are notoriously prone to periodic cutting out, and probably shouldn't be relied upon. Other communications equipment, like some on-site wireless systems or power-line transmitters, may also be less reliable than desired. UL 1741 does disallow off-site connections in the listing of regulatory controls in inverters, but the issue is complicated enough that the NEC should outline some basic parameters for what is allowable, as it does for numerous other engineering issues.

6. Listing requirements. In 2018, UL released a Certification Requirement Decision (CRD) adjunct to the 1741 standard. Among other things, it deals with controllers and DERs. This standard gives us a means of testing and listing regulatory controls under Scenario #2 in our descriptions of control systems. Unfortunately, it does not give us a clear standard for Scenario #3 or engineering guidelines for the wide functionality of supervisory controls. Supervisory controls are often in charge of equipment: a) from different manufacturers: b) that may have been installed at different times under different Code requirements; c) at different distances; d) with signaling systems that require different physical wire and connections (or even wireless signals) and different communications protocols; e) under applications with different response time horizons; and f) under applications with different functional outputs (i.e., current, voltage, power factor, etc.). UL and other standards are written to evaluate the behavior and the safety risks of either: a) individual pieces of manufactured equipment; or b) a limited number of self-contained pieces of equipment that can be tested together in the lab, and that generally operate in the "ecosystem" of the same manufacturer. However, supervisory controls are not a component of a single piece of equipment, nor are they necessarily derived from the limited configurations of a single manufacturer's "ecosystem." They are a set of virtual functions for a multi-component system. They can serve all different kinds of equipment for the special requirements of each site and each system. Their prime virtue is their adaptability and scalability.

If the standards and the Code are written such that only equipment within a single listed "ecosystem," installed together as a project, are acceptable, then there will be little opportunity for retrofit projects or for competitive product development to integrate the many possible configurations of various DERs. As efforts to modernize the grid proceed apace, with considerable economic and environmental consequences, this is not an insignificant consideration.

The proper venue for evaluating supervisory control behavior is electrical engineering for field applications in the construction sector. Compliance should fall under the purview of state-approved professional electrical engineers, with basic requirements articulated in the NEC and adopted by local AHJs. Listing standards are intended to govern the manufacturing of products, not all the details of their on-site installation, the advances represented in the UL 1741 CRD notwithstanding.

There are multiple precedents for this approach. Elsewhere in the construction industry, field engineering is standard for the kind of engineering problems that supervisory controls pose. Consider structural engineering. In order to build a structure or modify a building structurally, contractors don't typically contact an equipment manufacturer and determine that the modification is approved under a listing standard for a manufactured product ("manufactured homes" are a small minority of the building stock in the US, and even then modifications aren't necessarily within the purview of the manufacturer). Instead, they approach a structural engineer who can evaluate the new structure or a modification *in situ* under his or her professional training and relevant parameters of the local building code.

There are also closely related precedents in the NEC itself. Selective coordination, as defined in article 100, is the arrangement of overcurrent protection devices to limit current in different scenarios to busbars and conductors. In articles 620.62, 645.27, 695.3 (C) (3), 700.32, 701.32, and 708.54, a licensed professional must sign off on and document the selective coordination of overcurrent protection devices among relevant circuits. There is no expectation that equipment listing would be the appropriate mode of engineering for limiting current flow. Closer to home, 705.12 (B) (3) (5) allows for configurations that would otherwise violate the rules of 705.12 (B) (3) if a professional engineer has reviewed the particular configuration of equipment in detail and will sign off on it. Similar allowances are certainly possible for control systems to accomplish the same end.

The current policy in 705.13 to push engineering oversight of control systems onto the listing process, rather than professional engineering under local codes, is not a matter of safety: it's a matter of convenience for regulators and well-capitalized manufacturers.

7. Response time frames. For the purposes of 705.13, a crucial safety feature of control systems is how quickly they respond to overload conditions of different magnitudes. All switching and overcurrent protection devices are intended to *react* to specific conditions, and so, necessarily, there is a delay between

the onset of those conditions and the reaction. With breakers and fuses, this can be very, very fast, if necessary, although many overcurrent protection devices are designed to allow for temporary overloads at certain current levels, on the order of seconds, depending on the magnitude and application. Control systems, both regulatory and supervisory, because they rely on external signals, can be designed to meet certain response time thresholds for their reaction to current overload conditions; these response time thresholds have to be indexed for the magnitude of overload, the application (particularly for motors), and the difference between overloads due to faults and those due to excessive, but predictable loads. Where a listing standard, such as the UL 1741 CRD, is applicable, this information can be addressed in the standard, but where a listing standard does not apply, the NEC should articulate some thresholds, indexed, again, according to these variables.

RECOMMENDATIONS

Recommendation #1: The material from article 750 should be re-located to 705.13 or an adjacent number within article 705. Under the definition of "energy management systems" from 750, there isn't a coherent argument as to how these systems differ from the "power control systems" referenced in 705.13; it's a distinction without a difference. The intent of Article 750 is very limited -- it restricts what equipment can be controlled by "energy management systems." In fact, it might benefit 705.13 to explicitly restrict what load functions can be manipulated to limit current.

There is a bit of conceptual problem with this shift in that article 705 is labeled, "Interconnected Electric Power Production Sources." "Energy management systems" are focused on load control. However, as we've discussed, with the proliferation of ESSs and load control devices that can do demand response, loads and sources are both of concern when engineering against current overload. 705 should evolve towards addressing both power production and load control on equal terms. The fundamental interest of this article is the safe engineering of power *flow* and power *balancing*. So article 705 probably could be renamed to something like "Power Balancing Across the Premises Wiring."

Recommendation #2: The terminology and definitions for control systems needs a through-going overhaul that reaches across multiple articles. As described earlier, there are definitions relevant to 705.13 scattered in different parts of the Code, as well as other items we've discussed that are not defined or even conceptualized. The term "power control system" should be jettisoned for the specific context of 705.13 and the terminology used in 705.13 should be congruent with material covering control systems elsewhere in the NEC.

Control systems have a number of possible constituent parts; furthermore, supervisory control systems can be recursive in having regulatory controls or subordinate supervisory controls embedded within them. Here is a list of possible control system components:

* Supervisory computing devices
* Communications wiring and connections
* Communications signals and their protocols
* Software that gives instructions under some set of programmed functions
* An operator or technician
* The interface for that person which allows him or her to manipulate the controls.
* Regulatory controls in equipment or subordinate supervisory control systems

Additionally, the conceptual difference between regulatory and supervisory controls should be clearly drawn.

Here are some suggestions for definitions dealing with control systems. It is recommended that most of these be deployed in article 100, for a general scope of use, rather than article 705 or elsewhere. The content here is tentative, and the list by no means exhaustive; the code-making panels are encouraged to contemplate additional terms and alternate wordings in consultation with each other and other stakeholders.

control system — "A system comprised of components designed to control one or more pieces of equipment. These components could include controllers, other control systems, wires, wireless signaling devices, receivers, monitoring devices, software, and the signals routed along this system to relay information or give instructions. Control systems can have many different functions, only some of which are directly regulated by this Code. A control system does not itself include the equipment that it controls."

The definitions for "control system" in article 620, "control" in article 750, and "energy management system" in article 750 are not necessary if there is a general definition of "control system" in article 100. If the code-making panels feel that control systems governing different functional outputs need to be distinguished, then these could be treated as sub-types. For example, a control system that governs power output in an inverter, ESS or generator could be a "Control System, Power" ("Power Control System"), whereas the control system governing motion in a motor (as the term is used in article 620) could be a "Control System, Motor" or a "Control System, Motion" ("Motor Control System" or "Motion Control System").

controlled equipment — "Equipment which is governed by a control system. Components of controlled equipment, like receivers or regulatory control systems, may be part of a control system, but, as a whole, each piece of controlled equipment is not considered to be part of the control system governing it."

This definition would allow the Code to distinguish between that can and cannot be governed by a given control system. It also makes clear that control systems, as *systems*, ONLY include the mechanisms of control, not their object.

regulatory control system — "A type of control system which is incorporated within a single piece of equipment, which is integral to the design and function of this equipment, and which only governs the behavior of this equipment. Regulatory control systems may utilize information or may respond to instructions from an external signal to carry out its controls; they also may be part of a larger SCADA system."

This definition should be included in article 100.

SCADA system — "A Supervisory Controls And Data Acquisition (SCADA) system is a type of control system which independently coordinates the behavior of one or more piece of controlled equipment. SCADA systems can incorporate other SCADA or regulatory control systems which, in turn, control some subset of equipment within the governance of the larger SCADA system. SCADA systems receive information from different devices and send instructions to controlled equipment."

The presence of SCADA as a definition in article 708 is somewhat strange, given that the term is never actually used in that article, but only referenced in a non-binding Informative Annex at the end of the book. Granted, the Annex does just address the use of SCADA systems in COPS, but the whole arrangement comes across as kind of self-defeating jiu-jitsu. It would make more sense for SCADA systems not to be defined narrowly in terms of COPS and to be placed in article 100 *vis à vis* regulatory control systems. And given the rules articulated in the Informative Annex, perhaps they need their own article with a more general scope (and some specific rules pertaining to COPS SCADA functions)?

controller — "A computing device within a control system that receives data and sends instructions, either according to self-contained functions or according to signals originating from an external device.

The definition in article 100 limits "controller" to only devices that govern the electric power of controlled electrical equipment. The scope of the definition should be expanded to include any kind of functional output, and then the article specific definition from 430 can be eliminated. Specific

types of controllers, such as those defined in articles 620, 694 and 706, can remain in those articles and be article specific in scope.

signaling system — "A system for sending information between components in a control system."

The definition of "control circuit" can stay, if it's useful. A "signaling system" would include not only the control *circuits*, but the signals themselves. It's not clear why there needs to be a definition of "control circuit" *and* "signaling circuit" in article 100. Both definitions describe the same thing -- though they appear to be the provenance of different code-making panels.

monitoring device — "A device that generates information of a specific type, like temperature data or current flow, and reports this information to some other device, either continuously or periodically."

"Monitor" is a definition that only applies to article 750. It should be deleted and a more general term and definition, such as what is suggested here, put in its place in article 100. Note that 705.13 refers to monitoring without defining a "monitor" or "monitoring device."

control interface — "The interface containing set-points and other features of a control system that can be manipulated by qualified personnel."

Having a definition of a control interface makes the locus of 705.13 (E) more concrete and specific.

off-site — "Not located on the same physical property as other equipment associated with a control system and controlled equipment."

This definition would be used if the recommendation of this comment is accepted to restrict signaling systems; it could be article specific in scope to 705.

Recommendation #3: UL and similar standards are designed to test and certify manufactured pieces of equipment, if not strictly alone in their functionality, then with respect to a highly select number of commonly paired components. These standards can insist on *some* limits to the manner of integration for a given piece of equipment, but manufacturing standards are not able to anticipate every possible situation in which listed equipment can be installed and utilized. Critically, for our purpose, they are not meant to evaluate a heterogeneous multi-component system, considered as a gestalt, under a nearly unlimited range of field conditions -- as we have discussed with SCADA systems. Field integration, moreover, is a valid mode of engineering; in fact, it is the whole, entire purpose of the National Electric Code. If too much oversight over equipment behavior is vested in the manufacturing process, the final result isn't necessarily going to enhance safety, but it will hamper innovation and produce anti-competitive product markets.

The testing process within, and, indeed, the inherent purpose of, UL-type standards is not appropriate for evaluating many SCADA systems. The evaluation requirement for control systems in 705.13 should be broken into two separate stipulations:

For the purposes of controlling current in one or more pieces of equipment to prevent overload across a bus or circuit:

A) Regulatory control systems shall be listed for this function;

B) SCADA systems either shall be listed for this function, or they shall be evaluated and approved by a professional electrical engineer or other professional recognized by the AHJ.

Realistically, the company that builds and implements a SCADA system isn't necessarily going to be the company that does the electrical design, and chooses wire sizing, conduit sizing, grounding methods, etc. Controls engineering is a specialized discipline and so it should be allowable that the engineer who signs off on the SCADA system may not be the same engineer or electrician who signs off on the rest of the electrical design, as submitted to the AHJ. Therefore, it would be helpful if an Informational Note were added to stipulation B):

Information Note: The engineer who signs off on the SCADA system may not be the same engineer

who signs off on other aspects of the system electrical design and integration, nor will they necessarily be employed by the same company.

Recommendation #4: Without signaling reliability, most control systems will not be guaranteed to provide the safety protections that are the sole purpose of 705.13. In general, the efficacy and dependability of a signaling system should be something for which an electrical engineer can vouch, having evaluated its performance in the lab, and, if necessary, in the field. The approvals stipulated in Recommendation #2 should include signaling reliability as one of its benchmarks.

However, it is also recommended that the NEC include an additional requirement which cannot be bypassed by an engineer: no off-site control component can be used to implement the safety requirements of the NEC with respect to current overload. An Information Note could be added to clarify this requirement: off-site control components can be used to change set-points and manage equipment function for a variety of purposes, but any *reaction* to an overcurrent condition necessitated in article 705 or elsewhere in the NEC should never rely on off-site components. The code-making panel may also want to better understand the reliability of on-site wireless and power-line technologies for signaling.

Recommendation #5: Where supervisory controls are engineered by a professional and not specifically listed by the manufacturer for compliance with 705.13, the NEC should indicate minimum acceptable response times in which control systems should react. These response times should vary by magnitude (in terms of potential current), by application and by fault condition, and be organized in a table. To illustrate the need for these indices: a fault of 10,000 A over the rating of a conductor or busbar should clear much faster than a controlled overload of 1 A; the peak in-rush current of a motor is intrinsically limited in time in a way that a continuous load is not; a fault can generate near infinite current instantaneously for systems connect to the grid, whereas overload from too many loads will only exceed a predictable value. This comment is not proposing any specific time values, except to note that supervisory controls' signaling typically operates in the range of 1 second to 15 seconds.

Recommendation #6: At the moment, the NEC does not articulate a clear, principled conception of how multiple loads and sources can be balanced within the ampacity limits of busbars and conductors, particularly with equipment that can function, at different times, as either loads or sources. Traditionally, utilities controlled all power generation, so power would flow in one direction from the service point down a hierarchically arranged series of busses, feeders and branch circuits, and the existing rules have worked well where one or two DER sources might intrude on this configuration. However, in the not-too-distant future, there will be not just thousands, but *millions* of DERs and load-control devices connected at the grid edge, often in close proximity and performing many different functions, and so it is imperative that the NEC adopt a view of power balancing that appropriately accounts for this new paradigm.

In an earlier section of this article, we described a method for calculating possible current on a bus or conductor based on a worst balance of load and source. The NEC should adopt some version of this method in determining threshold current values when evaluating possible current overload on busbars or conductors for 705.11, 705.12 and 705.13. It would offer AHJs, engineers and electricians a more accurate assessment of potential overloads than current methods.

Statement of Problem and Substantiation for Public Input

The version of 705.13 adopted in the 2020 cycle was an important advance in incorporating DERs to the NEC, but its stipulations do not adequately address the composition and capabilities of control systems. This comment gives a background on control systems, critiques some aspects of 705.13 and related issues, and offers some recommendations for code-make panel #4 as they decide how to update the NEC for the next cycle.

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Submittal Date:	Thu Sep 10 11:41:21 EDT 2020
Committee:	NEC-P04

Public Input No. 4685-NFPA 70-2020 [Global Input]

Align the on-site energy sources into a series of articles as follows:

689 On-Site Energy Sources

690 Solar Photovoltaic (PV) Systems

691 Large-Scale Photovoltaic (PV) Systems

692 Fuel Cell Systems

693 Generators

694 Wind Electric Systems

695 Energy Storage Systems

696 Storage Batteries

Public inputs were made by this task group to accommodate the following:

1. **Move Article 445 to 693**
2. **Move Article 480 to 696**
3. **Move Article 695 to 703 (This is to make room for 706 Energy Storage Systems)**
4. **Move Article 706 to 695**

In addition, ARticle 705 should be renumbered to Article 689.

Statement of Problem and Substantiation for Public Input

This global input accommodates the work of the Alternative Energy Taskgroup appointed by the corrrelating committee and consisting of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

These actions impact multiple Code Making Panels. Public inputs were made for all of these actions except for the renumbering of ARticle 705. This task group is asking the correlating committee to coordinate these actions to ensure changes align with the new numbering and location of these articles. This will help ensure correlation between eachother and establish their true closer relationship. This task group is not asking that CMP ownership be changed for any of these Articles.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3006-NFPA 70-2020 [Article 706]	
Public Input No. 2984-NFPA 70-2020 [Article 445]	
Public Input No. 2985-NFPA 70-2020 [Article 480]	
Public Input No. 2692-NFPA 70-2020 [Article 705]	

Submitter Information Verification

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Submittal Date:	Thu Sep 10 16:46:36 EDT 2020
Committee:	NEC-P04

Public Input No. 4318-NFPA 70-2020 [Chapter 0 [Title Only]]

THIS IS A GLOBAL INPUT

THE TERRAVIEW SOFTWARE WOULD NOT ALLOW THE SUBMISSION OF A GLOBAL INPUT.

PROPOSED GLOBAL INPUT.

Mandate that all alternative energy sources referenced throughout this code comply with the requirements of 230.82(6).

Statement of Problem and Substantiation for Public Input

This global input is written to address a very serious safety issue that exists abundantly in the NEC.
CMP-10 has purview over services and mandates that PV, fuel cells, wind systems, energy storage systems and interconnected power production sources connected on the supply side of the service disconnecting means be done so only with a disconnecting means and overcorrect protection as required for service conductors in Article 230.
The problem here is that 90.3 provides committees dealing with alternative energy sources the ability to completely ignore 230.82(6). They simply claim that "their conductors are output conductors, not service conductors."
Any conductor that taps into or splices to service conductors is a service conductor.
This issue must be dealt with immediately by the NEC Correlating Committee. While this global input may not result in first revisions to correct this very serious safety concern, this concept now exists and is not new in the second draft stage.
We can no longer ignore this issue.

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Committee: NEC-P04

Public Input No. 2182-NFPA 70-2020 [New Article after 100]

Health Care Microgrid

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.

Statement of Problem and Substantiation for Public Input

NFPA 99 has included the concept for a Health Care Microgrid, including its definition. We are submitting a series of PIs to NFPA 70 to correlate with NFPA 99.

This comment is being made by a committee comprised of members of NFPA 99 ELS, NFPA 70 CMP15, and NFPA 110 who has worked over the summer to create a series of proposals to help correlate better with NFPA 99.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2173-NFPA 70-2020 [New Section after 517.30(B)]	

Submitter Information Verification

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Submittal Date: Thu Aug 06 17:15:27 EDT 2020
Committee: NEC-P04

Public Input No. 1993-NFPA 70-2020 [Definition: Generating Capacity, Inverter.]

Generating Capacity, Inverter.

The sum of parallel-connected inverter maximum continuous output power at 40°C in ~~watts or kilowatts~~ volt-ampere or kilovolt-ampere . (CMP-4)

Statement of Problem and Substantiation for Public Input

Problem: Many inverters are available with kVA ratings that are greater than their kW ratings. Example, the CPS SCH100/125KTL-DO/US-600 which is rated as 125kW and 132kVA AC output.
Solution: Since the generating capacity should represent the maximum capacity of the system it would be correct to use the higher volt-ampere rating of the inverter as the maximum output. Where inverter output is rated only in watts the volt-ampere will be equal to the watt rating and the volt-ampere unit is still the correct unit to use.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 1995-NFPA 70-2020 [Section No. 690.7(A)]	Paired change
Public Input No. 1996-NFPA 70-2020 [Section No. 690.8(A)(1)]	Paired change
Public Input No. 1995-NFPA 70-2020 [Section No. 690.7(A)]	
Public Input No. 1996-NFPA 70-2020 [Section No. 690.8(A)(1)]	

Submitter Information Verification

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Submittal Date: Fri Jul 24 11:35:51 EDT 2020
Committee: NEC-P04

Public Input No. 2683-NFPA 70-2020 [Definition: Hybrid System.]

~~**Hybrid System.**~~

~~A system comprised of multiple power sources. These power sources could include photovoltaic, wind, micro-hydro generators, engine-driven generators, and others, but do not include electric power production and distribution network systems. Energy storage systems such as batteries, flywheels, or superconducting magnetic storage equipment do not constitute a power source for the purpose of this definition. The energy regenerated by an overhauling (descending) elevator does not constitute a power source for the purpose of this definition. (CMP-4)~~

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

This definition is being deleted as it is not used in any alternative energy article and since a similar term exists in Chapter 8 its presence here could cause confusion.

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Submittal Date: Fri Aug 28 13:57:47 EDT 2020
Committee: NEC-P04

Public Input No. 2684-NFPA 70-2020 [Definition: Interactive System.]

Interactive ~~System~~ Mode .

~~An electric~~ The operational mode for power production ~~system~~ equipment that is operating in parallel with and capable of delivering energy to an electric power production and distribuution network or other primary source ~~supply system~~ . (CMP-4)

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

Replaced “system” in this term with “mode” since the term “interactive” is more often used without “system” and can be applied to a specific piece of equipment, not a system as a whole. With related changes to “microgrid system” and “stand-alone system” the term interactive mode should apply to a power source, such as an interactive inverter, not a system as a whole. Will need additional PIs or a global PI to ensure where the term interactive system or just interactive is used, the term mode is replaced or added.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2538-NFPA 70-2020 [Section No. 705.32]	
Public Input No. 2978-NFPA 70-2020 [Definition: Electric Power Production and Distribution Netw...]	
Public Input No. 2979-NFPA 70-2020 [Section No. 690.13(C)]	
Public Input No. 2980-NFPA 70-2020 [Section No. 694.24]	
Public Input No. 2981-NFPA 70-2020 [Section No. 694.50]	

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Submittal Date: Fri Aug 28 14:01:51 EDT 2020
Committee: NEC-P04

Public Input No. 2686-NFPA 70-2020 [Definition: Inverter, Multimode.]

Inverter, Multimode.

~~Equipment~~ Inverter equipment having the capabilities ~~of~~ to operate in both ~~the~~ interactive ~~inverter and the stand-alone inverter~~ mode and island mode . (CMP-4)

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

These changes reflect more accuratelywhat a multimode inverter is and aligns with how this term is being used in the alternative energy articles.

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Committee: NEC-P04

Public Input No. 2685-NFPA 70-2020 [Definition: Island Mode.]

Island Mode.

The operational mode for ~~stand-alone~~ power production equipment ~~or an isolated microgrid, or for a multimode inverter or an interconnected microgrid~~ that is disconnected from an electric power production and distribution network or other primary power source and capable of delivering energy to loads . (CMP-4)

~~Informational Note: Isolated microgrids are distinguished from interconnected microgrids, which are addressed in Article 705 .~~

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

Deleted undefined term and unnecessary terms to better restrict the application of this definition with the other defined terms of “stand-alone system” and “microgrid system” (in 705).

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Submittal Date: Fri Aug 28 14:04:39 EDT 2020
Committee: NEC-P04

Public Input No. 3666-NFPA 70-2020 [Definition: Island Mode.]

Island Mode.

The operational mode for stand-alone power production equipment or an isolated microgrid, or for a multimode inverter or an interconnected microgrid that is disconnected from an electric power production and distribution network or other primary power source. (CMP-4)

Informational Note: Isolated microgrids are distinguished from interconnected microgrids, ~~which are addressed in Article~~ see 705. 1 .

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(r) Style Manual prohibits reference to an entire article, other than Article 100. As such, it is proposed that you instead refer folks to the scope of the relevant article.

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Committee: NEC-P04

Public Input No. 2199-NFPA 70-2020 [Definition: Stand-Alone System.]

Stand-Alone System.

A system that is capable of supplying power independent, with no connection, of an electric utility power production and distribution network.(CMP-4)

Statement of Problem and Substantiation for Public Input

The parameters the Stand Alone Definition must be clearly established as to what is and what is not a connection with serving utility. A part of this definition appears in Article 712 and there is clarification that must be established for installations of Generators, P V. ESS and Wind. Neither of these systems are a Stand Alone System anytime there is a serving Utility connection.

The 4-Pole Transfer Switch of a Separately Derived System could be the only system closely near consideration for a Stand Alone System since the Grounded Conductor is actually Switched there by disconnecting the serving utility from the Premise Wiring. An Automatic Transfer Switch that complies with UL 1008 is the only Listed equipment that creates a Separately Derived System.

A device being installed currently is not evaluated to UL 1008, is not a 3-Pole or 4 Pole application and there is not a Separately Derived System terminated as Another Power Source.

This must be applied in Article 710.1 for clarification for Contractors and AHJ's.

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Submittal Date: Sat Aug 08 21:46:00 EDT 2020
Committee: NEC-P04

Public Input No. 2688-NFPA 70-2020 [Definition: Stand-Alone System.]

Stand-Alone System.

A premises wiring system that is ~~capable of supplying power independent of~~ not interconnected to an electric power production and distribution network or other primary source that has any combination of generation and energy storage capable of operating in island mode .(CMP-4)

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

Clarifies that a Stand-Alone system is one that is not connected to a utility. Definition is modified to align more closely (as a mirror image) with a microgrid system (as defined and modified in a related PI within 705.2).

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Submittal Date: Fri Aug 28 14:13:37 EDT 2020
Committee: NEC-P04

Public Input No. 588-NFPA 70-2020 [Definition: Stand-Alone System.]

Stand-Alone System.

A system that ~~is capable of supplying power~~ supplies power independent of an electric power production and distribution network.(CMP-4)

Statement of Problem and Substantiation for Public Input

As currently written, any piece of equipment that is capable of creating electrical energy falls under this definition. I apologize that I don't have a better suggestion, but perhaps some mention of transfer equipment should be added? Without that clarification an emergency generator is a stand-alone system.

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Submittal Date: Mon Mar 02 17:00:21 EST 2020
Committee: NEC-P04

Public Input No. 2792-NFPA 70-2020 [New Definition after Definition: Battery System.]

TITLE OF NEW CONTENT

Building Integrated Photovoltaic (BIPV) system . Building-integrated photovoltaics are photovoltaic materials that are used to replace conventional building materials in parts of the building envelope such as the roof, skylights, or facades.

Statement of Problem and Substantiation for Public Input

This is related to public input 2791-NFPA 70-2020. We need a definition listed for this new content.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2791-NFPA 70-2020 [New Section after 690.51]	Definition

Submitter Information Verification

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Submittal Date: Tue Sep 01 10:17:09 EDT 2020
Committee: NEC-P04

Public Input No. 1882-NFPA 70-2020 [New Definition after Definition: Conductor, Insulated.]

Conductor, System

Circuit conductors that are on the supply side of the main disconnect or transfer switch in systems where the supply source is not considered a service.

Statement of Problem and Substantiation for Public Input

The term "System Conductor" is used 12 times in the 2020 NEC and the usage is confined to Articles 100 and 250. In each instance of usage, it is describing a grounded conductor and in 11 of the 12 instances it is part of the term "Grounded System Conductor". The term "Circuit Conductor" is used 81 times throughout the 2020 NEC. The term "Grounded Circuit Conductor" is used 43 times throughout the 2020 NEC and 10 times in Article 250.

In Articles 100 and 250, it is not clear that there is a difference between a "Grounded System Conductor" and a "Grounded Circuit Conductor", these terms appear to be used interchangeably.

If it is not the intent that these terms be used interchangeably:

- Definitions should be provided as proposed in PIs 1881-NFPA 70-2020 and 1882-NFPA 70-2020 to delineate the unique features of a "System Conductor" versus those of a "Circuit Conductor“

- PIs 1883-NFPA 70-2020 , 1906-NFPA 70-2020 , 1892-NFPA 70-2020 , 1893-NFPA 70-2020 , 1904-NFPA 70-2020 , and 1905-NFPA 70-2020 should be disregarded

If it is the intent that the two terms are to be used interchangeably:

- All instances of "System Conductor" should be changed to "Circuit Conductor“

- PIs 1883-NFPA 70-2020 , 1906-NFPA 70-2020 , 1892-NFPA 70-2020 , 1893-NFPA 70-2020 , 1904-NFPA 70-2020 , and 1905-NFPA 70-2020 should be accepted to change instances of “system conductor” to “circuit conductor”

- PI 1881-NFPA 70-2020 may be helpful in this scenario to clarify the meaning of the term ”Circuit Conductor”

- Replacing all instances of "Circuit Conductor“ with "System Conductor" and defining the term "System Conductor" would accomplish the same goal. "Circuit Conductor“ is presently more used throughout the NEC, so the proposal above requires a smaller number of revisions.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 1881-NFPA 70-2020 [New Definition after Definition: Conductor, Bare.]	
Public Input No. 1906-NFPA 70-2020 [Section No. 250.36(B)]	
Public Input No. 1893-NFPA 70-2020 [Section No. 250.84]	
Public Input No. 1904-NFPA 70-2020 [Section No. 250.187(C)]	
Public Input No. 1905-NFPA 70-2020 [Section No. 250.34(C)]	
Public Input No. 1883-NFPA 70-2020 [Definition: Grounded Conductor.]	
Public Input No. 1892-NFPA 70-2020 [Section No. 250.80]	

Public Input No. 1881-NFPA 70-2020 [New Definition after Definition: Conductor, Bare.]

Public Input No. 1883-NFPA 70-2020 [Definition: Grounded Conductor.]

Public Input No. 1892-NFPA 70-2020 [Section No. 250.80]

Public Input No. 1893-NFPA 70-2020 [Section No. 250.84]

Public Input No. 1904-NFPA 70-2020 [Section No. 250.187(C)]

Public Input No. 1905-NFPA 70-2020 [Section No. 250.34(C)]

Public Input No. 1906-NFPA 70-2020 [Section No. 250.36(B)]

Submitter Information Verification

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Submittal Date: Mon Jul 13 15:41:04 EDT 2020
Committee: NEC-P04

Public Input No. 2682-NFPA 70-2020 [New Definition after Definition: Grounded, Solidly.]

Grounded, Functionally.

A system that has an electrical ground reference for operational purposes that is not solidly grounded.

Informational Note: A functionally grounded system is often connected to ground through an electronic means internal to an inverter or charge controller that provides ground-fault protection. Examples of operational purposes for functionally grounded systems include ground-fault detection and performance-related issues for some power sources.

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

This definition is being moved to Article 100 as part of an effort of the alternative energy task group which is expanding the usage of this term in various areas of the NEC associated with alternative energy.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2681-NFPA 70-2020 [Definition: Grounded, Functionally.]	Moved from 690
Public Input No. 2681-NFPA 70-2020 [Definition: Grounded, Functionally.]	

Submitter Information Verification

Submitter Full Name: Thomas Domitrovich
Organization: Eaton Corporation
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Submittal Date: Fri Aug 28 13:37:30 EDT 2020
Committee: NEC-P04

Public Input No. 2699-NFPA 70-2020 [New Definition after Definition: Inverter.]

Inverter , Stand-alone.

Inverter equipment having the capabilities to operate only in island mode. (CMP-4)

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

New term to address all three flavors of inverter that could be used in these systems.

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Committee: NEC-P04

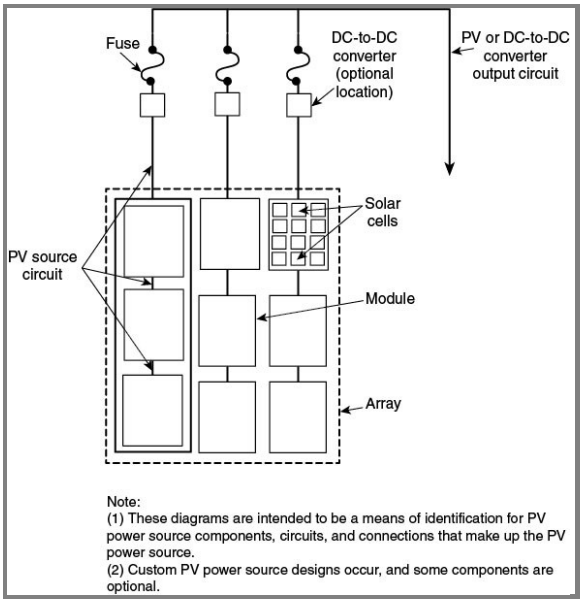
Public Input No. 4418-NFPA 70-2020 [Section No. 690.1]

690.1 Scope.

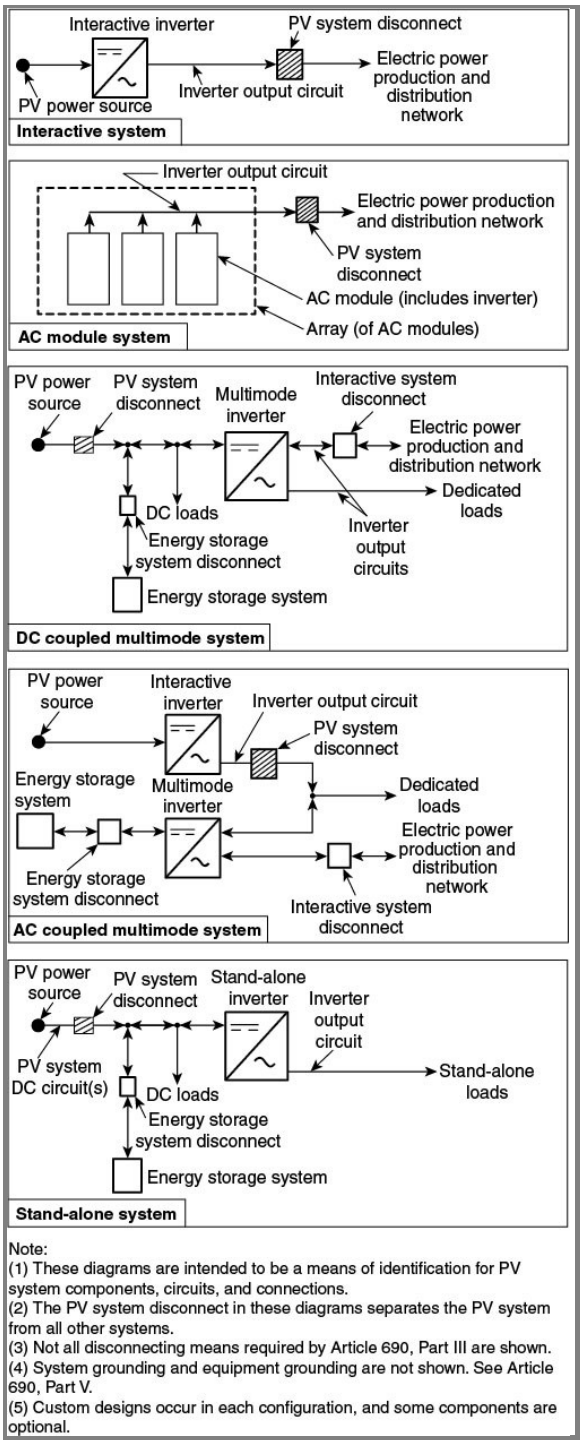
This article applies to solar PV systems, other than those covered by Article 691, including the array circuit(s), inverter(s), and controller(s) for such systems. The systems covered by this article include those interactive with other electric power production sources or stand-alone, or both. These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

Informational Note ~~No. 1~~ : ~~See~~ ~~Informational Note Figure 690.1(a)~~ ~~and~~ ~~Informational Note Figure 690.1(b)~~ . ~~Informational Note No. 2:~~ Article 691 covers the installation of large-scale PV electric supply stations.

~~Figure Informational~~ Informational Note Figure 690.1(a) Identification of PV ~~Power Source~~ DC Circuits and Common Components.



~~Figure Informational Note Figure 690.1(b) Identification of PV System Components in Common Configurations.~~



Note:
(1) These diagrams are intended to be a means of identification for PV system components, circuits, and connections.
(2) The PV system disconnect in these diagrams separates the PV system from all other systems.
(3) Not all disconnecting means required by Article 690, Part III are shown.
(4) System grounding and equipment grounding are not shown. See Article 690, Part V.
(5) Custom designs occur in each configuration, and some components are optional.

(replace with new figure and notes as shown in attachment)

Additional Proposed Changes

File Name	Description	Approved
690_1_IN_Figure_1a_correct.pdf	New figure 690.1a	

Statement of Problem and Substantiation for Public Input

As PV system typologies and designs proliferate, this Informational Note Figure has become increasingly problematic. Confusion about whether every component should be installed in every system, and what equipment is required where (such as fuses or dc-to-dc converters) has been expressed by enforcement and installers. Splitting the diagram into 3 more digestible sections, and simplifying each, will help better illustrate defined terms such as source circuit and dc-to-dc converter circuit while lessening confusion regarding design variations. This action is linked to related PIs to update this language to harmonize with the deletion of the PV Output Circuit definition and changes to the DC-to-DC Converter Source and Output Circuit definitions.

The deletion of IN Figure 1b is recommended, along with a suggested move to Article 705. PV Power Source is not a defined term in 690, and the use of this term on the diagram generates confusion. Article 705 uses the term “Power Source” to refer to the AC output of a power system, while this diagram currently uses the term to point to the DC side of a PV system. Substituting a term that is defined, PV System DC Circuit(s) improves the usability of these diagrams. In addition, swapping the “electric power production and distribution network” label for a more succinct and generalized term “Other Power Sources” will lessen confusion. Additionally, making these diagrams more generic (not PV system specific) and moving them to 705 will allow them to be referenced for any type of power production source operating in parallel with a primary source.

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Related Public Inputs for This Document

Related Input	Relationship

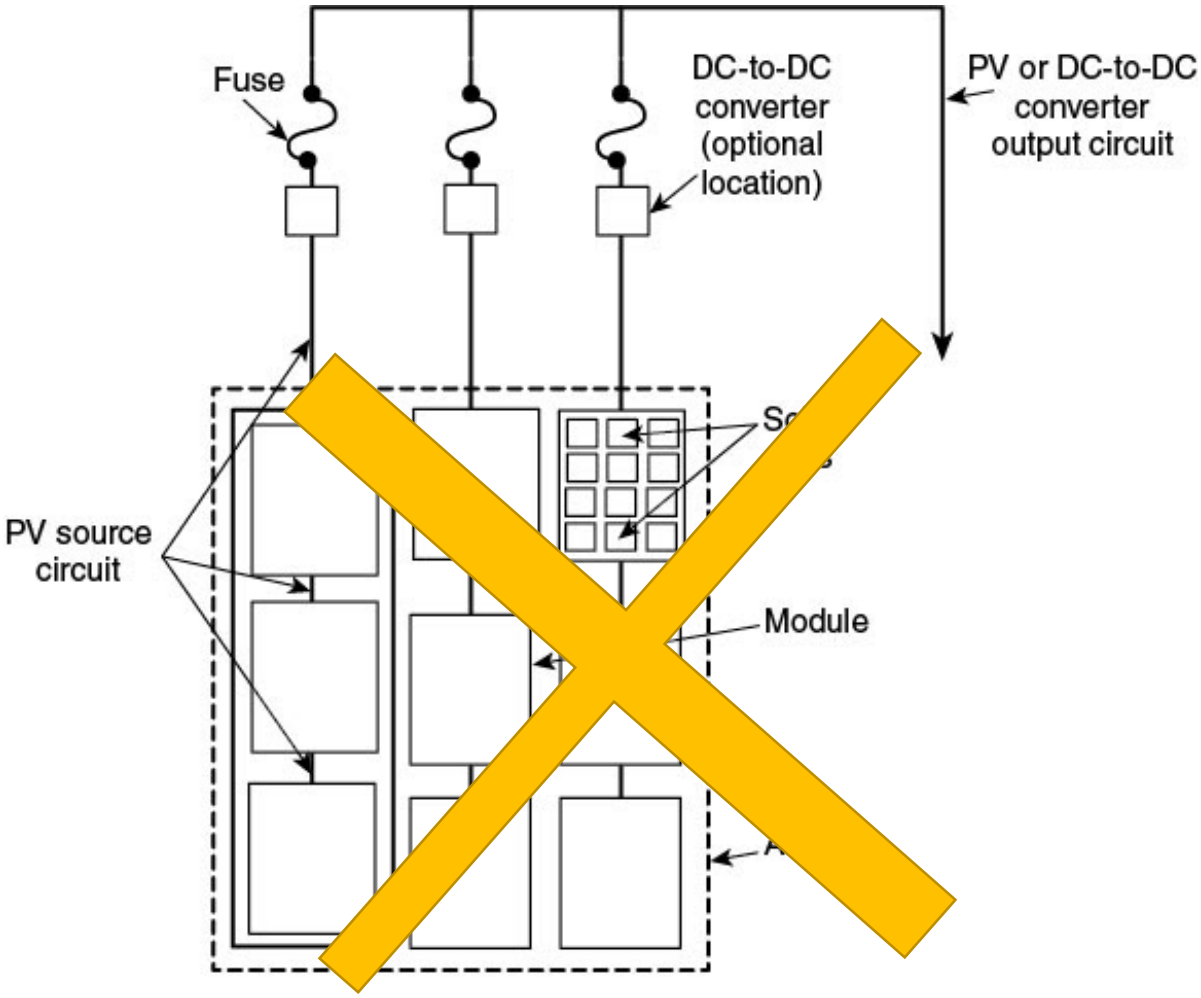
Public Input No. 3705-NFPA 70-2020 [Definition: PV System DC Circuit.]

Submitter Information Verification

Submitter Full Name: Evelyn Butler
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Committee: NEC-P04

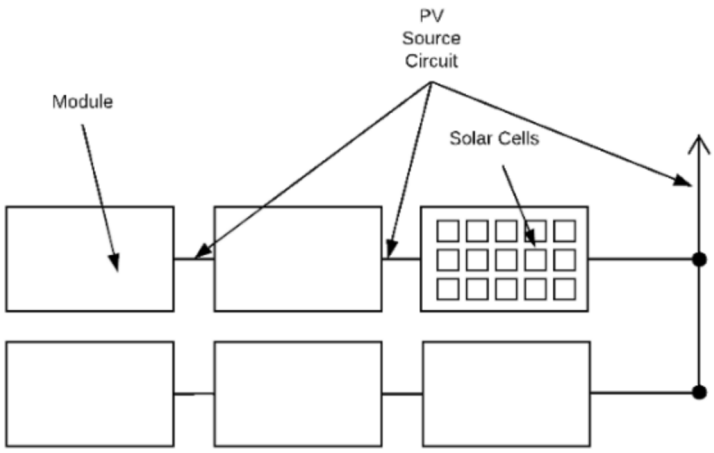
Informational Note Figure 690.1(a) Identification of PV DC Circuits and Common Components ~~Power Source Components~~.

(Cross out drawing and image notes immediately below it and replace with new)

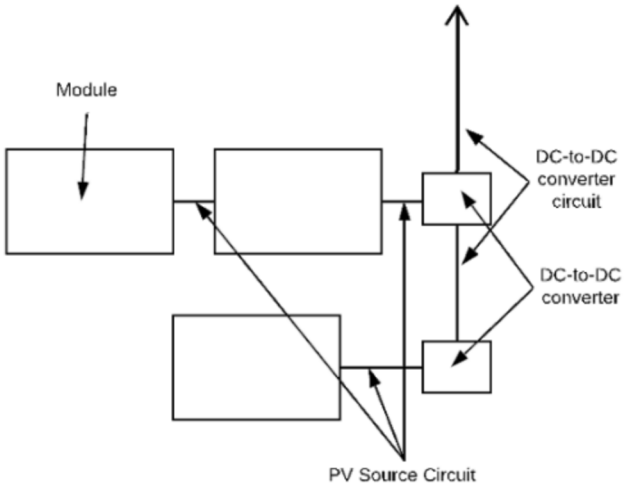


Note:
(1) These diagrams are intended to be a means of identification for PV power source components, circuits, and connections that make up the PV power source.
(2) Custom PV power source designs occur, and some components are optional.

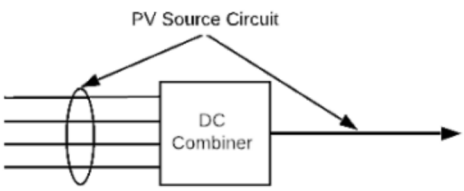
Identification of PV System DC Circuits and Common Components
Informational Note Figure 690.1(a)(1)



Informational Note Figure 690.1(a)(2)



Informational Note Figure 690.1(a)(3)



Note:

1. These diagrams are intended to be a means of identification for PV system dc circuits and common components.
2. Overcurrent protection and disconnects are not shown; custom configurations will occur.

Public Input No. 3892-NFPA 70-2020 [Section No. 690.2]

(Relocate all definitions in the 690. 2 to Article 100, arrange them in alphabetical order and without any subdivisions.)

690. 2 Definitions.

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

AC Module System.

An assembly of ac modules, wiring methods, materials, and subassemblies that are evaluated, identified, and defined as a system.

Alternating-Current (ac) Module (Alternating-Current Photovoltaic Module).

A complete, environmentally protected unit consisting of solar cells, inverter, and other components, designed to produce ac power.

Array.

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

Bipolar Circuit.

A dc circuit that is comprised of two monopole circuits, each having an opposite polarity connected to a common reference point.

DC-to-DC Converter Output Circuit.

The dc circuit conductors connected to the output of a dc combiner for dc-to-dc converter source circuits.

DC-to-DC Converter Source Circuit.

Circuits between dc-to-dc converters and from dc-to-dc converters to the common connection point(s) of the dc system.

Direct-Current (dc) Combiner.

An enclosure that includes devices used to connect two or more PV system dc circuits in parallel.

Electronic Power Converter.

A device that uses power electronics to convert one form of electrical power into another form of electrical power.

> Informational Note: Examples of electronic power converters include, but are not limited to, inverters, dc-to-dc converters, and electronic charge controllers. These devices have limited current capabilities based on the device ratings at continuous rated power.

Grounded, Functionally.

A system that has an electrical ground reference for operational purposes that is not solidly grounded.

> Informational Note: A functionally grounded system is often connected to ground through an electronic means internal to an inverter or charge controller that provides ground-fault protection. Examples of operational purposes for functionally grounded systems include ground-fault detection and performance-related issues for some power sources.

Module.

A complete, environmentally protected unit consisting of solar cells and other components designed to produce dc power.

Monopole Circuit.

An electrical subset of a PV system that has two conductors in the output circuit, one positive (+) and one negative (−).

PV Output Circuit.

The dc circuit conductors from two or more connected PV source circuits to their point of termination.

PV Source Circuit.

The dc circuit conductors between modules and from modules to dc combiners, electronic power converters, or a dc PV system disconnecting means.

PV System DC Circuit.

Any dc conductor in PV source circuits, PV output circuits, dc-to-dc converter source circuits, and dc-to-dc converter output circuits.

Solar Cell.

The basic PV device that generates electricity when exposed to light.

Statement of Problem and Substantiation for Public Input

"The National Electrical Code has definitions in multiple parts in Article 100 and many definitions scattered through out the code many of them in the .2 section of the articles.
Most of the other standards under NFPA have their definitions in one location and this will allow the NEC the same requirement. The revisions to the NEC Style Manual require all the definitions to be relocated to Article 100. "

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Submittal Date: Wed Sep 09 14:57:58 EDT 2020
Committee: NEC-P04

Public Input No. 3680-NFPA 70-2020 [Definition: Alternating-Current (ac) Module (Alternating-Cu...]

~~Alternating-Current (ac) Module (Alternating-Current Photovoltaic Module)~~ AC Module .

A complete, environmentally protected unit consisting of solar cells, inverter, and other components, designed to produce ac power.

Statement of Problem and Substantiation for Public Input

This change aligns the defined term with the way the term is actually used in the text of Article 690. The language that would be deleted is never used anywhere else in the text of Article 690.

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Affiliation:	PV Industry Forum (PVIF)
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Submittal Date:	Wed Sep 09 10:42:30 EDT 2020
Committee:	NEC-P04

Public Input No. 3714-NFPA 70-2020 [Definition: DC-to-DC Converter Output Circuit.]

PV DC-to-DC Converter ~~Output~~ Circuit.

The dc circuit conductors connected to the output of ~~a~~ dc ~~combiner for dc~~ -to-dc ~~converter source circuits~~ converters .

Statement of Problem and Substantiation for Public Input

There are two definitions related to dc-to-dc converters that can create a source of confusion among inspectors, installers, and system designers. The seeming overlap and lack of clarity make interpretation and enforcement subjective as both refer to circuits on the output of dc-to-dc converters.
Much like the previous distinction between PV source and PV output circuits, there are no significant, separate, or differentiating requirements for current calculations, overcurrent protection, or material installation methods in Article 690 that distinguish between dc-to-dc converter source and output circuits - with a single exception in 690.11 related to arc-fault circuit requirements which is addressed in the related PI.
For enforcement officials and system designers, correctly determining the circuit current and voltage is far more important than trying to distinguish between various circuits all on the output side of dc-to-dc converters, especially as changing system architectures and equipment options have rendered the current two definitions unclear and unnecessary.
Combining these two terms into a single definition will benefit both enforcement and system installers and help improve readability of the NEC.

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Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3724-NFPA 70-2020 [Definition: DC-to-DC Converter Source Circuit.]	

Submitter Information Verification

Submitter Full Name: Evelyn Butler
Organization: Solar Energy Industries Assn
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Submittal Date: Wed Sep 09 11:15:58 EDT 2020
Committee: NEC-P04

Public Input No. 3724-NFPA 70-2020 [Definition: DC-to-DC Converter Source Circuit.]

~~**DC-to-DC Converter Source Circuit.**~~

~~Circuits between dc-to-dc converters and from dc-to-dc converters to the common connection point(s) of the dc system.~~

Statement of Problem and Substantiation for Public Input

There are two definitions related to dc-to-dc converters that can create a source of confusion among inspectors, installers, and system designers. The seeming overlap and lack of clarity make interpretation and enforcement subjective as both refer to circuits on the output of dc-to-dc converters.
Much like the previous distinction between PV source and PV output circuits, there are no significant, separate, or differentiating requirements for current calculations, overcurrent protection, or material installation methods in Article 690 that distinguish between dc-to-dc converter source and output circuits - with a single exception in 690.11 related to arc-fault circuit requirements which is addressed in the related PI.
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Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3714-NFPA 70-2020 [Definition: DC-to-DC Converter Output Circuit.]	the new combined definition

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Committee: NEC-P04

Public Input No. 3675-NFPA 70-2020 [Definition: Electronic Power Converter.]

Electronic Power Converter. - Move to article 100

A device that uses power electronics to convert one form of electrical power into another form of electrical power.

Informational Note: Examples of electronic power converters include, but are not limited to, inverters, dc-to-dc converters, and electronic charge controllers. These devices have limited current capabilities based on the device ratings at continuous rated power.

Statement of Problem and Substantiation for Public Input

This term Electronic Power Converter applies both within Article 690 and throughout the Code, therefore it should be moved to Article 100. The defined term is used in multiple Articles, and is foundational in usage in Articles 690 and 705, requiring that it remain under the purview of CMP-4.

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Committee: NEC-P04

Public Input No. 2681-NFPA 70-2020 [Definition: Grounded, Functionally.]

~~**Grounded, Functionally.**~~

~~A system that has an electrical ground reference for operational purposes that is not solidly grounded.~~

~~Informational Note: A functionally grounded system is often connected to ground through an electronic means internal to an inverter or charge controller that provides ground-fault protection. Examples of operational purposes for functionally grounded systems include ground-fault detection and performance-related issues for some power sources.~~

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

This definition is being moved to Article 100 as part of an effort of the alternative energy task group which is expanding the usage of this term in various areas of the NEC associated with alternative energy.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2682-NFPA 70-2020 [New Definition after Definition: Grounded, Solidly.]	Destination in Article 100
Public Input No. 2682-NFPA 70-2020 [New Definition after Definition: Grounded, Solidly.]	

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Committee: NEC-P04

Public Input No. 3343-NFPA 70-2020 [Definition: Grounded, Functionally.]

This definition shall be relocated to Article 100. This identical definition is also found in Article 712. The revised Style Manual requires panel action to only have one definition.

Grounded, Functionally.

A system that has an electrical ground reference for operational purposes that is not solidly grounded.

Informational Note: A functionally grounded system is often connected to ground through an electronic means internal to an inverter or charge controller that provides ground-fault protection. Examples of operational purposes for functionally grounded systems include ground-fault detection and performance-related issues for some power sources.

Statement of Problem and Substantiation for Public Input

The identical definition for "Grounded, Functionally" is also used in Article 712.
This term may not be used elsewhere in the code and could apply for the entire document.
Review the Style Manual revisions for definitions and acronyms. 2.2.2.4 Terms with Multiple Definitions.

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Committee: NEC-P04

Public Input No. 3677-NFPA 70-2020 [Definition: Grounded, Functionally.]

Grounded, Functionally. - Move to 100

A system that has an electrical ground reference for operational purposes that is not solidly grounded.

Informational Note: A functionally grounded system is often connected to ground through an electronic means internal to an inverter or charge controller that provides ground-fault protection. Examples of operational purposes for functionally grounded systems include ground-fault detection and performance-related issues for some power sources.

Statement of Problem and Substantiation for Public Input

This term Functionally Grounded applies both within Article 690 and throughout the Code, therefore it should be moved to Article 100. The defined term is used in multiple Articles, and is foundational in usage in Articles 690 and 705, requiring that it remain under the purview of CMP-4.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
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Committee: NEC-P04

Public Input No. 4548-NFPA 70-2020 [Definition: Grounded, Functionally.]

Grounded, Functionally.

A system that has an electrical ground reference for operational purposes that is not solidly grounded.

Informational Note: A functionally grounded system is often connected to ground through an electronic means internal to an inverter or charge controller that provides ground-fault protection. Examples of operational purposes for functionally grounded systems include ground-fault detection and performance-related issues for some power sources.

Additional Proposed Changes

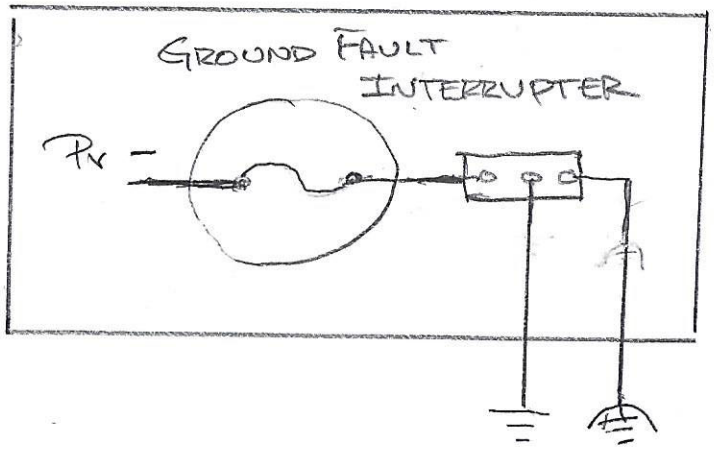
File Name	Description	Approved
Functional_Ground_Dwg.pdf	A Visual representation showing what a functionally grounded system might look like	

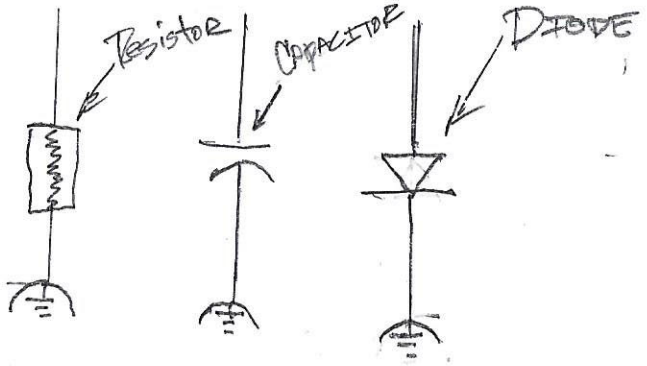
Statement of Problem and Substantiation for Public Input

The term functionally grounded is not well defined and there are no readily available drawings depicting what or how it is installed or used. The NEC is used primarily by installers and a visual representation of how this grounding method is installed is necessary for proper installation of the system.

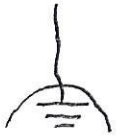
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Committee: NEC-P04

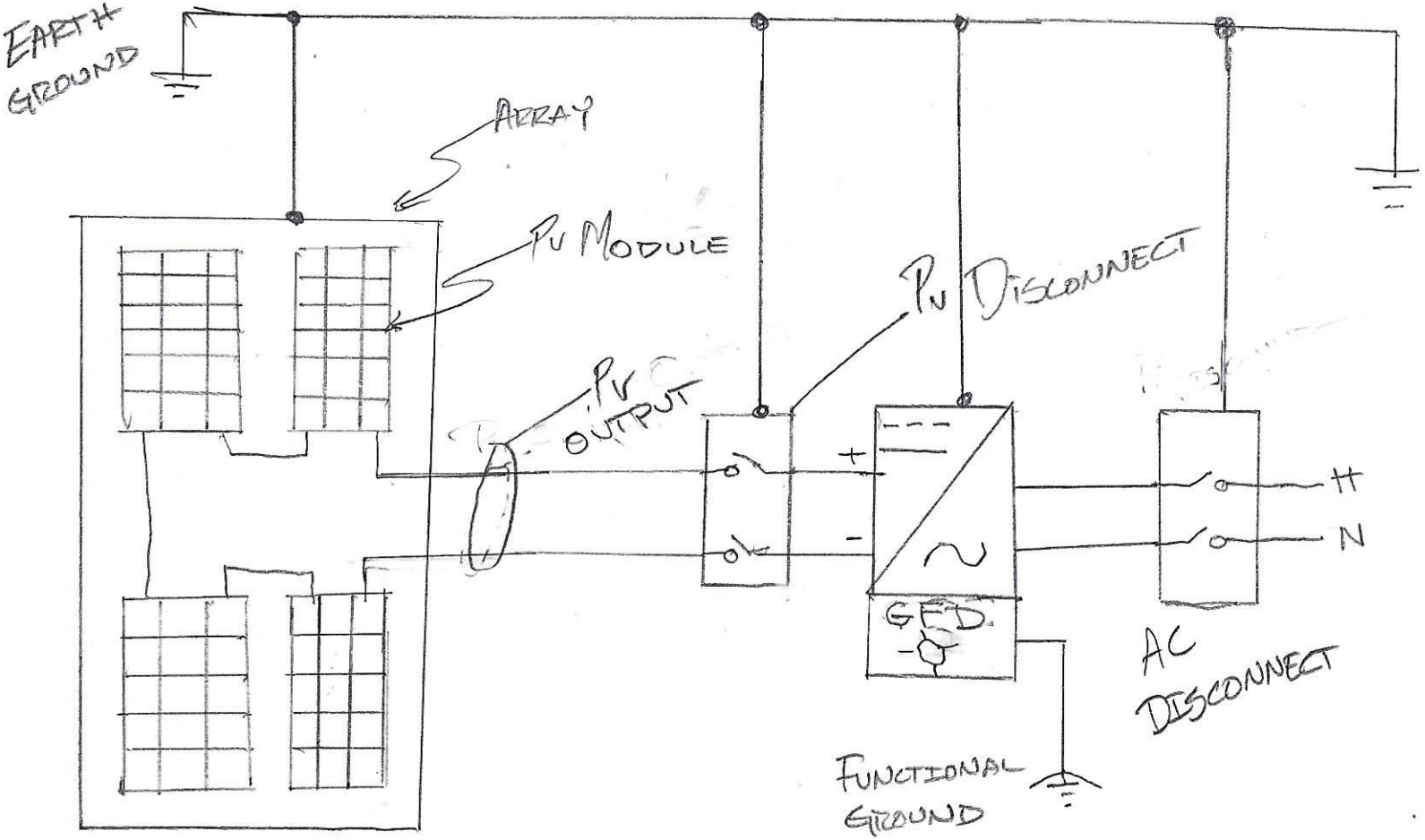




FUNCTIONAL
GROUND CONFIGURATIONS



FUNCTIONAL
GROUND
SYMBOL



Public Input No. 3701-NFPA 70-2020 [Definition: PV Output Circuit.]

~~**PV Output Circuit.**~~

~~The dc circuit conductors from two or more connected PV source circuits to their point of termination.~~

Statement of Problem and Substantiation for Public Input

The definition of PV output circuit as compared to that of PV source circuit has caused confusion among inspectors, installers, and system designers for years. This creation of a separate category for PV output circuits suffers from a lack of clear logic in regards to where source circuits end and an output circuit begins. There are no significant, separate, or differentiating requirements for current calculations, overcurrent protection, or material installation methods in Article 690 that distinguish between PV source and output circuits. Furthermore, the use of the word “output” creates confusion with regards to whether these are dc or ac conductors as Article 705 consistently uses “output” to denote the AC output of a power system.

Historically the term output circuit was used to distinguish between a single PV source circuit and some number of them in parallel, as the output circuit would have a higher maximum circuit current than a single PV source circuit.

However, as system architecture has evolved, there are numerous points where DC PV circuits may be connected in parallel; and sometimes it occurs at multiple locations, with single circuits paralleled, and then the output of these parallel circuits further paralleled; a common example is source circuits paralleled in wiring harnesses, then the output of the harness paralleled with others in a combiner box, then the output of the combiner box is paralleled with other combiner box outputs. In this case, the term “PV output circuit” could be applied to multiple circuits, and this adds no clarity because all these circuits would have different levels of current. In this case, the need to even distinguish between any of the circuits becomes questionable: what is fundamental is knowing the current level in a circuit, and sizing conductors and overcurrent appropriately. Calling different dc PV circuits different names, but in some cases the same name, does not add any functional benefit - it is far better to understand them all as PV source circuits, and base sizing on their specified currents.

Additionally, a PV system, under the current terminology, can have dc PV output circuits, but it doesn’t have to - it may only consist of PV source circuits. If it does have PV output circuits, it does, by current definition, have PV source circuits. It follows that all PV systems have PV source circuits. But those with only PV source circuits don’t have an “output”? This unnecessary confusion evaporates when all of these circuits are simply recognized as circuits in the PV source, with specific currents and voltages that the system designer must determine and use as the basis for conductor and overcurrent device calculations.

With one exception (noted below with associated PI), there are no differentiating requirements for current calculations, overcurrent protection, or material installation methods in Article 690 that distinguish between PV source and output circuits. It follows that this is an unnecessary distinction that does nothing to improve system safety, but instead just increases complexity and confusion when applying the Code. Therefore, PV output circuit should be deleted as a referenced term, reducing confusion and enhancing usability through brevity.

The only instance where this is not the case is the Exception to Section 690.11 regarding dc arc-fault protection. As such, this PI is submitted in conjunction and coordination with the related PI to update the Exception language and clarify where it applies.

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This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
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Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3705-NFPA 70-2020 [Definition: PV System DC Circuit.]	
Public Input No. 3774-NFPA 70-2020 [Section No. 690.7(C)]	
Public Input No. 4203-NFPA 70-2020 [Section No. 690.31(A)]	

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Committee: NEC-P04

Public Input No. 3705-NFPA 70-2020 [Definition: PV System DC Circuit.]

PV System DC Circuit.

Any dc conductor in PV source ~~circuits,~~ circuits and PV ~~output circuits,~~ dc-to-dc converter ~~source~~ circuits~~, and dc-to-dc converter output circuits~~ .

Statement of Problem and Substantiation for Public Input

This PI is submitted in conjunction with related PIs to update this language to harmonize with the deletion of the PV Output Circuit definition and changes to the DC-to-DC Converter Source and Output Circuit definitions.

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Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3701-NFPA 70-2020 [Definition: PV Output Circuit.]	Deletion of old definition

Public Input No. 4418-NFPA 70-2020 [Section No. 690.1]
Public Input No. 3785-NFPA 70-2020 [Section No. 690.9(C)]

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Committee: NEC-P04

Public Input No. 3641-NFPA 70-2020 [New Section after 690.4]

TITLE OF NEW CONTENT

690.4(G) PV Equipment and Systems Installed Over Water

PV equipment and PV systems installed over bodies of water shall be listed for the purpose.

Exception- PV equipment and PV systems on mounted onto fixed structures, including trackers that may occasionally have water under them as the result of heavy rains or flood waters, shall not be required to be listed for installation over bodies of water.

Informational Note: PV equipment and systems intended for installation over bodies of water are evaluated for the increased levels of humidity and mechanical and structural stresses associated with this type of installation.

Statement of Problem and Substantiation for Public Input

Substantiation – It is becoming more common for PV equipment and PV systems to be located within the jurisdiction of the NEC, including locations where additional hazards associated with bodies of water should be evaluated. Requiring these systems to be listed for the specific application ensure these hazards are taken into consideration and facilitate inspection by the local AHJs.

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Committee: NEC-P04

Public Input No. 3653-NFPA 70-2020 [New Section after 690.4]

TITLE OF NEW CONTENT

690.4 (H) Interoperability.

Multiple pieces of PV equipment protecting the same PV source circuit(s) shall be listed and rated for compatibility.

Informational Note: Some combinations of PV AFCI and PVRS equipment are incompatible and can reduce or prevent the level of protection each device is required to provide. The equipment instruction manuals identify compatible equipment that has been evaluated as a system to provide the required GFDI, PVRSS and AFCI functionality.

Statement of Problem and Substantiation for Public Input

Substantiation – It has been identified that some PVRS equipment can filter PV Arc Fault signals/signatures, reducing the effectiveness of PVAFCI protection. Some PVRS, PV DC to DC converters and optimizers can generate electrical noise that can mask a PV arc fault signal/signature and reduce the effectiveness of the PVAFCI protection. Some PV Ground fault protection equipment has been found to be ineffective or less effective when paired with some DC to DC converter and optimizer devices.

UL1741 requirements for rapid shutdown equipment require that PVRS equipment and systems that include PVAFCI protection be evaluated as a system to verify compliance with both sets of requirements. UL1699B includes evaluation and testing of PVAFCI equipment with electronics in the PV source circuits. It is important that the combination of these different protective equipment components are evaluated and rated for use together to prevent unintended consequences that can interfere with the protection these devices are required to provide. The equipment instruction manuals should identify the specific compatible equipment that have been evaluated to interoperate properly and provide the required GFDI, PVRSS and AFCI protection.

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Public Input No. 3311-NFPA 70-2020 [Section No. 690.4(B)]

(B) Equipment.

Inverters, electronic power converters, motor generators, PV modules, ac modules and ac module systems, dc combiners, dc-to-dc converters, rapid shutdown equipment, 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

690.2 in the 2020 NEC added the definition of Electronic Power Converter to the list of definitions. Electronic Power Converters are also periodically referenced throughout Article 690. Since the NEC now specifically references Electric Power Converter equipment, such should be added to the list of equipment required to be listed (found under NEC 690.4(B)).

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Public Input No. 3684-NFPA 70-2020 [Section No. 690.4(B)]

(B) Equipment.

Inverters, motor generators, PV modules, ac modules and ac module systems, dc combiners, dc-to-dc converters, rapid shutdown equipment, ~~dc~~ PV hazard control equipment, PV hazard control systems, 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. Modules and ac modules shall be marked in accordance with their listing.

Statement of Problem and Substantiation for Public Input

To increase usability of the NEC, the enforcement requirements for marking of modules and ac modules should be found in one section, and 690.4 generally covers equipment listing requirements for PV systems, including ac modules. Previously, these related requirements for ac modules were found in both Sections 690.4 and 690.51.
This change is part of a larger initiative to group applicable but dispersed information into fewer, but more comprehensive, sections.

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Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3686-NFPA 70-2020 [Section No. 690.51]	Source of module language
Public Input No. 3686-NFPA 70-2020 [Section No. 690.51]	

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Public Input No. 476-NFPA 70-2020 [Section No. 690.4(C)]

(C) Qualified Personnel.

The installation and maintenance of equipment and all 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

The code needs to provide clarity that PV systems not only have to be installed by qualified persons, but the PV system needs to be maintained throughout the equipment's life cycle by qualified persons as well.

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Public Input No. 3682-NFPA 70-2020 [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 ~~exterior~~ areas that are not readily accessible. Disconnecting means shall be installed in accordance with 690.15.

Statement of Problem and Substantiation for Public Input

A non-readily accessible location can be either inside or outside of a building. Existing disconnecting means requirements for PV system equipment (690.15), PV systems (690.13), and sources (705.20) makes it irrelevant whether an electronic power converter is located inside or outside. Regardless, this allowance has historically also been applied to electronic power converters located inside that are not readily accessible, such as in high bays or other elevated locations, provided the installation meets the other relevant requirements. Deleting “exterior will clarify this and allow this accepted practice to continue.

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Public Input No. 1995-NFPA 70-2020 [Section No. 690.7(A)]

(A) Photovoltaic Source and Output Circuits.

In a dc PV source circuit or output circuit, the maximum PV system voltage for that 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 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 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~~ 100 kVA 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 is 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: One industry standard method for calculating maximum voltage of a PV system is published by Sandia National Laboratories, reference SAND 2004-3535, *Photovoltaic Array Performance Model*.

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

Problem: Many inverters are available with kVA ratings that are greater than their kW ratings. Example, the CPS SCH100/125KTL-DO/US-600 which is rated as 125kW and 132kVA AC output.
Solution: Since the generating capacity should represent the maximum capacity of the system it would be

correct to use the higher volt-ampere rating of the inverter as the maximum output. Where inverter output is rated only in watts the volt-ampere will be equal to the watt rating and the volt-ampere unit is still the correct unit to use.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 1993-NFPA 70-2020 [Definition: Generating Capacity, Inverter.]	Paired change
Public Input No. 1996-NFPA 70-2020 [Section No. 690.8(A)(1)]	Paired change
Public Input No. 1993-NFPA 70-2020 [Definition: Generating Capacity, Inverter.]	
Public Input No. 1996-NFPA 70-2020 [Section No. 690.8(A)(1)]	

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Public Input No. 3729-NFPA 70-2020 [Section No. 690.7(A)]

(A) Photovoltaic Source ~~and Output~~ Circuits.

In a dc PV source circuit ~~or output circuit,~~ the maximum PV system voltage for that 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 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 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 is 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.

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Ambient Temperature (°C)	Factor	Ambient Temperature (°F)
24 to 20	1.02	76 to 68
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–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

This PI is submitted in conjunction with the related PIs to update this language to harmonize with the deletion of the PV Output Circuit definition.

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Public Input No. 3770-NFPA 70-2020 [Section No. 690.7(B)]

(B) DC-to-DC Converter ~~Source and Output~~ Circuits.

In a PV dc-to-dc converter ~~source and output circuit~~ 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.

Statement of Problem and Substantiation for Public Input

This PI is submitted in conjunction with the related PIs, to update this language to harmonize with the changes to the DC-to-DC Converter Source and Output Circuit definitions

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Public Input No. 3774-NFPA 70-2020 [Section No. 690.7(C)]

(C) Bipolar Source ~~and Output~~ Circuits.

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

Statement of Problem and Substantiation for Public Input

Following on the same logic as the related PI, the need to distinguish between bipolar source and output circuits is both unnecessary, and impractical to apply due to variations in system architecture, including where single or multiple points of parallel occur on the dc side of a PV system. Having clear circuit current values for sizing conductors and overcurrent protection is critical to system safety, not trying to decide if a circuit is a source or output circuit, when in some circumstances it could be called either.

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Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3701-NFPA 70-2020 [Definition: PV Output Circuit.]	deletion of old term

Submitter Information Verification

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Submittal Date: Wed Sep 09 12:20:25 EDT 2020
Committee: NEC-P04

Public Input No. 3622-NFPA 70-2020 [Section No. 690.7 [Excluding any Sub-Sections]]

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. 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.

PV system dc circuits within or originating from arrays located on or

~~in buildings shall be permitted to~~

attached to buildings, and PV system dc circuits inside buildings, shall have a maximum voltage no greater than 1000 volts. PV system dc circuits on or in one- and two-family dwellings shall

~~be permitted to~~

have a maximum voltage no greater than 600 volts.

~~Where not located on or in buildings, listed dc PV equipment, rated at~~

. PV system dc circuits with a maximum voltage

~~no~~

greater than

~~1500 volts, shall not be required to comply with Parts II and III of Article 490.~~

1000 volts shall comply with 690.31(G).

Additional Proposed Changes

File Name	Description	Approved
690_max_voltage_correct_text.pdf	690.7 revised text as it should be shown	

Statement of Problem and Substantiation for Public Input

This text modifies the phrase “on or in buildings” to clarify requirements of ground-mounted arrays interfacing with buildings.
Maximum System Voltage requirements have intended to differentiate the nature of risks between one- and two-family dwellings, commercial/ industrial buildings, and ground mounted PV arrays. With PV arrays mounted on buildings and dc wires within a building there are unique concerns over electrical shock risks since the conductors may be concealed. Ground-mounted PV arrays and equipment do not have the same risks since the circuits are not concealed behind building surface finishes, etc.
Ground-mounted PV arrays with a maximum system voltage of 1500 Vdc are becoming more common in commercial and industrial (C&I) applications. Often these arrays are located near commercial and industrial buildings, such as a PV array carport structure in a parking lot. It should be permitted to attach some equipment (e.g. inverters) on the outside wall of a building when there are area limitations, or necessary equipment clearances, or where constructing a concrete pad to support the equipment is not possible. The industry trend of 1500 Vdc ground-mounted arrays located near buildings creates a need to clarify Code language around ground-mounted arrays interfacing with buildings.
Currently, it is permitted to install >1000 Vdc equipment mere inches from a building, but it is not permitted to install this equipment on the exterior wall of a building. Providing an allowance to locate these circuits outside but attached to buildings, but never within buildings, provides the clarity needed to apply the voltage restrictions in this section. This allowance would not apply to one- or two- family dwellings. PV arrays installed on a rooftop or integrated in a building and any PV system dc circuits inside a building would remain limited to 600Vdc for one- or two- family dwellings and 1000 Vdc for other buildings.

The language on listed dc PV equipment up to 1500 Vdc not requiring compliance with Article 490 is proposed to be moved to a new subsection 690.31(G). As 690.31 concerns wiring methods and equipment requirements, it is a more relevant section for specifications of equipment over 1000 volts, similar to Article 490. Furthermore, the new subsection 690.31(G) covers the limitations stated above for dc circuits >1000 Vdc mounted on the outside wall of a building. Specific limitations are included there that the conductors be installed within a limited distance above grade to prevent this allowance be used for overhead conductors; inaccessibility of equipment to unqualified persons (referencing 110.31); and limiting the extent of wiring and equipment that can be attached to the outside of the building.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate.
Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain, P.E., SEIA; Bill Brooks, Brooks Engineering/PVICC; Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing, Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower; Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Ben Chamberlain, Olivewood Energy; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

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690.7 Maximum Voltage.
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. 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.

PV system dc circuits within or originating from arrays located on or ~~in~~ attached to buildings and PV system dc circuits inside buildings shall ~~be permitted to~~ have a maximum voltage no greater than 1000 volts. PV system dc circuits on or in one- and two-family dwellings shall ~~be permitted to~~ have a maximum voltage no greater than 600 volts. ~~Where not located on or in buildings, listed dc PV equipment, rated at a maximum voltage no greater than 1500 volts, shall not be required to comply with Parts II and III of Article 490.~~ PV system dc circuits with a maximum voltage greater than 1000 volts shall comply with 690.31(G).

Public Input No. 202-NFPA 70-2019 [Section No. 690.8]

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). Currents calculated as part of 690.8 shall be considered continuous loads for the purposes of sizing of conductors and selection of overcurrent protective devices.

(1) PV System Circuits.

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

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

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

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

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

(d) *Photovoltaic Output Circuit Currents.* The maximum current shall be the sum of parallel source circuit maximum currents as calculated in 690.8(A)(1)(a).

(e) *DC-to-DC Converter Source Circuit Current.* The maximum current shall be the dc-to-dc converter continuous output current rating.

(f) *DC-to-DC Converter Output Circuit Current.* The maximum current shall be the sum of parallel connected dc-to-dc converter source circuit currents as calculated in 690.8(A)(1)(c).

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

(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 be sized ~~to carry not less than the larger ampacity calculated~~ in accordance with ~~690.8(B)(1) or (B)(2).~~

~~**(1)** Without Adjustment and Correction Factors.~~

~~The maximum currents calculated in 690.8(A) multiplied by 125 percent without adjustment or correction factors.~~

~~*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.~~

~~(~~

210.19 or 215.2.

(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) Sizing of Module Interconnection Conductors.

Where a single overcurrent device is used to protect a set of two or more parallel-connected module circuits, the ampacity of each of the module interconnection conductors shall not be less than the sum of the rating of the single overcurrent device plus 125 percent of the short-circuit current from the other parallel-connected modules.

Statement of Problem and Substantiation for Public Input

The public input is not intended as a technical change but rather meant to better align these requirements with Chapters 1 through 4. Ampacity calculations are addressed in Article 210 for branch circuits and 215 for feeders. The only difference between earlier chapters and these article 705 requirements are found in how we calculate maximum currents as found in 690.8(A). The change in 690.8(A) makes it clear that these currents are to be considered as continuous load currents facilitating the application of 210.19 and 215.2.

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Committee: NEC-P04

Public Input No. 1996-NFPA 70-2020 [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)(e).

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

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

(3) For PV systems with an inverter generating capacity of

~~100 kW~~

(1) 100 kVA 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: One industry standard method for calculating maximum current of a PV system is available from Sandia National Laboratories, reference SAND 2004-3535, *Photovoltaic Array Performance Model*. This model is used by the System Advisor Model simulation program provided by the National Renewable Energy Laboratory.

(d) *Photovoltaic Output Circuit Currents.* The maximum current shall be the sum of parallel source circuit maximum currents as calculated in 690.8(A)(1)(a).

(e) *DC-to-DC Converter Source Circuit Current.* The maximum current shall be the dc-to-dc converter continuous output current rating.

(f) *DC-to-DC Converter Output Circuit Current.* The maximum current shall be the sum of parallel connected dc-to-dc converter source circuit currents as calculated in 690.8(A)(1)(c).

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

Additional Proposed Changes

File Name	Description	Approved
690.8_1_Proposal.docx	Correct markup of proposal	

Statement of Problem and Substantiation for Public Input

TerraView is not showing the correct markup of the proposal, see attached Word file for correct markup.
Problem: Many inverters are available with kVA ratings that are greater than their kW ratings. Example, the CPS SCH100/125KTL-DO/US-600 which is rated as 125kW and 132kVA AC output.
Solution: Since the generating capacity should represent the maximum capacity of the system it would be correct to use the higher volt-ampere rating of the inverter as the maximum output. Where inverter output is rated only in watts the volt-ampere will be equal to the watt rating and the volt-ampere unit is still the correct unit to use.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 1993-NFPA 70-2020 [Definition: Generating Capacity, Inverter.]	Paired change
Public Input No. 1995-NFPA 70-2020 [Section No. 690.7(A)]	Paired change
Public Input No. 1993-NFPA 70-2020 [Definition: Generating Capacity, Inverter.]	
Public Input No. 1995-NFPA 70-2020 [Section No. 690.7(A)]	

Submitter Information Verification

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Submittal Date: Fri Jul 24 12:10:02 EDT 2020
Committee: NEC-P04

(1) PV System Circuits.
The maximum current shall be calculated in accordance with 690.8(A)(1)(a) through (A)(1)(e).

1. *Photovoltaic Source Circuit Currents* The maximum current shall be as calculated in either of the following:
    1. The maximum current shall be the sum of the short-circuit current ratings of the PV modules connected in parallel multiplied by 125 percent.
    2. For PV systems with an inverter generating capacity of 100 ~~kW~~ kVA 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: One industry standard method for calculating maximum current of a PV system is available from Sandia National Laboratories, reference SAND 2004-3535, *Photovoltaic Array Performance Model*. This model is used by the System Advisor Model simulation program provided by the National Renewable Energy Laboratory.

2. *Photovoltaic Output Circuit Currents.* The maximum current shall be the sum of parallel source circuit maximum currents as calculated in 690.8(A)(1)(a).
3. *DC-to-DC Converter Source Circuit Current.* The maximum current shall be the dc-to-dc converter continuous output current rating.
4. *DC-to-DC Converter Output Circuit Current.* The maximum current shall be the sum of parallel connected dc-to-dc converter source circuit currents as calculated in 690.8(A)(1)(c).
5. *Inverter Output Circuit Current.* The maximum current shall be the inverter continuous output current rating.

Public Input No. 2411-NFPA 70-2020 [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)(e).

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

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

(3) For PV systems with an inverter generating capacity of 100 kW or greater,

~~a documented and stamped PV system design, using~~

(1) using an industry standard method maximum current calculation shall be permitted if provided by a licensed professional electrical engineer,

~~shall be permitted~~

(1) documented and stamped. 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: One industry standard method for calculating maximum current of a PV system is available from Sandia National Laboratories, reference SAND 2004-3535, *Photovoltaic Array Performance Model*. This model is used by the System Advisor Model simulation program provided by the National Renewable Energy Laboratory.

(d) *Photovoltaic Output Circuit Currents.* The maximum current shall be the sum of parallel source circuit maximum currents as calculated in 690.8(A)(1)(a).

(e) *DC-to-DC Converter Source Circuit Current.* The maximum current shall be the dc-to-dc converter continuous output current rating.

(f) *DC-to-DC Converter Output Circuit Current.* The maximum current shall be the sum of parallel connected dc-to-dc converter source circuit currents as calculated in 690.8(A)(1)(c).

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

Statement of Problem and Substantiation for Public Input

To say that an engineered design with sealed design documentation "is permitted" is not actually stating that anything is required. It appears that a requirement intent needs to be stated more clearly.

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Committee: NEC-P04

Public Input No. 3645-NFPA 70-2020 [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)(~~e~~ c).

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

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

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

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

(d) ~~*Photovoltaic Output Circuit Currents.* The maximum current shall be the sum of parallel source circuit maximum currents as calculated in 690.8(A)(1) (a).~~

(e) *PV DC-to-DC Converter* ~~Source~~

(f) *Circuit Current.* The maximum current shall be the ~~dc-to-dc converter continuous output current rating.~~

(g) ~~*DC-to-DC Converter Output Circuit Current.* The maximum current shall be the~~ sum of parallel connected dc-to-dc converter ~~source circuit currents as calculated in 690.8(A)(1) (c).~~ continuous output current ratings.

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

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.

Additional Proposed Changes

File Name	Description	Approved
690_8_A_1_correct_text.pdf	Correct text changes.	

Statement of Problem and Substantiation for Public Input

Note that the formatting shown in the legislative text is not accurate, no changes are being proposed to the existing text in (a). This input deletes a couple of items since the definitions for those circuits are deleted in related PIs plus it seeks to add a new informational note. Please see attached file for correct text.
This PI is submitted in conjunction with the related PIs, to update this language to harmonize with the

deletion of the PV Output Circuit definition and changes to the DC-to-DC Converter Source and Output Circuit definitions.

Making it clear that current needs to be considered for each circuit in a system is the best way to ensure adequate conductor and overcurrent protection device sizes, rather than trying to distinguish between circuit terminology that may not be clear for a large number of systems.

Regarding the IN, modules that can produce electricity when exposed to light on multiple surfaces may have higher short-circuit current ratings relative to ratings that are based solely on front-side illumination. Such modules will be labeled with appropriate short-circuit current ratings as required by the applicable safety standard (UL 61730), and the manual that is relied upon for the listing will contain additional guidance to guide designers.
Modules that can produce electricity when exposed to light on multiple surfaces may be installed in a manner that prevents light to reaching any surface other than the front, such as modules mounted flush to and in close proximity to a supporting surface. In such cases, the short-circuit current rating as it is traditionally measured based on illuminating only the front of the module is appropriate.
This new IN seeks to guide users of this Code to refer to the instructions included with the module listing for guidance on applying this section.

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This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate.
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Committee:	NEC-P04

Text Changes:

690.8(A)(1) PV System Circuits.
The maximum current shall be calculated in accordance with 690.8(A)(1)(a) through (A)(1)(~~e~~c).

a. *Photovoltaic Source Circuit Currents.* The maximum current shall be as calculated in either of the following:
   1. The maximum current shall be the sum of the short-circuit current ratings of the PV modules connected in parallel multiplied by 125 percent.
   2. 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: One industry standard method for calculating maximum current of a PV system is available from Sandia National Laboratories, reference SAND 2004-3535, *Photovoltaic Array Performance Model*. This model is used by the System Advisor Model simulation program provided by the National Renewable Energy Laboratory.

~~(b) *Photovoltaic Output Circuit Currents.* The maximum current shall be the sum of parallel source circuit maximum currents as calculated in 690.8(A)(1)(a).~~

~~(cb) *DC-to-DC Converter Source Circuit Current.* The maximum current shall be the dc-to-dc converter continuous output current rating.~~

(~~d~~b) PV *DC-to-DC Converter ~~Output~~ Circuit Current.* The maximum current shall be the sum of parallel connected dc-to-dc converter continuous output current ratings ~~source circuit currents as calculated in 690.8(A)(1)(cb)~~.

(~~e~~c) *Inverter Output Circuit Current.* The maximum current shall be the sum of the continuous output current ratings of inverters connected in parallel to a single set of circuit conductors.

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.

Clean Text:

690.8(A)(1) PV System Circuits.
The maximum current shall be calculated in accordance with 690.8(A)(1)(a) through (A)(1)(c).
(a) Photovoltaic Source Circuit Currents. The maximum current shall be as calculated in either of the following:
1. The maximum current shall be the sum of the short-circuit current ratings of the PV modules connected in parallel multiplied by 125 percent.
2. 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: One industry standard method for calculating maximum current of a PV system is available from Sandia National Laboratories, reference SAND 2004-3535, Photovoltaic Array Performance Model. This model is used by the System Advisor Model simulation program provided by the National Renewable Energy Laboratory.
(b) PV DC-to-DC Converter Circuit Current. The maximum current shall be the sum of parallel connected dc-to-dc converter continuous output current ratings.
(c) Inverter Output Circuit Current. The maximum current shall be the inverter continuous output current rating.

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

Public Input No. 200-NFPA 70-2019 [Section No. 690.8(B)]

(B) Conductor Ampacity.

Circuit conductors shall ~~be sized to carry~~ have an ampacity not less than the larger ~~ampacity calculated in accordance with~~ of 690.8(B)(1) or (B)(2) and comply with 110 .14(C) for equipment terminations.

(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

~~without adjustment or~~

.

(2) With Adjustment and Correction Factors.

The minimum conductor size with an ampacity not less than the maximum currents calculated in 690.8(A) with adjustment and correction factors.

Exception No. 1 to (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 to (

~~2) With Adjustment and Correction Factors.~~

~~The~~

~~1) and (2): Where a portion of a branch 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 allowable ampacity, in accordance with 310.15, not less than the maximum currents calculated in 690.8(A)~~

~~with adjustment and correction factors.~~

~~. No portion of a branch circuit installed under this exception shall extend into an enclosure containing either the branch-circuit supply or the branch-circuit load terminations.~~

Statement of Problem and Substantiation for Public Input

This public input does not seek to make a technical change to this section but provide better language for useability. The langauge being proposed better alighns with language found in other areas of the NEC such as Articles 210 for branch circuits and 215 for feeders.

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Committee: NEC-P04

Public Input No. 208-NFPA 70-2019 [Section No. 690.9(B)]

(B) Device Ratings.

Overcurrent devices used in PV system dc 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) :~~

- ~~Not less than 125 percent of the maximum currents calculated in 690.8(A) .~~
- ~~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.

Statement of Problem and Substantiation for Public Input

Proper selection of an overcurrent protective device is addressed in Article 240. Conductors must be protected at their ampacity.

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Public Input No. 3812-NFPA 70-2020 [Section No. 690.9(B)]

(B) Device Ratings.

Overcurrent devices used in PV ~~system dc circuits~~ 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) 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.

Statement of Problem and Substantiation for Public Input

This PI constrains the requirement of PV-rated overcurrent devices to PV source circuits. This excludes dc-to-dc converter circuits that do not have the same characteristics as PV source circuits. The PV Industry Forum is recommending the removal of the term PV output circuits to reduce confusion. This Code should be clear on the application of these special PV-rated devices. Also, the Panel should consider removing this sentence altogether and including this listing requirement in the existing list in 690.4(B).

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Committee: NEC-P04

Public Input No. 4045-NFPA 70-2020 [New Section after 690.9(C)]

TITLE OF NEW CONTENT

Type your content here ..

690.9(C). Exception. Ungrounded PV DC source and DC output circuits connected to non-isolated utility-interactive inverters which have ground-fault detector/interrupter systems that detect array ground faults only before startup and not during operation, shall have overcurrent protective devices at the inverter input in both polarities of the input conductors.

Statement of Problem and Substantiation for Public Input

Non-isolated utility-interactive inverters used with ungrounded PV arrays and connected to grounded ac services are subject to backfeed currents from the ac service into the dc source and output circuits when ground faults occur in the dc array circuits. Some, but not all ground fault detection and interruption circuits built into the inverters should stop any damage from these ground fault currents. However, at least one major inverter manufacturer (SMA Technologies AG) has the ground fault detection system check for ground faults only before inverter start up. With this ground fault detection and interruption system, ground faults that occur in the daytime during normal inverter operation will not be detected and large backfeed currents may flow from the utility into the either polarity of the dc circuit conductors depending on which conductor has faulted to ground. The instruction manual for these, and possibly other similar inverters, states that any damage (internal to the inverter or external) caused by daytime ground faults will not be covered under warranty. And, due to solar heating and operating currents heating and possibly softening conductor insulation and higher circuit-to-ground voltages during the daytime, ground faults during the day are at least as likely as ground faults occurring at night and possibly more likely. This Section 690.9(C) permits only one conductor to be protected from overcurrents. Obviously, these backflowing ground fault currents may flow in either conductor and therefore both circuit conductors should be protected from back flowing ground fault currents originating from the utility service. A proposal has been made to change UL Standard 1741 to test the ground fault system on all inverters for proper operation during normal daytime inverter operation.

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Submittal Date:	Wed Sep 09 19:02:03 EDT 2020
Committee:	NEC-P04

Public Input No. 3314-NFPA 70-2020 [Section No. 690.9(C)]

(C)– **PV** Source and PV Output Circuits.

A single overcurrent protective device, where required, shall be permitted to protect the PV modules, dc-to-dc converters, and conductors of each PV source circuit or the conductors of each PV output circuit. Where single overcurrent protection devices are used to protect PV source or PV output 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.

Statement of Problem and Substantiation for Public Input

The current wording of 690.9(C) uses phrases such as "Source" and "Output" circuits. However, such do not have definitions found under 690.2. The correct wording to use would be "PV Source" and "PV Output" circuits, which definitions are found in 690.2. Also, it would be problematic to leave the phrase "Output Circuits" as currently written in the text since individuals could misinterpret that such is referring to AC output circuits of inverters, which is not correct.

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Committee: NEC-P04

Public Input No. 3785-NFPA 70-2020 [Section No. 690.9(C)]

(C) ~~Source and Output~~ 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 ~~source~~ circuit ~~or the conductors of each output circuit~~ . Where single overcurrent protection devices are used to protect ~~source or output~~ 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.

Statement of Problem and Substantiation for Public Input

This PI is submitted in conjunction with the related PIs to update this language to harmonize with the deletion of the PV Output Circuit definition.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate.
Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain, P.E., SEIA; Bill Brooks, Brooks Engineering/PVICC; Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing, Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower; Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Ben Chamberlain, Olivewood Energy; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar;

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Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3705-NFPA 70-2020 [Definition: PV System DC Circuit.]	

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Public Input No. 3408-NFPA 70-2020 [Section No. 690.9(D)]

~~(D) Power Transformers.~~

~~Overcurrent protection for a transformer with a source(s) 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 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 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.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3409-NFPA 70-2020 [Section No. 705.30(C)]	
Public Input No. 3409-NFPA 70-2020 [Section No. 705.30(C)]	

Submitter Information Verification

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Committee: NEC-P04

Public Input No. 1864-NFPA 70-2020 [Section No. 690.10]

690.10 Stand-Alone Systems.

The wiring system ~~connected to a~~ for stand-alone ~~system.~~ systems shall be installed in accordance with Article 710. ~~15.~~

Statement of Problem and Substantiation for Public Input

This rule as written is way too 'specific.'

Submitter Information Verification

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Committee: NEC-P04

Public Input No. 2652-NFPA 70-2020 [Section No. 690.11]

690.11 Arc-Fault Circuit Protection (Direct Current).

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.

Informational Note: Annex A includes the reference for the *Photovoltaic DC Arc-Fault Circuit Protection* product standard.

Exception: For PV systems not installed on or in buildings, PV output circuits and dc-to-dc converter output circuits that are installed in metallic raceways or metal-clad cables, or installed ~~in enclosed metallic~~ in metallic cable trays, or are underground shall be permitted without arc-fault circuit protection. Detached structures whose sole purpose is to house PV system equipment shall not be considered buildings according to this exception.

Statement of Problem and Substantiation for Public Input

The term "enclosed" is problematic and not practical to accomplish. There is no way to completely enclose a cable tray when using string harnesses to combine multiple strings of modules (more prevalent with thin film type modules) ahead of a combiner box or inverter. There is no way to completely enclose the cable at the back of the modules where the module whips would enter it and for many inverters there is no way to enclose it at the input to the inverter. Also by totally enclosing a cable tray, the module/harness connectors and any inline fusing ends up being in an enclosure that does not allow proper heat dissipation and could lead to overheating and fire hazards related to those components and perpetuate fault problems rather than containing a potential arc flash as was intended. With new requirements for PV connectors required to be mated UL listed connectors, there is less likelihood of there being a risk of arc flash at those connectors, also as with other wiring systems that utilize standard metallic cable tray systems, the grounded cable tray would provide a path for any arc flash to conduct to causing a ground fault and allowing those elements at the inverters to function and also allow for fuses for the individual strings to clear and remove the arcing fault from the system like an arc fault detection system would. If there is still a concern on the spacing of rungs/support members being too far apart to allow for an arc to conduct to, maybe the exception that allows for the cable tray could limit rung/member spacing gaps for ladder, ventilated, and wire basket tray to limit any gaps to maybe 3" or 4" to insure an arc would be close enough to arc over to the grounded metal but also allow for ventilation of the cables, connectors, and inline fuses.

Submitter Information Verification

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Submittal Date: Thu Aug 27 12:40:22 EDT 2020
Committee: NEC-P04

Public Input No. 2824-NFPA 70-2020 [Section No. 690.11]

690.11 Arc-Fault Circuit Protection (Direct Current).

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.

Informational Note: Annex A includes the reference for the *Photovoltaic DC Arc-Fault Circuit Protection* product standard.

Exception: For PV systems not installed on or in buildings ~~, PV~~ and having PV output circuits and dc-to-dc converter output circuits that are installed in metallic raceways or metal-clad cables, or installed in enclosed metallic cable trays, or are underground shall be permitted without arc-fault circuit protection. Detached structures whose sole purpose is to house PV system equipment shall not be considered buildings according to this exception.

Statement of Problem and Substantiation for Public Input

A significant number of people are misinterpreting the exception to mean that all PV systems not on or in buildings are exempted from needing AFCI. People are not interpreting that the first clause of "not on or in a building" then needs to have one of the following conductor installation methods to be exempted. The addition of the words "and having" after the first cause will clarify the combination of requirements needed. Since a significant number of ground mount PV is installed in California and we now have a 5th season called "fire" I would like to see the chance of PV caused wildfires reduced by proper application of AFCI.

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Committee: NEC-P04

Public Input No. 3359-NFPA 70-2020 [Section No. 690.11]

690.11 Arc-Fault Circuit Protection (Direct Current).

Photovoltaic systems with PV system dc circuits operating at 80 volts dc or greater ~~between~~ up to and including 1,000 volts dc 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.

Informational Note: Annex A includes the reference for the *Photovoltaic DC Arc-Fault Circuit Protection* product standard.

Exception: For PV systems not installed on or in buildings, PV output circuits and dc-to-dc converter output circuits that are installed in metallic raceways or metal-clad cables, or installed in enclosed metallic cable trays, or are underground shall be permitted without arc-fault circuit protection. Detached structures whose sole purpose is to house PV system equipment shall not be considered buildings according to this exception.

Statement of Problem and Substantiation for Public Input

The requirement for arc-fault protection for PV dc circuits over 1,000V has been in the NEC since 2014. During that time no inverter manufacturer has made a 1,500V arc-fault protection product available for the US market. Only one DC combiner manufacturer has made 1,500V arc-fault protection equipment available in the US and due to lack of demand is discontinuing that product. This has left both contractors and AHJs having to invoke NEC 90.4 for every PV array over 1,000V and not covered by 691 to allow for the lack of arc-fault protection equipment. Since the lack of demand has resulted in the only available equipment no longer being produced and no other manufacturers have indicated that a product is likely to be put on the market in the future it appears that keeping the requirement for arc-fault protection on dc circuits over 1,000V is not useful and is just going to continue requiring the use of 90.4 when it is required. To acknowledge this fact the section should be revised to limit arc-fault protection to systems where equipment is available. While most of the time putting a requirement in the NEC does encourage manufactures to produce equipment satisfying that requirement there is a point at which we have to accept that it is not working in every instance. Three code cycles is more than long enough to say that it's just not working here.

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Committee: NEC-P04

Public Input No. 3442-NFPA 70-2020 [Section No. 690.11]

690.11 Arc-Fault Circuit Protection (Direct Current).

Photovoltaic systems with PV system dc ~~circuits operating at 80 volts dc or greater between any two conductors shall~~ circuits 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.

Informational Note: Annex A includes the reference for the *Photovoltaic DC Arc-Fault Circuit Protection* product standard.

Exception: For PV systems not installed on or in buildings, PV output circuits and dc-to-dc converter output circuits that are installed in metallic raceways or metal-clad cables, or installed in enclosed metallic cable trays, or are underground shall be permitted without arc-fault circuit protection. Detached structures whose sole purpose is to house PV system equipment shall not be considered buildings according to this exception.

Statement of Problem and Substantiation for Public Input

Voltage of a single 60 cell module can be enough for an arc. Modules themselves should be made more intelligent in their junction boxes. Adding additional equipment to the roof cannot change that modules, especially high wattage modules, are getting more potential for causing disasters.

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Public Input No. 3655-NFPA 70-2020 [Section No. 690.11]

690.11 Arc-Fault Circuit Protection (Direct Current).

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.

Informational Note: Annex A includes the reference for the *Photovoltaic DC Arc-Fault Circuit Protection* product standard.

Exception: For PV systems not installed on or in buildings, PV ~~output circuits and dc-to-dc converter output~~ system dc circuits that are installed in metallic raceways or metal-clad cables, or installed in enclosed metallic cable trays, or are underground shall be permitted without arc-fault circuit protection. Detached structures whose sole purpose is to ~~house~~ support or contain PV system equipment shall not be considered buildings according to this exception.

Statement of Problem and Substantiation for Public Input

This proposed change addresses and aligns with the related PVIF proposal to remove the terms “PV output circuits” and “dc to dc converter output circuits” from Article 690. These terms have created significant confusion without clear logic for their distinction from other PV dc circuits, particularly in ground mount systems.
Since ground-mounted systems generally use significant amounts of single-conductor cables and multi-conductor cables, that may include custom harnesses (some with fuses), there is a need to focus this exception not on the circuit’s name, but rather on the wiring protection provided. The exception as proposed applies to the more generic “PV system dc circuits” term, but as before is only applicable to those conductors not installed on or in buildings, and installed in metallic raceways, enclosed metallic cable trays, or underground. As such, in practice AFCI protection will still be needed in string inverters, combiner boxes, or the input wiring to other converters to protect any exposed module to module and string conductors and cables. Where an installation does use the physical protection methods identified in this exception to protect any system wiring from damage, those methods will provide the same level of fire protection regardless of their location in the circuit, or the term used to identify the circuit.
The modification to replace the term “house” with “support or contain” is simply to provide more clarity to the intention of the exception. This is necessary since the distinction between what is a “structure” and what is a “building” lacks clarity in this Code.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF’s effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI’s as they deem appropriate.
Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain,

P.E., SEIA; Bill Brooks, Brooks Engineering/PVICC; Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing, Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower; Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Ben Chamberlain, Olivewood Energy; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

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Submittal Date: Wed Sep 09 10:10:33 EDT 2020
Committee: NEC-P04

Public Input No. 4113-NFPA 70-2020 [Section No. 690.11]

690.11 Arc-Fault Circuit Protection (Direct Current).

Photovoltaic systems with PV system dc ~~circuits operating at 80 volts dc or greater between any two conductors shall~~ circuits 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.

Informational Note: Annex A includes the reference for the *Photovoltaic DC Arc-Fault Circuit Protection* product standard.

Exception: For PV systems not installed on or in buildings, PV output circuits and dc-to-dc converter output circuits that are installed in metallic raceways or metal-clad cables, or installed in enclosed metallic cable trays, or are underground shall be permitted without arc-fault circuit protection. Detached structures whose sole purpose is to house PV system equipment shall not be considered buildings according to this exception.

Additional Proposed Changes

File Name	Description	Approved
Electric_arc_ignition_below_80_volts.JPG	Electrical Arc possibilities voltage/amperage	
2018-06-14_PV_Fire_Safety_Fire_Guideline_Translation_V04_20180614_FINAL.pdf	Original Document, page 40 for the image	
ArcGen.pdf	Fronius recreation of the test using MC4 connectors	

Statement of Problem and Substantiation for Public Input

Test have shown that only a single module can cause arcs and therefore it's necessary to decrease the voltage from 80 volts to 0 volts. Attached is a graphic from TUV Rheinland indicating the arc threshold coming from the attached article found on page 40. We have recreated the tests and found that 1x40 VOC module can create a substantial sustained arc for longer than a minute. We also have numerous videos of this test which we re-created and can provide as well.

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Committee: NEC-P04

Public Input No. 4189-NFPA 70-2020 [Section No. 690.11]

690.11 Arc-Fault Circuit Protection (Direct Current).

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.

Informational Note: Annex A includes the reference for the *Photovoltaic DC Arc-Fault Circuit Protection* product standard.

Exception: For PV systems not installed on or in buildings, PV output circuits and dc-to-dc converter output circuits that are installed in metallic raceways or metal-clad cables, or installed in enclosed metallic cable trays, or are underground shall be permitted without arc-fault circuit protection. Detached structures whose sole purpose is to house PV system equipment shall not be considered buildings according to this exception.

Additional Proposed Changes

File Name	Description	Approved
2018-06-14_PV_Fire_Safety_Fire_Guideline_Translation_V04_20180614_FINAL.pdf	Assessing Fire Risks in Photovoltaic Systems and Developing Safety Concepts for Risk Minimization	

Statement of Problem and Substantiation for Public Input

limiting arc fault detection to an operating potential of 80V or above is an arbitrary value. We are beginning to regularly find melted copper and melted plastic MC4 connectors where only a single 60 cell module is connected and voltages are under 40V. We have independently tested arcs on a single 60 cell module in full sun and observed electrical arc ignition.

Third party testing has also shown that photovoltaic system arcs can ignite at voltages much lower than 80V. Per the paper Assessing Fire Risks in Photovoltaic Systems and Developing Safety Concepts for Risk Minimization:

Both the minimum voltage and the minimum current of an electric arc depend on the material. In the case of copper, they are 13 V and 0.4 A, respectively, according to the literature [4]. Series of measurements performed at TÜV Rheinland have confirmed these magnitudes [5]

[4] P. Slade, Electrical Contacts, Marcel-Dekker, New York, 1999.
[5] J. Zornikau, Investigation of the formation of arcs in photovoltaic modules and assessment of the risks, Diplomarbeit, TÜV Rheinland, Köln, 2007.

For these reasons, arc fault detection should be required in photovoltaic DC circuits operating at 12V or greater. Because practically all photovoltaic systems operate at over 12V this should be refined to state that ALL photovoltaic DC circuits shall be protected by arc-fault circuit interrupter.

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Public Input No. 3044-NFPA 70-2020 [New Section after 690.12]

690.13 Overvoltage Protection

(A) DC Protection. Surge-protective devices (SPDs) shall be installed for the protection of solar photovoltaic (PV) systems and PV system dc circuits. The SPDs shall be listed and marked "PV SPD"

(B) AC Protection. Surge-protective devices (SPDs) shall be installed for the protection of electric power production and distribution network circuits and equipment supplied by a solar PV system. The SPDs shall be listed and comply with Part II of Article 242.

Information Note: For further information on surge-protective devices (SPDs) for 50 or 60 Hz power circuits not exceeding 1000 volts and for solar photovoltaic (PV) applications up to 1500 volts dc, see UL 1449, Standard for Surge Protective Devices. Additional information can be found in NFPA 70 780-2020, Standard for the Installation of Lightning Protection Systems which contains detailed information on the installation of overvoltage protection for solar PV systems in Chapter 12 of the standard.

Statement of Problem and Substantiation for Public Input

This intent of this public input is to add overvoltage protection requirements to solar PV systems that are highly susceptible to transient voltages and surge currents from direct or nearby lightning strikes. The protection helps 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. This public input attempts to harmonize the NFPA 780 with the NFPA 70 and provides a pointer to the applicable chapter of the NFPA 780 for additional guidance in an Information Note.
Part (A) mandates protection of the “dc” side of the PV system with UL 1449 listed PV SPDs. Part (B) mandates protection on the “ac” side of the PV system with UL 1449 listed SPDs in accordance with Part II. of Article 242. In addition to the pointer to Chapter 12 of the NFPA 780, the Informational note also provides a pointer to UL 1449 where additional information on SPDs, 1000 volts or less and PV SPDs for applications up to 1500 volts dc can be found.

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Submittal Date: Fri Sep 04 10:32:46 EDT 2020
Committee: NEC-P04

Public Input No. 3520-NFPA 70-2020 [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: 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 .

(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.

(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) .

(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) A PV hazard control system listed for the purpose shall be installed in accordance with the instructions included with the listing or field labeling. Where a hazard control system requires initiation to transition to a controlled state, the rapid shutdown initiation device required in 690.12(C) shall perform this initiation.

Informational Note: A listed or field-labeled hazard PV control system 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 fire fighters. See UL 3741, *Photovoltaic Hazard Control* .

(2) Controlled conductors located inside the boundary shall be limited to not more than 80 volts within 30 seconds of rapid shutdown initiation. Voltage shall be measured between any two conductors and between any conductor and ground.

(3) PV arrays shall have no exposed wiring methods or conductive parts and be installed more than 2.5 m (8 ft) from exposed grounded conductive parts or ground.

~~**(C)** Initiation Device.~~

~~The initiation device(s) shall initiate the rapid shutdown function of the PV system. 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-family and two-family dwellings an initiation device(s) shall be located at a readily accessible location outside the building.~~

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

~~Informational Note: Examples of where an initiation device that complies with 690.12(C)(3) would be used is where a PV system is connected to an optional standby or stand-alone system.~~

~~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)** Equipment.~~

~~Equipment that performs the rapid shutdown functions, other than initiation devices such as listed disconnect switches, circuit breakers, or control switches, shall be listed for providing rapid shutdown protection.~~

Statement of Problem and Substantiation for Public Input

Rapid shutdown adds substantial safety issues to the deployment of solar systems. Current rapid shutdown systems available result in significantly more connections. Each of these additional connections creates safety risks in the form of additional points of failure as well as increased time on the roof for the installers. This dramatically increases the risk of failure at the component level as well as increasing the risk to any technicians, installers, or servicemen by increasing the amount of time required on the roof for the installation and subsequent service of each of these additional connection points. Also rapid shutdown has been extremely unreliable to date costing the end user un-necessary downtime and lost profitability from their investment at the same time giving a false sense of security. We've serviced and installed thousands of solar systems. Since the introduction of rapid shutdown devices a significant amount of our service technician's time spent on the roof was due to problems with rapid shutdown devices.

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Submittal Date: Tue Sep 08 20:20:57 EDT 2020
Committee: NEC-P04

Public Input No. 4099-NFPA 70-2020 [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: 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.

(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.

(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) .~~

(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:A PV hazard control system listed for the purpose shall be installed in accordance with the instructions included with the listing or field labeling. Where a hazard control system requires initiation to transition to a controlled state, the rapid shutdown initiation device required in 690.12(

C)

shall perform this initiation.

Informational Note: A listed or field-labeled hazard PV control system 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 fire fighters. See UL 3741, *Photovoltaic Hazard Control* .

- Controlled conductors located inside the boundary shall be limited to not more than 80 volts within 30 seconds of rapid shutdown initiation. Voltage shall be measured between any two conductors and between any conductor and ground.
- PV arrays shall have no exposed wiring methods or conductive parts and be installed more than 2.5 m (8 ft) from exposed grounded conductive parts or ground.

(C)

– Initiation Device.

The initiation device(s) shall initiate the rapid shutdown function of the PV system. 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-family and two-family dwellings an initiation device(s) shall be located at a readily accessible location outside the building.

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

Informational Note: Examples of where an initiation device that complies with 690.12(C)(3) would be used is where a PV system is connected to an optional standby or stand-alone system.

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) Equipment.

Equipment that performs the rapid shutdown functions, other than initiation devices such as listed disconnect switches, circuit breakers, or control switches, shall be listed for providing rapid shutdown protection.

Additional Proposed Changes

File Name	Description	Approved

2020-09-09-Rapid_Shutdown-WhitePaper.pdf Explanation of the safety issue

Statement of Problem and Substantiation for Public Input

The attached White Paper “Arc-Fault Detection at Photovoltaic Systems” shows that Module level Power Electronics (MLPEs) are interfering with state-of-the-art Arc-Fault Detection. This has an unintended consequence of the “inside the array boundary” equipment making the PV system more unsafe and rapid shutdown causing the problem it was designed to protect. At the moment their isn’t a standard is addressing these problems. 690.12(B)(2) should be removed, until this problem is addressed and working solutions are readily available, re-implementing of the 690.12(B)(2) makes sense.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 4105-NFPA 70-2020 [Section No. 690.12(D)]	

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Submittal Date: Wed Sep 09 20:40:49 EDT 2020
Committee: NEC-P04

Public Input No. 1783-NFPA 70-2020 [New Section after 690.12(A)]

Devices used for PV rapid shutdown.

A commonly quoted statement found in many Solar PV seminars and training.

"No specifics as to the location of the rapid shutdown initiating device to allow AHJs, System Integrators and First Responders the flexibility to locate devices and warning labels at location most appropriate for the specific installation."

Many AHJ's are requiring a Rapid shutdown device be installed within 3 feet outside the array boundary.

The NEC refers to controlled conductors.

Article 690.12 should clearly state if this is the intent or clarify that the Initiation Device may be installed more than 3 feet from the array boundary as long as the controlled conductor requirement is met.

Commonly the Solar PV inverters, mounted on the roof, are more than 3 feet from the array boundary. The rapid shut down function is contained in the inverters and the PV source conductors meet the 30 volts/30 seconds requirement. However, many jurisdictions reject this scheme and are requiring additional devices at the array boundary. The Utility has required a Solar Pv disconnecting means which serves as the Initiation Device.

(C) Initiation Device. The initiation device(s) shall initiate

the rapid shutdown function of the PV system. The device “off”

position shall indicate that the rapid shutdown function has

been initiated for all PV systems connected to that device.The initiation device shall shall shut down all PV circuit controlled conductors as per 690.12.(B)(1)

Statement of Problem and Substantiation for Public Input

Clearly state that the intent is to shut down all PV controlled conductors with 3 feet of the array boundary regardless of the location of the PV shut down equipment or initiation device.

Submitter Information Verification

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Submittal Date: Thu Jul 02 13:18:38 EDT 2020
Committee: NEC-P04

Public Input No. 4465-NFPA 70-2020 [Section No. 690.12(A)]

(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.

Additional Proposed Changes

File Name	Description	Approved
690.12_A_supporting_image.pdf	Supporting image with substantiation	

Statement of Problem and Substantiation for Public Input

{see attachment for image}
This exception is necessary to clarify the intention of the opening statement in 690.12 “PV system circuits installed on or in buildings.” This phrase has caused confusion in the field where AHJs have required Rapid Shutdown on ground-mounted PV systems that terminate on the outside wall of a house. Moving the termination point 3” away from the outside wall of the house fixes the language problem, but that is not the intent of the requirement for Rapid Shutdown. The purpose of rapid shutdown is to reduce of shock hazard for firefighters in operations on occupied buildings, where the shock hazard is prevalent around rooftop PV arrays. Currently, rapid shutdown applies to any PV circuit that interfaces with a building. Ground-mounted arrays in a field and arrays mounted on parking lot shade structures or similar structures are in non-enclosed, open air spaces with free ventilation. Often such ground-mounted PV arrays, particularly near commercial and industrial buildings, are routed to a nearby building in order to place the electrical equipment in a common location such as a service pad, electrical room, or mounted on the exterior of a building (see figure below). These ground-mounted arrays and their circuits are unlikely to be hazards for firefighters therefore rapid shutdown was not intended to apply to these arrays and circuits.

This PI clarifies the interface between the PV circuits and a building to determine whether controlled conductors requirements apply. 230.6 refers to requirements for service conductors to be considered outside the building. Circuits from a ground-mounted PV array that are located on the exterior of a building in open air or otherwise considered outside a building according to 230.6 would be separate from rapid shutdown firefighter concerns of rescue operations within a building. These circuits differentiate from those of rooftop arrays which remain subject to controlled conductor requirements.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.

This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate and their inclusion here is not necessarily an endorsement of all the PI's submitted.
Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain, P.E., SEIA; Bill Brooks, PVICC; John Berdner, PVICC, Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing, Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower; Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

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Committee: NEC-P04

690.12(A)
Substantiation

This exception is necessary to clarify the intention of the opening statement in 690.12 “PV system circuits installed on or in buildings.” This phrase has caused confusion in the field where AHJs have required Rapid Shutdown on ground-mounted PV systems that terminate on the outside wall of a house. Moving the termination point 3” away from the outside wall of the house fixes the language problem, but that is not the intent of the requirement for Rapid Shutdown. The purpose of rapid shutdown is to reduce of shock hazard for firefighters in operations on occupied buildings, where the shock hazard is prevalent around rooftop PV arrays. Currently, rapid shutdown applies to any PV circuit that interfaces with a building. Ground-mounted arrays in a field and arrays mounted on parking lot shade structures or similar structures are in non-enclosed, open air spaces with free ventilation. Often such ground-mounted PV arrays, particularly near commercial and industrial buildings, are routed to a nearby building in order to place the electrical equipment in a common location such as a service pad, electrical room, or mounted on the exterior of a building (see figure below). These ground-mounted arrays and their circuits are unlikely to be hazards for firefighters therefore rapid shutdown was not intended to apply to these arrays and circuits.



This PI clarifies the interface between the PV circuits and a building to determine whether controlled conductors requirements apply. 230.6 refers to requirements for service conductors to be considered outside the building. Circuits from a ground-mounted PV array that are located on the exterior of a building in open air or otherwise considered outside a building according to 230.6 would be separate from rapid shutdown firefighter concerns of rescue operations within a building. These circuits differentiate from those of rooftop arrays which remain subject to controlled conductor requirements.

Public Input No. 3797-NFPA 70-2020 [Section No. 690.12(B)]

(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)~~ .

(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) ~~A PV hazard control system listed for the purpose shall be installed in accordance with the instructions included with the listing or field labeling. Where a hazard control system requires initiation to transition to a controlled state, the rapid shutdown initiation device required in 690.12(C) shall perform this initiation.~~

~~Informational Note: A listed or field-labeled hazard PV control system 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 fire fighters. See UL 3741, *Photovoltaic Hazard Control* .~~

(2) ~~Controlled conductors located inside the boundary shall be limited to not more than 80 volts within 30 seconds of rapid shutdown initiation. Voltage shall be measured between any two conductors and between any conductor and ground.~~

(3) ~~PV arrays shall have no exposed wiring methods or conductive parts and be installed more than 2.5 m (8 ft) from exposed grounded conductive parts or ground.~~

Statement of Problem and Substantiation for Public Input

Adding additional hardware or software to a PV array increases the risk of fire hazards from including more points of junction.

There is no clear indicator that the devices are actually dead or alive and should still be treated as high voltage. It isn't like Visible blade disconnects where you can verify that conductors are dead.

Adding additional points of potential failure also increases risk or falling injuries as these roof units often go bad.

Often MPLE are operated like small computers or PLC and failures are bound to happen.

Submitter Information Verification

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Zip:	
Submittal Date:	Wed Sep 09 13:02:59 EDT 2020
Committee:	NEC-P04

Public Input No. 4191-NFPA 70-2020 [Section No. 690.12(B)]

(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).~~

(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) ~~A PV hazard control system listed for the purpose shall be installed in accordance with the instructions included with the listing or field labeling. Where a hazard control system requires initiation to transition to a controlled state, the rapid shutdown initiation device required in 690.12(C) shall perform this initiation.~~

~~Informational Note: A listed or field-labeled hazard PV control system 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 fire fighters. See UL 3741, *Photovoltaic Hazard Control* .~~

(2) ~~Controlled conductors located inside the boundary shall be limited to not more than 80 volts within 30 seconds of rapid shutdown initiation. Voltage shall be measured between any two conductors and between any conductor and ground.~~

(3) ~~PV arrays shall have no exposed wiring methods or conductive parts and be installed more than 2.5 m (8 ft) from exposed grounded conductive parts or ground.~~

Additional Proposed Changes

File Name	Description	Approved
IMG_20200428_180227.jpg		

Statement of Problem and Substantiation for Public Input

MLSD (Module Level Shutdown Device) is now required per code. With even one module per device (operating < 40V), we are finding melted and burnt out connectors which is causing fire hazards. The amount of mismatched connectors is greatly increased with MLSD requirements. Below is a example to illustrate the increase in mismatched connectors in a typical residential system.

In a typical 26 module array without MLSD there are:
24 factory match pairs
4 non-factory home run connections
28 total

The same system with MLSD will now have:
24 factory matched pairs between MLSD

52 non-factory matched connections from modules to MLSD device
4 non-factory home run connections
80 total

Additionally the amount of roof-top work required to service systems with MLSD is greatly increased. Working on elevated pitched services near roof edges is widely regarded as an extreme risk to workers. In 2018, there were 320 fatal falls to a lower level out of 1,008 construction fatalities (BLS data). While module level shutdown was intended to reduce injuries, it has had the unintended affect of increasing risk and injuries by significantly increasing the time workers must work and service existing systems from an elevated platform.

At the same time, these devices do not have requirements to not interfere with the operation of other devices connected to the same system, preventing them from properly detecting ark and ground faults. Because these devices isolate the module source circuits from the array output circuits technicians are unable to properly test system wiring for faults. For example, it is no longer possible to use a isolation testing device to test for pinched source circuit wires or other faults when MLPD prevent this without removing each individual module which is highly unsafe.

Fpr this reason the requirement Module Level Rapid shutdown (inside the array boundary) should be removed to drastically reduce the amount of mismatched connectors reducing fire hazard, drastically reducing service work from unsafe elevated platforms, and reducing fire hazard and safety by allowing other devices to properly detect arc and ground faults. This also returns the ability of technicians to properly test the DC circuits of an array.

Submitter Information Verification

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Submittal Date: Thu Sep 10 01:03:34 EDT 2020
Committee: NEC-P04

Public Input No. 2848-NFPA 70-2020 [Section No. 690.12(B)(2)]

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

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

(1) ~~A PV hazard control system listed for the purpose shall be installed in accordance with the instructions included with the listing or field labeling. Where a hazard control system requires initiation to transition to a controlled state, the rapid shutdown initiation device required in 690.12(C) shall perform this initiation.~~

~~Informational Note: A listed or field-labeled hazard PV control system 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 fire fighters. See UL 3741, *Photovoltaic Hazard Control* .~~

(2) ~~Controlled conductors located inside the boundary shall be limited to not more than 80 volts within 30 seconds of rapid shutdown initiation. Voltage shall be measured between any two conductors and between any conductor and ground.~~

(3) ~~PV arrays shall have no exposed wiring methods or conductive parts and be installed more than 2.5 m (8 ft) from exposed grounded conductive parts or ground.~~

Statement of Problem and Substantiation for Public Input

From my experience in the field, there is a safety confliction between AFCI and rapid shutdown devices (PVRSE) on rooftops. This is a safety concern for me and my installers as I need systems to work seamlessly and safety is our top priority.

Submitter Information Verification

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Submittal Date: Wed Sep 02 14:43:57 EDT 2020
Committee: NEC-P04

Public Input No. 3662-NFPA 70-2020 [Section No. 690.12(B)(2)]

(2) Inside the Array Boundary.

~~The PV system shall comply with one of the following:A~~ A listed PV hazard control system ~~listed for the purpose~~ shall be installed in accordance with the instructions included with the listing or field labeling. Where a hazard control system requires initiation to transition to a controlled state, the rapid shutdown initiation device required in 690.12(C) shall perform this initiation.

Informational Note: A listed or field-labeled hazard PV control system 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 fire fighters. See UL 3741, *Photovoltaic Hazard Control* .

- ~~Controlled conductors located inside the boundary shall be limited to not more than 80 volts within 30 seconds of rapid shutdown initiation. Voltage shall be measured between any two conductors and between any conductor and ground.~~
- ~~PV arrays shall have no exposed wiring methods or conductive parts and be installed more than 2.5 m (8 ft) from exposed grounded conductive parts or ground.~~

Statement of Problem and Substantiation for Public Input

The Standard for Photovoltaic Hazard Control, UL 3741, was developed based upon safety science and is the best option to reduce hazards for fire fighters that need to perform firefighting work in and around PV arrays installed on buildings. A listed PV hazard control system is the safest and most reliable solution, negating the need for options (2) and (3). The option (2) 80V limit was an negotiated / estimated voltage intended to be a compromise between traditional electric shock hazard limits and what was thought to be a feasible implementation. Option (2) was not based upon detailed shock hazard science, does not account for the many differences in PV equipment and system implementations, and relies exclusively upon a system implemented in the field rather than an engineered and tested hazard control system. The systems described in option (3) could yield a plausible implementation that may pass a UL3741 evaluation; however, technological progress has supported reliance on demonstrating compliance with the product standard specific to the intended safety purpose. Based on these evolutions a listed PV hazard control system is the best solution for safety.

UL 3741 was developed based on a US Department of Energy (US DOE) research grant, being jointly conducted by UL LLC and Sandia National Laboratories, specifically developed to evaluate the shock hazards to fire fighters working on PV arrays. The research investigated common fire fighter PPE, work practices, working conditions, and foreseeable abnormal conditions and identified science-based criteria to reasonably limit hazards for fire fighters performing their duties on buildings with PV systems. The UL Standards Technical Panel (STP) UL 3741 includes AHJs, Fire Fighters, NEC experts, representatives from the PV industry, and representatives from US National Labs. Researched conducted as part of the US DOE grant, combined with PV rapid shutdown requirements from UL 1741, and ground fault protection requirements from UL62109-1 -2, provided an excellent foundation for the development of UL 3741. This Standard has passed the initial ballot and the STP is addressing comments received during the ballot period. UL3741 is expected to be published by the end of 2020.

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Submittal Date:	Wed Sep 09 10:19:43 EDT 2020
Committee:	NEC-P04

Public Input No. 4456-NFPA 70-2020 [Section No. 690.12(B)(2)]

(2) Inside the Array Boundary.

The PV system shall comply with one of the following:

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

Informational Note: A ~~listed or field-labeled hazard PV control system 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~~ PVHCS is often comprised of one or more pieces of PV hazard control equipment (PVHCE) combined to form a system per the instructions of a PVHCS installed per the instructions that perform the functions to reduce the risk of electric shock hazard within a ~~damaged~~ PV array ~~for fire fighters~~ . See UL 3741, *Photovoltaic Hazard Control*.

(2) ~~Controlled conductors located~~ The PV system shall provide shock hazard control for firefighters by limiting the voltage inside the array boundary ~~shall be limited~~ to not more than ~~80 volts~~ 80 volts within ~~30 seconds~~ 30 seconds of rapid shutdown initiation. Voltage shall be measured between any two conductors and between any conductor and ground.

~~PV arrays shall have no exposed wiring methods or conductive parts and be installed more than 2.5 m (8 ft) from exposed grounded conductive parts or ground.~~

Informational Note: Common methods include the use of PV equipment with a limited maximum voltage of 80 volts as determined by 690.7, PV rapid shutdown equipment (PVRSE), PV hazard control equipment (PVHCE), or any combination of these.

Statement of Problem and Substantiation for Public Input

The changes to 690.12(B)(2) are based on the soon to be published UL3741 for firefighter shock hazard control and provide clarification of how the different listed equipment or listed systems will be identified in UL3741.

The changes to 690.12(B)(2)(1) uses the UL3741 term, PV hazard control system (PVHCS), to describe the hazard control system. The informative note explains that creating a PVHCS can be done by combining one or more pieces of listed equipment, termed PV hazard control equipment (PVHCE) in UL3741, to form a system (when installed per the listing and instructions for each piece of equipment) or by a listed PVHCS where the complete system is listed by one entity and installed per that entities instructions.

The changes to 690.12(B)(2)(2) clarify that this option also provides shock hazard control for firefighters and differentiates the option from 690.12(B)(2)(1). The code had previously established that less than 80 volts was an acceptable level for internal to the array and this concept was not changed. However, based on the wording, it was not clear whether the limit just applied to the external wiring or if it also considered voltage levels within equipment (such as a PV module or electronic device located inside the array boundary). The changes keep that value and the informational note explains the methods that can accomplish that. If the 80 volts is relied on, than the informational note clarifies that this is the maximum voltage of equipment within the array after activation of the rapid shutdown initiator. No UL3741 listing is required. Any equipment that would be energized with higher than 80 volts after activation of the rapid shutdown initiator would fall under a UL3741 investigation even if that voltage was internal to equipment and not just the exposed wiring. Other options would be: using a listed PVRSE at a PV module with a maximum output voltage less than 80 volts, using a listed PVHCE from UL3741 or any combination of these.

The option provided by 690.12(B)(2)(3) is no longer applicable with the above two options. The design

either falls within option 2 or option 1. Therefore, this option is deleted since there is not enough criteria specified to determine an adequate PVHCS.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate and their inclusion here is not necessarily an endorsement of all the PI's submitted.
Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain, P.E., SEIA; Bill Brooks, PVICC; John Berdner, PVICC, Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing, Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower; Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

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Committee: NEC-P04

Public Input No. 4494-NFPA 70-2020 [Section No. 690.12(B) [Excluding any Sub-Sections]]

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 listed for the purpose 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.

Statement of Problem and Substantiation for Public Input

Note that despite the legislative text shown, this input only seeks to add a new last sentence. The existing language is unchanged. This additional language is to clarify that products, such as those listed as rapid shutdown equipment (RSE), can be used to provide the necessary functions for the requirements within the array boundary [690.12(B)(2)] and those outside the array boundary[690.12(B)(1)]. A simple example of this is a microinverter installed on a PV module with a maximum voltage less than 80Volts. The listed microinverter reduces the voltage on its ac output to less than 30V in less than 30 seconds while the PV module side of the inverter stays energized at up to 80V in compliance with 690.12(B)(2)(2). No additional certifications are required for the microinverter that is listed as RSE.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate and their inclusion here is not necessarily an endorsement of all the PI's submitted.
Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain, P.E., SEIA; Bill Brooks, PVICC; John Berdner, PVICC, Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing, Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower; Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett,

DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

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Committee: NEC-P04

Public Input No. 3221-NFPA 70-2020 [Section No. 690.12(C)]

(C) Initiation Device.

The initiation device(s) shall initiate the rapid shutdown function of the PV system. 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-family and two-family dwellings an initiation device(s) shall be located at a readily accessible location outside the building. The initiation device shall be labeled "PV RAPID SHUTDOWN DISCONNECT"

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

Informational Note: Examples of where an initiation device that complies with 690.12(C)(3) would be used is where a PV system is connected to an optional standby or stand-alone system.

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

The proposed language will add clarity for the Firefighter or other person who is charged with disconnecting the photovoltaic (PV) system during an emergency situation. As an Electrical Inspector, I have requested installers to label the disconnect in this fashion, as this labeling is presently not required to plainly indicate which disconnect or other initiation device is for the rapid shutdown of the PV system. As an Electrical Inspector and as a volunteer Firefighter, it is very important to label these devices with their purpose. We, as Electrical Inspectors and Instructors, keep educating the Firefighters that the rapid shutdown is on newer PV systems to assist in making these systems safe when a fire event occurs, but we fail to label the initiation devices a "PV RAPID SHUTDOWN DEVICE" so the Firefighters know which disconnect to turn off when needed. By adding this requirement into the NEC, this will make it very clear the purpose of this device and clear up confusion on which disconnect or imitation device to turn to the off postion.

Submitter Information Verification

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Committee: NEC-P04

Public Input No. 4053-NFPA 70-2020 [Section No. 690.12(C)]

(C) Initiation Device.

The initiation device(s) shall initiate the rapid shutdown function of the PV system. 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-family and two-family dwellings an initiation device(s) ~~shall~~ shall ~~be~~ ~~located at a readily accessible location outside the building~~ meet the following requirements .

(1) Be located in a readily accessible location outside the building

(2) Be located within 1 m (3 ft) of any required emergency service disconnect or where there is no required emergency service disconnect, shall be located within 1 m (3 ft) of any other power source emergency disconnect

(3) If remotely controlled, the remote-control system shall be "fail safe" where the rapid shut down system is automatically activated on loss of control signal or control power

(4) Be labeled to comply with 690.56(2).

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

Informational Note: Examples of where an initiation device that complies with 690.12(C)(3) would be used is where a PV system is connected to an optional standby or stand-alone system.

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

This proposal is one of several related, but separate proposals involving the 2020 NEC requirements for external (outside the building) emergency disconnects on one- and two-family dwellings for energy sources such as the utility service, batteries, energy storage systems (ESS), wind systems and also stand-alone PV systems plus PV rapid shutdown systems. The intent of these proposals is to require multiple emergency disconnects to be grouped in one location to increase safety for Fire Service first responders.

Also, when remote activation of these disconnects is allowed, the proposal establishes an additional safety requirement that the remote controls be fail safe and in the event of loss of control power or control signal, the emergency disconnect shall automatically be opened.

It has been determined that some inverter manufacturers are already starting to put inputs on their products to allow an external remote shutdown control system that is fail safe. Also, it has been determined that adding such a fail-safe remotely controlled emergency disconnect system is relatively inexpensive using voltage-trip circuit breakers and a relay on large battery banks or ESS.

Submitter Information Verification

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Submittal Date:	Wed Sep 09 19:17:58 EDT 2020
Committee:	NEC-P04

Public Input No. 4341-NFPA 70-2020 [Section No. 690.12(C)]

(C) Initiation Device.

The initiation device(s) shall initiate the rapid shutdown function of the PV system. 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-family and two-family dwellings an initiation device(s) shall be located at a readily accessible location outside the building.

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

Informational Note: Examples of where an initiation device that complies with 690.12(C)(3) would be used is where a PV system is connected to an optional standby or stand-alone system.

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

Section 230.71(B) no longer permits the up to six service disconnecting means to be mounted in a single enclosure. As presently written, 690.12(C) is in conflict with 230.71(B).

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Committee: NEC-P04

Public Input No. 4500-NFPA 70-2020 [Section No. 690.12(C)]

(C) Initiation Device.

~~The initiation~~ 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 ~~of the PV system~~ . 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-family and two-family dwellings an initiation device(s) ~~shall~~ , where required, shall be located at a readily accessible location outside the building.

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

Informational Note: Examples of where an initiation device that complies with 690.12(C)(3) would be used is where a PV system is connected to an optional standby or stand-alone system.

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

This additional language is to clarify that initiation devices are only required when the installation requires a rapid shutdown function. No such device is necessary when the function is not required for the PV system.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
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Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

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Submittal Date: Thu Sep 10 14:19:22 EDT 2020
Committee: NEC-P04

Public Input No. 1302-NFPA 70-2020 [Section No. 690.12(D)]

(D) Equipment.

Equipment that performs the rapid shutdown functions, other than initiation devices such as listed disconnect switches, circuit breakers, or control switches, shall be listed ~~for providing rapid shutdown protection.~~ and identified as a PV rapid shutdown system or as a PV hazard control system.

Informational Note: See UL 3741, *Photovoltaic Hazard Control* .

Statement of Problem and Substantiation for Public Input

It has been identified by installers that there are field installation issues with the compatibility of individual listed PV Rapid Shutdown Equipment. Currently within UL 1741 and within UL 3741 there are required functional safety tests. This section should require that the products that perform PV rapid Shutdown not only be listed, but also identified as “photovoltaic rapid shutdown system” or “PV rapid shutdown system.” Individual listed PV Rapid Shutdown Equipment used as components outside of a listed PV Rapid Shutdown System will be limited in performance and may or may not address all of the critical aspects of its use in the end PV rapid shutdown System (PV Hazard Control System).

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Committee: NEC-P04

Public Input No. 3803-NFPA 70-2020 [Section No. 690.12(D)]

(D) Equipment.

Equipment that performs the rapid shutdown functions, other than initiation devices such as listed disconnect switches, circuit breakers, or control switches, shall be listed for providing rapid shutdown protection. These devices should not interfere with other devices, or functions, including safety features such as Arc Fault Circuit Interuption or Ground Fault Circuit Interruption.

Statement of Problem and Substantiation for Public Input

If you are adding a system that increases the chances of someone getting hurt, either by causing an existing system to become a nuisance and end user circumvents or completely non functional, you really haven't gained anything at all.

Submitter Information Verification

Submitter Full Name: Jason Eiseman
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Submittal Date: Wed Sep 09 13:12:11 EDT 2020
Committee: NEC-P04

Public Input No. 4105-NFPA 70-2020 [Section No. 690.12(D)]

(D) Equipment.

Equipment that performs the rapid shutdown functions, other than initiation devices such as listed disconnect switches, circuit breakers, or control switches, shall be listed for providing rapid shutdown protection. These devices should not interfere with other devices or functions (e.g. Arc-Fault Circuit Interrupter (AFCI), Or Ground-Fault Circuit Interrupter (GFCI).

Additional Proposed Changes

File Name	Description	Approved
2020-09-09-Rapid_Shutdown-WhitePaper.pdf	Rapid Shutdown & AFCI documentation on safety issues.	

Statement of Problem and Substantiation for Public Input

The attached White Paper “Arc-Fault Detection at Photovoltaic Systems” shows that Module Level Power Electronics (MLPEs) are interfering with state-of-the-art Arc-Fault Detection. This shows that Module Level Shutdown (MLSD) unintentionally makes the PV system unsafe and MLSD is causing the problem which it is made to protect against, fires. At the moment no standard (e.g. UL 1741, or UL1699B) is addressing this problem. I believe it is the first step in fixing the issue.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 4099-NFPA 70-2020 [Section No. 690.12]	

Submitter Information Verification

Submitter Full Name: Chris Connell
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Submittal Date: Wed Sep 09 20:48:08 EDT 2020
Committee: NEC-P04

Public Input No. 4193-NFPA 70-2020 [Section No. 690.12(D)]

(D) Equipment.

Equipment that performs the rapid shutdown functions, other than initiation devices such as listed disconnect switches, circuit breakers, or control switches, shall be listed for providing rapid shutdown protection. Devices connected to the DC conductors of a photovoltaic array shall not interfere with other devices of the same system to function as required by 690.41(B) Ground-Fault Protection, and 690.11 Arc-Fault Circuit Protection (Direct Current)

Statement of Problem and Substantiation for Public Input

MLPE, which is now required per code (690.12). We have found that these devices interfere with proper functioning of arc fault detection and ground-fault detection of other devices such as string inverters, on the same system. If module Level Power Electronics are to be required by code, they should not prevent or interfere with the arc-fault detection and ground fault-detection required by code of these other devices.

Submitter Information Verification

Submitter Full Name: Scott Carman
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Submittal Date: Thu Sep 10 01:17:40 EDT 2020
Committee: NEC-P04

Public Input No. 4472-NFPA 70-2020 [Section No. 690.12(D)]

~~(D) Equipment.~~

~~Equipment that performs the rapid shutdown functions, other than initiation devices such as listed disconnect switches, circuit breakers, or control switches, shall be listed for providing rapid shutdown protection.~~

Statement of Problem and Substantiation for Public Input

This proposal moves the language from 690.12(D) to 690.4(B). The language in 690.12(D) serves the same purpose as 690.4(B), which requires that equipment shall be listed for its purpose. The proposed change condenses the language related to listings in 690. The informational note is intended to maintain the distinction that was in 690.12(D) related to listed switches and circuit breakers used rapid shutdown initiators. While those devices are commonly used to comply with 690.12 requirements, they need not have specific listings for rapid shutdown or PV hazard control if they are simply performing a switching function within their ratings. This statement is generally true of general purpose listed devices used in PV systems so the informational note is made more general for that reason.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
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Committee: NEC-P04

Public Input No. 3986-NFPA 70-2020 [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 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 2: Rapid shutdown function need not be provided where the fire code official has determined that PV system circuits do not expose a fire fighter to electrical shock hazards during fire-fighting operations for that type and configuration of building or structure.

Statement of Problem and Substantiation for Public Input

This public input is submitted to provide the Code Making Panel another option for debate on how to improve the scope of the requirement for Rapid Shutdown of PV Systems on Buildings. The initial development of language for Rapid Shutdown was based on consideration of hazards related to fire-fighting rooftop operations for rooftop PV systems. Unfortunately, the language "installed on or in buildings" is overly restrictive for some types of PV installations, primarily because the NEC definitions of "building" and "structure" are overly broad. For example, an elevated PV support structure installed over a parking lot falls within the definition of building, but there are no rooftop operations involved with fire-fighting, as fire fighters will not go on top of those structures during a fire event, and will instead attack the fire from the ground.

2020 NEC Definitions:

Building. A structure that stands alone or that is separated from adjoining structures by fire walls. (CMP-1)

Structure: That which is built or constructed, other than equipment. (CMP-1)

Because a building is defined as "a structure," and a structure is defined as "that which is built or constructed," almost anything made by the hands of humans can be considered to be a building under current NEC definitions. This is problematic.

This Public Input is not intended to compete against other PI's as a stand-alone solution, but instead is intended to encourage the Code Making Panel to consider fire fighting operations that benefit from -- or do not benefit from -- Rapid Shutdown to improve fire fighter safety, while considering how to improve the primary charging language for Rapid Shutdown to more specifically describe the type of building for which Rapid Shutdown is needed.

The language of this Public Input is inspired by similar exception language for rooftop access pathways and setbacks found in 2021 International Fire Code Section 1205.2 Access and Pathways, Exceptions 2 and 3, and in 2021 NFPA 1 Fire Code Section 11.12.3.1.2. These sections allow the fire code official the flexibility to exempt or modify requirements for access pathways and setbacks where rooftop operations are not employed.

For Rapid Shutdown requirements, the Code Making Panel could consider developing a list of use cases for which Rapid Shutdown is not needed because it does not enhance fire fighter safety, and then debate final charging language (or exceptions) that would require Rapid Shutdown in those use cases where it helps, and not require it where it does not improve safety.

For example, consider the following (incomplete) list of use cases:

- Elevated PV support structures commonly found over parking lots on grade

- Elevated PV support structures commonly found on the upper-most level of a parking garage
- Elevated PV support structure over an agricultural use, such as over a cranberry bog or as a livestock shade structure.
- Elevated PV support structure over a vegetative roof.
- PV on detached garages for one- or two-family dwellings
- PV on detached sheds for one- or two-family dwellings
- PV on patio cover or trellis for one- or two-family dwellings
- PV on agricultural buildings
- Pole-mounted PV systems (tracking or fixed)
- Single-axis trackers
- Fixed-tilt ground mounts
- Float-o-voltaics

- BIPV facade systems (on cladding, spandrel glass, or windows)
- BIPV facade systems at a height greater than 75-feet above grade

This list of use cases could be expanded, based on experiences of CMP members or interested parties. Hopefully, this partial list of use cases will inform the discussion of CMP members when considering final language for 2023 NEC Rapid Shutdown.

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Committee: NEC-P04

Public Input No. 4405-NFPA 70-2020 [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: 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.

Exeption: Small PV systems of 25 kw or less, with an OCV of 150 or less, on concrete structures, like a concrete roof of a concrete house, shall not be required to comply with 690.12. A label must be installed next to the main disconect of the facility explaining that the property have a PV system without a RapidShutdown Disconnect.

Additional Proposed Changes

File Name	Description	Approved
exeption_for_RS_of_systems_installed_in_concrete_roofs.pdf		

Statement of Problem and Substantiation for Public Input

RS implementation in PR has left low income families and small comercial without the possibilities to install PV backup systems because the increase in cost and complexity. Emergency responder dont make ventilation holes in concrete roofs. An Exemption of the RS requirement for concrete roofs will help reduce cost and complexity of the PV system make it more accessible to low income families and small comercial applications.

Submitter Information Verification

Submitter Full Name: Homar Torres
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Submittal Date: Thu Sep 10 12:12:39 EDT 2020
Committee: NEC-P04

Renewable energy systems have proven in recent years to be the fastest growing commercial, industrial, and residential energy alternative. Technological advances in this industry make the incorporation of these systems more and more accessible and necessary as an alternative for energy generation to alleviate the burden on traditional systems. After the hurricane season of 2017, where it was clearly evidenced that Global Warming has raised the temperatures of the Atlantic Ocean to levels never seen before. These temperatures in the ocean water have contributed to the development of extreme hurricanes. Since 2005, these extreme events of force majeure began to create a new paradigm in terms of Emergency Management and Disaster Management.

In the local context, the damages caused by Hurricane María completely destroyed the electrical distribution system. In addition, the earthquakes destroyed part of Costa Sur, the biggest power plant in Puerto Rico, also cause substantial damage other power plants, transmission, and distribution system. Because of all the bureaucracy of the government and the Puerto Rico Electric Power Authority (PREPA) been in bankrupt, the processes to restore will take decades.

Up to 12 month without power in some areas after Hurricane Maria, cause 4,645 deaths, because of the lack of power to preserve food, to preserve medicines, operate medical equipment, operate communication devices, pump potable water for people to drink, to clean, to bath.

Meanwhile, hurricanes will continue to threaten the island again. The humanitarian crisis has reached unsuspected levels. The public health system collapsed from: Hospitals, Health Centers, Medical Offices, Laboratories, Renal Centers, Hospice Bedridden Patients and “Home Care” programs were affected and will be affected again as new atmospheric phenomena arrive, or worse yet a Major Earthquake.

Faced with this picture, the Emergency Preparedness phase together with the Mitigation phase are our only defense weapons. We are an Island, and as such it is impossible to pre-position resources from other jurisdictions before the threat of atmospheric events. We also have seismic vulnerability, which does not warn us and therefore we have to raise our guard and put ourselves on ALERT.

Been a small, Island, PR have to import everything, for this reason, electrical and technologic equipment are more expensive. High income families and corporations are securing their energy needs with expensive and luxury last technologies batteries. But, a big part of the Island live under poverty, The implementation of Rapid Shutdown in PR, can increase in over $3,000 the cost of a simple small backup system, leaving low income families with no market choices to install PV Backup system to protect their family members from the disasters PR is experimenting every year and the daily power failures of a grid that can collapse at any moment.

Exemption for 25kw systems or less installed in concrete structures with concrete roof.

Rapid Shutdown have changed a lot since it was first mentioned. But we have to maintain focus on what it is main purpose, so any changes don’t bend its original reason to exit.
In some jurisdictions, Firefighters and other emergency responders, access roofs in order to make holes for ventilation procedures, or gain access to the interior of the property. In concrete buildings with concrete roof, emergency responders will never access a roof to make a hole! Its is simply impossible for it to happen!
So, if emergency responders will never access a roof with heavy machinery to make a ventilation hole in a solid concrete roof, then, the risk of electrical shock does not exist at all!

Why 25kw or less?

Because my petition is focused on reducing the complexity and cost for low income houses and small commercial, backup systems. For example, 48v battery base systems with arrays of 150Vdc in open circuit. Typically, one single inverter system may have from 12 up to 48 PV panels. Two inverters in parallel may have from 36 to 96 PV panels. These 150 Vdc pv arrays have less hazards than larger 600 Vdc arrays. And because emergency responders never go to a roof to make a ventilation hole in a concrete roof, there is not risk at all.

I personally don't work with large commercial systems, but the board should consider have less strict rules for all concrete buildings with concrete roofs. Integration of RS in PV Systems larger than 25.1 KW should be discussed later with professionals that works those type of systems.

Petition:

To make an exception of the 690.12 for 25kw or less PV systems installed in concrete buildings with concrete roofs.

Homar Torres Arzola, PE, MEM

Member of the board of ACONER, the Association of Energy Consultants of Puerto Rico.

www.aconer.com

Public Input No. 4445-NFPA 70-2020 [Section No. 690.12 [Excluding any Sub-Sections]]

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

Exception:

~~Ground-mounted~~

PV system

~~circuits that enter buildings, of which the sole purpose is to house PV system equipment,~~

equipment or circuits installed on or in buildings or structures without occupiable spaces or habitable rooms, including but not limited to equipment attached to ground mounting structures, detached garages, parking shade structures, carports, trellises and similar structures, shall not be required to

~~comply with 690.12 .~~

include a rapid shutdown function.

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

Statement of Problem and Substantiation for Public Input

The intent of this proposal is to clearly define that PV systems, installed in or on locations where firefighters will perform rooftop operations, require rapid shutdown (RSD) functions to allow firefighters to safely perform vertical ventilation and rescue operations. Basic firefighting methods are performed when there is an enclosed space below the PV system where the occupants may be working, living, or engaged in other similar actions. RSD was not envisioned for PV systems installed on solar carports, accessory structures, or ground mounted arrays since any heat, smoke, or occupants could egress through the open sides of the structure. For this purpose, the definitions of “habitable rooms” from the NEC and “occupiable space” from the International Building Code are referenced to indicate when rooftop operations would be performed. The defined area where RSD is required is an enclosed space, designed for human occupancy, where living, sleeping, eating, cooking, or working is performed and there are means of egress, light, and ventilation facilities.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
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Submittal Date: Thu Sep 10 13:10:21 EDT 2020
Committee: NEC-P04

Public Input No. 4504-NFPA 70-2020 [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). For the purposes of this section, PV systems installed on a carport where the carport has no walls and is not attached to a building, shall be considered as a ground-mounted PV system.

Exception: 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: Ground-mounted PV systems utilizing listed utility-interactive inverter(s) where only inverter AC output circuit(s) are installed on or within buildings, shall not be required to comply with 690.12. For such systems there shall be provided a readily accessible AC disconnect or overcurrent protection device on the outside of the building to disrupt the inverter(s) interaction with the electric utility when the disconnect is opened.

Statement of Problem and Substantiation for Public Input

Justification for adding second sentence of 690.12: : The 2020 NEC does not give any direction on if a PV system mounted on a carport is to be treated like a PV system on a building, or if it should be treated like a ground-mounted PV system. This has caused significant confusion across the country when AHJ's try to apply the requirements of NEC 690.12. However, the functionality of a solar PV system mounted on a carport is not any different than a ground-mounted PV system. Also, there is not any reason for a firefighter to get on top of a carport which contains a solar PV system. It's been stressed through the last several code cycles that rapid shutdown requirements for PV system are specifically for protecting firefighters. The words "for firefighters" were even added to Section 690.12 in the 2020 NEC. Because of this, a PV system mounted on a carport should not be any different than a ground-mounted PV system when determining whether or not rapid shutdown requirements of NEC 690.12 apply to such system.

Justification for adding 2nd exception: Providing rapid shutdown equipment for PV systems can often be difficult and expensive. Since a ground-mounted PV system does not pose the same hazards as a roof-mounted PV system for firefighters, there needs to be more flexibility on when rapid shutdown equipment is required for a ground-mounted PV system. Adding the proposed exception #2 would add more flexibility to the design of a PV system and save costs.The AC output circuit of a listed utility-interactive inverter can easily be shut down simply by opening an AC disconnect switch or breaker that interrupts the link between the inverter(s) and the electric utility grid. All the firefighters would have to do is shut down the service disconnect(s) to the building or shut off an AC disconnect for the PV system. By doing so the listed utility-interactive inverter(s) would shut down and ensure there's no live PV AC circuit wiring on or in the building. Yes, the wiring at the array (under the solar modules) would remain energized, but such does not affect nor present a hazard to firefighters. Adding the proposed exception #2 to 690.12 would afford firefighters protection from live wiring while at the same time simplify the solar PV installation and reduce the amount of required equipment. Many jurisdictions are already allowing ground-mounted PV systems and PV systems mounted on carports to not meet the requirements of 690.12(B)(2) (often called "module-level" rapid shutdown) as long as the inverter(s) are mounted at or immediately adjacent to the PV array. The proposed exception #2 is in line with such practice.

Submitter Information Verification

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Submittal Date:	Thu Sep 10 14:22:31 EDT 2020
Committee:	NEC-P04

Public Input No. 1862-NFPA 70-2020 [Section No. 690.13(A)]

(A) Location.

(1) Readily Accessible. The PV system disconnecting means shall be installed at a readily accessible location.

(2) Restriction to Unqualified Persons. Where disconnecting means of systems above 30 ~~V are~~ volts are readily accessible to unqualified persons, any enclosure door or hinged cover that exposes live parts when open shall be locked or require a tool to open.

Informational Note: PV systems installed in accordance with 690.12 address the concerns related to energized conductors entering a building.

Statement of Problem and Substantiation for Public Input

Revision into a list format of each us use and application.

Submitter Information Verification

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Submittal Date: Sat Jul 11 19:04:04 EDT 2020
Committee: NEC-P04

Public Input No. 2979-NFPA 70-2020 [Section No. 690.13(C)]

(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~~ in an interactive system~~ .

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.

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

Interactive system is no longer a defined term as this definition is being changed as part of public inputs of this task group. This public input removes the reference to this as this last sentence is not needed here and could cause confusion.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2684-NFPA 70-2020 [Definition: Interactive System.]	Definition / Term change

Submitter Information Verification

Submitter Full Name: Thomas Domitrovich
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Submittal Date: Thu Sep 03 18:13:47 EDT 2020
Committee: NEC-P04

Public Input No. 1871-NFPA 70-2020 [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:~~

(1) Fused disconnects, unless otherwise marked, shall be considered suitable for backfeed. Circuit breakers not marked “line” and “load”

~~may not~~

(1) shall 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

The replacement of the informational note 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 705.12(D). It is always great when NEC rules are consistent between articles – plus this is great information.

Submitter Information Verification

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Submittal Date: Mon Jul 13 10:34:44 EDT 2020
Committee: NEC-P04

Public Input No. 3663-NFPA 70-2020 [Section No. 690.15(A)]

(A D) Location and Control .

Isolating devices or equipment disconnecting means shall ~~be installed in circuits connected to equipment at a location~~ comply with one or more of the following:

(1) Located within the equipment

~~, or within sight and within 3 m (10 ft) of the equipment. An equipment disconnecting means shall be permitted to be remote from the equipment where the equipment disconnecting means can be remotely operated from within 3 m (10 ft) of the equipment. Where disconnecting means of equipment operating above 30 volts are readily accessible to unqualified persons, any enclosure door or hinged cover that exposes live parts when open shall be locked or require a tool to open~~

(1)

(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 for the disconnecting means are not located within sight of the equipment, the disconnecting means is lockable 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

There are three primary components to this PI, each of which is interrelated.
(1) 690.15(A) and 690.15(D) are switched to improve readability
(2) The modified 690.15(A) Type of Disconnecting Means is modified for clarity:
- Item 1 in the list item already exists, but is reworded for clarity
- Item 2 in the list is modified to clarify that listed equipment may have a mechanism or series of operations that can allow for safe servicing of equipment by removing current. In this scenario, the equipment would remove current and would need to be listed for this type of operation. This type of equipment would allow a technician to safely operate an isolating device where the circuit normally operates at any current level. For example, this is a common configuration in systems as part of listed equipment where current must be removed before accessing fuse holders that are used as isolating devices.
- Item 3 in the list is modified to clarify that an equipment disconnecting means is allowed on any circuit, not just on circuits greater than 30A.

(3) The modified 690.15(D) Location and Control is modified as a list for clarity. The list item covering “remote controls” is based on the language at 480.7(D). This change would clearly allow for remote operation where the remote operation device is not within sight of the equipment, and would require the disconnect to be lockable in these circumstances, even when the disconnecting means is within sight of the equipment.
References to 3m (10ft) are removed and where they would have been used, replaced with “readily accessible for whom access is required.” This is language used elsewhere in the Code, for example, disconnecting means for rooftop air conditioning equipment. This removes possibilities that equipment may be close to the isolating means but at a different level, behind a fence, or otherwise not readily accessible during servicing.

The requirement to secure hinged covers and doors has been deleted since 110.27 should provide requirements for guarding of all electrical equipment. See related PI.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar

Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate.
Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain, P.E., SEIA; Bill Brooks, Brooks Engineering/PVICC; Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing, Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower; Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Ben Chamberlain, Olivewood Energy; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3661-NFPA 70-2020 [Section No. 690.15(D)]	These section locations are switched.
Public Input No. 3926-NFPA 70-2020 [New Section after 110.27(C)]	For guarding of certain equipment
Public Input No. 3661-NFPA 70-2020 [Section No. 690.15(D)]	
Public Input No. 3926-NFPA 70-2020 [New Section after 110.27(C)]	

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Submittal Date: Wed Sep 09 10:21:41 EDT 2020
Committee: NEC-P04

Public Input No. 3668-NFPA 70-2020 [Section No. 690.15(C)]

(C) Equipment Disconnecting Means.

Equipment disconnecting means shall comply with each of the following:

(1) Equipment disconnecting means shall have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals.

(2) Equipment disconnecting means shall simultaneously disconnect all current-carrying conductors that are not solidly grounded to the circuit to which it is connected.

(3) Equipment disconnecting means shall 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) Equipment disconnecting means, where used, shall 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

The existing text is reorganized as a list for readability, and to clarify that all of the listed items are required for equipment disconnecting means used for isolating equipment. Despite the appearance of the legislative text, the only new text that is being added is between the charging paragraph and the first list item one.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate.
Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain, P.E., SEIA; Bill Brooks, Brooks Engineering/PVICC; Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing, Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower;

Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Ben Chamberlain, Olivewood Energy; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

Submitter Information Verification

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Submittal Date: Wed Sep 09 10:29:32 EDT 2020
Committee: NEC-P04

Public Input No. 3661-NFPA 70-2020 [Section No. 690.15(D)]

(~~D~~ A) Type of Disconnecting Means.

Where disconnects are required to isolate equipment, the disconnecting means shall ~~be~~ comply with one or more of the following applicable types:

~~An equipment disconnecting means in accordance with~~ 690.15(C) ~~shall be required to isolate dc~~

(1) For circuits with a maximum circuit current ~~over~~

(2) of 30 amperes ~~.An~~

(3) or less, an isolating device in accordance with 690.15(B) ~~shall be permitted for circuits other than those covered by~~

(4)

(5) For any circuit, an isolating device where there are means as part of listed equipment to first remove current and then allow access to the isolating device

(6) For any circuit, an equipment disconnecting means in accordance with 690.15(~~D~~

(7) C) ~~(1).~~

(8)

Additional Proposed Changes

File Name	Description	Approved
690.15_D_correct_text.pdf	Correct text for the PI for this section	

Statement of Problem and Substantiation for Public Input

There are three primary components to this PI, each of which is interrelated.
(1) 690.15(A) and 690.15(D) are switched to improve readability
(2) The modified 690.15(A) Type of Disconnecting Means is modified for clarity:
- Item 1 in the list item already exists, but is reworded for clarity
- Item 2 in the list is modified to clarify that listed equipment may have a mechanism or series of operations that can allow for safe servicing of equipment by removing current. In this scenario, the equipment would remove current and would need to be listed for this type of operation. This type of equipment would allow a technician to safely operate an isolating device where the circuit normally operates at any current level. For example, this is a common configuration in systems as part of listed equipment where current must be removed before accessing fuse holders that are used as isolating devices.
- Item 3 in the list is modified to clarify that an equipment disconnecting means is allowed on any circuit, not just on circuits greater than 30A.

(3) The modified 690.15(D) Location and Control is modified as a list for clarity. The list item covering “remote controls” is based on the language at 480.7(D). This change would clearly allow for remote operation where the remote operation device is not within sight of the equipment, and would require the disconnect to be lockable in these circumstances, even when the disconnecting means is within sight of the equipment.
References to 3m (10ft) are removed and where they would have been used, replaced with “readily accessible for whom access is required.” This is language used elsewhere in the Code, for example,

disconnecting means for rooftop air conditioning equipment. This removes possibilities that equipment may be close to the isolating means but at a different level, behind a fence, or otherwise not readily accessible during servicing.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
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Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3663-NFPA 70-2020 [Section No. 690.15(A)]	These section locations are switched
Public Input No. 3663-NFPA 70-2020 [Section No. 690.15(A)]	

Submitter Information Verification

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Submittal Date: Wed Sep 09 10:15:09 EDT 2020
Committee: NEC-P04

690.15(~~D~~A) Type of Disconnecting Means.

Where disconnects are required to isolate equipment, the disconnecting means shall ~~be~~ comply with one or more of the following applicable types:

~~1. An equipment disconnecting means in accordance with 690.15(C) shall be required to isolate dc circuits with a maximum circuit current over 30 amperes.~~

~~2. An isolating device in accordance with 690.15(B) shall be permitted for circuits other than those covered by 690.15(D)(1).~~

1. For circuits with a maximum circuit current of 30 amperes or less, an isolating device in accordance with 690.15(B)
2. For any circuit, an isolating device where there are means as part of listed equipment to first remove current and then allow access to the isolating device
3. For any circuit, an equipment disconnecting means in accordance with 690.15(C)

Public Input No. 1157-NFPA 70-2020 [Section No. 690.31(A)]

(A) Wiring Systems.

All raceway and cable wiring methods included in this *Code*, other wiring systems and fittings specifically listed for use in PV arrays, and wiring as part of a listed system shall be permitted. Where wiring devices with integral enclosures are used, sufficient length of cable shall be provided to facilitate replacement.

Where PV source and output circuits operating at voltages greater than 30 volts are installed immediately under the array and in readily accessible locations, circuit conductors shall be guarded ~~or installed in Type MC cable or in raceway.~~ by either of the following methods:

1. Surround the array with substantial fencing with a 1.8 m (6 ft) minimum height and with a lockable gate if gated.

2. Install metallic mesh 19 gauge or greater with openings of 1/2" or less to the underside of the array covering the cabling.

PV source and output circuits shall be provided with physical protection by a raceway or MC cable for every portion immediately outside the arrays. PV cabling that isn't within a raceway or MC cable on the underside of array(s) shall be regarded as live parts.

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

Table 690.31(A)(a) Correction Factors

	Temperature Rating of Conductor		
Ambient Temperature	**105°C**	**125°C**	**Ambient Temperature**
(°C)	**(221°F)**	**(257°F)**	**(°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
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

Table 690.31(A)(b) 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)

AWG	**Types**

	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

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

Statement of Problem and Substantiation for Public Input

Guidelines are needed for guarding readily accessible PV cabling.

Submitter Information Verification

Submitter Full Name: Norman Feck
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Zip:
Submittal Date: Tue May 19 07:56:07 EDT 2020
Committee: NEC-P04

Public Input No. 3838-NFPA 70-2020 [Section No. 690.31(A)]

(A) Wiring Systems.

All raceway and cable wiring methods included in Chapter 3 of this *Code*, other wiring systems and fittings specifically listed for use in PV arrays, and wiring as part of a listed system shall be permitted. Where wiring devices with integral enclosures are used, sufficient length of cable shall be provided to facilitate replacement.

Where PV source and output circuits operating at voltages greater than 30 volts are installed in readily accessible locations, circuit conductors shall be guarded or installed in Type MC cable or in raceway. The ampacity of 105°C (221°F) and 125°C (257°F) conductors shall be permitted to be determined by Table 690.31(A)(b). For ambient temperatures greater than 30°C (86°F), the ampacities of these conductors shall be corrected in accordance with Table 690.31(A)(a).

Table 690.31(A)(a) Correction Factors

Ambient Temperature (°C)	Temperature Rating of Conductor 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
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

Table 690.31(A)(b) 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)

AWG	Types	
	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

AWG	Types	
	PVC, CPE, XLPE 105°C	XLPE, EPDM 125°C
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

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

Statement of Problem and Substantiation for Public Input

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

This Task Group's initial tasks were to establish a demarcation for what can be referred to as Medium or High Voltage. The recommendation has been to establish this threshold as being equipment rated over 1000 Vac, 1500 Vdc.

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

This proposed change provides consistency in the Alternative Energy articles in order to address the wiring system(s) and/or method(s) that could be encountered within or as a part of the system (solar, wind or energy storage) installation. By adding the reference back to Chapter 3, the new text will correlate with the existing language found in NEC 692.31 for "Wiring Systems" for Fuel Cell Systems and provide direction to the installer, so that regardless of the voltage, all wiring systems and methods would comply with the applicable Chapter 3 Article.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3728-NFPA 70-2020 [Global Input]	Companion Public Input (New Articles 245 and 495)
Public Input No. 3765-NFPA 70-2020 [New Section after 250.194(B)]	Companion Public Input (New Article 255)
Public Input No. 3772-NFPA 70-2020 [New Section after 110.79]	Companion Public Input (New Article 115)
Public Input No. 3815-NFPA 70-2020 [New Section after 200.11]	Companion Public Input (New Article 205)
Public Input No. 3819-NFPA 70-2020 [Global Input]	Companion Public Input (New Article 235)

Public Input No. 3827-NFPA 70-2020 [Global Input]

Public Input No. 3846-NFPA 70-2020 [Section No. 694.30(A)]

Public Input No. 3849-NFPA 70-2020 [New Part after IV.]

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

Public Input No. 3765-NFPA 70-2020 [New Section after 250.194(B)]

Public Input No. 3772-NFPA 70-2020 [New Section after 110.79]

Public Input No. 3815-NFPA 70-2020 [New Section after 200.11]

Public Input No. 3819-NFPA 70-2020 [Global Input]

Public Input No. 3827-NFPA 70-2020 [Global Input]

Public Input No. 3846-NFPA 70-2020 [Section No. 694.30(A)]

Public Input No. 3849-NFPA 70-2020 [New Part after IV.]

Companion Public Input (New Article 305)

Companion Public Input (New Section 694.30(A))

Companion Public Input (New Section 706.30)

Submitter Information Verification

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Submittal Date: Wed Sep 09 13:50:48 EDT 2020
Committee: NEC-P04

Public Input No. 4203-NFPA 70-2020 [Section No. 690.31(A)]

(A) Wiring Systems.

All raceway and cable wiring methods included in this *Code*, other wiring systems and fittings specifically listed for use in PV arrays, and wiring as part of a listed system shall be permitted. Where wiring devices with integral enclosures are used, sufficient length of cable shall be provided to facilitate replacement.

Where PV ~~source and output circuits~~ system dc circuits operating at voltages greater than 30 volts are installed in readily accessible locations, circuit conductors shall be guarded or installed in Type MC cable or in raceway. The ampacity of 105°C (221°F) and 125°C (257°F) conductors shall be permitted to be determined by Table 690.31(A)(b). For ambient temperatures greater than 30°C (86°F), the ampacities of these conductors shall be corrected in accordance with Table 690.31(A)(a).

Table 690.31(A)(a) Correction Factors

Ambient Temperature (°C)	Temperature Rating of Conductor 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
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

Table 690.31(A)(b) 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)

AWG	Types	
	PVC, CPE, XLPE 105°C	XLPE, EPDM 125°C
18	15	16
16	19	20
14	29	31
12	36	39
10	46	50

AWG	Types	
	PVC, CPE, XLPE 105°C	XLPE, EPDM 125°C
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

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

Statement of Problem and Substantiation for Public Input

This change is needed to remove the reference to PV output circuits in the related PIs. Applying the more general term “PV system dc conductors” to this section is more appropriate.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF’s effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI’s as they deem appropriate and their inclusion here is not necessarily an endorsement of all the PI’s submitted.
Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain, P.E., SEIA; Bill Brooks, PVICC; John Berdner, PVICC, Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing, Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower; Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger,

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Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3701-NFPA 70-2020 [Definition: PV Output Circuit.]	deletion of old term

Submitter Information Verification

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Committee: NEC-P04

Public Input No. 3345-NFPA 70-2020 [Section No. 690.31(B) [Excluding any Sub-Sections]]

PV system dc circuits and Class 1 remote control, signaling, and power-limited circuits of a PV system shall be permitted to occupy the same equipment wiring enclosure, cable, or raceway. PV system dc circuits shall not occupy the same equipment wiring enclosure, cable, or ~~raceway. as~~ raceway as other non-PV systems, or inverter output circuits, unless the PV system dc circuits are separated from other circuits by a barrier or partition. PV system circuit conductors shall be identified and grouped as required by 690.31(B)(1) and (B)(2).

Exception: 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. All conductors, harnesses, or assemblies shall have an insulation rating equal to at least the maximum circuit voltage applied to any conductor within the enclosure, cable, or raceway.

Statement of Problem and Substantiation for Public Input

There is a misplaced period in the 2020 code. This proposal makes a correction.

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Committee: NEC-P04

Public Input No. 4204-NFPA 70-2020 [Section No. 690.31(B) [Excluding any Sub-Sections]]

PV system dc circuits ~~and Class 1 remote control, signaling, and power-limited circuits of a PV system~~ shall be permitted to occupy the same equipment wiring enclosure, cable, or raceway ~~. 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 the PV system dc circuits are separated from other circuits by a barrier or partition. PV system~~ with conductors of different systems where installed in accordance with 300.3(C). PV system circuit conductors shall be identified and grouped as required by 690.31(B)(1) and (B)(2).

~~*Exception: 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. All conductors, harnesses, or assemblies shall have an insulation rating equal to at least the maximum circuit voltage applied to any conductor within the enclosure, cable, or raceway.*~~

Statement of Problem and Substantiation for Public Input

PV systems, and the equipment utilized within them, have evolved significantly over the past 15 years. All major equipment used to build PV systems requires listings, most are specifically listed for use in PV systems. This is especially true for power conversion equipment used in PV systems. Per 300.3(C)(1), conductors of ac and dc circuits rated 1000V or less are allowed to occupy the same wiring enclosure, cable, or raceway, so long as insulation ratings are sufficiently rated. Additionally, there are important restrictions within 300.3(C) to prevent the mixing of other circuits such as those used for remote control, signaling, and communications. These same general rules in 300.3 should apply to conductors associated with PV systems. The previous text suggests there are different requirements within PV systems but is insufficient to clarify what they are. Leveraging the general rules in 300.3(C) is the best approach toward promoting consistent installations and enforcement within PV systems and where the wiring from PV systems must be connected to other systems. The exception is struck as this is unnecessary with this change.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate and their inclusion here is not necessarily an endorsement of all the PI's submitted.
Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain, P.E., SEIA; Bill Brooks, PVICC; John Berdner, PVICC, Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing, Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower; Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional

Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

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Committee: NEC-P04

Public Input No. 4514-NFPA 70-2020 [Section No. 690.31(B) [Excluding any Sub-Sections]]

PV system dc circuits and Class 1 remote control, signaling, and power-limited circuits of a PV system shall be permitted to occupy the same equipment wiring enclosure, cable, or raceway. 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 the PV system dc circuits are separated from other circuits by a barrier or partition. PV system circuit conductors shall be identified and grouped as required by 690.31(B)(1) and (B)(2).

Exception: PV system dc circuits utilizing multiconductor jacketed cable or metal-clad cable assemblies or flexible metal conduit 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. All conductors, harnesses, or assemblies shall have an insulation rating equal to at least the maximum circuit voltage applied to any conductor within the enclosure, cable, or raceway.

Statement of Problem and Substantiation for Public Input

Justification: For PV systems it is often difficult to keep circuits separated in accordance with NEC 690.31(B). The exception of 690.31(B) already allows for multiconductor jacketed cable, MC cable, and listed wiring harnesses. Installers are often complaining that these options are not always viable for an installation. Adding flexible metal conduit to the list of acceptable barriers will allow more flexibility and options for the installer. Flexible metal conduit would also be equivalent protection as MC cable or wiring harnesses, and certainly provides more protection than multiconductor jacketed cable.

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Committee: NEC-P04

Public Input No. 464-NFPA 70-2020 [Section No. 690.31(B) [Excluding any Sub-Sections]]

PV system dc circuits and Class 1 remote control, signaling, and power-limited circuits of a PV system shall be permitted to occupy the same equipment wiring enclosure, cable, or raceway. 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 the PV system dc circuits are separated from other circuits by a barrier or partition. PV system circuit conductors shall be identified and grouped as required by 690.31(B)(1) and (B)(2).

Exception No. 1 : 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. All conductors, harnesses, or assemblies shall have an insulation rating equal to at least the maximum circuit voltage applied to any conductor within the enclosure, cable, or raceway.

Exception No. 2: PV system dc circuits shall be permitted to occupy the same equipment wiring enclosure without a barrier or partition where the equipment is listed for the use.

Statement of Problem and Substantiation for Public Input

The listing process for inverters does permit ac, dc, and Article 725 circuits to occupy the same enclosure where the circuits have the proper spacing and separations. The proposed exception will provide clarity to AHJs that these circuits are permitted to be within the same equipment enclosure without physical barriers where proper spacing is maintained and the equipment is listed for the use in accordance with 110.3(B).

Submitter Information Verification

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Committee: NEC-P04

Public Input No. 1625-NFPA 70-2020 [Section No. 690.31(C)]

(C) Cables.

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

Informational Note 1 : See UL 4703, *Standard for Photovoltaic Wire*, for PV wire and UL 3003, *Distributed Generation Cables*, for DG cable.

Informational Note 2: PV wire and cable and DG cable have a nonstandard outer diameter. Table 1 of Chapter 9 contains the allowable percent of cross section of conduit and tubing for conductors and cables.

(1) Single-Conductor Cable.

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

(1) PV wire or cable

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

Exposed cables 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.

(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 1.4 m (4½ ft).

~~Informational Note: PV wire and cable and DG cable have a nonstandard outer diameter. Table 1 of Chapter 9 contains the allowable percent of cross section of conduit and tubing for conductors and cables.~~

(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.

Statement of Problem and Substantiation for Public Input

Please move the Informational Note from (2) to before (1) so that it applies to both (C)(1) and (C)(2).

Submitter Information Verification

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Submittal Date: Wed Jun 24 14:54:30 EDT 2020
Committee: NEC-P04

Public Input No. 2933-NFPA 70-2020 [Section No. 690.31(C)(1)]

(1) Single-Conductor Cable.

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

(1) PV wire or cable

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

Exposed cables shall be supported and secured at intervals not to exceed ~~600~~ 1400 mm (~~24~~ 54 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.

Statement of Problem and Substantiation for Public Input

These cables typically fall into the NM, SE, USE, or TC-ER rated type cable and this language over rides the allowed support spacing that the articles in Chapter 3 cover for those cable types and in doing so force unnecessary cost to be incurred to meet the 24" minimum support requirement. The 24" seems like an arbitrary distance with no justification as the sections for NM, USE, and TC-ER all allow for larger unsupported distances.

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Submittal Date: Thu Sep 03 10:55:50 EDT 2020
Committee: NEC-P04

Public Input No. 4616-NFPA 70-2020 [Section No. 690.31(C)(1)]

(1) Single-Conductor Cable.

Single conductors or 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:~~ Type PV wire.

~~(1) PV wire or cable~~

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

Exception: Single-conductor cable marked sunlight resistant and Type USE-2 and Type RHW-2 shall be permitted to replace existing USE-2 and RHW-2 conductors ~~,~~ in existing PV arrays , where installation, service and maintenance are only performed by qualified persons.

Exposed cables 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.

Statement of Problem and Substantiation for Public Input

Mechanical damage to exposed PV module and/or string wiring is known to have caused electrical faults. Electrical faults are a known cause of fires. PV wire is required to have 60 mils of insulation thickness, whereas USE-2/RHW-2 is 45 mils. This additional thickness is to compensate for the lack of mechanical protection typically given to an RHW-2 that is installed in a conduit or other raceway. In addition, PV wire is required to pass the vertical flame test, whereas USE-2/RHW-2 is required to pass the less severe horizontal flame test. PV wire is required to pass a cold bend at -40C, whereas USE-2/RHW-2 requires testing at -25C. Therefore, USE-2/RHW-2 is less robust than PV wire.

USE-2 wire was initially permitted for use in PV systems due to the lack of other options. Now that PV wire is readily available and in widespread use, and because mechanical damage is a known cause of electrical faults, it is prudent to restrict the use of USE-2/RHW-2 to installations where this wire type was already in place, and where the installation will be serviced and maintained by qualified persons.

Submitter Information Verification

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Committee: NEC-P04

Public Input No. 1754-NFPA 70-2020 [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 1.4 m (4½ ft).

Informational Note: PV wire and cable and DG cable have a nonstandard outer diameter. ~~Table 1 of Chapter 9 contains the allowable percent of cross section of conduit and tubing for conductors and cables.~~

Statement of Problem and Substantiation for Public Input

Chapter 9, Table 1 refers to conduit and tubing but not cable tray so it is not applicable here. The unnecessary text should be deleted to clarify the IN.

Submitter Information Verification

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Submittal Date: Fri Jun 26 12:05:20 EDT 2020
Committee: NEC-P04

Public Input No. 2932-NFPA 70-2020 [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 ~~1.4 m (4 1/2 ft~~ 1400 m (54 in.).

Informational Note: PV wire and cable and DG cable have a nonstandard outer diameter. Table 1 of Chapter 9 contains the allowable percent of cross section of conduit and tubing for conductors and cables.

Statement of Problem and Substantiation for Public Input

690.31(C)(1) states cable types and DG Cable is not listed there. Also dimension information should be consistently stated using the same units.

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Committee: NEC-P04

Public Input No. 4207-NFPA 70-2020 [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 1.4 m (4½ ft).

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

Where single-conductor PV wire smaller than 1/0 AWG is 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 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.

Informational Note: PV wire and cable and DG cable have a nonstandard outer diameter. Table 1 of Chapter 9 contains the allowable percent of cross section of conduit and tubing for conductors and cables.

Statement of Problem and Substantiation for Public Input

While 690.31(C)(2) has allowed the use of PV or DG cable in cable tray, Article 392 does not fully describe the requirements for cable sized smaller than 1/0 AWG. For example, 392.22(B)(1) only informs the designer of requirements for 1/0 AWG and larger for ladder or ventilated trough cable trays, which are now often used for PV systems. 392.20(D) notes that single conductors of 1/0 to 4/0 AWG shall be installed in a single layer, unless conductors are bound together to comprise a circuit group. Language from these two sections is included in this PI as newly-numbered items (1)-(3).
Additionally, 392.80(A)(2) imposes ampacity adjustment factors in various conductor configurations, and these rules are expanded here to also apply to smaller single conductors

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This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate and their inclusion here is not necessarily an endorsement of all the PI's submitted.
Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain, P.E., SEIA; Bill Brooks, PVICC; John Berdner, PVICC, Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing,

Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower; Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

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Committee: NEC-P04

Public Input No. 1863-NFPA 70-2020 [Section No. 690.31(D)]

(D) Direct-Current Circuits on or in Buildings.

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(10)(b) or 250.118(10)c) , or in metal enclosures.

Exception: PV hazard control systems 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 to the PV hazard control actuator.

Wiring methods on or in buildings shall comply with the additional installation requirements in 690.31(D)(1) and (D)(2).

(1) Flexible Wiring Methods.

Where flexible metal conduit (FMC) smaller than metric designator 21 (trade size ¾) or Type MC cable smaller than 25 mm (1 in.) in diameter containing PV power circuit conductors is installed across ceilings or floor joists, the raceway or cable shall be protected by substantial guard strips that are at least as high as the raceway or cable. Where run exposed, other than within 1.8 m (6 ft) of their connection to equipment, these wiring methods shall closely follow the building surface or be protected from physical damage by an approved means.

(2) Marking and Labeling Required.

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.

Statement of Problem and Substantiation for Public Input

Referencing 250.118(10) is too general since the metal sheath of Type MC cable in accordance with 250.118(10)(a) is not suitable as an effective ground-fault current path. But 250.118(10)(b) and 250.118(10)(c) is a suitable wiring method.

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Committee: NEC-P04

Public Input No. 4205-NFPA 70-2020 [Section No. 690.31(D)]

(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(10) , or in metal enclosures.

Exception: PV hazard control systems 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 to the PV hazard control actuator.

~~Wiring methods on or in buildings shall comply with the additional installation requirements in 690.31~~

(

~~D)(1) and (D)(~~

2)

.

~~(1) (2)~~

–

~~Flexible Wiring Methods.~~

~~Where flexible metal conduit (FMC) smaller than metric designator 21 (trade size~~ **3** ⁄ **4** ~~) or Type MC cable smaller than 25 mm (1 in.) in diameter containing PV power circuit conductors is installed across ceilings or floor joists, the raceway or cable shall be protected by substantial guard strips that are at least as high as the raceway or cable. Where run exposed, other than within 1.8 m (6 ft) of their connection to equipment, these wiring methods shall closely follow the building surface or be protected from physical damage by an approved means.~~

~~Marking and Labeling~~

~~Required~~

.

~~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 (~~ **3** ⁄ **8** ~~ 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.~~

Additional Proposed Changes

File Name	Description	Approved
690.31_D_correct_text.pdf	Correct text changes	

Statement of Problem and Substantiation for Public Input

Rapid shutdown requirements in 690.12 control conductors located within buildings during firefighting events. The 2020 690.31(D)(1) requirements addressing the location of certain wiring methods predated the implementation of, and are rendered unnecessary by the rapid shutdown requirements in 690.12. The same requirements for these wiring methods that exist for all other applications are sufficient as described in Articles 330 and 348. 690.31(C)(3) exists to define wiring methods not already defined in Chapter 3, but Chapter 3 wiring methods are sufficient to ensure safe installation of these “flexible wiring methods.”
With the deletion of 690.31(D)(1) text, the section is better structured by moving the original (D) language into a re-titled (D)(1) and (D)(2) remains unchanged except for removing the superfluous “Required” from the title.

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This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
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Submittal Date: Thu Sep 10 05:43:55 EDT 2020
Committee: NEC-P04

Legislative Text:

690.31(D) Direct-Current Circuits on or in Buildings.
~~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(10), or in metal enclosures.~~

~~*Exception: PV hazard control systems 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 to the PV hazard control actuator.*~~

Wiring methods on or in buildings shall comply with the ~~additional~~ installation requirements in 690.31(D)(1) and (D)(2).

690.31(D)(1) ~~Flexible Wiring Methods~~. Metal Raceways and Enclosures.
~~Where flexible metal conduit (FMC) smaller than metric designator 21 (trade size 3/4) or Type MC cable smaller than 25 mm (1 in.) in diameter containing PV power circuit conductors is installed across ceilings or floor joists, the raceway or cable shall be protected by substantial guard strips that are at least as high as the raceway or cable. Where run exposed, other than within 1.8 m (6 ft) of their connection to equipment, these wiring methods shall closely follow the building surface or be protected from physical damage by an approved means.~~
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(10), or in metal enclosures.
Exception: PV hazard control systems 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 to the PV hazard control actuator.

690.31(D)(2) Marking and Labeling ~~Required~~.
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 (3/8 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.

Clean Text:

690.31(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).

690.31(D)(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(10), or in metal enclosures.
Exception: PV hazard control systems 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 to the PV hazard control actuator.

690.31(D)(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 (3⁄8 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.

Public Input No. 3588-NFPA 70-2020 [Section No. 690.31(D)(2)]

(2) Marking and Labeling Required.

(a) 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.

(b) Building integrated PV systems installed as the roof covering shall have markings to identify any areas with electrical hazards hidden from view. Marking shall be reflective and visible from grade.

Statement of Problem and Substantiation for Public Input

This PI is one of three submitted on behalf of the NFPA 1/ NEC PV Joint Task Group. The Task Group is comprised of Ken Bush – NFPA 1 (Technical Committee Chair), Shane Clary – NFPA 1, Rebekah Hren – NEC Panel 4, Bruce Johnson – NFPA 1 (Task Group Chair) and Jim Rogers – NEC Panel 4 Chair. Three consensus proposals are being submitted by the Task Group with the purpose of fully harmonizing the PV system and power source labeling and marking requirements of the NEC with those of the Fire Code. Slight variations that have existed in color, formatting, and marking language requirements between the Fire Code and the NEC have made it unnecessarily difficult for enforcement and inspections agencies to align. As an example, the requirement for a yellow background on the Rapid Shutdown label in the NEC as compared to a red background in NFPA 1 could result in a jurisdiction requiring two labels serving the same purpose, though by their dual presence possibly causing confusion. Clearly this is not practical or desirable and the Codes should be harmonized. This PI specifically aligns the requirement for BIPV marking as required in NFPA 1 11.12.2.1.6.1 and 11.12.2.1.6.2.

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Committee: NEC-P04

Public Input No. 4490-NFPA 70-2020 [Section No. 690.31(D) [Excluding any Sub-Sections]]

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(10), or in metal enclosures.

Exception: PV systems with only listed class 2 limited power output circuits using 4-pair communications cables in accordnce with 725.154(A) shall comply with 725.144.

Exception: PV hazard control systems 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 to the PV hazard control actuator.

Wiring methods on or in buildings shall comply with the additional installation requirements in 690.31(D)(1) and (D)(2).

Statement of Problem and Substantiation for Public Input

Inside window film surfaces using limited power circuits should not apply to this requirement. By definition, these listed devices installed in accordance with article 725 are already safe.

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Committee: NEC-P04

Public Input No. 4206-NFPA 70-2020 [New Section after 690.31(F)]

690.31(G) Over 1000V 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 suitable for use in PV systems, equipment containing PV system dc circuits with a maximum voltage no greater than 1500 volts shall not be required to comply with Parts II and III of Article 490.

(4) 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 a distance of 10 m (33 ft) along the building surface from the equipment.

(5) Where accessible to unqualified persons, the installation shall comply with 110.31(C)(1) and 110.31(D).

Statement of Problem and Substantiation for Public Input

The industry trend of 1500 Vdc ground-mounted arrays located near buildings creates a need to clarify Code language around wiring from different types of arrays interfacing with buildings. This proposal adds a new subsection to 690.31 to specify equipment and wiring methods of PV system circuits above 1000 Vdc. Items 1, 2, and 3 incorporate language moved from 690.7. 690.31 is a more relevant section than 690.7 for specifications of equipment over 1000 volts, since 690.31 concerns wiring methods and equipment requirements. Items 4 and 5 are introduced to provide limitations for equipment and wiring methods >1000 Vdc that are mounted on the exterior wall of a building.
Currently, it is permitted to install >1000 Vdc equipment mere inches from a building, yet it is not permitted to install >1000 Vdc equipment on the exterior wall of a building. Since the equipment is located outside in open air rather than enclosed, there is much less risk than that of PV arrays on a roof with circuits entwined with the building envelope and circuits inside a building. This proposal would allow, with certain limitations, inverters and associated dc equipment from a ground-mounted 1500Vdc array to be mounted on the outside wall of a building that is not a one- or two- family dwelling. Specific limitations include that the conductors shall be installed within several feet above grade to prevent the installation of overhead conductors; inaccessibility of equipment to unqualified persons (referencing 110.31); and limiting the extent of wiring and equipment that can be attached to the outside of the building. At the same time, PV arrays installed on a rooftop or integrated in a building and any PV system dc circuits inside a building would remain limited to 600Vdc for one- or two- family dwellings and 1000Vdc for other buildings.

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This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.

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Submittal Date: Thu Sep 10 05:51:32 EDT 2020
Committee: NEC-P04

Public Input No. 4208-NFPA 70-2020 [Section No. 690.33(C)]

(C) Type.

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

Informational Note: Information on tool requirements and intermatability can be found in the manufacturer's assembly instructions, in the required certification labeling on the product, or directly from the listing agency.

Statement of Problem and Substantiation for Public Input

The term intermatability is defined in the certification standard UL6703. Many products claim to have that capability, but fall short of meeting the requirements outlined in the standard. The UL6703 standard also outlines how a product complies with requiring a tool. Some AHJs and independent engineers have questioned products as not requiring a tool because they are able to open the connector with their fingers. The criteria for needing a tool is covered by UL6703 and not by ability of some people who are capable of opening a connector without a tool.

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Public Input No. 917-NFPA 70-2020 [Section No. 690.41]

690.41 ~~.~~ 41 PV System DC Circuit Grounding and Protection .

(A) PV System DC Circuit Grounding Configurations.

~~One or more~~ For each PV system dc circuit in a PV system, one of the following ~~system~~ grounding configurations shall be employed:

(1) 2-wire PV ~~arrays~~ system dc circuits with one functionally grounded conductor

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

(3) PV ~~arrays~~ system dc circuits not isolated from the grounded inverter output circuit

(4) Ungrounded PV
~~arrays~~

(5) system dc circuits

(6) Solidly grounded PV ~~arrays~~ system dc circuits as permitted in 690.41(B)

(7) PV ~~systems that use other methods that accomplish equivalent system protection in accordance with~~ 250.4(A) ~~with~~ system dc circuits protected by equipment listed and identified for the use

(B) Ground-Fault Protection.

PV system dc circuits that exceed 30 volts or 8 amperes shall be provided with dc ground-fault 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 ground-fault protection.

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

(1) Ground-Fault Detection.

The ground-fault protection device or system shall detect ground fault(s) in the PV system dc ~~circuit conductors~~ circuits , including any ~~functional~~ functionally grounded conductors, and be listed for providing PV ground-fault protection. For dc-to-dc converters not listed as providing ground-fault protection, where required, listed ground fault protection equipment identified for the combination of the dc-to-dc converter and ground-fault protection device shall be installed to protect the circuit.

Informational Note: Some dc-to-dc converters without integral ground-fault protection on their input (source) side can prevent other ground-fault 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 ground-fault 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~~ circuits .

(3) Indication of Faults.

Ground-fault 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

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

This section is modified to focused on DC circuit grounding. This is necessary as there may be multiple DC circuits requiring grounding in a PV system and there is no requirement that all dc circuits utilize the same circuit grounding configuration.

The terms Array and circuit conductors are inadequate to describe what requires grounding or is impacted by this section. These terms and various part of this section was reworded to reflect PV system dc circuits which is a defined term.

Note that there should only be 6 options and Terra has apparently made modifications. Item (4) should read “Ungrounded PV system dc circuits”.

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Committee: NEC-P04

Public Input No. 3799-NFPA 70-2020 [Section No. 690.41(B)(1)]

(1) Ground-Fault Detection.

The ground-fault protection device or system shall detect ground fault(s) in the PV system dc circuit conductors, including any ~~functional~~ functionally grounded conductors, and be listed for providing PV ground-fault protection. For dc-to-dc converters not listed as providing ground-fault protection, where required, listed ground fault protection equipment identified for the combination of the dc-to-dc converter and ground-fault protection device shall be installed to protect the circuit.

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

Statement of Problem and Substantiation for Public Input

The term "functional" in the phrase "functional grounded conductors" needs to be replaced with "functionally" to be consistent with changes made in the 2020 code referring to functionally grounded systems.

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Public Input No. 4347-NFPA 70-2020 [Section No. 690.41(B) [Excluding any Sub-Sections]]

PV system dc circuits that exceed 30 volts or 8 amperes shall be provided with dc ground-fault 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 ground-fault protection.

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

Statement of Problem and Substantiation for Public Input

Informational notes are for providing information. While most people in the electrical industry are familiar with a ground-fault circuit interrupter (GFCI), I do not think that most folks are as familiar with a ground-fault detector interrupter (GFDI) device. We can't assume that everyone knows what we know. I have personally been ask in the seminar/webinar setting if this "GFDI" reference is a clerical error in the NEC.

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Public Input No. 3801-NFPA 70-2020 [Section No. 690.42]

690.42 Point of System Grounding Connection.

Systems with a ground-fault protective device in accordance with 690.41(B) shall have any current-carrying conductor-to-ground connection made by the ground-fault protective device. For solidly grounded PV systems, the dc circuit grounding connection shall be made at any single point on the PV ~~output~~ system dc circuit(s) .

Statement of Problem and Substantiation for Public Input

This proposed change addresses and aligns with the related proposal to remove the terms “PV output circuits” and “dc to dc converter output circuits” from Article 690. Accordingly, the PI replaces the term “PV output circuit” with “PV system dc circuit(s).” The addition of the optional plural “(s)” reflects the fact that solidly grounded systems may have up to two strings. The use of “circuit(s)” clarifies that there should be only a single ground connection for the system dc circuit(s), regardless of whether there is one dc circuit or two parallel connected dc circuits.

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Public Input No. 918-NFPA 70-2020 [Section No. 690.42]

690.42 Point of PV System DC Circuit Grounding Connection.

~~Systems with~~ **(A) Circuits with Ground-Fault Protection**

Circuits protected by a ground-fault protective device in accordance with 690.41(B) shall have any ~~current~~ circuit ~~-carrying conductor-~~ to-ground connection made by the ground-fault protective device.

(B) Solidly Grounded Circuits

For solidly grounded PV ~~systems~~ system dc circuits , the ~~dc circuit~~ grounding connection shall be made ~~at~~ from any single point on the PV ~~output circuit~~ system dc circuit to a point on the grounding electrode system .

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).
The title of 690.42 is changed adding “PV System DC Circuit” which is a defined term and will add clarity to what this section is impacting. The title is more specific.
This section is now separated into two first level subdivisions (A) and (B) focusing on Circuits with ground-fault protection and solidly grounded circuits respectively. This distinction adds clarity to this section on grounding as these are the two methods used for PV systems and are different in how they are grounded. Separating these into two separate first level subdivision aligns with guidance from the style manual as this section included two separate requirements.

New first level subdivision (A) focuses on the more common application of functionally grounded systems which are grounded through Ground-Fault protection.
New first level subdivision (B) focuses on solidly grounded circuits which are grounded differently than those in (A) of this section. This section points out that the grounding connection can be made to any point on the grounding electrode system which aligns with similar guidance / requirements found in Article 250.

The focus on this section has be aligned with PV system dc circuits for clarity throughout.

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Public Input No. 1378-NFPA 70-2020 [Section No. 690.43]

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. Devices that mount adjacent PV modules shall be permitted to bond adjacent PV modules.

(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.

(C) With Circuit Conductors.

Equipment grounding conductors for the PV array and metal support structure where installed shall be contained within the same raceway or cable or otherwise run with the PV system conductors where those circuit conductors leave the vicinity of the PV array.

(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.

Statement of Problem and Substantiation for Public Input

Just some suggested 'editorial' edits.

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Public Input No. 3806-NFPA 70-2020 [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. ~~Devices that mount adjacent PV modules shall be permitted to bond adjacent PV modules~~

I nformational note: Some listed equipment including but not limited to PV module mounting systems, PV module clamping devices, and devices for bonding PV module frames, are evaluated for mounting and/or bonding individual or adjacent PV modules. 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 for solar trackers. Manufacturer's instructions for equipment listed to these standards identify PV modules and equipment that have been evaluated for compatibility .

Statement of Problem and Substantiation for Public Input

This input is intended to address two separate issues. First, the 2nd sentence of the clause is unnecessary because the product listing described in the first sentence will define relevant uses for the devices and whether a device has been evaluated for the purpose of bonding adjacent PV modules. It is important to understand that the intent of deleting the sentence is not to suggest that devices should no longer be permitted to bond adjacent modules, just that the proper source for such distinctions should be in the product listings and not the code. The proposed Informational note adds additional contextual information about the listings and further makes the sentence unnecessary.
Second, the new informational note is proposed to help reduce confusion about how listings are applied to mounting/ grounding components, and how they are identified for compatibility with other modules and components. Currently these are applied inconsistently in the field leading to installation of inadequately evaluated parts. Specifically, mounting or bonding devices that have been listed (e.g. to UL 2703) identify in their installation instructions modules or other components with which they are tested for compatibility. They are not universally applicable. This informational note should hopefully provide better guidance to installers and AHJs to ensure that compatibility is verified.

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Committee: NEC-P04

Public Input No. 2635-NFPA 70-2020 [Section No. 690.43(C)]

(C) With Circuit Conductors.

Equipment grounding conductors for the PV array and support structure where installed shall be contained within the same raceway or cable or otherwise run with the PV system conductors where those circuit conductors leave the vicinity of the PV array.

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 input is being submitted on behalf of the Minnesota Department of Labor and Industry. The Department's 15 office/field staff, and 65 plus contract electrical inspectors complete over 150,000 electrical inspections annually and are involved in the daily enforcement and interpretation of the National Electrical Code.
It is very important that the effective ground fault path required in NEC section 690.43 always be present. The same concerns that exist for rooftop air-conditioning and refrigerating equipment exist for rooftop PV installations. The language from section 440.9 was used to make sure that if compression fittings are used in rooftop PV installations that a wire type equipment grounding conductor be installed in the conduit.

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Public Input No. 3808-NFPA 70-2020 [Section No. 690.43(C)]

(C) ~~With Circuit Conductors~~ Location .

Equipment grounding conductors ~~for the PV array and support structure where installed shall be contained within the same raceway or cable or otherwise run with~~ shall be permitted to be run separately from the PV system conductors ~~where those circuit~~ within the PV array. Where PV system conductors leave the vicinity of the PV array, equipment grounding conductors shall comply with 250 .134.

Statement of Problem and Substantiation for Public Input

The existing language of 690.43(C) is derived in part from 250.134, and its purpose is generally understood to state that equipment ground conductors, often not run with PV system conductors within the array, should do so once in raceways between the array and utilization equipment in other locations. However, the specific language has led to overly strict interpretation, particularly in the wiring transitions between above and below ground circuits in ground-mount system. In those instances, ground conductors are not run “with” circuit conductors until after the transition to underground, even though that transition could strictly be interpreted as having left the “vicinity of the array.” The language is also interpreted by some AHJs to override the allowance in 250.134 for ground conductors to be run separately from circuit conductors in dc circuits.

The proposed text changes achieve the following:
- Makes explicit that equipment grounding conductors may be run separately within the array
- Clarifies that where conductors leave the vicinity of the array, the EGCs shall comply with 250.134, rather than re-stating similar text.
- Prevents over-strict interpretation for wiring transitions because 250.134 appropriately allows for EGCs to be run separately from circuit conductors in dc circuits.

Changes the title of the clause to “Location” as it is no longer specific to EGCs run with circuit conductors.

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Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain, P.E., SEIA; Bill Brooks, PVICC; John Berdner, PVICC, Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing, Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower; Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John

Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Ben Chamberlain, Olivewood Energy; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

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Public Input No. 2636-NFPA 70-2020 [Section No. 690.45]

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.~~

Statement of Problem and Substantiation for Public Input

This input is being submitted on behalf of the Minnesota Department of Labor and Industry. The Department's 15 office/field staff, and 65 plus contract electrical inspectors complete over 150,000 electrical inspections annually and are involved in the daily enforcement and interpretation of the National Electrical Code.
Deletion of the wording in the 2020 NEC will assure that an equipment grounding conductor maintains a low impedance effective ground fault path to assure proper operation of overcurrent devices and ground fault detectors.

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Public Input No. 1379-NFPA 70-2020 [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 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~~ in accordance with Part VII of Article 250, 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) Auxiliary Grounding ~~Electrodes and Grounding~~ Electrode ~~Conductors~~ .

~~Additional grounding electrodes shall be permitted to be installed~~ Auxiliary grounding electrode(s) 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.~~ PV systems covered by this article.

Statement of Problem and Substantiation for Public Input

My edits to (A) were to streamline the requirements so that the rule focused on “grounding” and not the “equipment grounding conductor.” I revised (B) to reflect similar text used for Signs [600.7(A)(4)] relating to the use of an auxiliary electrode.

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Committee: NEC-P04

Public Input No. 3811-NFPA 70-2020 [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 ~~Part III of Article 250.~~ 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.

Grounding electrodes in accordance with Part III of Article 250 shall be utilized for PV systems. Support structures consisting of at least one bare or electrically conductive coated iron or steel structural member that exposes not less than 0.186 m2 (2 ft2) of surface to exterior soil below a depth of 30” shall be permitted to meet the requirements of an electrode for grounding in 250.52(A). Where a portion of the support structure is utilized as the electrode, the grounding electrode conductor shall connect to the structural member acting as an electrode.

Additional grounding electrodes shall be permitted to be installed and connected to the equipment grounding conductor in accordance with ~~250.52 and 250.~~ 2 50. 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 to connect to the electrode if the requirements of 250.68(C)(2) are met.

If multiple structural member electrodes are present at a building or structure, it shall be permissible to bond only one compliant structural member into the grounding electrode system.

Additional Proposed Changes

File Name	Description	Approved
690.47_images.pdf	Supporting images.	

Statement of Problem and Substantiation for Public Input

The purpose of this public input is to create an explicit allowance for structural piers commonly used in

ground-mounted PV systems to be used as grounding electrodes. Currently, structural steel members driven to depths greater than 3 feet but less than 10 feet do not meet the requirements of 250.52(A)(2) and yet are perfectly substantial electrodes.

The proposed language changes the opening sentence of 690.47(A) to replace a broad reference to article 250 with a simple reference to 690.47(B), which is expanded in this proposal to clarify the use of structural members and piers as grounding electrodes.

The term “structures” has a basic definition in the NEC and can be as simple as a metal pole. Many ground-mounted PV support structures in the industry today are comprised of multiple metal support piles, typically embedded 6 ft into the earth. In large scale systems, these structures contain hundreds of support piles with at least 6 ft of direct contact with earth. Currently, 250.52(A)(5) allows rod and pipe electrodes to be considered as a grounding electrode system with a surface area of 2 ft2. Grounding electrodes specified by 250.52(A)(7) for plate electrodes have a similar surface area. Many ground-mounted PV support structures meet this minimum surface area and yet are not explicitly allowed.

Thickness of the electrode was excluded as part of this proposal. While 250.52(A)(7) for plate electrodes specifies a ¼” thickness, 250.52(A)(5) for rod and pipe electrodes do not specify a thickness requirement. The ¼” thickness for plate electrodes is understood to account for a worst-case scenario when no background information of site-specific soil corrosive properties is available. However, structural piles in ground-mounted PV arrays are designed for site-specific soil properties. PV structural pile design involves engineering oversight and accounts for expansive and corrosive soils, frost heave, wind, temperature cycles and other geotechnical factors. As such, the structural piles would be designed to remain intact for the life of the project.

Furthermore, PV structural piles are thicker than rod and pipe electrode requirements and the surface area of typical PV piles comfortably exceed the 2 ft2 requirement. 250.52(A)(5) for rod and pipe electrodes specifies at least trade size ¾ (thickness 0.107”), while PV system structural piles are typically at least 0.125” thick. The surface area of a typical pile is calculated to be 2.29 ft2 per foot length. Given that most piles are embedded at least 6 ft, the surface area of the piles well exceed the required surface area below a buried depth of 30”. Examples of typical piles are shown in the photos below.

The minimum buried depth specification of 30” follows 250.53(A)(4) and (5).
An additional sentence is added at the end of the clause to make it clear that a PV system could have 1000 steel piles that meet the minimum depth and surface area requirements and that those additional 999 steel piles need not be bonded together as a grounding electrode system. They merely need to be bonded to the equipment grounding conductor as required in 250.54.

Lastly, the phrase “to connect to the electrode” was added to the last sentence of the existing language to make it clearer that it is the building that is being used as the conductor to connect to the actual electrode.

Please see attachment for reference images.

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CAT

Public Input No. 2791-NFPA 70-2020 [New Section after 690.51]

TITLE OF NEW CONTENT

690.52 **Building Integrated Photovoltaic (BIPV) Systems.** Where building integrated photovoltaic **(BIPV)** systems are installed in a manner that creates areas with electrical hazards to be hidden from view, the installer must clearly mark the hazardous areas to avoid. The hazardous areas shall be marked with the wording PV POWER HAZARD AREA by means of permanently affixed labels or other approved permanent markings. The labels shall be visible from grade after installation. All letters shall be capitalized and shall be a minimum height of 9.5 mm (3/8 in.) in white on a red background. Labels shall be reflective and appear on every hazardous area. Spacing between labels shall not be more than 3m (10 ft). Labels required by this section shall be suitable for the environment where they are installed.

Exception: Where the entire hazardous area is clearly visible as a single demarcated area from grade, only one label is required to be visible for each visible (from grade) compass direction. **BIPV** systems listed in accordance with Section 690.12(B)(2) of NFPA 70, where the removal or cutting away of portions of the **BIPV** system during firefighting operations have been determined to not expose a firefighter to electrical shock hazards.

Statement of Problem and Substantiation for Public Input

This code is being considered for Section 1205.2.3 of the 2021 IFC International Fire Code. We think the demand for this marking may be low as most BIPV system manufacturers will probably want to follow the exception to avoid the marking. They are also attempting to improve the language for the 2024 I-codes. Similar language will also appear in the 2021 IRC and in the 2021 NFPA1 Fire Code. We should adopt this in order to stay consistent with the other groups.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2792-NFPA 70-2020 [New Definition after Definition: Battery System.]	

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Public Input No. 2414-NFPA 70-2020 [Section No. 690.51]

690.51 Modules and AC Modules.

Modules and ac modules shall be lsited and marked in accordance with their listing.

Statement of Problem and Substantiation for Public Input

1) There appears to be an inference that is not yet explicitly stated; that AC modules and modules are NRTL Listed, but no such requirement is stated.
2) There is an apparent lack of consistency; in that of all PV equipment that may be NRTL Listed, only Modules and AC Modules shall be marked in accordance with said listing. Perhaps more of this type of "listing and marking" requirement would be prudent to add to other PV equipment categories of 690.
3) The group "modules and AC modules" is inferred to not be somewhat redundant, but rather are two distinct categories with their own definitions. The terms themselves (module vs AC module are may benefit from improved clarity in their independent distinctions.

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Public Input No. 3686-NFPA 70-2020 [Section No. 690.51]

~~**690.51** Modules and AC Modules.~~

~~Modules and ac modules shall be marked in accordance with their listing.~~

Statement of Problem and Substantiation for Public Input

To increase usability of the NEC, the enforcement requirements for marking of modules and ac modules should be found in one section, and 690.4 generally covers equipment listing requirements for PV systems, including ac modules. Previously, these related requirements for ac modules were found in Sections 690.4 and 690.51.
This change is part of a larger initiative to group applicable but dispersed information into fewer, but more comprehensive, sections.

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Related Public Inputs for This Document

Related Input	Relationship

Public Input No. 3684-NFPA 70-2020 [Section No. 690.4(B)]	This language is moved to 690.4
Public Input No. 3684-NFPA 70-2020 [Section No. 690.4(B)]	

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Public Input No. 3693-NFPA 70-2020 [Section No. 690.53]

690.~~53~~ 7(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

Statement of Problem and Substantiation for Public Input

To increase usability, the enforcement requirements for maximum PV system voltage should be in one section.
This change is part of a larger initiative to group applicable but dispersed information into fewer, but more comprehensive, sections.
In particular, marking and labeling requirements have historically been either interspersed through the Article or in the non-comprehensive Part VI. Marking. In lieu of Part VI never containing all of the marking requirements, the proposal is to group specific requirements in their applicable Sections wherever feasible.

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Public Input No. 2415-NFPA 70-2020 [Section No. 690.54]

690.54 Interactive System Point of Interconnection.

All interactive system(s) points of interconnection with other sources shall be marked ~~at an accessible location at the disconnecting means as a power source and~~ with the rated ac output current and the nominal operating ac ~~voltage.~~ voltage at the disconnecting means which serves as the source input from the interactive system. The disconnect means shall be at an accessible location.

Statement of Problem and Substantiation for Public Input

The intent warrants clarification by parsing the criterion into separate sentences, rather than using one sentence for all of it. As one example; the statement "...sources shall be marked at an accessible location..." could be interpreted multiple ways.

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Public Input No. 3795-NFPA 70-2020 [Section No. 690.54]

~~**690.54** Interactive System Point of Interconnection.~~

~~All interactive system(s) points of interconnection with other sources shall be marked at an accessible location at the disconnecting means as a power source and with the rated ac output current and the nominal operating ac voltage.~~

Statement of Problem and Substantiation for Public Input

This PI is submitted in conjunction with the related PI to move the marking requirement now located in 690.54 to a more appropriate location in 705.14. Because this requirement is not specific to PV systems but instead is a more general requirement for labeling an interactive point of interconnection to other sources, it belongs in Article 705. The intent of this PI is not to change the marking requirement – which will still apply to interconnected PV systems – but rather to insure that it is applied across the board to all interconnected power sources.

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Public Input No. 3698-NFPA 70-2020 [Section No. 690.55]

~~**690.55** Photovoltaic Systems Connected to Energy Storage Systems.~~

~~The PV system output circuit conductors shall be marked to indicate the polarity where connected to energy storage systems.~~

Statement of Problem and Substantiation for Public Input

The provisions for marking polarity on PV system dc circuit conductors are adequately addressed in Section 690.31(B)(1), and in many cases the connection between PV and ESS occurs on the ac side, in which case polarity as specified in 690.55 and 690.31(B)(1) are not relevant and other requirements and conventions apply.
Additionally, Article 706 has requirements for marking ESS disconnecting means [706.15(C)], directories of power sources (706.21), and connection to other sources (706.16), which refers to Articles 705, 710, and 712, including the marking and directory requirements therein.
Together, these requirements make a specific call out for the marking of a connection between PV and energy storage systems unnecessary.

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Public Input No. 2995-NFPA 70-2020 [Section No. 690.56]

690.56 Identification of Power Sources.

(A) Facilities with ~~Stand-Alone Systems~~ Other Sources .

Plaques or directories shall be installed in accordance with ~~710~~ 689 .10.

~~**(C)**~~

(B) ~~Facilities with Utility Services and Photovoltaic Systems.~~

~~Plaques or directories shall be installed in accordance with 705.10 and 712.10 , as required.~~

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.

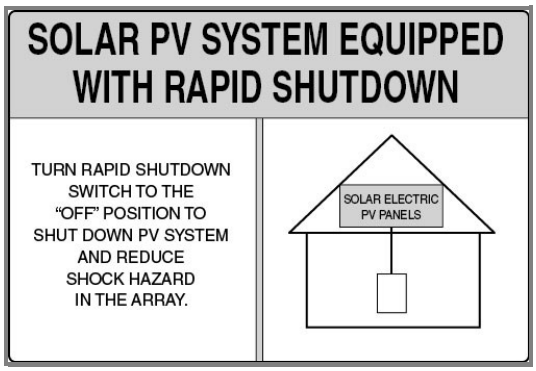
TURN RAPID SHUTDOWN SWITCH TO THE "OFF" POSITION TO SHUT DOWN

PV SYSTEM AND REDUCE SHOCK HAZARD IN ARRAY.

The title "SOLAR PV SYSTEM IS EQUIPPED WITH RAPID SHUTDOWN" shall utilize capitalized characters with a minimum height of 9.5 mm (⅜ in.) in black on yellow background, and the remaining characters shall be capitalized with a minimum height of 4.8 mm (³⁄₁₆ in.) in black on white background.

Informational Note: See Informational Note Figure 690.56(C).

Figure Informational Note Figure 690.56(C) 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.

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

This modification is necessary as 710, 712 and 689 are combined as part of this task group effort into a new Article 689. The proper reference for plaques and directories is found in 689.10 only. In addition, this section was simplified as only one reference section exists. Changes simplify and add clarity.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2535-NFPA 70-2020 [Section No. 705.10]	
Public Input No. 2692-NFPA 70-2020 [Article 705]	

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Public Input No. 3572-NFPA 70-2020 [Section No. 690.56(C)]

(C) 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.

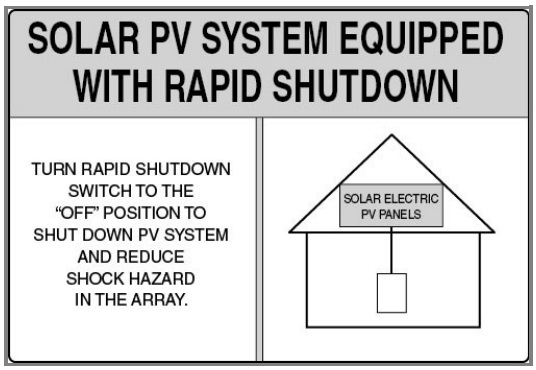
TURN RAPID SHUTDOWN SWITCH TO THE "OFF" POSITION TO SHUT DOWN

PV SYSTEM AND REDUCE SHOCK HAZARD IN ARRAY.

The ~~title "SOLAR PV SYSTEM IS EQUIPPED WITH RAPID SHUTDOWN" shall utilize capitalized characters with~~ label shall be reflective, with all letters capitalized and having a minimum height of 9.5 mm (⅜ in.) in ~~black on yellow background, and the remaining characters shall be capitalized with a minimum height of 4.8 mm (3⁄16 in.) in black on white~~ white on a red background.

Informational Note: See Informational Note Figure 690.56(C).

Figure Informational Note Figure 690.56(C) 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.

Statement of Problem and Substantiation for Public Input

This PI is one of three submitted on behalf of the NFPA 1/ NEC PV Joint Task Group. The Task Group is comprised of Ken Bush – NFPA 1 (Technical Committee Chair), Shane Clary – NFPA 1, Rebekah Hren – NEC Panel 4, Bruce Johnson – NFPA 1 (Task Group Chair) and Jim Rogers – NEC Panel 4 Chair. The three consensus proposals are being submitted by the Task Group with the purpose of fully harmonizing the PV system and power source labeling and marking requirements of the NEC with those of the Fire Code. Slight variations that have existed in color, formatting, and marking language requirements between the Fire Code and the NEC have made it unnecessarily difficult for enforcement and inspections agencies to align. As an example, the requirement for a yellow background on the Rapid Shutdown label in the NEC as compared to a red background in NFPA 1 could result in a jurisdiction requiring two labels serving the same purpose, though by their dual presence possibly causing confusion. Clearly this is not practical or desirable and the Codes should be harmonized. This PI specifically aligns Rapid Shutdown label reflectivity, font height, and red-on-white background color requirements in NFPA 1 11.12.2.1.1.2 with the NEC.

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Public Input No. 3696-NFPA 70-2020 [Section No. 690.56(C)]

690.12 (~~C~~ E) – Marking for 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 utilize capitalized characters with a minimum height of 9.5 mm (⅜ in.) in black on yellow background, and the remaining characters shall be capitalized with a minimum height of 4.8 mm (3⁄16 in.) in black on white background.

Informational Note

~~: See Informational Note~~

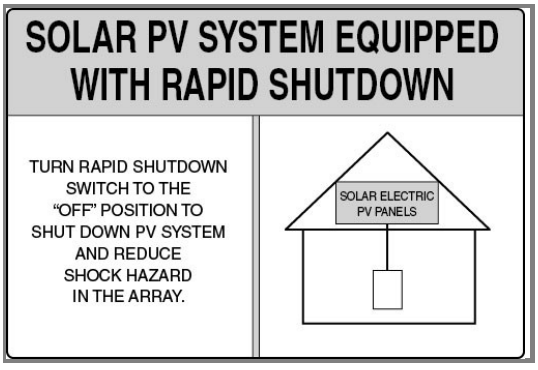
Figure 690.

~~56~~

12 (

~~C).~~

~~**Figure Informational Note Figure 690.56(C) E) 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.

Statement of Problem and Substantiation for Public Input

To increase usability, the enforcement requirements for rapid shutdown should be located together in one section. This PI is not intended to change any intent of this Code requirement, it is simply merely moving the location of the existing language so labeling is co-located with other rapid shutdown requirements. This change is part of a larger initiative to group applicable but dispersed information into fewer, but more comprehensive, sections.
In particular, marking and labeling requirements have historically been either interspersed through the Article or in the non-comprehensive Part VI. Marking. In lieu of Part VI never containing all of the marking requirements, the proposal is to group specific requirements in their applicable sections wherever feasible.

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Public Input No. 2996-NFPA 70-2020 [Section No. 690.59]

~~**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 and Article 712 .~~

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

This text is not necessary and the existing language violates the style manual. This is a reference to another Article and is not required and so is being deleted.

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Public Input No. 2997-NFPA 70-2020 [Section No. 690.71]

~~**690.71** General.~~

~~An energy storage system connected to a PV system shall be installed in accordance with Article 706 .~~

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

This Section violates the style manual and is not necessary. The realignment of alternative energy system articles will raise the awareness on all pertinent requirements in the NEC such that this type of reference is no longer necessary.

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Public Input No. 4334-NFPA 70-2020 [Section No. 690.71]

~~**690.71** General.~~

~~An energy storage system connected to a PV system shall be installed in accordance with Article 706.~~

Statement of Problem and Substantiation for Public Input

This language was added when Article 706 was new but since this is the third cycle for this article, this pointer is no longer needed. Additionally, it is not accurate or complete since Article 705 would also apply, along with potentially other articles.

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Committee:	NEC-P04

Public Input No. 776-NFPA 70-2020 [New Section after 690.72]

TITLE OF NEW CONTENT

Type your content here ...

Part IX Electromagnetic Pulse (EMP) Protection

690.74 Electromagnetic Pulse (EMP) Protection. Protection for solar photovoltaic (PV) systems against the effects of electromagnetic pulses shall be provided at a minimum of Level 2. See 709.7 for levels of electromagnetic pulse protection.

Exception: The requirements of 709.7(A)(5) and 709.7(B)(3) shall not apply.

This requirement shall become effective January 1, 2026.

Statement of Problem and Substantiation for Public Input

A devastating electromagnetic pulse (EMP), caused by a sun-spot or a nuclear bomb exploded high in the atmosphere, can impress 50,000 volts per meter on unprotected electrical and electronic equipment. It is similar to a radio wave impressing a very small voltage on a radio antenna, only orders of magnitude larger. The problem is that a significant EMP will fry every electrical/electronic component or piece of equipment that is not protected.

The EMP won't directly harm or injure people, but because there is no longer a working electrical infrastructure, which may take years to repair/rebuild, people will die from the lack of clean water, medicine, food, fuel, and eventual rioting due to the breakdown of society. Unclassified studies, referenced at the end of this substantiation, have estimated from 66% to 90% of the US population will die within one year if a significant sun spot were to occur or if a nuclear explosion were to occur 25 to 250 miles over the Midwest.

Our US military already "hardens" systems/buildings so that our country's critical defensive capabilities are not completely destroyed. There are two major methods of protecting electrical/electronic systems. The first is that surge protective devices are installed on all "incoming" power and communications cables, shunting overvoltages to ground. The second is that Faraday cages are installed around equipment/rooms, preventing the EMP from reaching critical equipment/components.

The NEC® needs to address EMP protection for equipment, systems and special occupancies that are critical to our survival. Electrical and electronic equipment can and must be protected, as has been achieved by our military. Unfortunately, there are no requirements to protect civilian electrical and electronic equipment/systems from EMPs.

The NEC Correlating Committee has informally advised that an EMP Protection Article, if passed and adopted into the NEC®, would be most appropriately located after Article 708 (COPS). Thus, Public Input 756 has suggested a new Article 709 under jurisdiction of CMP 13, which already has purview over Emergency Systems (Article 700), Legally Required Standby Systems (Article 701), Optional Standby Systems (Article 702), and Critical Operations Power Systems (Article 708).

Levels of protection and associated protection requirements listed in the Public Input(s) are based upon the unclassified National Cybersecurity and Communications Integration Center report "Electromagnetic Pulse (EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment". This study explains electromagnetic pulses and provides the necessary protective measures. It also contains estimates of the costs associated with properly protecting our electrical infrastructure.
The following table contains critical infrastructure components/special occupancies and the maximum time for outages caused by an EMP. Electrical components/infrastructure that is not functioning for periods longer than shown in this table may begin to cause injury or death to people and harm to society/economy.

Critical Infrastructure Component/Special Occupancy	Permitted Outage Time
Branch banking facilities	10 hours
Critical Operations Power Systems	10 minutes
Data centers	10 minutes
Direct current microgrids	10 hours
Drug stores/distribution centers	10 hours
Electrically driven or controlled irrigation machines	1 week
Elevators, dumbwaiters, escalators, moving walks, platform lifts, and stairway chairlifts	See facility requirements
Emergency systems	10 hours
Energy storage systems	10 hours
Fire alarm systems	1 week
Fire houses/stations	10 hours
Fire pumps	10 hours
Food processing and storage facilities	10 hours
Fuel cell systems	10 hours
Generators	10 hours
Grocery stores	10 hours
Hardware stores/home centers	10 hours
Healthcare facilities	See NFPA 99
Information technology equipment	10 minutes
Interconnected electric power production sources	10 minutes
Jails and prisons	10 minutes
Large-scale photovoltaic (PV) electric supply stations	10 hours
Legally required standby systems	10 hours
Modular data centers	10 minutes
Motor fuel dispensing facilities	1 week
Motors, motor circuits, and controllers	See facility requirements
Nuclear reactors	10 seconds
Optional standby systems	1 week
Petrochemical plants/facilities	10 hours
Pharmaceutical plants/facilities	10 hours
Police stations	10 minutes
Solar photovoltaic (PV) systems	10 hours
Stand-alone systems	10 hours
Storage batteries	See facility requirements
Transformers	See facility requirements
Waste water treatment facilities	10 minutes
Water supply facilities	10 hours
Wind electric systems	10 hours

An effectivity date of January 1, 2026 is chosen to allow time for engineering and industry to adequately pan and prepare for the required changes.

Opponents of EMP protection requirements will likely charge that it is too costly to protect our critical infrastructure, and that the NEC® is not a war-time document. A close reading of 90.1 reveals that there is no mention of the “cost” of safeguarding persons and property. Neither does 90.1 mention that safeguarding persons and property is only required during peacetime. Additionally, a significant EMP event, caused by a sunspot, would be an act of God, not an act of war.

The novel, “One Second After”, provides an understanding of what happens when the majority of all unprotected electrical and electronic equipment/systems is destroyed during an EMP event. An audio version of this book is available in two parts, for free, on YouTube.

This link provides the unclassified report “Electromagnetic Pulse (EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment”
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&
ved=2ahUKEwjQhp2-77DoAhXBHM0KHboOB2QQFjACegQIBRAC&url=https%3A%2F
%2Fwww.cisa.gov%2Fsites%2Fdefault%2Ffiles%2Fpublications%2F19_0307_CISA_EMP-Protection-Resilience-Guidelines.pdf&usg=AOvVaw2n7jLtJAUJtOJKHPMqWsTE

This link provides the study predicting up to 90% of our population could die from an EMP event
http://www.firstempcommission.org/uploads/1/1/9/5/119571849
/nuclear_emp_attack_scenarios_and_combined-arms_cyber_warfare_by_peter_pry_july_2017.pdf

This link provides unclassified guidelines for facility EMP protection
https://info.publicintelligence.net/DHS-FacilitiesGuidelinesEMP.pdf

These links provide Parts 1 and 2 of a national plan for EMP protection.
https://interferencetechnology.com/a-national-plan-for-emp-protection-part-1/
https://interferencetechnology.com/national-plan-emp-protection-part-2-protection-buildings/

We have all just witnessed the chaos and pain caused by not having the “protections” in place to quickly defeat the Covid-19 virus. As unfortunate, costly, painful, and deadly as Covid-19 was, it would be child’s play when compared to a significant EMP event if our critical electrical/electronic infrastructure remains unprotected. Quite simply, NEC® requirements to protect electrical and electronic equipment from an EMP event, could literally save millions of American lives.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 756-NFPA 70-2020 [New Section after 708.64]	
Public Input No. 756-NFPA 70-2020 [New Section after 708.64]	

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Committee: NEC-P04

Public Input No. 2998-NFPA 70-2020 [Section No. 690.72]

690.72 Self-Regulated PV Charge Control.

The PV source circuit shall be considered to comply with the requirements of ~~706~~ 695 .33 if:

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

(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

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

This change aligns with an effort to re-organize the alternative energy sources NEC Articles into a series of articles closely located together. This reorganization places all sources alternate sources as follows:

689 On-Site Energy Sources
690 Solar Photovoltaic (PV) Systems
691 Large-Scale Photovoltaic (PV) Systems
692 Fuel Cell Systems
693 Generators
694 Wind Electric Systems
695 Energy Storage Systems
696 Storage Batteries

This public input aligns with changes that movie 706 to 695. This input supports this effort and to better align with the fact that this Article is closely related to emergency systems. This move makes way for alignment of alternative energy sources article arrangement. These articles are closely related to each other and this change is in alignment with the direction by the correlating committee to review alternative energy sources for conflicts and usability. This new alignment will create a similar structure as that found for hazardous locations. The new Article 689 is the a combination of Articles 705, 710 and 712 and will act to be the new general requirements for this series of alternative energy sources.

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Committee: NEC-P04

Public Input No. 4641-NFPA 70-2020 [Section No. 690.72]

690.72 Self-Regulated PV Charge Control.

The PV source circuit shall be considered to comply with the requirements ~~of 706.33 if~~ for charge control of a battery if :

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

(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 reference to 706 is not accurate as this allowance for specific PV equipment applies more generally to the charging of batteries.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate and their inclusion here is not necessarily an endorsement of all the PI's submitted.
Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain, P.E., SEIA; Bill Brooks, PVICC; John Berdner, PVICC, Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing, Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower; Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

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Committee: NEC-P04

Public Input No. 3971-NFPA 70-2020 [Section No. 691.1]

691.1 Scope.

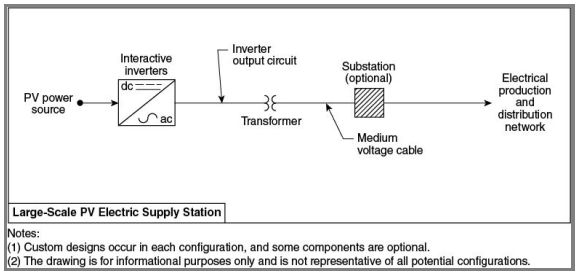
This article covers the installation of large-scale PV electric supply stations ~~with an inverter generating capacity of no less than 5000 kW, and~~ not under exclusive utility control.

Informational Note No. 1: Facilities covered by this article t ypically have a generating capacity of many megawatts located at a single premises or a group of sites from different locations being monitored and controlled from a central command center. These facilities have specific design and safety features, including those stated in 691.4, that are unique to large-scale PV facilities ~~and~~ . They are operated for the sole purpose of providing electric supply through a dedicated connection to a system operated by a regulated utility for the transfer of electric energy and commonly include communications for monitoring and control as specified by the regulating utility .

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

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.



Additional Proposed Changes

File Name	Description	Approved
PV_power_plants_5_MW_or_smaller.pdf		

Statement of Problem and Substantiation for Public Input

The proposed changes provide better clarification of how 691 is used in relationship to 690 and allows for smaller than 5000kW sites to be installed where they meet the restrictions and safety measures within this article.

Article 691 contains additional safety measures and restrictions that remove the need to apply a lot of the requirements in 690 while requiring engineering justification of how those requirements in 690 that do apply are complied with. These addition safety measures and restrictions have nothing to do with the generating capacity other than the feasibility of adding this extra expense to small facilities. The wording of 691 should not keep these smaller sites from applying these restrictions and additional requirements. With the introduction of more advanced equipment required by standards like IEEE1547-2018 (including communications and interoperability requirements) that equipment will be complying with before the 2023 code, it is more feasible to include these additional requirements to smaller sites. Or, even a group of sites being monitored and controlled by one command center.

For those requirements in 690 that should also apply to 691 equipment, the stamped engineered design and report shall include these details of conformance as stated in 691.6. Therefore, 691 should not be

viewed as a way to ignore 690. It puts the responsibility on the licensed engineer and the ability of the AHJ to question how compliance with 690 is met.

The development of Article 691 (Large-Scale Photovoltaic) was a great step forward, recognizing the uniqueness to this part of the photovoltaic industry. As the industry continues to develop, many of the facilities being constructed are falling below the 5000kW threshold mentioned in the Scope, however these facilities meet all of the other Special Requirements listed in Section 691.4. Recognizing that 5000kW was intended as the minimum size for a project, many AHJ's have and continue to accept projects below the 5000kW capacity.

Referring to the U.S. Energy Information Administration (EIA) webpage, an article from February 7, 2019 "Most U.S. utility-scale solar photovoltaic power plants are 5 megawatts or smaller" notes that "Currently, North Carolina has 433 utility-scale PV facilities with capacities no greater than 5 MW, the most of any state, and accounting for nearly a quarter of all utility-scale PV facilities in the country between 1 MW and 5 MW." (https://www.eia.gov/todayinenergy/detail.php?id=38272);

The EIA also tracks "'Monthly Update to Annual Electric Generator Report' supplements the annual survey form EIA-860 data", this information "monitors the current status of existing and proposed generating units at electric power plants with 1 megawatt or greater of combined nameplate capacity". (https://www.eia.gov/electricity/data/eia860M/) Downloading the spreadsheet and filtering by "Solar Photovoltaic", limiting the size to 5 MW, filtering "IPP" (Independent Power Producer), you find the following statistics: "Inventory of Operating Generators as of May 2020" equals 1,108 projects and the "Inventory of Planned Generators as of May 2020" equals 250 projects with the following breakdown: South Carolina (SC) @ 46, North Carolina (NC) @ 16, Illinois (IL) @ 11, Massachusetts (MA) @ 21. Additionally, the State of Illinois under it's "Power Agency Act" defines a "utility-scale solar project" that has a nameplate capacity that is greater than 2,000 kilowatts (https://www.ilga.gov/legislation /ilcs/ilcs5.asp?ActID=2934)

The ANSI/IEEE C2, National Electrical Safety Code is being updated, similarly to the NEC code cycle. Plus, Authority Having Jurisdiction` often are not in alignment with one another regarding which code cycle to utilize. Omission of the date (year), allows the code to remain relevant, while lifting the specific date reference.

An attachment is included with some of the references referred to in this substantiation.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
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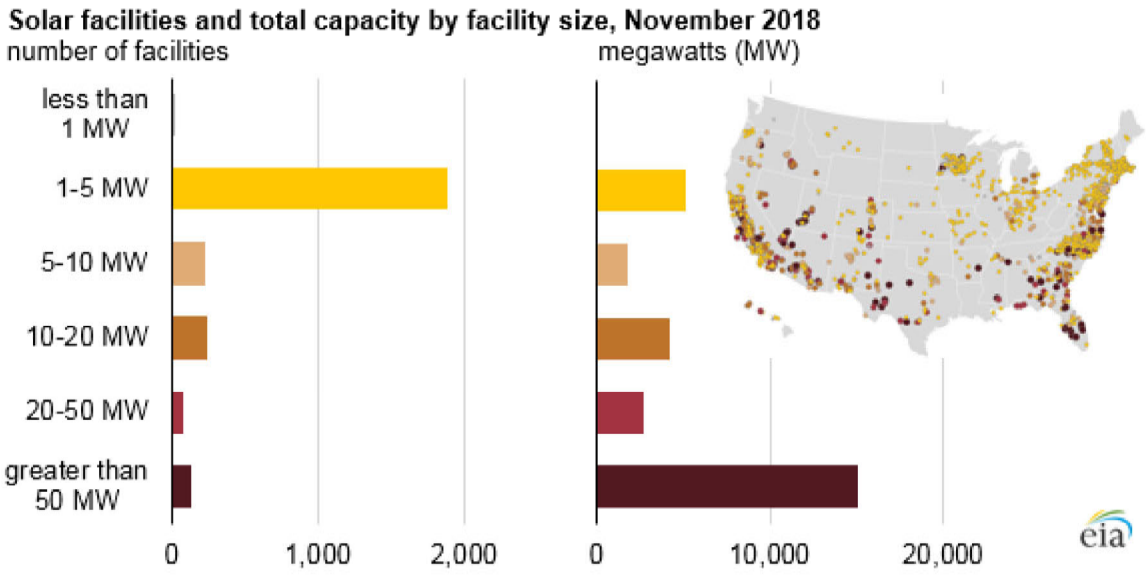
U.S. Energy Information Administration

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Today in Energy

February 7, 2019

Most U.S. utility-scale solar photovoltaic power plants are 5 megawatts or smaller



Source: U.S. Energy Information Administration, *Preliminary Monthly Electric Generator Inventory*, November 2018

The United States has more than 2,500 utility-scale solar photovoltaic (PV) electricity generating facilities. Most of these power plants are relatively small and collectively account for 2.5% of utility-scale electric generating capacity and 1.7% of annual electricity generation, based on data through November 2018.

EIA considers utility-scale generating facilities to be those where total generation capacity is one megawatt (MW) or greater. However, some utility-scale sites use more than one generating technology. At utility-scale facilities where PV is one of several technologies in use, the PV capacity itself may be less than one megawatt, but this is relatively rare: based on EIA's latest data, only 20 sites with a total combined capacity of 10 MW were in this category.

The growth in small utility-scale facilities is driven by several factors, many of which are tied to state-level policies and practices. For example, North Carolina used the Public Utilities Regulatory Policies Act of 1978 to allow utilities to set long-term purchase agreements with solar facilities, enabling solar developers to secure project funding more easily and spurring growth.

Currently, North Carolina has 433 utility-scale PV facilities with capacities no greater than 5 MW, the most of any state, and accounting for nearly a quarter of all utility-scale PV facilities in the country between 1 MW and 5 MW. These facilities collectively account for 1,803 MW of capacity, or 35% of the total U.S. PV capacity located at facilities with 1 MW to 5 MW of installed capacity.

In other states, the growth of small utility-scale PV capacity is encouraged by strategies that include, for example, community solar facilities. Community solar facilities offer a share of their solar capacity for sale to off-site customers who may not necessarily have access to solar generation. In these programs, customers may subscribe to a designated community solar

facility and receive monthly credits on their electric bills for the energy generated by the share of solar capacity they purchase. The average community solar facility has a capacity of 2.0 MW.

Growth in small utility-scale facilities is expected to continue through 2020. EIA's Preliminary Monthly Electric Generator Inventory for October 2018 reports that most of the 216 solar PV facilities that will come online by the end of 2020 will have capacities of five megawatts or less.

Solar PV facilities with less than one megawatt in capacity are not included in EIA's surveys of electricity generators, but their aggregate capacities are included in the EIA's survey of electric power sales, revenue, and energy efficiency and are represented in EIA's *Electric Power Monthly*. EIA estimates small-scale solar PV capacity to be about 40% of total solar capacity connected to the grid as of November 2018.

Principal contributor: Alex Mey

U.S. Energy Information Administration

Electricity

The monthly survey Form EIA-860M, 'Monthly Update to Annual Electric Generator Report' supplements the annual survey form EIA-860 data with monthly information that monitors the current status of existing and proposed generating units at electric power plants with 1 megawatt or greater of combined nameplate capacity. EIA estimates the current and near-term unit inventory of electric power generating capacity by integrating the information on these surveys along with ongoing EIA research of new units. However, creating this monthly estimate sometimes requires the use of data submitted on the annual EIA-860 before it has been fully verified by EIA. For this reason, reported capacities are EIA's preliminary estimates of capacity for that month. Estimates will be corrected without specific acknowledgement or explanation in subsequent month's inventory.

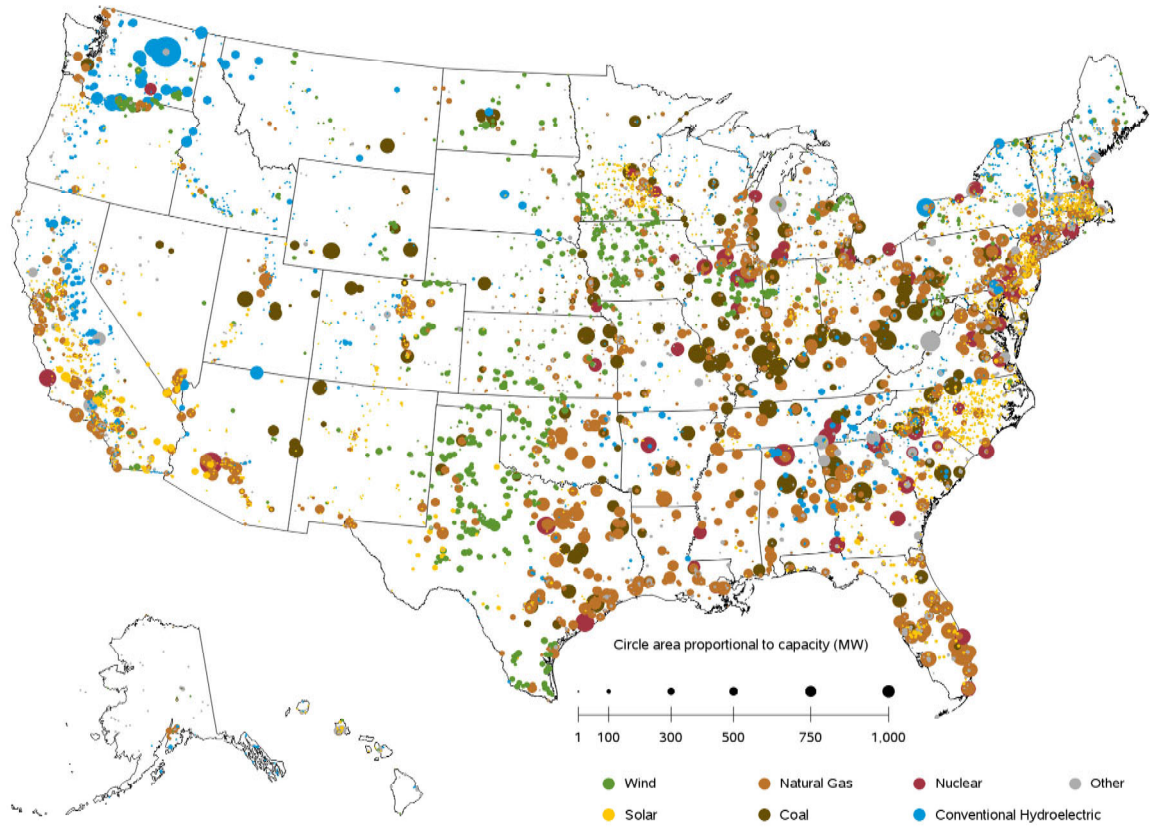
Starting with March 2017 data, Preliminary Monthly Electric Generator Inventory includes a comprehensive list of generators which retired since 2002. The list can be found on the 'Retired' tab of the datafile.

Starting with March 2018 data, *Preliminary Monthly Electric Generator Inventory* also includes data from Puerto Rico for existing, retired, and proposed generating units at electric power plants with combined nameplate capacity of 1 megawatt or greater.

Capacities reported in this preliminary inventory are best estimates of current generating capacity, but are not meant to be capacity commitments by the associated facilities.

The final inventory of generators is published each year with the annual EIA-860.

Operable utility-scale generating units as of May 2020



Sources: U.S. Energy Information Administration, Form EIA-860, 'Annual Electric Generator Report' and Form EIA-860M, 'Monthly Update to the Annual Electric Generator Report.'

EIA 860M

2020





Illinois Compiled Statutes

Information maintained by the Legislative Reference Bureau
Updating the database of the Illinois Compiled Statutes (ILCS) is an ongoing process. Recent laws may not yet be included in the ILCS database, but they are found on this site as Public Acts soon after they become law. For information concerning the relationship between statutes and Public Acts, refer to the Guide.

Because the statute database is maintained primarily for legislative drafting purposes, statutory changes are sometimes included in the statute database before they take effect. If the source note at the end of a Section of the statutes includes a Public Act that has not yet taken effect, the version of the law that is currently in effect may have already been removed from the database and you should refer to that Public Act to see the changes made to the current law.

EXECUTIVE BRANCH
(20 ILCS 3855/) Illinois Power Agency Act.

(20 ILCS 3855/Art. 1 heading)
ARTICLE 1

(Source: P.A. 95-481, eff. 8-28-07.)

(20 ILCS 3855/1-1)
Sec. 1-1. Short title. This Article may be cited as the Illinois Power Agency Act. References in this Article to "this Act" mean this Article.
(Source: P.A. 95-481, eff. 8-28-07.)

(20 ILCS 3855/1-5)
Sec. 1-5. Legislative declarations and findings. The General Assembly finds and declares:
(1) The health, welfare, and prosperity of all Illinois citizens require the provision of adequate, reliable, affordable, efficient, and environmentally sustainable electric service at the lowest total cost over time, taking into account any benefits of price stability.
(2) (Blank).
(3) (Blank).
(4) It is necessary to improve the process of procuring electricity to serve Illinois residents, to promote investment in energy efficiency and demand-response measures, and to maintain and support development of clean coal technologies, generation resources that operate at all hours of the day and under all weather conditions, zero emission facilities, and renewable resources.
(5) Procuring a diverse electricity supply portfolio will ensure the lowest total cost over time for adequate, reliable, efficient, and environmentally sustainable electric service.
(6) Including renewable resources and zero emission credits from zero emission facilities in that portfolio will reduce long-term direct and indirect costs to consumers by decreasing environmental impacts and by avoiding or delaying the need for new generation,

an agreement between the owner of a clean coal SNG brownfield facility and the gas utility, which agreement shall have the terms and conditions meeting the requirements of subsection (h-1) of Section 9-220 of the Public Utilities Act.

"Subscriber" means a person who (i) takes delivery service from an electric utility, and (ii) has a subscription of no less than 200 watts to a community renewable generation project that is located in the electric utility's service area. No subscriber's subscriptions may total more than 40% of the nameplate capacity of an individual community renewable generation project. Entities that are affiliated by virtue of a common parent shall not represent multiple subscriptions that total more than 40% of the nameplate capacity of an individual community renewable generation project.

"Subscription" means an interest in a community renewable generation project expressed in kilowatts, which is sized primarily to offset part or all of the subscriber's electricity usage.

"Substitute natural gas" or "SNG" means a gas manufactured by gasification of hydrocarbon feedstock, which is substantially interchangeable in use and distribution with conventional natural gas.

"Total resource cost test" or "TRC test" means a standard that is met if, for an investment in energy efficiency or demand-response measures, the benefit-cost ratio is greater than one. The benefit-cost ratio is the ratio of the net present value of the total benefits of the program to the net present value of the total costs as calculated over the lifetime of the measures. A total resource cost test compares the sum of avoided electric utility costs, representing the benefits that accrue to the system and the participant in the delivery of those efficiency measures and including avoided costs associated with reduced use of natural gas or other fuels, avoided costs associated with reduced water consumption, and avoided costs associated with reduced operation and maintenance costs, as well as other quantifiable societal benefits, to the sum of all incremental costs of end-use measures that are implemented due to the program (including both utility and participant contributions), plus costs to administer, deliver, and evaluate each demand-side program, to quantify the net savings obtained by substituting the demand-side program for supply resources. In calculating avoided costs of power and energy that an electric utility would otherwise have had to acquire, reasonable estimates shall be included of financial costs likely to be imposed by future regulations and legislation on emissions of greenhouse gases. In discounting future societal costs and benefits for the purpose of calculating net present values, a societal discount rate based on actual, long-term Treasury bond yields should be used. Notwithstanding anything to the contrary, the TRC test shall not include or take into account a calculation of market price suppression effects or demand reduction induced price effects.

"Utility-scale solar project" means an electric generating facility that:

(1) generates electricity using photovoltaic cells; and

(2) has a nameplate capacity that is greater than 2,000 kilowatts.

"Utility-scale wind project" means an electric generating facility that:

(1) generates electricity using wind; and

(2) has a nameplate capacity that is greater than 2,000 kilowatts.

"Zero emission credit" means a tradable credit that represents the environmental attributes of one megawatt hour of energy produced from a zero emission facility.

Public Input No. 3893-NFPA 70-2020 [Section No. 691.2]

(Relocate all definitions in the 691. 2 to Article 100, arrange them in alphabetical order and without any subdivisions.)

691. 2 Definitions.

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

Electric Supply Stations.

Locations containing the generating stations and substations, including their associated generator, storage battery, transformer, and switchgear areas.

Generating Station.

A plant wherein electric energy is produced by conversion from some other form of energy (e.g., chemical, nuclear, solar, wind, mechanical, or hydraulic) by means of suitable apparatus.

Statement of Problem and Substantiation for Public Input

"The National Electrical Code has definitions in multiple parts in Article 100 and many definitions scattered through out the code many of them in the .2 section of the articles.
Most of the other standards under NFPA have their definitions in one location and this will allow the NEC the same requirement. The revisions to the NEC Style Manual require all the definitions to be relocated to Article 100. "

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Public Input No. 4013-NFPA 70-2020 [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 only by qualified personnel.

Informational Note: Refer to *NFPA 70E*-2018, *Standard for Electrical Safety in the Workplace*, for electrical safety requirements.

(2) Access to PV electric supply stations shall be restricted ~~by fencing or other adequate means~~ 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 safely and effectively 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.

Statement of Problem and Substantiation for Public Input

This change removes the qualifier so as not to imply any modification to 110.31 requirements and keeps the first part of the sentence which states 110.31 applies to the entire PV Electric Supply Station facility including all equipment.

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This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate and their inclusion here is not necessarily an endorsement of all the PI's submitted.
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Public Input No. 4015-NFPA 70-2020 [Section No. 691.9]

691.9 Disconnecting Means for Isolating Photovoltaic Equipment.

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

Informational Note: For information on electrical system maintenance, see NFPA 70B-2019, *Recommended Practice for Electrical Equipment Maintenance*. For information on written procedures and conditions of maintenance, including lockout/tagout procedures, see NFPA *70E*-2018.

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

Statement of Problem and Substantiation for Public Input

This change removes the first sentence from 691.9 since it is unnecessary as this allowance exists within 690.

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Public Input No. 2417-NFPA 70-2020 [Section No. 691.10]

691.10 Arc-Fault Mitigation.

PV ~~systems that do not comply with the requirements of~~ 690.11 ~~shall~~ systems shall include details of fire mitigation plans to address dc arc-faults in the documentation required in 691.6.

Statement of Problem and Substantiation for Public Input

1) To institute a provision for non-compliance to a separate segment of code, infers an alternate compliance path. However, 690.11 makes no mention of an alternate compliance path. Either this reference should be struck from this passage, or text added to 690.11 to correlate an understanding of an alternate compliance path.
2) The code text indicates that no consideration of DC arc fault is required if fencing details are included in the design documents. This intent does not seem reasonable as arc faults can be an issue for much more than fencing.

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Public Input No. 4018-NFPA 70-2020 [Section No. 691.10]

691.10 ~~Arc-Fault Mitigation~~ 10 Fire Mitigation .

PV systems that do not comply with the requirements of 690.11 shall include details of fire mitigation plans to address dc arc-faults in the documentation required in 691.6.

Informational Note: Fire mitigation plans typically are reviewed by the local fire agency and include topics such as access roads within the facility. Consideration of other requirements including the National Pollutant Discharge Elimination System (NPDES) or equivalent, pollinator habitats and other environmental restrictions are generally incorporated into the plan.

Statement of Problem and Substantiation for Public Input

The title change addresses fire mitigation, in lieu of arc-fault mitigation which represents the intent of this subsection better. Future fire mitigation requirements would fall within this subsection and would not necessarily address arc-fault mitigation.

The addition of the informational note is to recognize that other environmental regulations play into consideration in how the fire mitigation plan should be addressed for a given facility location. Since each jurisdiction has its unique challenges, not all plans will work in all locations.

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Public Input No. 1499-NFPA 70-2020 [New Section after 691.11]

691.12 Energy Storage System.

An energy storage system connected to a large-scale PV electric supply station shall be installed in accordance with Article 706.

Statement of Problem and Substantiation for Public Input

Currently ESS's are being installed in conjunction with large-scale PV electric supply stations. As Article 706 is a relatively new article, there needs to be a requirement like 690.71 where users of this code are directed to the additional requirements of ESS's.

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Public Input No. 770-NFPA 70-2020 [New Section after 691.11]

TITLE OF NEW CONTENT

Type your content here ...

691.12Electromagnetic Pulse (EMP) Protection. Protection for large-scale photovoltaic (PV) electric supply stations against the effects of electromagnetic pulses shall be provided at a minimum of Level 2. See 709.7 for levels of electromagnetic pulse protection.

Exception: The requirements of 709.7(A)(5) and 709.7(B)(3) shall not apply.

This requirement shall become effective January 1, 2026.

Statement of Problem and Substantiation for Public Input

A devastating electromagnetic pulse (EMP), caused by a sun-spot or a nuclear bomb exploded high in the atmosphere, can impress 50,000 volts per meter on unprotected electrical and electronic equipment. It is similar to a radio wave impressing a very small voltage on a radio antenna, only orders of magnitude larger. The problem is that a significant EMP will fry every electrical/electronic component or piece of equipment that is not protected.

The EMP won't directly harm or injure people, but because there is no longer a working electrical infrastructure, which may take years to repair/rebuild, people will die from the lack of clean water, medicine, food, fuel, and eventual rioting due to the breakdown of society. Unclassified studies, referenced at the end of this substantiation, have estimated from 66% to 90% of the US population will die within one year if a significant sun spot were to occur or if a nuclear explosion were to occur 25 to 250 miles over the Midwest.

Our US military already "hardens" systems/buildings so that our country's critical defensive capabilities are not completely destroyed. There are two major methods of protecting electrical/electronic systems. The first is that surge protective devices are installed on all "incoming" power and communications cables, shunting overvoltages to ground. The second is that Faraday cages are installed around equipment/rooms, preventing the EMP from reaching critical equipment/components.

The NEC® needs to address EMP protection for equipment, systems and special occupancies that are critical to our survival. Electrical and electronic equipment can and must be protected, as has been achieved by our military. Unfortunately, there are no requirements to protect civilian electrical and electronic equipment/systems from EMPs.

The NEC Correlating Committee has informally advised that an EMP Protection Article, if passed and adopted into the NEC®, would be most appropriately located after Article 708 (COPS). Thus, Public Input 756 has suggested a new Article 709 under jurisdiction of CMP 13, which already has purview over Emergency Systems (Article 700), Legally Required Standby Systems (Article 701), Optional Standby Systems (Article 702), and Critical Operations Power Systems (Article 708).

Levels of protection and associated protection requirements listed in the Public Input(s) are based upon the unclassified National Cybersecurity and Communications Integration Center report "Electromagnetic Pulse (EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment". This study explains electromagnetic pulses and provides the necessary protective measures. It also contains estimates of the costs associated with properly protecting our electrical infrastructure.
The following table contains critical infrastructure components/special occupancies and the maximum time for outages caused by an EMP. Electrical components/infrastructure that is not functioning for periods longer than shown in this table may begin to cause injury or death to people and harm to society/economy.
Critical Infrastructure Component/Special Occupancy Permitted Outage Time
Branch banking facilities 10 hours

Critical Operations Power Systems 10 minutes
Data centers 10 minutes
Direct current microgrids 10 hours
Drug stores/distribution centers 10 hours
Electrically driven or controlled irrigation machines 1 week
Elevators, dumbwaiters, escalators, moving walks, platform lifts, and stairway chairlifts See facility requirements
Emergency systems 10 hours
Energy storage systems 10 hours
Fire alarm systems 1 week
Fire houses/stations 10 hours
Fire pumps 10 hours
Food processing and storage facilities 10 hours
Fuel cell systems 10 hours
Generators 10 hours
Grocery stores 10 hours
Hardware stores/home centers 10 hours
Healthcare facilities See NFPA 99
Information technology equipment 10 minutes
Interconnected electric power production sources 10 minutes
Jails and prisons 10 minutes
Large-scale photovoltaic (PV) electric supply stations 10 hours
Legally required standby systems 10 hours
Modular data centers 10 minutes
Motor fuel dispensing facilities 1 week
Motors, motor circuits, and controllers See facility requirements
Nuclear reactors 10 seconds
Optional standby systems 1 week
Petrochemical plants/facilities 10 hours
Pharmaceutical plants/facilities 10 hours
Police stations 10 minutes
Solar photovoltaic (PV) systems 10 hours
Stand-alone systems 10 hours
Storage batteries See facility requirements
Transformers See facility requirements
Waste water treatment facilities 10 minutes
Water supply facilities 10 hours
Wind electric systems 10 hours

An effectivity date of January 1, 2026 is chosen to allow time for engineering and industry to adequately pan and prepare for the required changes.

Opponents of EMP protection requirements will likely charge that it is too costly to protect our critical infrastructure, and that the NEC® is not a war-time document. A close reading of 90.1 reveals that there is no mention of the “cost” of safeguarding persons and property. Neither does 90.1 mention that safeguarding persons and property is only required during peacetime. Additionally, a significant EMP event, caused by a sunspot, would be an act of God, not an act of war.

The novel, “One Second After”, provides an understanding of what happens when the majority of all unprotected electrical and electronic equipment/systems is destroyed during an EMP event. An audio version of this book is available in two parts, for free, on YouTube.

This link provides the unclassified report “Electromagnetic Pulse (EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment”
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=2ahUKEwjQhp2-77DoAhXBHM0KHboOB2QQFjACegQIBRAC&url=https%3A%2F%2Fwww.cisa.gov%2Fsites%2Fdefault%2Ffiles%2Fpublications%2F19_0307_CISA_EMP-Protection-Resilience-Guidelines.pdf&usg=AOvVaw2n7jLtJAUJtOJKHPMqWsTE

This link provides the study predicting up to 90% of our population could die from an EMP event
http://www.firstempcommission.org/uploads/1/1/9/5/119571849

/nuclear_emp_attack_scenarios_and_combined-arms_cyber_warfare_by_peter_pry_july_2017.pdf

This link provides unclassified guidelines for facility EMP protection
https://info.publicintelligence.net/DHS-FacilitiesGuidelinesEMP.pdf

These links provide Parts 1 and 2 of a national plan for EMP protection.
https://interferencetechnology.com/a-national-plan-for-emp-protection-part-1/
https://interferencetechnology.com/national-plan-emp-protection-part-2-protection-buildings/

We have all just witnessed the chaos and pain caused by not having the “protections” in place to quickly defeat the Covid-19 virus. As unfortunate, costly, painful, and deadly as Covid-19 was, it would be child’s play when compared to a significant EMP event if our critical electrical/electronic infrastructure remains unprotected. Quite simply, NEC® requirements to protect electrical and electronic equipment from an EMP event, could literally save millions of American lives.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 756-NFPA 70-2020 [New Section after 708.64]	
Public Input No. 756-NFPA 70-2020 [New Section after 708.64]	

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Public Input No. 3894-NFPA 70-2020 [Section No. 692.2]

(Relocate all definitions in the 692. 2 to Article 100, arrange them in alphabetical order and without any subdivisions.)

692. 2 Definitions.

The following definition(s) shall apply only within this article.

Fuel Cell Output Circuit.

The conductors used to connect the fuel cell system to its electrical point of delivery.

Informational Note: In the case of sites that have series- or parallel-connected multiple units, the term *output circuit* also refers to the conductors used to electrically interconnect the fuel cell system(s).

Statement of Problem and Substantiation for Public Input

"The National Electrical Code has definitions in multiple parts in Article 100 and many definitions scattered through out the code many of them in the .2 section of the articles.
Most of the other standards under NFPA have their definitions in one location and this will allow the NEC the same requirement. The revisions to the NEC Style Manual require all the definitions to be relocated to Article 100. "

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Public Input No. 2999-NFPA 70-2020 [Section No. 692.4(B)]

(B) Identification of Power Sources.

Fuel cell systems shall be ~~identified according to~~ 692.4(B)(1) ~~through (B)(3).~~

~~**(1)** Interconnected AC Systems.~~

~~Plaques or directories shall be installed in accordance with~~ 705.10 .

~~**(2)** DC Microgrid Systems.~~

~~Plaques or directories shall be~~

marked with p laques or directories installed in accordance with

~~712~~

689 .10 .

~~**(3)** Stand-Alone Systems.~~

~~Plaques or directories shall be installed in accordance with~~ 710.10 .

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

This modification is necessary as 710, 712 and 689 are combined as part of this task group effort into a new Article 689. The proper reference for plaques and directories is found in 689.10 only. In addition, this section was simplified as only one reference section exists. Changes simplify and add clarity.

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Public Input No. 765-NFPA 70-2020 [New Section after 692.6]

TITLE OF NEW CONTENT

Type your content here ...

692.7 Electromagnetic Pulse (EMP) Protection. Protection for fuel cell systems against the effects of electromagnetic pulses shall be provided at a minimum of Level 2. See 709.7 for levels of electromagnetic pulse protection.

Exception: The requirements of 709.7(A)(5) and 709.7(B)(3) shall not apply.

This requirement shall become effective January 1, 2026.

Statement of Problem and Substantiation for Public Input

A devastating electromagnetic pulse (EMP), caused by a sun-spot or a nuclear bomb exploded high in the atmosphere, can impress 50,000 volts per meter on unprotected electrical and electronic equipment. It is similar to a radio wave impressing a very small voltage on a radio antenna, only orders of magnitude larger. The problem is that a significant EMP will fry every electrical/electronic component or piece of equipment that is not protected.

The EMP won't directly harm or injure people, but because there is no longer a working electrical infrastructure, which may take years to repair/rebuild, people will die from the lack of clean water, medicine, food, fuel, and eventual rioting due to the breakdown of society. Unclassified studies, referenced at the end of this substantiation, have estimated from 66% to 90% of the US population will die within one year if a significant sun spot were to occur or if a nuclear explosion were to occur 25 to 250 miles over the Midwest.

Our US military already "hardens" systems/buildings so that our country's critical defensive capabilities are not completely destroyed. There are two major methods of protecting electrical/electronic systems. The first is that surge protective devices are installed on all "incoming" power and communications cables, shunting overvoltages to ground. The second is that Faraday cages are installed around equipment/rooms, preventing the EMP from reaching critical equipment/components.

The NEC® needs to address EMP protection for equipment, systems and special occupancies that are critical to our survival. Electrical and electronic equipment can and must be protected, as has been achieved by our military. Unfortunately, there are no requirements to protect civilian electrical and electronic equipment/systems from EMPs.

The NEC Correlating Committee has informally advised that an EMP Protection Article, if passed and adopted into the NEC®, would be most appropriately located after Article 708 (COPS). Thus, Public Input 756 has suggested a new Article 709 under jurisdiction of CMP 13, which already has purview over Emergency Systems (Article 700), Legally Required Standby Systems (Article 701), Optional Standby Systems (Article 702), and Critical Operations Power Systems (Article 708).

Levels of protection and associated protection requirements listed in the Public Input(s) are based upon the unclassified National Cybersecurity and Communications Integration Center report "Electromagnetic Pulse (EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment". This study explains electromagnetic pulses and provides the necessary protective measures. It also contains estimates of the costs associated with properly protecting our electrical infrastructure.
The following table contains critical infrastructure components/special occupancies and the maximum time for outages caused by an EMP. Electrical components/infrastructure that is not functioning for periods longer than shown in this table may begin to cause injury or death to people and harm to society/economy.
Critical Infrastructure Component/Special Occupancy Permitted Outage Time
Branch banking facilities 10 hours

Critical Operations Power Systems 10 minutes
Data centers 10 minutes
Direct current microgrids 10 hours
Drug stores/distribution centers 10 hours
Electrically driven or controlled irrigation machines 1 week
Elevators, dumbwaiters, escalators, moving walks, platform lifts, and stairway chairlifts See facility requirements
Emergency systems 10 hours
Energy storage systems 10 hours
Fire alarm systems 1 week
Fire houses/stations 10 hours
Fire pumps 10 hours
Food processing and storage facilities 10 hours
Fuel cell systems 10 hours
Generators 10 hours
Grocery stores 10 hours
Hardware stores/home centers 10 hours
Healthcare facilities See NFPA 99
Information technology equipment 10 minutes
Interconnected electric power production sources 10 minutes
Jails and prisons 10 minutes
Large-scale photovoltaic (PV) electric supply stations 10 hours
Legally required standby systems 10 hours
Modular data centers 10 minutes
Motor fuel dispensing facilities 1 week
Motors, motor circuits, and controllers See facility requirements
Nuclear reactors 10 seconds
Optional standby systems 1 week
Petrochemical plants/facilities 10 hours
Pharmaceutical plants/facilities 10 hours
Police stations 10 minutes
Solar photovoltaic (PV) systems 10 hours
Stand-alone systems 10 hours
Storage batteries See facility requirements
Transformers See facility requirements
Waste water treatment facilities 10 minutes
Water supply facilities 10 hours
Wind electric systems 10 hours

An effectivity date of January 1, 2026 is chosen to allow time for engineering and industry to adequately pan and prepare for the required changes.

Opponents of EMP protection requirements will likely charge that it is too costly to protect our critical infrastructure, and that the NEC® is not a war-time document. A close reading of 90.1 reveals that there is no mention of the “cost” of safeguarding persons and property. Neither does 90.1 mention that safeguarding persons and property is only required during peacetime. Additionally, a significant EMP event, caused by a sunspot, would be an act of God, not an act of war.

The novel, “One Second After”, provides an understanding of what happens when the majority of all unprotected electrical and electronic equipment/systems is destroyed during an EMP event. An audio version of this book is available in two parts, for free, on YouTube.

This link provides the unclassified report “Electromagnetic Pulse (EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment”
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=2ahUKEwjQhp2-77DoAhXBHM0KHboOB2QQFjACegQIBRAC&url=https%3A%2F%2Fwww.cisa.gov%2Fsites%2Fdefault%2Ffiles%2Fpublications%2F19_0307_CISA_EMP-Protection-Resilience-Guidelines.pdf&usg=AOvVaw2n7jLtJAUJtOJKHPMqWsTE

This link provides the study predicting up to 90% of our population could die from an EMP event
http://www.firstempcommission.org/uploads/1/1/9/5/119571849

/nuclear_emp_attack_scenarios_and_combined-arms_cyber_warfare_by_peter_pry_july_2017.pdf

This link provides unclassified guidelines for facility EMP protection
https://info.publicintelligence.net/DHS-FacilitiesGuidelinesEMP.pdf

These links provide Parts 1 and 2 of a national plan for EMP protection.
https://interferencetechnology.com/a-national-plan-for-emp-protection-part-1/
https://interferencetechnology.com/national-plan-emp-protection-part-2-protection-buildings/

We have all just witnessed the chaos and pain caused by not having the “protections” in place to quickly defeat the Covid-19 virus. As unfortunate, costly, painful, and deadly as Covid-19 was, it would be child’s play when compared to a significant EMP event if our critical electrical/electronic infrastructure remains unprotected. Quite simply, NEC® requirements to protect electrical and electronic equipment from an EMP event, could literally save millions of American lives.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 756-NFPA 70-2020 [New Section after 708.64]	
Public Input No. 756-NFPA 70-2020 [New Section after 708.64]	

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Committee: NEC-P04

Public Input No. 2418-NFPA 70-2020 [Section No. 692.8(A)]

(A) Nameplate Rated Circuit Current.

The ~~nameplate(s) rated circuit current~~ nameplate rated current of a fuel cell system, used for circuit sizing, shall be the total of the rated current(s) indicated on the constituent fuel cell module nameplate(s).

Statement of Problem and Substantiation for Public Input

1) The first use of "nameplate current" used in the sentence does not identify the equipment or system intended to be associated to the requirement. The governing topic indicates it may be for a fuel cell system, but it is unclear due to pluralizing it as nameplate(s).
2) The use of the term "rated circuit current" is unclear to intent as "full load current" or as "circuit ampacity" (e.g. full load current plus some factor), or something else.
3) The second pluralized use of nameplate(s) infers a total sum of currents, where multiple fuel cells exist, may need to be applied; which could be clarified by expounding more description upon the term, such as "constituent fuel cell module nameplates."

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Public Input No. 4103-NFPA 70-2020 [New Section after 692.13]

TITLE OF NEW CONTENT

Type your content here ...

692.15 Emergency Disconnect. For one- and two-family dwellings, an emergency disconnecting means shall comply with (1) through (4).

(1) Be located in a readily accessible location outside the building

(2) Be located within 1 m (3 ft) of any required emergency service disconnect or where there is no required emergency service disconnect, shall be located within 1 m (3 ft) of any other power source emergency disconnect or any PV rapid shutdown initiator

(3) If remotely controlled, the remote-control system shall be “fail safe” where the disconnect automatically opens on loss of control signal or control power

(4) Be labeled “EMERGENCY FUEL CELL DISCONNECT” and comply with 110.21(B).

Statement of Problem and Substantiation for Public Input

This proposal is one of several related, but separate proposals involving the 2020 NEC requirements for external (outside the building) emergency disconnects on one- and two-family dwellings for energy sources such as the utility service, batteries, energy storage systems (ESS), wind systems and also stand-alone PV systems plus PV rapid shutdown systems. The intent of these proposals is to require multiple emergency disconnects to be grouped in one location to increase safety for Fire Service first responders.

Also, when remote activation of these disconnects is allowed, the proposal establishes an additional safety requirement that the remote controls be “fail safe” and in the event of loss of control power or control signal, the emergency disconnect shall automatically be opened. It has been determined that some inverter manufacturers are already starting to put inputs on their products to allow an external remote shutdown control system that is fail safe.

It has been determined that adding such a fail-safe remotely controlled emergency disconnect system is relatively inexpensive using voltage-trip circuit breakers and a relay on large battery banks or ESS.

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Public Input No. 4172-NFPA 70-2020 [Section No. 692.41(C)]

(C) Systems with Alternating-Current and Direct-Current Grounding Requirements.

When fuel ~~cell power systems~~ cell systems have both alternating-current (ac) and direct-current (dc) grounding requirements, the dc grounding system shall be bonded to the ac grounding system. The bonding conductor shall be sized according to 692.45. A single common grounding electrode and grounding bar may be used for both systems, in which case the common grounding electrode conductor shall be sized to meet the requirements of both 250.66 (ac) and 250.166 (dc).

Statement of Problem and Substantiation for Public Input

This public input is submitted on behalf of the task group formed under the direction of the Correlating Committee to harmonize terminology across NFPA70, 99, 110, and 111 that relate to emergency and standby power and energy storage. This task group was appointed to identify potential proposed changes to the 2023 edition of the NEC in the form of Public Inputs (PIs) that within the Task Group's scope of activity as specified by the Correlating Committee.
The task group members are; Alan Manche-Co-Chair, Todd Lottmann Co-Chair, Steve Froemming, David Stymiest, John Kovacik, Chad Kennedy, Duke Schamel, Linda Little, Jason D'Antona, Chris Coache, Mike McCabe, and Chad Beebe. This task group of balanced interests provided the expertise to develop these public inputs covering the harmonization of terms across NFPA70, 99, 110, and 111.
Public Inputs are being submitted in the following sections: Article 100 definitions, 480.2, 517.30 (B)(1), 517.30(B)(3), 517.31(D), 517.31(F), 517.41(B), 692.41(C), 695.3(C)(2), 700.2, 700.12(D)(1), 700.12(D)(2), 700.18, 701.2, 701.12(D)(1), and 708.20(F)(1)
Summary of Changes
These proposed PIs are intended provide consistent use of terms between the NEC®, NFPA 110, 111. These proposed revisions identified correlating terminology issues and looked across all three standards to determine the changes necessary to harmonize key terms. These public inputs were the changes recommended for the NEC by the task group.

Technical Substantiation
The following substantiation is provided for each change separated by section:
Article 100 – Uninterruptible Power Supply definition was revised to align with the NFPA111 definition.
480.2 – definition for storage battery revised to match NFPA855
517.30 (B)(1) – revised to text to align with references across NEC, NFPA110, and NFPA111
517.30(B)(3) – revised to text to align with references across NEC, NFPA110, and NFPA111
517.31(D) – revised to text to align with references across NEC, NFPA110, and NFPA111
517.31(F) – revised to text to align with references across NEC, NFPA110, and NFPA111
517.41(B) – revised to text to align with references across NEC, NFPA110, and NFPA111
692.41(C) – removed the word power since fuel cell system is a defined term in the NEC
695.3(C)(2) – revised to text to align with references across NEC, NFPA110, and NFPA111
700.2, - Added informational note number 2 to describe the interaction of the terms used in NFPA110 and NFPA111with emergency systems in the NEC. Revised definition for Branch-Circuit Emergency Lighting Transfer Switch to align with terminology in NFPA110 and NFPA111. Added informational note 3 to tie the levels defined in NFPA110 to the systems used in the NEC. This will aid in the interaction of these standards.
700.12(D)(1), - Normal service implies that the normal or primary power source can only be a utility per the NEC definition of "service." This section was revised to say power source to allow other types of sources for the normal power.
700.12(D)(2) – revised wording since legally required standby system and emergency system are defined terms.
700.18 – added the word "system" since emergency system is a defined term
701.2 - Added informational note 2 to tie the levels defined in NFPA110 to the systems used in the NEC. This will aid in the interaction of these standards. It also provides guidance as to which legally required standby systems are considered level 1 due to their critical nature tied to loss of life or serious injury versus the level 2 that is less critical.

701.12(D)(1) - Normal service implies that the normal or primary power source can only be a utility per the NEC definition of “service.” This section was revised to say power source to allow other types of sources for the normal power.
708.2 - Added informational note to tie the levels defined in NFPA110 to the systems used in the NEC. This will aid in the interaction of these standards.
708.20(F)(1) - Normal service implies that the normal or primary power source can only be a utility per the NEC definition of “service.” This section was revised to say power source to allow other types of sources for the normal power.

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Public Input No. 3178-NFPA 70-2020 [Section No. 692.45]

~~**692.45** Size of Equipment Grounding Conductor.~~

~~The equipment grounding conductor shall be sized in accordance with 250.122 .~~

Statement of Problem and Substantiation for Public Input

Text in 692.45 of 2020 NEC does not supplement or modify the grounding requirements in 250.122, but simply repeats that general requirement. NEC 90.3 indicates those general requirements apply to special equipment without repeating the text.

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Public Input No. 3179-NFPA 70-2020 [Section No. 692.47]

~~**692.47** Grounding Electrode System.~~

~~Any auxiliary grounding electrode(s) required by the manufacturer shall be connected to the equipment grounding conductor specified in 250.118 .~~

Statement of Problem and Substantiation for Public Input

Text in 692.47 of 2020 NEC does not supplement or modify the grounding requirements in Article 250, but simply repeats that general requirement. NEC 90.3 indicates those general requirements apply to special equipment without repeating the text. The 2020 text actually references 250.118 that covers types of equipment grounding conductors rather than 250.54 that addresses an auxiliary grounding electrode which seems to be what this section is referring to. As indicated, reference to neither section is necessary as those general Article 250 requirements are applicable for fuel cells.

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Public Input No. 2422-NFPA 70-2020 [Section No. 692.54]

692.54 Fuel Shut-Off.

The primary disconnecting means of the building or circuits supplied shall be marked with a description and/or diagram that indicates the location of the manual fuel shut-off valve ~~shall be marked at the location of the primary disconnecting means of the building or circuits supplied~~ .

Statement of Problem and Substantiation for Public Input

Clarify intent of "the location of the...valve shall be marked at the location of the...disconnect"...

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Public Input No. 4601-NFPA 70-2020 [Article 694]

Article 694 Wind Electric Systems

Part I. General

694.1 Scope.

This article applies to wind (turbine) electric systems that consist of one or more wind electric generators and their related alternators, generators, inverters, controllers, and associated equipment.

Informational Note: Some wind electric systems are interactive with other electric power sources *[see Figure 694.1(a)]* and some are stand-alone systems *[see Figure 694.1(b)]*. Some systems have ac output and some have dc output. Some systems contain electrical energy storage, such as batteries.

Figure 694.1(a) Identification of Wind Electric System Components — Interactive System.

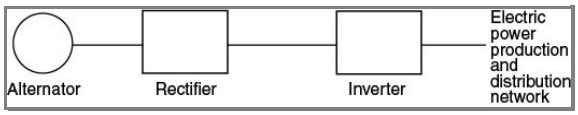
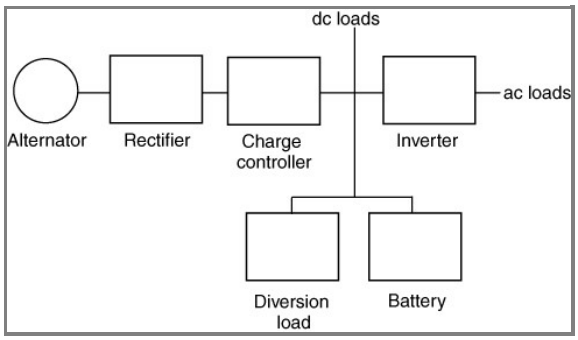


Figure 694.1(b) Identification of Wind Electric System Components — Stand-Alone System.



694.2 Definitions.

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

Diversion Charge Controller.

Equipment that regulates the charging process of a battery or other energy storage device by diverting power from energy storage to dc or ac loads, or to an interconnected utility service.

Diversion Load.

A load connected to a diversion charge controller or diversion load controller, also known as a dump load.

Diversion Load Controller.

Equipment that regulates the output of a wind generator by diverting power from the generator to dc or ac loads or to an interconnected utility service.

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).

Maximum Voltage.

The maximum voltage the wind turbine produces in operation including open circuit conditions.

Nacelle.

An enclosure housing the alternator and other parts of a wind turbine.

Rated Power.

The output power of a wind turbine at its rated wind speed.

Informational Note: The method for measuring wind turbine power output is specified in IEC 61400-12-1, *Power Performance Measurements of Electricity Producing Wind Turbines*.

Tower (as applied to wind electric systems).

A pole or other structure that supports a wind turbine.

Wind Turbine.

A mechanical device that converts wind energy to electrical energy.

Wind Turbine Output Circuit.

The circuit conductors between the internal components of a wind turbine (which might include an alternator, integrated rectifier, controller, and/or inverter) and other equipment.

Informational Note: See also definitions for interconnected systems in Article 705.

694.7 Installation.

Systems covered by this article shall be installed 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.

(B) Equipment.

Wind electric systems shall be approved for the application in accordance 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: Testing for certification and listing is typically performed under the supervision of a qualified electrical testing organization.

(C) 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) Surge Protective Devices (SPD).

A surge protective device shall be installed between a wind electric system and any loads served by the premises electrical system. The surge protective device shall be permitted to be a 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. Surge protective devices shall be installed in accordance with Part II of Article 242.

(E) 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) 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) 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 for systems up to 1000 V nominal.

Table 694.7 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)

Part II. Circuit Requirements

694.10 Maximum Voltage.

(A) Wind Turbine Output Circuits.

Wind turbine output circuits on or in one- and two-family dwellings shall be permitted to have a maximum voltage up to 600 volts.

(B) Direct-Current Utilization Circuits.

The voltage of dc utilization circuits shall comply with 210.6.

(C) Circuits over 150 Volts to Ground.

In one- and two-family dwellings, live parts in circuits over 150 volts to ground shall not be accessible to other than qualified persons while energized.

Informational Note: See 110.27 for guarding of live parts and 210.6 for branch circuit voltage limitations.

694.12 Circuit Sizing and Current.

(A) Calculation of Maximum Circuit Current.

The maximum current for a circuit shall be calculated in accordance with 694.12(A)(1) through (A)(3).

(1) Turbine Output Circuit Currents.

The maximum current shall be based on the circuit current of the wind turbine operating at maximum output power.

(2) Inverter Output Circuit Current.

The maximum output current shall be the inverter continuous output current rating.

(3) Stand-Alone Inverter Input Circuit Current.

The maximum input current shall be the stand-alone continuous inverter input current rating of the inverter producing rated power at the lowest input voltage.

(B) Ampacity and Overcurrent Device Ratings.

(1) Continuous Current.

Wind turbine electric system currents shall be considered to be continuous.

(2) Sizing of Conductors and Overcurrent Devices.

Circuit conductors and overcurrent devices shall be sized to carry not less than 125 percent of the maximum current as calculated in 694.12(A). The rating or setting of overcurrent devices shall be permitted in accordance with 240.4(B) and (C).

Exception: Circuits containing an assembly, together with its overcurrent devices, listed for continuous operation at 100 percent of its rating shall be permitted to be used at 100 percent of its rating.

694.15 Overcurrent Protection.

(A) Circuits and Equipment.

Turbine output circuits, inverter output circuits, and storage battery circuit conductors and equipment shall be protected in accordance with the requirements of Article 240. Circuits connected to more than one electrical source shall have overcurrent devices located so as to provide overcurrent protection from all sources.

Exception: An overcurrent device shall not be required for circuit conductors sized in accordance with 694.12(B) where the maximum current from all sources does not exceed the ampacity of the conductors.

Informational Note: Possible backfeed of current from any source of supply, including a supply through an inverter to the wind turbine output circuit, is a consideration in determining whether overcurrent protection from all sources is provided. Some wind electric systems rely on the turbine output circuit to regulate turbine speed. Inverters may also operate in reverse for turbine startup or speed control.

(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.

(C) Direct-Current Rating.

Overcurrent devices, either fuses or circuit breakers, used in any dc portion of a wind electric system shall be listed for use in dc circuits and shall have appropriate voltage, current, and interrupting ratings.

Part III. Disconnecting Means

694.20 All Conductors.

Means shall be provided to disconnect all current-carrying conductors of a wind electric power source from all other conductors in a building or other structure. A switch, circuit breaker, or other device, either ac or dc, shall not be installed in a grounded conductor if operation of that switch, circuit breaker, or other device leaves the marked, grounded conductor in an ungrounded and energized state.

Exception: A wind turbine that uses the turbine output circuit for regulating turbine speed shall not require a turbine output circuit disconnecting means.

694.22 Additional Provisions.

Disconnecting means shall comply with 694.22(A) through (D).

(A) Disconnecting Means.

The disconnecting means shall not be required to be suitable for use as service equipment. The disconnecting means for ungrounded conductors shall consist of manually operable switches or circuit breakers complying with all of the following requirements:

(1) They shall be located where readily accessible.

(2) They shall be externally operable without exposing the operator to contact with live parts.

(3) They shall plainly indicate whether in the open or closed position.

(4) They shall have an interrupting rating sufficient for the nominal circuit voltage and the current that is available at the line terminals of the equipment.

Where all terminals of the disconnecting means are capable of being 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:

WARNING.

ELECTRIC SHOCK HAZARD.

DO NOT TOUCH TERMINALS.

TERMINALS ON BOTH 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).

(B) Equipment.

Equipment such as rectifiers, controllers, output circuit isolating and shorting switches, and over-current devices shall be permitted on the wind turbine side of the disconnecting means.

(C) Requirements for Disconnecting Means.

(1) Location.

The wind electric system disconnecting means shall be installed at a readily accessible location either on or adjacent to the turbine tower, on the outside of a building or structure, or inside at the point of entrance of the wind system conductors.

Exception: Installations that comply with 694.30(C) shall be permitted to have the disconnecting means located remotely from the point of entry of the wind system conductors.

A wind turbine disconnecting means shall not be required to be located at the nacelle or tower.

The disconnecting means shall not be installed in bathrooms.

For one-family and two-family dwellings, a disconnecting means or manual shutdown button or switch shall be located at a readily accessible location outside the building.

(2) Marking.

Each turbine system disconnecting means shall be permanently marked to identify it as a wind electric system disconnect.

(3) Suitable for Use.

Turbine system disconnecting means shall be suitable for the prevailing conditions.

(4) Maximum Number of Disconnects.

The turbine disconnecting means shall consist of not more than six switches or six circuit breakers mounted in a single enclosure, in a group of separate enclosures, or in or on a switchgear.

(D) Equipment That Is Not Readily Accessible.

Rectifiers, controllers, and inverters shall be permitted to be mounted in nacelles or other exterior areas that are not readily accessible.

694.23 Turbine Shutdown.

(A) Manual Shutdown.

Wind turbines shall be required to have a readily accessible manual shutdown button or switch. Operation of the button or switch shall result in a parked turbine state that shall either stop the turbine rotor or allow limited rotor speed combined with a means to de-energize the turbine output circuit.

Exception: Turbines with a swept area of less than 50 m^2 (538 ft^2) shall not be required to have a manual shutdown button or switch.

(B) Shutdown Procedure.

The shutdown procedure for a wind turbine shall be defined and permanently posted at the location of a shutdown means and at the location of the turbine controller or disconnect, if the location is different.

694.24 Disconnection of Wind Electric System Equipment.

Means shall be provided to disconnect equipment, such as inverters, batteries, and charge controllers, from all ungrounded conductors of all sources. If the equipment is energized from more than one source, the disconnecting means shall be grouped and identified.

A single disconnecting means in accordance with 694.22 shall be permitted for the combined ac output of one or more inverters in an interactive system.

A shorting switch or plug shall be permitted to be used as an alternative to a disconnect in systems that regulate turbine speed using the turbine output circuit.

Exception: Equipment housed in a turbine nacelle shall not be required to have a disconnecting means.

694.26 Fuses.

Means shall be provided to disconnect a fuse from all sources of supply where the fuse is energized from both directions and is accessible to other than qualified persons. Switches, pullouts, or similar devices that are rated for the application shall be permitted to serve as a means to disconnect fuses from all sources of supply.

694.28 Installation and Service of a Wind Turbine.

Open circuiting, short circuiting, or mechanical brakes shall be used to disable a turbine for installation and service.

Informational Note: Some wind turbines rely on the connection from the alternator to a remote controller for speed regulation. Opening turbine output circuit conductors may cause mechanical damage to a turbine and create excessive voltages that could damage equipment or expose persons to electric shock.

Part IV. Wiring Methods

694.30 Permitted Methods.

(A) Wiring Systems.

All raceway and cable wiring methods included in this *Code*, and other wiring systems and fittings specifically intended for use on wind turbines, shall be permitted. In readily accessible locations, turbine output circuits that operate at voltages greater than 30 volts shall be installed in raceways.

(B) Flexible Cords and Cables.

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

(C) Direct-Current Turbine Output Circuits Inside a Building.

Direct-current turbine output circuits installed inside a building or structure shall be enclosed in metal raceways or installed in metal enclosures, or run in Type MC metal-clad cable that complies with 250.118(10), from the point of penetration of the surface of the building or structure to the first readily accessible disconnecting means.

Part V. Grounding and Bonding

694.40 Equipment Grounding and Bonding.

(A) General.

Exposed non–current-carrying metal parts of towers, turbine nacelles, other equipment, and conductor enclosures shall be grounded and bonded to the premises grounding and bonding system. Attached metal parts, such as turbine blades and tails that are not likely to become energized, shall not be required to be grounded or bonded.

(B) Tower Grounding and Bonding.

(1) Grounding Electrodes and Grounding Electrode Conductors.

A wind turbine tower shall be connected to a grounding electrode system. Where installed in close proximity to galvanized foundation or tower anchor components, galvanized grounding electrodes shall be used.

> Informational Note: Copper and copper-clad grounding electrodes, where used in highly conductive soils, can cause electrolytic corrosion of galvanized foundation and tower anchor components.

(2) Bonding Conductor.

Equipment grounding conductors or supply-side bonding jumpers, as applicable, shall be required between turbines, towers, and the premises grounding system.

(3) Tower Connections.

Equipment grounding, bonding, and grounding electrode conductors, where used, shall be connected to metallic towers using listed means. All mechanical elements used to terminate these conductors shall be accessible.

(4) Guy Wires.

Guy wires used to support turbine towers shall not be required to be connected to an equipment grounding conductor or to comply with the requirements of 250.110.

> Informational Note: Guy wires supporting grounded towers are unlikely to become energized under normal conditions, but partial lightning currents could flow through guy wires when exposed to a lightning environment. Grounding of metallic guy wires may be required by lightning standards. For information on lightning protection systems, see NFPA 780-2017, *Standard for the Installation of Lightning Protection Systems*.

Part VI. Marking

694.50 Interactive System Point of Interconnection.

All interactive system points of interconnection with other sources shall be marked at an accessible location at the disconnecting means and with the rated ac output current and the nominal operating ac voltage.

694.52 Power Systems Employing Energy Storage.

Wind electric systems employing energy storage shall be marked with the maximum operating voltage, any equalization voltage, and the polarity of the grounded circuit conductor.

694.54 Identification of Power Sources.

Wind turbine systems shall be identified according to 694.54(A) through (C).

(A) Interconnected AC Systems.

Plaques or directories shall be installed in accordance with 705.10.

(B) DC Microgrid Systems.

Plaques or directories shall be installed in accordance with 712.10.

(C) Stand-Alone Systems.

Plaques or directories shall be installed in accordance with 710.10.

694.56 Instructions for Disabling Turbine.

A plaque shall be installed at or adjacent to the turbine location providing basic instructions for disabling the turbine.

Part VII. Connection to Other Sources

694.60 Identified Interactive Equipment.

Only inverters that are listed, labeled, and identified as interactive shall be permitted in interactive systems.

694.62 Installation.

Wind electric systems, where connected to utility electric sources, shall comply with the requirements of Article 705.

694.66 Operating Voltage Range.

Wind electric systems connected to dedicated branch or feeder circuits shall be permitted to exceed normal voltage operating ranges on these circuits, provided that the voltage at any distribution equipment supplying other loads remains within normal ranges.

> Informational Note: Wind turbines might use the electric grid to dump energy from short-term wind gusts. Normal operating voltages are defined in ANSI C84.1-2006, *Voltage Ratings for Electric Power Systems and Equipment (60 Hz)*.

694.68 Point of Connection.

Points of connection to interconnected electric power sources shall comply with 705.12.

Part VII Large Scale Wind Electric Systems

This part covers the installation of wind electric supply stations with an inverter generating capacity of not less than 5000 Kw, and not under the exclusive utility control.

694.xx

Electric Supply Station

Locations containing the generating stations and substations, including their associated generator, storage battery, transformer and switchgear areas.

Generating Station

A plant wherein electric energy is produced by conversion from some other formof energy(e.g. chemical, nuclear, wind, mechanical or hydraulic0 BY MEANS OF SUITABLE APPARATUS.

694.xx Special Requirements for Large Scale Wind Electric Supply Stations

Large scal Wind electric supply stations shall be accessible only to qualified personnel and comply with the following:

(1) Electrical circuits and equipment shall be maintained and operated only by qualified personnel

(2) Access to Wind electric supply stations shall be restricted by fencing or other adequate means in accordance with 110.31 Field applied hazard marking shall applied in accordance with 110.21 (B)

(3) The connection of the wind electric supply station and the system operated by a utility for the transfer of electrical energy shall be through medium or high voltage switchgear, substation, switch yard or similar methods whose sole purpose shall be to safely and effectively interconnect the two systems.

(4) The electrical loads within the wind electric supply station shall only be used to power auxillary equipment for the generation of the wind power.

694.xx Equipment

(1) Listing and Labeling

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

(3) Where products compluing with 694.xx (1) or (2) are not available, by engineering review validating that the electrical equipment is evaluated and tested to relevant standards or industry proctices.

694.xx Engineered Design

Documentation of the electrical portion of the engineered design of the electric supply station shall be stamped and provided upon request to the AHJ. Additional stamped independent engineering reports detailing compliance of the design with applicable electrical standards and industry proctices shall be provided upon request of the AHJ, the independent engineer shall be a licensed professional electrical engineer retained by the system owner or installer. This documentatin shall include details of conformance of the design with Article 694 or other articles of this code.

694.xx Conformance to Construction to Engineered Design Same as 691.7 substitute Wind in place of PV

Documentation that the construction of the electric supply station conforms to the electrical engineered design shall be providedupon request to the AHJ.Additional stamped independent engineering reports detailing compliance of the design with applicable electrical standards and industry proctices shall be provided upon request of the AHJ, the independent engineer shall be a licensed professional electrical engineer retained by the system owner or installer. This documentatin where requested shall be available prior to commercial operation of the station

694.xx Operating Voltage

For large scale Wind electric supply stations, calculations shall be included in the documentation.

694.xx Disconnection means for Isolatining Wind Systems.

Isolating devices shall not be required within sight of equipment snd shall be permitted to be remotely locatedfrom the equipment. The engineered design shall document the disconnection procedures and means of isolating the equipment.

Informational note: For information on electrical system maintenance see NFPA 70 B-2019, Recommended practice for Electrical Equipment Maintenance. For information on written procedures snd conditions of maintenance, including lockout/tagout procedures, see NFPA 70E-2021

Building whosee sole purpose is to house and protect supply station equipment shall not be required to comply woith shut down requirements. Written operating instructions shall be available at the site detailing necessary shutdown procedures in the event of an emergency.

694.xx Arc-Fault Mitigation

Wind systems shall include details of fire mitigation plans to address arc-faults in the documentation.

694.xx Fence Bonding andGrounding

Fence Grounding requirements and details shall be included in the documentation.

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

Statement of Problem and Substantiation for Public Input

As with Article 691 large scale wind electric supply stations have restricted access and by allowing for these modifications this equipment can be installed in a safe manner. these systems are not accessible by the general public.

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Committee: NEC-P04

Public Input No. 3944-NFPA 70-2020 [Section No. 694.2]

(Relocate all definitions in the 694. 2 to Article 100, arrange them in alphabetical order and without any subdivisions.)

694. 2 Definitions.

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

Diversion Charge Controller.

Equipment that regulates the charging process of a battery or other energy storage device by diverting power from energy storage to dc or ac loads, or to an interconnected utility service.

Diversion Load.

A load connected to a diversion charge controller or diversion load controller, also known as a dump load.

Diversion Load Controller.

Equipment that regulates the output of a wind generator by diverting power from the generator to dc or ac loads or to an interconnected utility service.

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).

Maximum Voltage.

The maximum voltage the wind turbine produces in operation including open circuit conditions.

Nacelle.

An enclosure housing the alternator and other parts of a wind turbine.

Rated Power.

The output power of a wind turbine at its rated wind speed.

Informational Note: The method for measuring wind turbine power output is specified in IEC 61400-12-1, *Power Performance Measurements of Electricity Producing Wind Turbines*.

Tower (as applied to wind electric systems).

A pole or other structure that supports a wind turbine.

Wind Turbine.

A mechanical device that converts wind energy to electrical energy.

Wind Turbine Output Circuit.

The circuit conductors between the internal components of a wind turbine (which might include an alternator, integrated rectifier, controller, and/or inverter) and other equipment.

Informational Note: See also definitions for interconnected systems in Article 705.

Statement of Problem and Substantiation for Public Input

"The National Electrical Code has definitions in multiple parts in Article 100 and many definitions scattered through out the code many of them in the .2 section of the articles.
Most of the other standards under NFPA have their definitions in one location and this will allow the NEC the same requirement. The revisions to the NEC Style Manual require all the definitions to be relocated to Article 100. "

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Committee: NEC-P04

Public Input No. 3000-NFPA 70-2020 [Definition: Wind Turbine Output Circuit.]

Wind Turbine Output Circuit.

The circuit conductors between the internal components of a wind turbine (which might include an alternator, integrated rectifier, controller, and/or inverter) and other equipment.

~~Informational Note: See also definitions for interconnected systems in Article 705 .~~

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

Interconnected Systems is not a defined term. This is being deleted to increase clarity and remove possible points of confusion.

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Committee: NEC-P04

Public Input No. 780-NFPA 70-2020 [New Definition after Definition: Wind Turbine Output Circui...]

TITLE OF NEW CONTENT

Type your content here ...

694.5 Electromagnetic Pulse (EMP) Protection. Protection for wind electric systems against the effects of electromagnetic pulses shall be provided at a minimum of Level 2. See 709.7 for levels of electromagnetic pulse protection.

Exception: The requirements of 709.7(A)(5) and 709.7(B)(3) shall not apply.

This requirement shall become effective January 1, 2026.

Statement of Problem and Substantiation for Public Input

A devastating electromagnetic pulse (EMP), caused by a sun-spot or a nuclear bomb exploded high in the atmosphere, can impress 50,000 volts per meter on unprotected electrical and electronic equipment. It is similar to a radio wave impressing a very small voltage on a radio antenna, only orders of magnitude larger. The problem is that a significant EMP will fry every electrical/electronic component or piece of equipment that is not protected.

The EMP won't directly harm or injure people, but because there is no longer a working electrical infrastructure, which may take years to repair/rebuild, people will die from the lack of clean water, medicine, food, fuel, and eventual rioting due to the breakdown of society. Unclassified studies, referenced at the end of this substantiation, have estimated from 66% to 90% of the US population will die within one year if a significant sun spot were to occur or if a nuclear explosion were to occur 25 to 250 miles over the Midwest.

Our US military already "hardens" systems/buildings so that our country's critical defensive capabilities are not completely destroyed. There are two major methods of protecting electrical/electronic systems. The first is that surge protective devices are installed on all "incoming" power and communications cables, shunting overvoltages to ground. The second is that Faraday cages are installed around equipment/rooms, preventing the EMP from reaching critical equipment/components.

The NEC® needs to address EMP protection for equipment, systems and special occupancies that are critical to our survival. Electrical and electronic equipment can and must be protected, as has been achieved by our military. Unfortunately, there are no requirements to protect civilian electrical and electronic equipment/systems from EMPs.

The NEC Correlating Committee has informally advised that an EMP Protection Article, if passed and adopted into the NEC®, would be most appropriately located after Article 708 (COPS). Thus, Public Input 756 has suggested a new Article 709 under jurisdiction of CMP 13, which already has purview over Emergency Systems (Article 700), Legally Required Standby Systems (Article 701), Optional Standby Systems (Article 702), and Critical Operations Power Systems (Article 708).

Levels of protection and associated protection requirements listed in the Public Input(s) are based upon the unclassified National Cybersecurity and Communications Integration Center report "Electromagnetic Pulse (EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment". This study explains electromagnetic pulses and provides the necessary protective measures. It also contains estimates of the costs associated with properly protecting our electrical infrastructure.
The following table contains critical infrastructure components/special occupancies and the maximum time for outages caused by an EMP. Electrical components/infrastructure that is not functioning for periods longer than shown in this table may begin to cause injury or death to people and harm to society/economy.
Critical Infrastructure Component/Special Occupancy Permitted Outage Time

Branch banking facilities 10 hours
Critical Operations Power Systems 10 minutes
Data centers 10 minutes
Direct current microgrids 10 hours
Drug stores/distribution centers 10 hours
Electrically driven or controlled irrigation machines 1 week
Elevators, dumbwaiters, escalators, moving walks, platform lifts, and stairway chairlifts See facility requirements
Emergency systems 10 hours
Energy storage systems 10 hours
Fire alarm systems 1 week
Fire houses/stations 10 hours
Fire pumps 10 hours
Food processing and storage facilities 10 hours
Fuel cell systems 10 hours
Generators 10 hours
Grocery stores 10 hours
Hardware stores/home centers 10 hours
Healthcare facilities See NFPA 99
Information technology equipment 10 minutes
Interconnected electric power production sources 10 minutes
Jails and prisons 10 minutes
Large-scale photovoltaic (PV) electric supply stations 10 hours
Legally required standby systems 10 hours
Modular data centers 10 minutes
Motor fuel dispensing facilities 1 week
Motors, motor circuits, and controllers See facility requirements
Nuclear reactors 10 seconds
Optional standby systems 1 week
Petrochemical plants/facilities 10 hours
Pharmaceutical plants/facilities 10 hours
Police stations 10 minutes
Solar photovoltaic (PV) systems 10 hours
Stand-alone systems 10 hours
Storage batteries See facility requirements
Transformers See facility requirements
Waste water treatment facilities 10 minutes
Water supply facilities 10 hours
Wind electric systems 10 hours

An effectivity date of January 1, 2026 is chosen to allow time for engineering and industry to adequately pan and prepare for the required changes.

Opponents of EMP protection requirements will likely charge that it is too costly to protect our critical infrastructure, and that the NEC® is not a war-time document. A close reading of 90.1 reveals that there is no mention of the “cost” of safeguarding persons and property. Neither does 90.1 mention that safeguarding persons and property is only required during peacetime. Additionally, a significant EMP event, caused by a sunspot, would be an act of God, not an act of war.

The novel, “One Second After”, provides an understanding of what happens when the majority of all unprotected electrical and electronic equipment/systems is destroyed during an EMP event. An audio version of this book is available in two parts, for free, on YouTube.

This link provides the unclassified report “Electromagnetic Pulse (EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment”
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=2ahUKEwjQhp2-77DoAhXBHM0KHboOB2QQFjACegQIBRAC&url=https%3A%2F%2Fwww.cisa.gov%2Fsites%2Fdefault%2Ffiles%2Fpublications%2F19_0307_CISA_EMP-Protection-Resilience-Guidelines.pdf&usg=AOvVaw2n7jLtJAUJtOJKHPMqWsTE

This link provides the study predicting up to 90% of our population could die from an EMP event

http://www.firstempcommission.org/uploads/1/1/9/5/119571849
/nuclear_emp_attack_scenarios_and_combined-arms_cyber_warfare_by_peter_pry_july_2017.pdf

This link provides unclassified guidelines for facility EMP protection
https://info.publicintelligence.net/DHS-FacilitiesGuidelinesEMP.pdf

These links provide Parts 1 and 2 of a national plan for EMP protection.
https://interferencetechnology.com/a-national-plan-for-emp-protection-part-1/
https://interferencetechnology.com/national-plan-emp-protection-part-2-protection-buildings/

We have all just witnessed the chaos and pain caused by not having the “protections” in place to quickly defeat the Covid-19 virus. As unfortunate, costly, painful, and deadly as Covid-19 was, it would be child’s play when compared to a significant EMP event if our critical electrical/electronic infrastructure remains unprotected. Quite simply, NEC® requirements to protect electrical and electronic equipment from an EMP event, could literally save millions of American lives.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 756-NFPA 70-2020 [New Section after 708.64]	
Public Input No. 756-NFPA 70-2020 [New Section after 708.64]	

Submitter Information Verification

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Committee: NEC-P04

Public Input No. 477-NFPA 70-2020 [Section No. 694.7]

694.7 Installation and Maintenance .

Systems covered by this article shall be installed and maintained 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.

(B) Equipment.

Wind electric systems shall be approved for the application in accordance 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: Testing for certification and listing is typically performed under the supervision of a qualified electrical testing organization.

(C) 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) Surge Protective Devices (SPD).

A surge protective device shall be installed between a wind electric system and any loads served by the premises electrical system. The surge protective device shall be permitted to be a 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. Surge protective devices shall be installed in accordance with Part II of Article 242.

(E) 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) 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) 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 for systems up to 1000 V nominal.

Table 694.7 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

The code needs to provide clarity that not only do wind electric systems need to be installed by qualified persons, these systems should also be maintained by qualified persons.

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Public Input No. 3998-NFPA 70-2020 [Section No. 694.7(B)]

(B) Equipment.

Wind electric systems shall be approved for the application and installation location (onshore or off-shore) in accordance 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: Testing for certification and listing is typically performed under the supervision of a qualified electrical testing organization.

Statement of Problem and Substantiation for Public Input

Off-shore wind turbines are becoming more common and these generators maybe located within the jurisdiction of the NEC. Requiring these systems to be listed for the specific application ensure these hazards are taken into consideration and facilitate inspection by the local AHJs.

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Submittal Date: Wed Sep 09 16:58:12 EDT 2020
Committee: NEC-P04

Public Input No. 4002-NFPA 70-2020 [Section No. 694.7(B)]

(B) Equipment.

Wind electric systems shall be approved for the application in accordance 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: ~~Testing for certification and listing~~ For further information on wind turbine equipment, see ANSI/ UL 6141 , Standard for Wind Turbines Permitting Entry of Personnel , and ANSI / UL 6142 , Standard for Small Wind Turbine Systems. Testing is typically performed under the supervision of a qualified electrical testing organization.

Statement of Problem and Substantiation for Public Input

Substantiation – The Standard for Wind Turbines Permitting Entry of Personnel, UL 6141, and the Standard for Small Wind Turbine Systems, UL 6142 were specifically written to address wind turbine equipment for the US market considering installation within the scope of the NEC and NESC. These two standards provide a certification (listing) pathway for equipment designed to US and international standards.

It is critical that wind turbines operate safely under normal and foreseeable abnormal fault conditions. The industrial control equipment standards often used for wind turbine components do not address the electrical and environmental conditions of use in the wind turbine application. It is safety critical that equipment be listed to the correct standard developed for wind turbine power production applications. This informational note is similar to the one used in 625 and 706 to provide guidance to the appropriate safety standard for the application.

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Public Input No. 3042-NFPA 70-2020 [Section No. 694.7(D)]

(D) ~~Surge Protective Devices (SPD).~~ Overvoltage Protection

A listed surge- protective device (SPD) shall be installed between a wind electric system and any loads served by the premises electrical system. The ~~surge protective device~~ 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. ~~Surge protective devices~~ SPDs shall be installed in accordance with Part II of Article 242.

Statement of Problem and Substantiation for Public Input

The purpose of this public input is to correlate and harmonize all of the current sections of the code where “overvoltage protection” is required by:

1. Changing the section titles to “Overvoltage Protection” to properly correlate with Article 242.

2. Correcting the product description to “listed surge-protective device (SPD)” which is defined in Article 100 and correlates with Article 242.

3. Adding a pointer to “Part II. of Article 242” to ensure compliance with all of the requirements for SPDs are met when complying with the rule.

This public input is one of eleven correlating public inputs covering Sections 230.67, 501.35, 502.35, 620.51(E), 645.18, 670.6, 694.7(D), 695.15, 700.8, 708.20(D), and Informative Annex G.

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Public Input No. 3216-NFPA 70-2020 [Section No. 694.7(D)]

(D) ~~Surge Protective Devices (SPD).~~

~~A surge protective device~~

Overvoltage Protection.

Overvoltage protection shall be installed between a wind electric system and any loads served by the premises electrical system. The ~~surge~~ overvoltage protective device shall be permitted to be a VSGR, 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. ~~Surge~~ Overvoltage protective devices shall be installed in accordance with Part II of Article 242.

Additional Proposed Changes

File Name	Description	Approved
Code_Input.docx	input to improve overvoltage protection requirements	

Statement of Problem and Substantiation for Public Input

In the 2020 NEC cycle, ARTICLES 280 and 285 were combined to make ARTICLE 242. This was a positive change that began to address the issue of OVERVOLTAGE as a technical subject apart from particular product methods (SPDs and Surge Arresters). There are other technologies and products to address the issue of OVERVOLTAGE. This input attempts to add one such technology as well as correlate the other code references to the subject of OVERVOLTAGE, surge protective devices, and surge arresters to be consistent. This is important to allow for other technologies to be utilized without prejudice to certain products promoted by manufacturers.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3200-NFPA 70-2020 [Section No. 242.1]	
Public Input No. 3202-NFPA 70-2020 [New Article after 100]	
Public Input No. 3203-NFPA 70-2020 [New Article after 242]	
Public Input No. 3205-NFPA 70-2020 [Section No. 501.35]	
Public Input No. 3206-NFPA 70-2020 [Section No. 502.35]	
Public Input No. 3208-NFPA 70-2020 [Section No. 551.72(E)]	
Public Input No. 3209-NFPA 70-2020 [Section No. 490.24]	
Public Input No. 3210-NFPA 70-2020 [Section No. 490.48(A)]	
Public Input No. 3211-NFPA 70-2020 [Section No. 620.51(E)]	
Public Input No. 3212-NFPA 70-2020 [Section No. 645.18]	
Public Input No. 3214-NFPA 70-2020 [Section No. 670.6]	
Public Input No. 3217-NFPA 70-2020 [Section No. 695.15]	
Public Input No. 3218-NFPA 70-2020 [Section No. 700.8]	
Public Input No. 3219-NFPA 70-2020 [Section No. 708.20(D)]	

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Substantiation for Changes: In the 2020 NEC cycle, ARTICLES 280 and 285 were combined to make ARTICLE 242. This was a positive change that began to address the issue of OVERVOLTAGE as a technical subject apart from particular product methods (SPDs and Surge Arresters). There are other technologies and products to address the issue of OVERVOLTAGE. This input attempts to add one such technology as well as correlate the other code references to the subject of OVERVOLTAGE, surge protective devices, and surge arresters to be consistent. This is important to allow for other technologies to be utilized without prejudice to certain products promoted by manufacturers.

ARTICLE 100 - DEFINITIONS

Voltage Stabilizing Ground Reference (VSGR) System – an engineered assembly of interconnected passive inductive devices that utilize mutual counter electro-magnetic inductance to stabilize phase voltages of a connected supply system with respect to each other and to ground.

ARTICLE 242 Overvoltage Protection

Part I. General

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

Informational Note: Article 242 combines and replaces Articles 280 and 285 in *NFPA 70*-2017.

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

Table 242.3 Other Articles

Equipment	Article
Class I locations	501
Class II locations	502
Community antenna television and radio distribution systems	820
Critical operations power systems	708

Table 242.3 Other Articles

Equipment	Article
Elevators, dumbwaiters, escalators, moving walks, platform lifts, and stairway chairlifts	620
Emergency systems	700
Equipment over 1000 volts, nominal	490
Fire pumps	695
Industrial machinery	670
Information technology equipment	645
Modular data centers	646
Outdoor overhead conductors over 1000 volts	399
Radio and television equipment	810
Receptacles, cord connectors, and attachment plugs (caps)	406
Wind electric systems	694

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

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

242.6 Uses Not Permitted.

An SPD device shall not be installed in the following:

1. (1)

   Circuits over 1000 volts

2. (2)

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

3. (3)

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

242.8 Listing.
An SPD shall be a listed device.

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

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

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

1. (1)

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

2. (2)

   As specified in 242.14

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

1. (1)

   Grounded service conductor

2. (2)

   Grounding electrode conductor

3. (3)

   Grounding electrode for the service

4. (4)

   Equipment grounding terminal in the service equipment

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

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

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

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

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

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

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

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

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

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

242.28 Conductor Size.
Line and grounding conductors shall not be smaller than 14 AWG copper or 12 AWG aluminum.

242.30 Connection Between Conductors.
An SPD shall be permitted to be connected between any two conductors — ungrounded conductor(s), grounded conductor, equipment grounding conductor, or grounding electrode conductor. The grounded conductor and the equipment grounding conductor shall be interconnected only by the normal operation of the SPD during a surge.

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

Part III. Surge Arresters, Over 1000 Volts

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

242.42 Surge Arrester Selection.
The surge arresters shall comply with 242.42(A) and (B).

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

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

242.42(A)(2) Impedance or Ungrounded System.

The maximum continuous operating voltage shall be the phase-to-phase voltage of the system.

242.42(B) Silicon Carbide Types.

The rating of a silicon carbide-type surge arrester shall be not less than 125 percent of the rating specified in 242.42(A).

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

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

242.44 Number Required.

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

242.46 Location.

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

242.48 Routing of Surge Arrester Equipment Grounding Conductors.

The conductor used to connect the surge arrester to line, bus, or equipment and to an equipment grounding conductor or grounding electrode connection point as provided in 242.50 shall not be any longer than necessary and shall avoid unnecessary bends.

242.50 Connection.

The arrester shall be connected to one of the following:

1. (1)

   Grounded service conductor

2. (2)

   Grounding electrode conductor

3. (3)

   Grounding electrode for the service

4. (4)

   Equipment grounding terminal in the service equipment

242.52 Surge-Arrester Conductors.

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

242.54 Interconnections.

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

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

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

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

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

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

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

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

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

Part IV. Voltage Stabilizing Ground Reference (VSGR) systems.

242.68 Listing.
A VSGR shall be a listed device or system composed of listed components.

242.70 Short-Circuit Current Rating.
The VSGR shall be marked with a short-circuit current rating and shall not be installed at a point on the system where the available fault current is in excess of that rating.

242.71 Voltage Rating.
The rating of the VSGR shall be equal to or greater than the maximum system continuous operating voltage at the point of application.

242.72 Installation.
VSGRs shall be installed in accordance with 242.72(A) through (C).

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

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

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

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

242.84 Conductor Size.
Line and grounding conductors shall not be smaller than 14 AWG copper or 12 AWG aluminum.

242.90 Connection Between Conductors.
VSGR connections shall follow the manufacturer's instructions for the system connections.

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

501.35 Overvoltage ~~Surge~~ Protection.

501.35(A) Class I, Division 1.
Overvoltage protection devices, surge arresters, surge-protective devices, and capacitors shall be installed in enclosures identified for Class I, Division 1 locations. Surge-protective capacitors shall be of a type designed for specific duty.

501.35(B) Class I, Division 2.
Overvoltage protection devices, surge arresters and surge-protective devices shall be nonarcing, such as metal-oxide varistor (MOV) sealed type, and surge-protective capacitors shall be of a type designed for specific duty. Enclosures shall be permitted to be of the general-purpose type. Overvoltage ~~Surge~~ protection of types other than described in this paragraph shall be installed in enclosures identified for Class I, Division 1 locations.

502.35 Overvoltage ~~Surge~~ Protection — Class II, Divisions 1 and 2.
Overvoltage protection devices, surge arresters and surge-protective devices installed in a Class II, Division 1 location shall be in suitable enclosures. Surge-protective capacitors shall be of a type designed for specific duty.

551.72(E) Connected Devices.
The use of autotransformers shall not be permitted. The use of listed overvoltage and surge protective devices shall be permitted.

Table 490.24 Minimum Clearance of Live Parts

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

490.48(A) Design and Documentation.

(12) Overvoltage ~~Surge~~ arresters

620.51(E) Overvoltage ~~Surge~~ Protection.
Overvoltage protection shall be provided where any of the disconnecting means in 620.51 has been designated as supplying an emergency system load, a legally required system load, or a critical operation power system load, ~~listed surge protection shall be provided.~~

645.18 Overvoltage ~~Surge~~ Protection for Critical Operations Data Systems.
Overvoltage ~~Listed surge~~ protection shall be provided for critical operations data systems.

670.6 Surge Protection.
Industrial machinery with safety interlock control devices not effectively protected from voltage surges on the incoming supply circuit shall have overvoltage ~~surge~~ protection installed.

694.7(D) Overvoltage Protection ~~Surge Protective Devices (SPD).~~
Overvoltage protection ~~A surge protective device~~ shall be installed between a wind electric system and any loads served by the premises electrical system. The ~~surge~~ protective device shall be permitted to be a VSGR, or a Type 3 SPD on the circuit serving a wind electric system, or a Type 2 SPD located anywhere on the load side of the service disconnect. Overvoltage ~~Surge~~ protective devices shall be installed in accordance with Part II of Article 242.

695.15 Overvoltage ~~Surge~~ Protection.
Overvoltage ~~A listed surge~~ protection ~~device~~ shall be provided for ~~installed in or on~~ the fire pump controller.

700.8 Overvoltage ~~Surge~~ Protection.
Overvoltage protection ~~A listed SPD~~ shall be provided ~~installed in or on~~ for all emergency systems switchboards and panelboards.

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

Surge protection devices shall be provided at all facility distribution voltage levels

Public Input No. 4102-NFPA 70-2020 [Section No. 694.15(A)]

(A) Circuits and Equipment.

Turbine output circuits, inverter output circuits, and storage battery circuit conductors and equipment shall be protected in accordance ~~with the requirements of~~ with Article 240. Circuits connected to more than one electrical source shall have overcurrent devices located so as to provide overcurrent protection from all sources.

Exception: An overcurrent device shall not be required for circuit conductors sized in accordance with 694.12(B) where the maximum current from all sources does not exceed the ampacity of the conductors.

Informational Note: Possible backfeed of current from any source of supply, including a supply through an inverter to the wind turbine output circuit, is a consideration in determining whether overcurrent protection from all sources is provided. Some wind electric systems rely on the turbine output circuit to regulate turbine speed. Inverters may also operate in reverse for turbine startup or speed control.

Statement of Problem and Substantiation for Public Input

Deleting the words ""the requirements of"" does not change the meaning of the section.
The panel should consider revising the section due to a Style Manual issue 4.1.4 where a section shall not reference a complete article.

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Public Input No. 4089-NFPA 70-2020 [Section No. 694.22(C)(1)]

(1) Location.

The wind electric system disconnecting means shall be installed at a readily accessible location either on or adjacent to the turbine tower, on the outside of a building or structure, or inside at the point of entrance of the wind system conductors.

Exception: Installations that comply with 694.30(C) shall be permitted to have the disconnecting means located remotely from the point of entry of the wind system conductors.

A wind turbine disconnecting means shall not be required to be located at the nacelle or tower.

The disconnecting means shall not be installed in bathrooms.

~~For one-family and two-family dwellings, a disconnecting means or manual shutdown button or switch shall be located at a readily accessible location outside the building.~~

694.22(C)(5). **Emergency Disconnect/Shutdown.** For one- and two-family dwellings, an emergency disconnecting or shutdown means shall comply with (1) through (4).

(1) Be located in a readily accessible location outside the building

(2) Be located within 1 m (3 ft) of any required emergency service disconnect or where there is no required emergency service disconnect, shall be located within 1 m (3 ft) of any other power source emergency disconnect or any PV rapid shutdown initiator

(3) If remotely controlled, the remote-control system shall be “fail safe” where the disconnect automatically opens or the wind system is shutdown on loss of control signal or control power

(4) Be labeled “EMERGENCY WIND SYSTEM DISCONNECT/SHUTDOWN” and comply with 110.21(B).

Statement of Problem and Substantiation for Public Input

This proposal is one of several related, but separate proposals involving the 2020 NEC requirements for external (outside the building) emergency disconnects on one- and two-family dwellings for energy sources such as the utility service, batteries, fuel cell systems, energy storage systems (ESS), wind systems and also stand-alone PV systems plus PV rapid shutdown systems. The intent of these proposals is to require multiple emergency disconnects to be grouped in one location to increase safety for Fire Service responders.

Also, when remote activation of these disconnects is allowed, the proposal establishes an additional safety requirement that the remote controls be fail safe and in the event of loss of control power or control signal, the emergency disconnect shall automatically be opened.

It has been determined that some inverter manufacturers are already starting to put inputs on their products to allow an external remote shutdown control system that is fail safe. Also, it has been determined that adding such a fail-safe remotely controlled emergency disconnect system is relatively inexpensive using voltage-trip circuit breakers and a relay on large battery banks or ESS.

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Public Input No. 2980-NFPA 70-2020 [Section No. 694.24]

694.24 Disconnection of Wind Electric System Equipment.

Means shall be provided to disconnect equipment, such as inverters, batteries, and charge controllers, from all ungrounded conductors of all sources. If the equipment is energized from more than one source, the disconnecting means shall be grouped and identified.

A single disconnecting means in accordance with 694.22 shall be permitted for the combined ac output of one or more inverters ~~in an interactive system~~ .

A shorting switch or plug shall be permitted to be used as an alternative to a disconnect in systems that regulate turbine speed using the turbine output circuit.

Exception: Equipment housed in a turbine nacelle shall not be required to have a disconnecting means.

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

As part of this task group's effort, the term Interactive system is being changed and will no longer exist should the PI be accepted. This section is accurate and more concise without this language. there is no need to add reference to the newly created term of interactive mode.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2684-NFPA 70-2020 [Definition: Interactive System.]	New Term / Definition

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Public Input No. 3846-NFPA 70-2020 [Section No. 694.30(A)]

(A) Wiring Systems.

All raceway and cable wiring methods included in Chapter 3 of this *Code*, and other wiring systems and fittings specifically intended for use on wind turbines, shall be permitted. In readily accessible locations, turbine output circuits that operate at voltages greater than 30 volts shall be installed in raceways.

Statement of Problem and Substantiation for Public Input

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

This Task Group's initial tasks were to establish a demarcation for what can be referred to as Medium or High Voltage. The recommendation has been to establish this threshold as being equipment rated over 1000 Vac, 1500 Vdc.

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

This proposed change provides consistency in the Alternative Energy articles in order to address the wiring system(s) and/or method(s) that could be encountered within or as a part of the system (solar, wind or energy storage) installation. By adding the reference back to Chapter 3, the new text will correlate with the existing language found in NEC 692.31 for "Wiring Systems" for Fuel Cell Systems and provide direction to the installer, so that regardless of the voltage, all wiring systems and methods would comply with the applicable Chapter 3 Article.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3728-NFPA 70-2020 [Global Input]	Companion Public Input (Articles 245 and 495)
Public Input No. 3765-NFPA 70-2020 [New Section after 250.194(B)]	Companion Public Input (Article 255)
Public Input No. 3772-NFPA 70-2020 [New Section after 110.79]	Companion Public Input (Article 115)
Public Input No. 3815-NFPA 70-2020 [New Section after 200.11]	Companion Public Input (Article 205)
Public Input No. 3819-NFPA 70-2020 [Global Input]	Companion Public Input (Article 235)
Public Input No. 3827-NFPA 70-2020 [Global Input]	Companion Public Input (Article 305)
Public Input No. 3838-NFPA 70-2020 [Section No. 690.31(A)]	Companion Public Input (Section 690.31(A))
Public Input No. 3849-NFPA 70-2020 [New Part after IV.]	Companion Public Input (Section 706.30)
Public Input No. 3728-NFPA 70-2020 [Global Input]	

Public Input No. 3765-NFPA 70-2020 [New Section after 250.194(B)]

Public Input No. 3772-NFPA 70-2020 [New Section after 110.79]

Public Input No. 3815-NFPA 70-2020 [New Section after 200.11]

Public Input No. 3819-NFPA 70-2020 [Global Input]

Public Input No. 3827-NFPA 70-2020 [Global Input]

Public Input No. 3838-NFPA 70-2020 [Section No. 690.31(A)]

Public Input No. 3849-NFPA 70-2020 [New Part after IV.]

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Public Input No. 2981-NFPA 70-2020 [Section No. 694.50]

694.50 Interactive System Point of Interconnection.

~~All interactive system points~~ All points of interconnection with other sources shall be marked at an accessible location at the disconnecting means and with the rated ac output current and the nominal operating ac voltage.

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

The work of this committee includes modifying the term Interactive System found in Article 100. With this modification this term is no longer defined and so this section is impacted. This public input is simply removing this language as its removal helps remove possible confusion and this section is not technically impacted without it being there.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2684-NFPA 70-2020 [Definition: Interactive System.]	Term / Definition change

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Public Input No. 3001-NFPA 70-2020 [Section No. 694.54]

694.54 Identification of Power Sources.

Wind turbine systems shall be ~~identified according to~~ 694.54(A) ~~through (C).~~

~~**(A)** Interconnected AC Systems.~~

~~Plaques or directories shall be installed in accordance with~~ 705.10 ~~.~~

~~**(B)** DC Microgrid Systems.~~

~~Plaques or directories shall be installed in accordance with~~ 712.10 ~~.~~

~~**(C)** Stand-Alone Systems.~~

~~Plaques or directories shall be installed in accordance with~~ 710.10 ~~.~~

marked with a plaque or directory installed in accordance with 689.10 .

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

This modification is necessary as 710, 712 and 689 are combined as part of this task group effort into a new Article 689. The proper reference for plaques and directories is found in 689.10 only. In addition, this section was simplified as only one reference section exists. Changes simplify and add clarity.

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Public Input No. 1500-NFPA 70-2020 [Section No. 694.62]

694.62 Installation.

(A) Utility.

Wind electric systems, where connected to utility electric sources, shall comply with the requirements of Article 705.

(B) Energy Storage System.

An energy storage system connected to a wind electric system shall be installed in accordance with Article 706.

Statement of Problem and Substantiation for Public Input

Currently ESS's are being installed in conjunction with wind systems. As Article 706 is a relatively new article, there needs to be a requirement like 690.71 where users of this code are directed to the additional requirements of ESS's.

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Public Input No. 3002-NFPA 70-2020 [Section No. 694.62]

~~**694.62** Installation.~~

~~Wind electric systems, where connected to utility electric sources, shall comply with the requirements of Article 705 .~~

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

New organization of these articles makes it clear that all sources that are combined with other sources must be installed in accordance with Article 689. The reference to Article 705, which violates the style manual, is not necessary.

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Public Input No. 1438-NFPA 70-2020 [Article 705]

Article 705 Interconnected Electric Power ~~Production~~ Generating Sources

Part I. General

705.1 Scope.

This article covers installation of one or more electric power ~~production~~ generating sources operating in parallel with a primary source(s) of electricity.

Informational Note: Examples of the types of primary sources include a utility supply or an on-site electric power source(s).

705.2 Definitions.

The definitions in this section shall apply within this article and throughout the *Code*.

Microgrid Interconnect Device (MID).

A device that enables a microgrid system to separate from and reconnect to operate in parallel with a primary power source.

Informational Note: Microgrid controllers typically are used to measure and evaluate electrical parameters and provide the logic for the signal to initiate and complete transition processes. IEEE Std 2030.7-2017, *IEEE Standard for the Specification of Microgrid Controllers*, and IEEE Std 2030.8-2018, *IEEE Standard for the Testing of Microgrid Controllers*, provide information on microgrid controllers. IEEE Std 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*, provides information on interconnection requirements.

Microgrid System.

A premises wiring system that has generation, energy storage, and load(s), or any combination thereof, that includes the ability to disconnect from and parallel with the primary source.

Informational Note: The application of Article 705 to microgrid systems is limited by the exclusions in 90.2(B)(5) related to electric utilities. Additional information may be found in IEEE 1547, IEEE 2030.7, and IEEE 2030.8.

Power Source Output Circuit.

The conductors between power ~~production~~ generating equipment and the service or distribution equipment.

705.6 Equipment Approval.

All equipment shall be approved for the intended use. Interactive equipment intended to operate in parallel with electric power ~~production~~ generating sources including, but not limited to, interactive inverters, engine generators, energy storage equipment, and wind turbines shall be listed for interactive function or be evaluated for interactive function and have a field label applied, or both.

705.8 System Installation.

Installation of one or more electrical power ~~production~~ generating sources operating in parallel with a primary source(s) of electricity shall be performed only by qualified persons.

Informational Note: See Article 100 for the definition of *Qualified Person*.

705.10 Identification of Power Sources.

A permanent plaque or directory shall be installed at each service equipment location, or at an approved readily visible location. The plaque or directory shall denote the location of each power source disconnecting means for the building or structure and be grouped with other plaques or directories for other on-site sources. The plaque or directory shall be marked with the wording "CAUTION: MULTIPLE SOURCES OF POWER." Any posted diagrams shall be correctly oriented with respect to the diagram's location. The marking shall comply with 110.21(B).

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

705.11 Supply-Side Source Connections.

An electric power ~~production~~ generating source, where connected on the supply side of the service disconnecting means as permitted in 230.82(6), shall comply with 705.11(A) through (E).

(A) Output Rating.

The sum of the power source continuous current output ratings on a service, other than those controlled in accordance with 705.13, shall not exceed the ampacity of the service conductors.

Informational Note: See Article 100 definition for Service Conductors.

(B) Conductors.

The power source output circuit conductors from the service conductors point of connection to the first overcurrent protection device shall be sized in accordance with 705.28 and in no case sized smaller than 6 AWG copper or 4 AWG aluminum. These conductors shall be installed in accordance with 230.30 or 230.43.

(C) Overcurrent Protection.

The power source output circuit conductors shall be protected from overcurrent in accordance with 705.30. If fuses are not integral with the disconnecting means, the disconnecting means shall be located on the service side of the fuses. Where the power source output circuit conductors make their connection to the service outside of a building, they shall be protected by overcurrent devices in a readily accessible location outside the building or at the first readily accessible location where the power source conductors enter the building. 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

(D) Connections.

The connection of power source output circuit conductors to the service conductors shall be made using listed connectors as described in 110.14 and comply with all enclosure fill requirements Any modifications to existing equipment shall be made in accordance with the manufacturer's instructions or the modification must be evaluated for the application and have a field label applied. 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.

(E) Ground-Fault Protection.

For connections rated 1000 amperes or more to solidly grounded wye services exceeding 150 volts to ground but not exceeding 1000 volts, phase-to-phase, ground-fault protection meeting the requirements of 230.95 shall be provided.

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 and are capable of supplying multiple branch circuits or feeders, or both, the interconnecting equipment shall comply with 705.12(A) through (E). Where a power control system (PCS) is installed in accordance with 705.13, the setting of the PCS controller shall be considered the power-source output circuit current in 705.12(A) through (E).

(A) Dedicated Overcurrent and Disconnect.

Each source interconnection of one or more power sources installed in one system shall be made at a dedicated circuit breaker or fusible disconnecting means.

(B) Bus or Conductor Ampere Rating.

The power source output circuit current multiplied by 125 percent shall be used in ampacity calculations for 705.12(B)(1) through (B)(3).

(1) Feeders.

Where the power source output connection is made to a feeder, the feeder shall have an ampacity greater than or equal to 125 percent of the power-source output circuit current. Where the power-source output connection is made to a feeder at a location other than the opposite end of the feeder from the primary source overcurrent device, that portion of the feeder on the load side of the power source output connection shall be protected by one of the following:

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

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

(2) Taps.

Where power source output connections are made at feeders, all taps shall be sized based on the sum of 125 percent of all power source(s) output circuit current(s) and the rating of the overcurrent device protecting the feeder conductors for sizing tap conductors using the calculations in 240.21(B).

(3) Busbars.

One of the following methods shall be used to determine the 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 ampacity of the busbar.

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

(2) 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 ampacity of the busbar. 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 CONNECTION—

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:

THIS EQUIPMENT FED BY MULTIPLE SOURCES.

TOTAL RATING OF ALL OVERCURRENT DEVICES

EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE

SHALL NOT EXCEED AMPACITY OF BUSBAR.

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

(4) 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 current rating of the busbar.

(5) Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 705.12(B)(3)(1) through (B)(3)(4) where designed under engineering supervision that includes available fault-current and busbar load calculations.

(6) Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors. The feed-through conductors shall be sized in accordance with 705.12(B)(1). Where an overcurrent device is installed at the supply end of the feed-through conductors, the busbar in the supplying panelboard shall be permitted to be sized in accordance with 705.12(B)(3)(1) through 705.12(B)(3)(3).

(C) Marking.

Equipment containing overcurrent devices in circuits supplying power to a busbar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources.

(D) Suitable for Backfeed.

Fused disconnects, unless otherwise marked, shall be considered suitable for backfeed. Circuit breakers not marked “line” and “load” shall be considered suitable for backfeed. Circuit breakers marked “line” and “load” shall be considered suitable for backfeed or reverse current if specifically rated.

(E) Fastening.

Listed plug-in-type circuit breakers back-fed 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.

705.13 Power Control Systems.

A power control system (PCS) shall be listed and evaluated to control the output of one or more power production sources, energy storage systems (ESS), and other equipment. The PCS shall limit current and loading on the busbars and conductors supplied by the PCS.

For the circuits connected to a PCS, the PCS shall limit the current to the ampacity of the conductors or the ratings of the busbars to which it is connected in accordance with 705.13(A) through (E).

(A) Monitoring.

The PCS controller shall monitor all currents within the PCS. Any busbar or conductor on the load side of the service disconnecting means that is not monitored by the PCS shall comply with 705.12. Where the PCS is connected in accordance with 705.11, the PCS shall monitor the service conductors and prevent overload of these conductors.

(B) Settings.

The sum of all PCS-controlled currents plus all monitored currents from other sources of supply shall not exceed the ampacity of any busbar or conductor supplied by the power production sources. Where the PCS is connected to an overcurrent device protecting any busbar or conductor not monitored by the PCS, the setting of the PCS controller shall be set within the ratings of that overcurrent device.

(C) Overcurrent Protection.

The PCS shall provide overcurrent protection either by overcurrent devices or by the PCS including the functionality as an overcurrent device in the product listing.

Informational Note: Some PCS are listed to provide overcurrent protection.

(D) Single Power Source Rating.

The rating of the overcurrent device for any single power source controlled by the PCS shall not exceed the rating of the busbar or the ampacity of the conductors to which it is connected.

(E) Access to Settings.

The access to settings of the PCS shall be restricted to qualified personnel in accordance with the requirements of 240.6(C).

705.14 Output Characteristics.

The output of a power ~~production~~ generating source operating in parallel with an electrical supply system shall be compatible with the voltage, wave shape, and frequency of the system to which it is connected. Synchronous generators operating in parallel with an electrical supply system shall be provided with the necessary equipment to establish and maintain a synchronous condition.

Informational Note: The term *compatible* does not necessarily mean matching the primary source wave shape.

705.16 Interrupting and Short-Circuit Current Rating.

Consideration shall be given to the contribution of fault currents from all interconnected power sources for the interrupting and short-circuit current ratings of equipment on interactive systems.

705.20 Disconnecting Means, Source.

Means shall be provided to disconnect power source output circuit conductors of electric power ~~production~~ generating equipment from conductors of other systems.

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) Enclosures with doors or hinged covers with exposed live parts when open that require a tool to open or are lockable where readily accessible to unqualified persons

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

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

(12) Be marked in accordance with the warning in 690.13(B), where the line and load terminals are capable of being energized in the open position

Informational Note: With interconnected power sources, some equipment, including switches and fuses, is likely to be energized from both directions. See 240.40.

705.25 Wiring Methods.

(A) General.

All raceway and cable wiring methods included in Chapter 3 of this *Code* and other wiring systems and fittings specifically listed, intended, and identified for use with power production systems and equipment shall be permitted. Where wiring devices with integral enclosures are used, sufficient length of cable shall be provided to facilitate replacement.

(B) Flexible Cords and Cables.

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

(C) Multiconductor Cable Assemblies.

Multiconductor cable assemblies used in accordance with their listings shall be permitted.

Informational Note: See UL 3003, *Distributed Generation Cables*, for additional information on DG Cable, Distributed Generation Cable. An ac module harness is one example of a multiconductor cable assembly.

705.28 Circuit Sizing and Current.

(A) Calculation of Maximum Circuit Current.

Where not elsewhere required or permitted in this *Code*, the maximum current for the circuit shall be the continuous output current rating of the power ~~production~~ generating equipment.

(B) Conductor Ampacity.

Where not elsewhere required or permitted in this *Code*, the circuit conductors shall be sized to carry not less than the largest of the following:

(1) The maximum currents in 705.28(A) multiplied by 125 percent without adjustment or correction factors

(2) The maximum currents in 705.28(A) with adjustment and correction factors

(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

(C) Neutral Conductors.

Neutral conductors shall be permitted to be sized in accordance with either 705.28(C)(1) or (C)(2).

(1) Single-Phase Line-to-Neutral Power Sources.

Where not elsewhere required or permitted in this *Code*, the ampacity of a neutral conductor to which a single-phase line-to-neutral power source is connected shall not be smaller than the ampacity in 705.28(B).

(2) Neutral Conductor Used Solely for Instrumentation, Voltage, Detection, or Phase Detection.

A power production equipment neutral conductor used solely for instrumentation, voltage detection, or phase detection shall be permitted to be sized in accordance with 250.102.

705.30 Overcurrent Protection.

(A) Circuit and Equipment.

Power source output circuit conductors and equipment shall be provided with overcurrent protection. Circuits connected to more than one electrical source shall have overcurrent devices located to provide overcurrent protection from all sources.

(B) Overcurrent Device Ratings.

The overcurrent devices in other than generator systems shall be sized to carry not less than 125 percent of the maximum currents as calculated in 705.28(A). The rating or setting of overcurrent devices shall be permitted in accordance with 240.4(B) and (C).

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 utilized at 100 percent of its rating.

(C) Power Transformers.

Transformers with sources on each side shall be provided with overcurrent protection in accordance with 450.3. The primary shall be the side connected to the largest source of available fault current. Secondary protection shall not be required for a transformer secondary that has a current rating not less than the sum of the rated continuous output currents of the power sources connected to that secondary.

(D) Generators.

Generators shall be provided with overcurrent protection in accordance with 445.12.

705.32 Ground-Fault Protection.

Where protection is installed in accordance with 230.95, the output of an interactive system shall be connected to the supply side of the ground-fault protection.

Exception: Connection shall be permitted to be made to the load side of ground-fault protection, if there is ground-fault protection for equipment from all ground-fault current sources.

705.40 Loss of Primary Source.

The output of electric power ~~production~~ generating equipment shall be automatically disconnected from all ungrounded conductors of the interconnected systems when one or more of the phases to which it is connected opens. The electric power ~~production~~ generating equipment shall not be reconnected until all the phases of the interconnected system to which it is connected are restored. This requirement shall not be applicable to electric power ~~production~~ generating equipment providing power to an emergency or legally required standby system.

Exception: A listed interactive inverter shall trip or shall be permitted to automatically cease exporting power when one or more of the phases of the interconnected system opens and shall not be required to automatically disconnect all ungrounded conductors from the primary source. A listed interactive inverter shall be permitted to automatically or manually resume exporting power to the interconnected system once all phases of the source to which it is connected are restored.

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~~ generating equipment shall be permitted to operate in island mode to supply loads that have been disconnected from the electric power production and distribution network.

705.45 Unbalanced Interconnections.

(A) Single Phase.

Single-phase power sources in interactive systems shall be connected to 3-phase power systems in order to limit unbalanced voltages at the point of interconnection to not more than 3 percent.

Informational Note: For interactive power sources, unbalanced voltages can be minimized by the same methods that are used for single-phase loads on a 3-phase power system. See ANSI/C84.1-2016, *Electric Power Systems and Equipment — Voltage Ratings (60 Hertz)*.

(B) Three Phase.

Three-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.

Part II. Microgrid Systems

705.50 System Operation.

Microgrid systems shall be permitted to disconnect from the primary source of power or other interconnected electric power ~~production~~ generating sources and operate as an isolated microgrid system operating in island mode.

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, 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.

705.65 Reconnection to Primary Power Source.

Microgrid systems that reconnect to primary power sources shall be provided with the necessary equipment to establish a synchronous transition.

705.70 Microgrid Interconnect Devices (MID).

Microgrid interconnect devices shall comply with the following:

(1) Be required for any connection between a microgrid system and a primary power source

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

(3) Have sufficient number of overcurrent devices located to provide overcurrent protection from all sources

Informational Note: MID functionality is often incorporated in an interactive or multimode inverter, energy storage system, or similar device identified for interactive operation.

Statement of Problem and Substantiation for Public Input

The term production is incorrect a electrical power is no produced. instead the correct term in generating

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Public Input No. 2692-NFPA 70-2020 [Article 705]

~~**Article 705**~~ ~~Interconnected~~ Article 705 Onsite Electric ~~Power~~ Power Production Sources

Part I. General

705.1 Scope.

This article covers installation of one or more electric power production sources operating in parallel with a primary source(s) of electricity.

Informational Note: Examples of the types of primary sources include a utility supply or an on-site electric power source(s).

705.2 Definitions.

The definitions in this section shall apply within this article and throughout the *Code*.

Microgrid Interconnect Device (MID).

A device that enables a microgrid system to separate from and reconnect to operate in parallel with a primary power source.

Informational Note: Microgrid controllers typically are used to measure and evaluate electrical parameters and provide the logic for the signal to initiate and complete transition processes. IEEE Std 2030.7-2017, *IEEE Standard for the Specification of Microgrid Controllers*, and IEEE Std 2030.8-2018, *IEEE Standard for the Testing of Microgrid Controllers*, provide information on microgrid controllers. IEEE Std 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*, provides information on interconnection requirements.

Microgrid System.

A premises wiring system that has generation, energy storage, and load(s), or any combination thereof, that includes the ability to disconnect from and parallel with the primary source.

Informational Note: The application of Article 705 to microgrid systems is limited by the exclusions in 90.2(B)(5) related to electric utilities. Additional information may be found in IEEE 1547, IEEE 2030.7, and IEEE 2030.8.

Power Source Output Circuit.

The conductors between power production equipment and the service or distribution equipment.

705.6 Equipment Approval.

All equipment shall be approved for the intended use. Interactive equipment intended to operate in parallel with electric power production sources including, but not limited to, interactive inverters, engine generators, energy storage equipment, and wind turbines shall be listed for interactive function or be evaluated for interactive function and have a field label applied, or both.

705.8 System Installation.

Installation of one or more electrical power production sources operating in parallel with a primary source(s) of electricity shall be performed only by qualified persons.

Informational Note: See Article 100 for the definition of *Qualified Person*.

705.10 Identification of Power Sources.

A permanent plaque or directory shall be installed at each service equipment location, or at an approved readily visible location. The plaque or directory shall denote the location of each power source disconnecting means for the building or structure and be grouped with other plaques or directories for other on-site sources. The plaque or directory shall be marked with the wording "CAUTION: MULTIPLE SOURCES OF POWER." Any posted diagrams shall be correctly oriented with respect to the diagram's location. The marking shall comply with 110.21(B).

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

705.11 Supply-Side Source Connections.

An electric power production source, where connected on the supply side of the service disconnecting means as permitted in 230.82(6), shall comply with 705.11(A) through (E).

(A) Output Rating.

The sum of the power source continuous current output ratings on a service, other than those controlled in accordance with 705.13, shall not exceed the ampacity of the service conductors.

Informational Note: See Article 100 definition for Service Conductors.

(B) Conductors.

The power source output circuit conductors from the service conductors point of connection to the first overcurrent protection device shall be sized in accordance with 705.28 and in no case sized smaller than 6 AWG copper or 4 AWG aluminum. These conductors shall be installed in accordance with 230.30 or 230.43.

(C) Overcurrent Protection.

The power source output circuit conductors shall be protected from overcurrent in accordance with 705.30. If fuses are not integral with the disconnecting means, the disconnecting means shall be located on the service side of the fuses. Where the power source output circuit conductors make their connection to the service outside of a building, they shall be protected by overcurrent devices in a readily accessible location outside the building or at the first readily accessible location where the power source conductors enter the building. 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

(D) Connections.

The connection of power source output circuit conductors to the service conductors shall be made using listed connectors as described in 110.14 and comply with all enclosure fill requirements Any modifications to existing equipment shall be made in accordance with the manufacturer's instructions or the modification must be evaluated for the application and have a field label applied. 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.

(E) Ground-Fault Protection.

For connections rated 1000 amperes or more to solidly grounded wye services exceeding 150 volts to ground but not exceeding 1000 volts, phase-to-phase, ground-fault protection meeting the requirements of 230.95 shall be provided.

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 and are capable of supplying multiple branch circuits or feeders, or both, the interconnecting equipment shall comply with 705.12(A) through (E). Where a power control system (PCS) is installed in accordance with 705.13, the setting of the PCS controller shall be considered the power-source output circuit current in 705.12(A) through (E).

(A) Dedicated Overcurrent and Disconnect.

Each source interconnection of one or more power sources installed in one system shall be made at a dedicated circuit breaker or fusible disconnecting means.

(B) Bus or Conductor Ampere Rating.

The power source output circuit current multiplied by 125 percent shall be used in ampacity calculations for 705.12(B)(1) through (B)(3).

(1) Feeders.

Where the power source output connection is made to a feeder, the feeder shall have an ampacity greater than or equal to 125 percent of the power-source output circuit current. Where the power-source output connection is made to a feeder at a location other than the opposite end of the feeder from the primary source overcurrent device, that portion of the feeder on the load side of the power source output connection shall be protected by one of the following:

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

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

(2) Taps.

Where power source output connections are made at feeders, all taps shall be sized based on the sum of 125 percent of all power source(s) output circuit current(s) and the rating of the overcurrent device protecting the feeder conductors for sizing tap conductors using the calculations in 240.21(B).

(3) Busbars.

One of the following methods shall be used to determine the 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 ampacity of the busbar.

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

(2) 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 ampacity of the busbar. 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 CONNECTION—

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:

THIS EQUIPMENT FED BY MULTIPLE SOURCES.

TOTAL RATING OF ALL OVERCURRENT DEVICES

EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE

SHALL NOT EXCEED AMPACITY OF BUSBAR.

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

(4) 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 current rating of the busbar.

(5) Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 705.12(B)(3)(1) through (B)(3)(4) where designed under engineering supervision that includes available fault-current and busbar load calculations.

(6) Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors. The feed-through conductors shall be sized in accordance with 705.12(B)(1). Where an overcurrent device is installed at the supply end of the feed-through conductors, the busbar in the supplying panelboard shall be permitted to be sized in accordance with 705.12(B)(3)(1) through 705.12(B)(3)(3).

(C) Marking.

Equipment containing overcurrent devices in circuits supplying power to a busbar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources.

(D) Suitable for Backfeed.

Fused disconnects, unless otherwise marked, shall be considered suitable for backfeed. Circuit breakers not marked “line” and “load” shall be considered suitable for backfeed. Circuit breakers marked “line” and “load” shall be considered suitable for backfeed or reverse current if specifically rated.

(E) Fastening.

Listed plug-in-type circuit breakers back-fed 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.

705.13 Power Control Systems.

A power control system (PCS) shall be listed and evaluated to control the output of one or more power production sources, energy storage systems (ESS), and other equipment. The PCS shall limit current and loading on the busbars and conductors supplied by the PCS.

For the circuits connected to a PCS, the PCS shall limit the current to the ampacity of the conductors or the ratings of the busbars to which it is connected in accordance with 705.13(A) through (E).

(A) Monitoring.

The PCS controller shall monitor all currents within the PCS. Any busbar or conductor on the load side of the service disconnecting means that is not monitored by the PCS shall comply with 705.12. Where the PCS is connected in accordance with 705.11, the PCS shall monitor the service conductors and prevent overload of these conductors.

(B) Settings.

The sum of all PCS-controlled currents plus all monitored currents from other sources of supply shall not exceed the ampacity of any busbar or conductor supplied by the power production sources. Where the PCS is connected to an overcurrent device protecting any busbar or conductor not monitored by the PCS, the setting of the PCS controller shall be set within the ratings of that overcurrent device.

(C) Overcurrent Protection.

The PCS shall provide overcurrent protection either by overcurrent devices or by the PCS including the functionality as an overcurrent device in the product listing.

Informational Note: Some PCS are listed to provide overcurrent protection.

(D) Single Power Source Rating.

The rating of the overcurrent device for any single power source controlled by the PCS shall not exceed the rating of the busbar or the ampacity of the conductors to which it is connected.

(E) Access to Settings.

The access to settings of the PCS shall be restricted to qualified personnel in accordance with the requirements of 240.6(C).

705.14 Output Characteristics.

The output of a power production source operating in parallel with an electrical supply system shall be compatible with the voltage, wave shape, and frequency of the system to which it is connected. Synchronous generators operating in parallel with an electrical supply system shall be provided with the necessary equipment to establish and maintain a synchronous condition.

Informational Note: The term *compatible* does not necessarily mean matching the primary source wave shape.

705.16 Interrupting and Short-Circuit Current Rating.

Consideration shall be given to the contribution of fault currents from all interconnected power sources for the interrupting and short-circuit current ratings of equipment on interactive systems.

705.20 Disconnecting Means, Source.

Means shall be provided to disconnect power source output circuit conductors of electric power production equipment from conductors of other systems.

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) Enclosures with doors or hinged covers with exposed live parts when open that require a tool to open or are lockable where readily accessible to unqualified persons

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

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

(12) Be marked in accordance with the warning in 690.13(B), where the line and load terminals are capable of being energized in the open position

Informational Note: With interconnected power sources, some equipment, including switches and fuses, is likely to be energized from both directions. See 240.40.

705.25 Wiring Methods.

(A) General.

All raceway and cable wiring methods included in Chapter 3 of this *Code* and other wiring systems and fittings specifically listed, intended, and identified for use with power production systems and equipment shall be permitted. Where wiring devices with integral enclosures are used, sufficient length of cable shall be provided to facilitate replacement.

(B) Flexible Cords and Cables.

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

(C) Multiconductor Cable Assemblies.

Multiconductor cable assemblies used in accordance with their listings shall be permitted.

Informational Note: See UL 3003, *Distributed Generation Cables*, for additional information on DG Cable, Distributed Generation Cable. An ac module harness is one example of a multiconductor cable assembly.

705.28 Circuit Sizing and Current.

(A) Calculation of Maximum Circuit Current.

Where not elsewhere required or permitted in this *Code*, the maximum current for the circuit shall be the continuous output current rating of the power production equipment.

(B) Conductor Ampacity.

Where not elsewhere required or permitted in this *Code*, the circuit conductors shall be sized to carry not less than the largest of the following:

(1) The maximum currents in 705.28(A) multiplied by 125 percent without adjustment or correction factors

(2) The maximum currents in 705.28(A) with adjustment and correction factors

(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

(C) Neutral Conductors.

Neutral conductors shall be permitted to be sized in accordance with either 705.28(C)(1) or (C)(2).

(1) Single-Phase Line-to-Neutral Power Sources.

Where not elsewhere required or permitted in this *Code*, the ampacity of a neutral conductor to which a single-phase line-to-neutral power source is connected shall not be smaller than the ampacity in 705.28(B).

(2) Neutral Conductor Used Solely for Instrumentation, Voltage, Detection, or Phase Detection.

A power production equipment neutral conductor used solely for instrumentation, voltage detection, or phase detection shall be permitted to be sized in accordance with 250.102.

705.30 Overcurrent Protection.

(A) Circuit and Equipment.

Power source output circuit conductors and equipment shall be provided with overcurrent protection. Circuits connected to more than one electrical source shall have overcurrent devices located to provide overcurrent protection from all sources.

(B) Overcurrent Device Ratings.

The overcurrent devices in other than generator systems shall be sized to carry not less than 125 percent of the maximum currents as calculated in 705.28(A). The rating or setting of overcurrent devices shall be permitted in accordance with 240.4(B) and (C).

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 utilized at 100 percent of its rating.

(C) Power Transformers.

Transformers with sources on each side shall be provided with overcurrent protection in accordance with 450.3. The primary shall be the side connected to the largest source of available fault current. Secondary protection shall not be required for a transformer secondary that has a current rating not less than the sum of the rated continuous output currents of the power sources connected to that secondary.

(D) Generators.

Generators shall be provided with overcurrent protection in accordance with 445.12.

705.32 Ground-Fault Protection.

Where protection is installed in accordance with 230.95, the output of an interactive system shall be connected to the supply side of the ground-fault protection.

Exception: Connection shall be permitted to be made to the load side of ground-fault protection, if there is ground-fault protection for equipment from all ground-fault current sources.

705.40 Loss of Primary Source.

The output of electric power production equipment shall be automatically disconnected from all ungrounded conductors of the interconnected systems when one or more of the phases to which it is connected opens. The electric power production equipment shall not be reconnected until all the phases of the interconnected system to which it is connected are restored. This requirement shall not be applicable to electric power production equipment providing power to an emergency or legally required standby system.

Exception: A listed interactive inverter shall trip or shall be permitted to automatically cease exporting power when one or more of the phases of the interconnected system opens and shall not be required to automatically disconnect all ungrounded conductors from the primary source. A listed interactive inverter shall be permitted to automatically or manually resume exporting power to the interconnected system once all phases of the source to which it is connected are restored.

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 shall be permitted to operate in island mode to supply loads that have been disconnected from the electric power production and distribution network.

705.45 Unbalanced Interconnections.

(A) Single Phase.

Single-phase power sources in interactive systems shall be connected to 3-phase power systems in order to limit unbalanced voltages at the point of interconnection to not more than 3 percent.

Informational Note: For interactive power sources, unbalanced voltages can be minimized by the same methods that are used for single-phase loads on a 3-phase power system. See ANSI/C84.1-2016, *Electric Power Systems and Equipment — Voltage Ratings (60 Hertz)*.

(B) Three Phase.

Three-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.

Part II. Microgrid Systems

705.50 System Operation.

Microgrid systems shall be permitted to disconnect from the primary source of power or other interconnected electric power production sources and operate as an isolated microgrid system operating in island mode.

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, 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.

705.65 Reconnection to Primary Power Source.

Microgrid systems that reconnect to primary power sources shall be provided with the necessary equipment to establish a synchronous transition.

705.70 Microgrid Interconnect Devices (MID).

Microgrid interconnect devices shall comply with the following:

(1) Be required for any connection between a microgrid system and a primary power source

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

(3) Have sufficient number of overcurrent devices located to provide overcurrent protection from all sources

Informational Note: MID functionality is often incorporated in an interactive or multimode inverter, energy storage system, or similar device identified for interactive operation.

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

This changes the title of Article 705 to align with the work of this taskgroup. We understand that the Correlating Committee has purview over scope and title. The changes included in this article by this task group includes expanding beyond just looking at interconnected systems and thus the existing title is not appropriate should these changes be accepted by the Code Making Panel.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2994-NFPA 70-2020 [Section No. 480.7(G)]	
Public Input No. 2995-NFPA 70-2020 [Section No. 690.56]	

Public Input No. 3011-NFPA 70-2020 [Definition:]

Public Input No. 4685-NFPA 70-2020 [Global Input]

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Public Input No. 2967-NFPA 70-2020 [Article 705]

Article 705 Interconnected Electric Power Production Sources

Part I. General

705.1 Scope.

This article

~~covers installation of one or more electric power~~ applies to the electrical safety of the installation, operation, and maintenance of systems consisting of circuits and equipment interconnecting electric power production sources operating in parallel. Unitized battery backup devices do not apply. The paralleled sources may be a combination of the following sources;

(1) On-site Power production sources operating in parallel to each other.

705.1(1) Informational Note 1: examples of power distribution topologies and operational configurations include, but are not limited to, a combination of the following;

(a) Power sources for required essential, emergency or critical power distribution systems. The power system generally has at least one preservation mode of operation due to code designated criticality of loads. When configured to supply power to other systems, a preservation often employs load shed to isolate it from normal power systems and optional standby power systems. Other modes of operation may supply normal power systems or optional standby power systems where permitted by code. Examples of required essential, emergency or critical power distribution systems include, but are not limited to, the following:

i. Emergency Power Supply System circuit in accordance with NFPA 110

ii. Stored Energy Power Supply System circuit in accordance with NFPA 111

iii. Essential Electrical System circuits in accordance with Article 517, or any of its sub-system branches as follows;

1. Life Safety Branch

2. Critical Branch

3. Equipment Branch

a. Equipment Branch A

b. Equipment Branch B

iv. Emergency system circuit in accordance with Article 700.

v. Legally required standby system circuit in accordance with Article 701.

vi. Optional standby system circuit in accordance with Article 702.

vii. Critical Operations Power system circuit in accordance with Article 708

viii. Fuel cell power supply system circuit, when used as a power source for power system type (iii) through (vii) above.

ix. A multi-source power system type derived to strictly serve fire pumps in accordance with Article 695. With its alternate source, as permitted from a power source type (1) through (8) above, or derived from an alternate normal power service to satisfy the reliability requirements.

(b) Power sources for normal power distribution systems.

705.1(1) Informational Note 2: example distribution gear includes equipment that parallels generators and equipment that supplies both an Optional Standby Power System and Essential Power Supply System.

(2) Power production sources operating in parallel with

~~a~~

primary source(s) of electricity.

705.1(2) Informational Note:

~~Examples of the types of primary sources include a utility supply or an on-site electric power source(s).~~

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examples of power distribution topologies and operational configurations include, but are not limited to, a combination of the following;

(a) A utility service power supply or other normal power source as the primary source(s), paralleled with other normal power source(s). Configurations include, but are not limited to, a combination of: distributed generation, distributed energy, on-site generation, district energy; whether utility-grid connected or not.

(b) Cogeneration or Combined Heat and Power (CHP) serving as a base load normal power supply, with a utility service power supply or other normal power source attending to the variable portion of the load.

(c) Microgrid power systems utilizing a decentralized group of electricity sources connected together and operating concurrently.

(d) Renewable energy source(s) connected to other renewable energy source(s), or connected to any other source(s), while operating concurrently.

(3) Spot Network with multiple primary source(s) of normal (typically utility) power concurrently supplying power to a common bus or bus system.

705.1(3) Informational Note: Spot Networks utilize the equivalent of a closed tie between facility source transformers. Spot Networks use reverse power circuit protection at the transformer secondary to guard against back-feeding a fault on the line side of either transformer primary, as required by 450.6(B).

705. 2 Definitions.

The definitions in this section shall apply within this article and throughout the *Code*.

Microgrid Interconnect Device (MID).

A device that enables a microgrid system to separate from and reconnect to operate in parallel with a primary power source.

Informational Note: Microgrid controllers typically are used to measure and evaluate electrical parameters and provide the logic for the signal to initiate and complete transition processes. IEEE Std 2030.7-2017, *IEEE Standard for the Specification of Microgrid Controllers*, and IEEE Std 2030.8-2018, *IEEE Standard for the Testing of Microgrid Controllers*, provide information on microgrid controllers. IEEE Std 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*, provides information on interconnection requirements.

Microgrid System.

A premises wiring system that has generation, energy storage, and load(s), or any combination thereof, that includes the ability to disconnect from and parallel with the primary source.

Informational Note: The application of Article 705 to microgrid systems is limited by the exclusions in 90.2(B)(5) related to electric utilities. Additional information may be found in IEEE 1547, IEEE 2030.7, and IEEE 2030.8.

Power Source Output Circuit.

The conductors between power production equipment and the service or distribution equipment.

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3 Qualified Personnel.

The installation and maintenance of paralleling equipment and all associated wiring and interconnections shall be performed only by qualified persons. Informational Note: See Article 100 for the definition of qualified person.

705.4 System Requirements.

Each unit of the paralleling equipment system shall be provided with a nameplate plainly visible after installation and marked with the following:

(1) Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for supplying the equipment can be identified

(2) Rated frequency

(3) Number of phases, if ac

(4) Rating (kW or kVA)

(5) Available fault current derived at the output terminals

(6) Maximum output and input current at the output terminals

(7) Maximum output and input voltage at the output terminals

(8) Utility-interactive capability, if applicable

706.5 Listing.

Paralleling distribution gear and systems shall be listed

705.6 Equipment Approval.

(1) All equipment shall be approved for the intended use.

(2) Where the paralleled power shall provide the backup alternate source, or any portion thereof, of a required emergency, critical or essential power system, the following shall apply;

(3) Listed equipment, suitable to the purpose, shall be utilized. If listed equipment is not available due to the custom nature of the application, the components and assemblies shall be listed to the extent possible.

(4) Documentation for design shall be given to the Authority Having Jurisdiction and approved prior to installation and energization. To include a grounding plan, an outline of operation schemes, and overview description of automated sequences.

Informational Note: Required emergency, critical or essential power systems include, but are not limited to, the following;

(i) Emergency Systems in accordance with Article 700.

(ii) Legally Required Standby System in accordance with Article 701.

(iii) Essential Electrical System in accordance with Article 517.

(iv) Fire pump circuits in accordance with Article 695.

(v) Critical Operations Power System in accordance with Article 708.

(vi) Emergency Power Supply System in accordance with NFPA 110.

(vii) Stored Energy Emergency Power Supply System (SEPSS) in accordance with NFPA 111.

(viii) Fuel Cell Power System in accordance with Parts II through VIII of Article 692 and not less than 2 hours of full-demand operation.

(c) The paralleling distribution equipment shall not substitute for Automatic Transfer Switches, where they are required to be listed for emergency use.

(3) Interactive equipment intended to operate in parallel with electric power production sources including, but not limited to, interactive inverters, engine generators, energy storage equipment, and wind turbines shall be listed for interactive function or be evaluated for interactive function and have a field label applied, or both.

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~~8 System Installation.~~

~~Installation of one or more electrical power production sources operating in parallel with a primary source(s) of electricity shall be performed only by qualified persons.~~

~~Informational Note: See Article 100 for the definition of *Qualified Person* .~~

~~**705.10** Identification of Power Sources.~~

~~A~~

~~7 Signs.~~

~~705.7(A) Sources and Service Entrance(s).~~

~~For each service equipment location and each on-site power source equipment location, a permanent plaque or directory shall be installed at~~

~~each service~~

~~the equipment location, or installed at an approved readily visible location. The plaque or directory shall denote the distinct name and the type of each power source. The plaque or directory shall denote the location of each power source disconnecting means for the building or structure . Multiple instances of a plaque or directory shall be consistent in appearance and be~~

~~grouped~~

~~grouped with other plaques or directories for other on-site sources or their disconnecting means . The plaque or directory shall be marked with the~~

~~wording~~

~~heading;~~

~~"CAUTION: MULTIPLE SOURCES OF POWER."~~

~~Any posted diagrams shall be correctly oriented with respect to the diagram's location. The marking shall comply with 110.21(B) .~~

~~Exception:~~

~~Installations with multiple co-located power production sources shall be permitted to be identified as a group(s). The plaque or directory shall not be required to identify each power source individually.~~

~~705. 7(B) Grounding.~~

~~Where removal of a grounding or bonding connection in a power source equipment interrupts the grounding electrode conductor connection to the grounded conductor of alternate power source(s), a warning sign shall be installed at the normal power source equipment stating:~~

~~WARNING~~

~~SHOCK HAZARD EXISTS IF GROUNDING ELECTRODE CONDUCTOR OR BONDING JUMPER CONNECTION IN THIS EQUIPMENT IS REMOVED WHILE ALTERNATE SOURCE(S) IS ENERGIZED.~~

~~Sign(s) and label(s) shall comply with 110.21(B).~~

705.8 System Installation.

Installation of electrical power production sources operating in parallel shall be performed only by qualified persons.

Where the power source into a paralleling system, or the power supplied by a paralleling system, is associated with other codified types of required essential, emergency or critical power, the system installation shall comply with those requirements. Those systems include, but are not limited to, the following:

(1) Emergency Power Supply System circuit in accordance with NFPA 110

(2) Stored Energy Power Supply System circuit in accordance with NFPA 111

(3) Essential Electrical System circuits in accordance with Article 517, or any of its sub-system branches as follows;

(4) Life Safety Branch

(5) Critical Branch

(6) Equipment Branch

(7) Equipment Branch A

(8) Equipment Branch B

(9) Emergency system circuit in accordance with Article 700.

(10) Legally required standby system circuit in accordance with Article 701.

(11) Optional standby system circuit in accordance with Article 702.

(12) Critical Operations Power system circuit in accordance with Article 708

(13) Fuel cell power supply system circuit, when used as a power source for power system type (3) through (7) above.

(14) A multi-source power system type derived to strictly serve fire pumps in accordance with Article 695. With its alternate source, as permitted from a power source type (1) through (8) above, or derived from an alternate normal power service to satisfy reliability requirements.

Informational Note: See Article 100 for the definition of *Qualified Person*.

Part II. Circuit Wiring

705.10 Wiring of High Criticality Loads

Wherever the parallel power equipment or parallel power system supplies power to required essential, emergency or critical power distribution systems, the following requirements shall apply.

705.10(A) Identification.

Power circuits shall be permanently marked so they will be readily identified as a component of a circuit or system by the following methods:

(1) All boxes and enclosures (including transfer switches, generators, and power distribution equipment) for power circuits shall be permanently marked as a component of a circuit or system associated with one of the power system types 705.8 through 705.8(9).

(2) Where boxes or enclosures are not encountered so that markings would be readily visible, exposed cable or raceway systems shall be permanently marked to be identified as a component of a circuit or system associated with one of the power system types 705.8(1) through 705.8(9). Marking shall be at intervals not to exceed 7.6 m (25 ft).

705.10(B) Wiring

Wiring of two or more emergency circuits supplied from the same source shall be permitted in the same raceway, cable, box, or cabinet.

(1) Wiring Involving Different Sources

Wiring from the alternate power source, used to supply a required power supply system, including wiring from the source's distribution overcurrent protection, shall be kept entirely independent of all other wiring and equipment derived from other sources (e.g. normal power source), unless otherwise permitted below;

a. Wiring of different sources in the transfer equipment enclosure where they terminate.

b. Branch circuit wiring from two sources within a common junction box, attached to dual source unit equipment.

(2) Distribution Wiring from Bus With Paralleled Sources

Wiring that supplies power from equipment used to parallel sources shall comply with the following;

a. Wiring circuit(s) supplying power to one of the power system types 705.8(1) through 705.8(9) shall comply with all applicable codes for the power system type(s).

b. Multiple feeders with overcurrent protection shall be selectively coordinated with the next downstream overcurrent protective device, including nonemergency system(s)

705.10(C) Design and Location

Equipment and wiring circuits shall be designed and located so as to minimize the hazards that might cause failure due to fire, icing, vandalism, and other adverse conditions, along with flooding that may occur from; weather, failed piping, sewer backup, or firefighting.

705.10(C)(1) Wiring Design and Location.

Wiring circuits shall be designed and located so as to minimize the hazards that might cause failure due to faults, excavation, or other disasters or occurrences. Design and install consideration shall be given to minimizing the probability of concurrent failure of redundant supply circuits.

705.10(C)(2) Equipment Design and Location

Where equipment function(s) and rating(s) are required below, they shall be marked by the manufacturer on the equipment.

a. Equipment design shall consider minimizing the probability of equipment failure and cable failure internal to the equipment to reduce disruption of loads.

b. Circuit breakers and switches shall be electrically operated and mechanically held.

c. Circuit breakers and switches shall be rated to withstand the number of load break operations for the life of the equipment, as reported in the manufacturer literature and recommended maintenance schedule; a copy of which, or its location, shall be posted at the equipment. Labeling and signage shall comply to 110.21(B).

d. Circuit breakers and switches shall be rated to perform a close and latch function to the available fault.

e. Circuit breaker and switch interrupting rating(s) shall be suitable to the available fault.

(1) For closed-transition switch schemes, where designed interrupting ratings rely upon a fault not drawing fault current from multiple sources concurrently, due to the brevity of switching sequence or for any other reason, a label shall be provided at each affected switch location indicating the associated design assumption(s), and that upon a fault condition, the switch should not be reclosed until the power supply from each respective source has been deenergized.

(2) Based upon possible switch schemes in compliance or out of compliance with design, and whether manual or automatic operation of the equipment, where there exists a potential to exceed the designed maximum available fault or exceed the interrupting rating for any system or component , a danger or warning label shall be provided at each switch location indicating the hazard of operating the breaker or switch outside the parameters of the design intent for distribution topologies. Signs and labels shall comply to 110.21(B).

(3) Where equipment is series rated, the engineered series rating calculations shall address any potential for manual or automatic configurations of the equipment to exceed design levels. Kirk-key lock out, or similar automated control-constraint means of prevention, shall be employed where particular switch configurations are relied upon for safe operation. A sign or label posted at each affected switch location shall convey the operation and maintenance terms for the switch configurations, where suitable to guard against operational non-compliance with the design.

Informational Note: ANSI Z535.4-2011, Product Safety Signs and Labels, provides guidelines for the design and durability of safety signs and labels for application to electrical equipment.

705.10(C)(2)(a) Indoor Equipment Location :

The room shall be separated from the rest of the building by construction with a 2-hour fire resistance rating.

The equipment may be located in either;

(1) Dedicated space(s) designated for essential power supply system equipment.

(2) Other electrical equipment space(s) dedicated to a codified non-normal power distribution type.

705.10(C)(2)(b) Outdoor Equipment Location

The equipment shall be installed in a suitable enclosure located outside the building and capable

of resisting the entrance of snow or rain at a maximum wind velocity as required by local building codes. No other equipment, except those that serve this space or equipment dedicated to the same power system type, shall be permitted in the enclosure.

705.10(C)(3) Feeder Equipment.

Equipment for feeder circuits (including transfer switches, transformers, and panelboards) shall be located either in spaces fully protected by an approved automatic fire protection system or in spaces with a 2-hour fire resistance rating.

705.10(C)(4) Generator Control Wiring.

Control conductors installed between the transfer equipment and the emergency generator shall be kept entirely independent of all other wiring and shall meet the conditions of 705.10(D)(2). The integrity of the generator remote start circuit shall be monitored for broken, disconnected, or shorted wires. Loss of integrity shall start the generator(s).

705. 11 Supply-Side Source Connections.

An electric power production source, where connected on the supply side of the service disconnecting means as permitted in 230.82(6), shall comply with 705.11(A) through (E).

(A) Output Rating.

The sum of the power source continuous current output ratings on a service, other than those controlled in accordance with 705.13, shall not exceed the ampacity of the service conductors.

Informational Note: See Article 100 definition for Service Conductors.

(B) Conductors.

The power source output circuit conductors from the service conductors point of connection to the first overcurrent protection device shall be sized in accordance with 705.28 and in no case sized smaller than 6 AWG copper or 4 AWG aluminum. These conductors shall be installed in accordance with 230.30 or 230.43.

(C) Overcurrent Protection.

The power source output circuit conductors shall be protected from overcurrent in accordance with 705.30. If fuses are not integral with the disconnecting means, the disconnecting means shall be located on the service side of the fuses. Where the power source output circuit conductors make their connection to the service outside of a building, they shall be protected by overcurrent devices in a readily accessible location outside the building or at the first readily accessible location where the power source conductors enter the building. 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

(D) Connections.

The connection of power source output circuit conductors to the service conductors shall be made using listed connectors as described in 110.14 and comply with all enclosure fill requirements Any modifications to existing equipment shall be made in accordance with the manufacturer's instructions or the modification must be evaluated for the application and have a field label applied. 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.

(E) Ground-Fault Protection.

For connections rated 1000 amperes or more to solidly grounded wye services exceeding 150 volts to ground but not exceeding 1000 volts, phase-to-phase, ground-fault protection meeting the requirements of 230.95 shall be provided.

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 and are capable of supplying multiple branch circuits or feeders, or both, the interconnecting equipment shall comply with 705.12(A) through (E). Where a power control system (PCS) is installed in accordance with 705.13, the setting of the PCS controller shall be considered the power-source output circuit current in 705.12(A) through (E).

(A) Dedicated Overcurrent and Disconnect.

Each source interconnection of one or more power sources installed in one system shall be made at a dedicated circuit breaker or fusible disconnecting means.

(B) Bus or Conductor Ampere Rating.

The power source output circuit current multiplied by 125 percent shall be used in ampacity calculations for 705.12(B)(1) through (B)(3).

(1) Feeders.

Where the power source output connection is made to a feeder, the feeder shall have an ampacity greater than or equal to 125 percent of the power-source output circuit current. Where the power-source output connection is made to a feeder at a location other than the opposite end of the feeder from the primary source overcurrent device, that portion of the feeder on the load side of the power source output connection shall be protected by one of the following:

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

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

(2) Taps.

Where power source output connections are made at feeders, all taps shall be sized based on the sum of 125 percent of all power source(s) output circuit current(s) and the rating of the overcurrent device protecting the feeder conductors for sizing tap conductors using the calculations in 240.21(B).

(3) Busbars.

One of the following methods shall be used to determine the 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 ampacity of the busbar.

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

(2) 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 ampacity of the busbar. 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 CONNECTION—

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:

THIS EQUIPMENT FED BY MULTIPLE SOURCES.

TOTAL RATING OF ALL OVERCURRENT DEVICES

EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE

SHALL NOT EXCEED AMPACITY OF BUSBAR.

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

(4) 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 current rating of the busbar.

(5) Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 705.12(B)(3)(1) through (B)(3)(4) where designed under engineering supervision that includes available fault-current and busbar load calculations.

(6) Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors. The feed-through conductors shall be sized in accordance with 705.12(B)(1). Where an overcurrent device is installed at the supply end of the feed-through conductors, the busbar in the supplying panelboard shall be permitted to be sized in accordance with 705.12(B)(3)(1) through 705.12(B)(3)(3).

(C) Marking.

Equipment containing overcurrent devices in circuits supplying power to a busbar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources.

(D) Suitable for Backfeed.

Fused disconnects, unless otherwise marked, shall be considered suitable for backfeed. Circuit breakers not marked “line” and “load” shall be considered suitable for backfeed. Circuit breakers marked “line” and “load” shall be considered suitable for backfeed or reverse current if specifically rated.

(E) Fastening.

Listed plug-in-type circuit breakers back-fed 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.

705.13 Power Control Systems.

A power control system (PCS) shall be listed and evaluated to control the output of one or more power production sources, energy storage systems (ESS), and other equipment. The PCS shall limit current and loading on the busbars and conductors supplied by the PCS.

For the circuits connected to a PCS, the PCS shall limit the current to the ampacity of the conductors or the ratings of the busbars to which it is connected in accordance with 705.13(A) through (E).

(A) Monitoring.

The PCS controller shall monitor all currents within the PCS. Any busbar or conductor on the load side of the service disconnecting means that is not monitored by the PCS shall comply with 705.12. Where the PCS is connected in accordance with 705.11, the PCS shall monitor the service conductors and prevent overload of these conductors.

(B) Settings.

The sum of all PCS-controlled currents plus all monitored currents from other sources of supply shall not exceed the ampacity of any busbar or conductor supplied by the power production sources. Where the PCS is connected to an overcurrent device protecting any busbar or conductor not monitored by the PCS, the setting of the PCS controller shall be set within the ratings of that overcurrent device.

(C) Overcurrent Protection.

The PCS shall provide overcurrent protection either by overcurrent devices or by the PCS including the functionality as an overcurrent device in the product listing.

Informational Note: Some PCS are listed to provide overcurrent protection.

(D) Single Power Source Rating.

The rating of the overcurrent device for any single power source controlled by the PCS shall not exceed the rating of the busbar or the ampacity of the conductors to which it is connected.

(E) Access to Settings.

The access to settings of the PCS shall be restricted to qualified personnel in accordance with the requirements of 240.6(C).

705.14 Output Characteristics.

The output of a power production source operating in parallel with an electrical supply system shall be compatible with the voltage, wave shape, and frequency of the system to which it is connected. Synchronous generators operating in parallel with an electrical supply system shall be provided with the necessary equipment to establish and maintain a synchronous condition.

Informational Note: The term *compatible* does not necessarily mean matching the primary source wave shape.

705.16 Interrupting and Short-Circuit Current Rating.

Consideration shall be given to the contribution of fault currents from all interconnected power sources for the interrupting and short-circuit current ratings of equipment on interactive systems.

705.20 Disconnecting Means, Source.

Means shall be provided to disconnect power source output circuit conductors of electric power production equipment from conductors of other systems.

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) Enclosures with doors or hinged covers with exposed live parts when open that require a tool to open or are lockable where readily accessible to unqualified persons

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

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

(12) Be marked in accordance with the warning in 690.13(B), where the line and load terminals are capable of being energized in the open position

Informational Note: With interconnected power sources, some equipment, including switches and fuses, is likely to be energized from both directions. See 240.40.

705.25 Wiring Methods.

(A) General.

All raceway and cable wiring methods included in Chapter 3 of this *Code* and other wiring systems and fittings specifically listed, intended, and identified for use with power production systems and equipment shall be permitted. Where wiring devices with integral enclosures are used, sufficient length of cable shall be provided to facilitate replacement.

(B) Flexible Cords and Cables.

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

(C) Multiconductor Cable Assemblies.

Multiconductor cable assemblies used in accordance with their listings shall be permitted.

Informational Note: See UL 3003, *Distributed Generation Cables*, for additional information on DG Cable, Distributed Generation Cable. An ac module harness is one example of a multiconductor cable assembly.

705.28 Circuit Sizing and Current.

(A) Calculation of Maximum Circuit Current.

Where not elsewhere required or permitted in this *Code*, the maximum current for the circuit shall be the continuous output current rating of the power production equipment.

(B) Conductor Ampacity.

Where not elsewhere required or permitted in this *Code*, the circuit conductors shall be sized to carry not less than the largest of the following:

(1) The maximum currents in 705.28(A) multiplied by 125 percent without adjustment or correction factors

(2) The maximum currents in 705.28(A) with adjustment and correction factors

(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

(C) Neutral Conductors.

Neutral conductors shall be permitted to be sized in accordance with either 705.28(C)(1) or (C)(2).

(1) Single-Phase Line-to-Neutral Power Sources.

Where not elsewhere required or permitted in this *Code*, the ampacity of a neutral conductor to which a single-phase line-to-neutral power source is connected shall not be smaller than the ampacity in 705.28(B).

(2) Neutral Conductor Used Solely for Instrumentation, Voltage, Detection, or Phase Detection.

A power production equipment neutral conductor used solely for instrumentation, voltage detection, or phase detection shall be permitted to be sized in accordance with 250.102.

705.30 Overcurrent Protection.

(A) Circuit and Equipment.

Power source output circuit conductors and equipment shall be provided with overcurrent protection. Circuits connected to more than one electrical source shall have overcurrent devices located to provide overcurrent protection from all sources.

(B) Overcurrent Device Ratings.

The overcurrent devices in other than generator systems shall be sized to carry not less than 125 percent of the maximum currents as calculated in 705.28(A). The rating or setting of overcurrent devices shall be permitted in accordance with 240.4(B) and (C).

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 utilized at 100 percent of its rating.

(C) Power Transformers.

Transformers with sources on each side shall be provided with overcurrent protection in accordance with 450.3. The primary shall be the side connected to the largest source of available fault current. Secondary protection shall not be required for a transformer secondary that has a current rating not less than the sum of the rated continuous output currents of the power sources connected to that secondary.

(D) Generators.

Generators shall be provided with overcurrent protection in accordance with 445.12.

705.32 Ground-Fault Protection.

Where protection is installed in accordance with 230.95, the output of an interactive system shall be connected to the supply side of the ground-fault protection.

Exception: Connection shall be permitted to be made to the load side of ground-fault protection, if there is ground-fault protection for equipment from all ground-fault current sources.

705.40 Loss of Primary Source.

The output of electric power production equipment shall be automatically disconnected from all ungrounded conductors of the interconnected systems when one or more of the phases to which it is connected opens. The electric power production equipment shall not be reconnected until all the phases of the interconnected system to which it is connected are restored. This requirement shall not be applicable to electric power production equipment providing power to an emergency or legally required standby system.

Exception: A listed interactive inverter shall trip or shall be permitted to automatically cease exporting power when one or more of the phases of the interconnected system opens and shall not be required to automatically disconnect all ungrounded conductors from the primary source. A listed interactive inverter shall be permitted to automatically or manually resume exporting power to the interconnected system once all phases of the source to which it is connected are restored.

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 shall be permitted to operate in island mode to supply loads that have been disconnected from the electric power production and distribution network.

705.45 Unbalanced Interconnections.

(A) Single Phase.

Single-phase power sources in interactive systems shall be connected to 3-phase power systems in order to limit unbalanced voltages at the point of interconnection to not more than 3 percent.

Informational Note: For interactive power sources, unbalanced voltages can be minimized by the same methods that are used for single-phase loads on a 3-phase power system. See ANSI/C84.1-2016, *Electric Power Systems and Equipment — Voltage Ratings (60 Hertz)*.

(B) Three Phase.

Three-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.

Part II. Microgrid Systems

705.50 System Operation.

Microgrid systems shall be permitted to disconnect from the primary source of power or other interconnected electric power production sources and operate as an isolated microgrid system operating in island mode.

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, 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.

705.65 Reconnection to Primary Power Source.

Microgrid systems that reconnect to primary power sources shall be provided with the necessary equipment to establish a synchronous transition.

705.70 Microgrid Interconnect Devices (MID).

Microgrid interconnect devices shall comply with the following:

(1) Be required for any connection between a microgrid system and a primary power source

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

(3) Have sufficient number of overcurrent devices located to provide overcurrent protection from all sources

Informational Note: MID functionality is often incorporated in an interactive or multimode inverter, energy storage system, or similar device identified for interactive operation.

Statement of Problem and Substantiation for Public Input

BASIS FOR CODE REVISION: …
1) Article 705's scope indicates that, as regards paralleled power systems, only the installation is covered. No other NEC code addresses power paralleling systems in regards to the equipment construction criterion, nor operation, nor its maintenance.
2) Paralleled power systems are commonly affiliated with design intentions for power reliability. Paralleled power systems may be relied upon as intermediate distribution between the source and load for required alternate power systems. For these applications, Article 705 does not yet have language suitable for minimum requirements consistent with other code requirements for a higher than "normal" reliability power system. Article 705 could include a sub-category of paralleled power systems for this purpose. If the intent is to not permit Article 705 to be used in the applications of alternate source of required power systems, that is yet to be stated clearly.
3) The term "utility" is commonly used in the article, whereas generally in the NEC, the term "service" is instead applied. If the term "utility" is not replaced, the terminology should be overtly correlated through definition(s) or in deliberate code text usage, so to clarify the conditions for their common meanings. If use continues, "electric utility", "electric utility service", or "electric utility supply" may be suitable terms.
4) The inclusion or exclusion of unitized battery systems as a potential power source in application of paralleling types of power systems is not yet clarified.

5) Only a narrow application scope of the potential forms of paralleled power are stated explicitly or inferenced by information note within this article; such as on-site power sources which are paralleled with a utility. This infers exclusion of Article 705 to particular types of paralleled power sources, such as a group of strictly generators, whose paralleling gear is not paralleled with utility. Other types of paralleled power system distribution topologies, that join normal sources with essential-class power source are either;

a. not explicitly stated to be covered by this article, …

b. or, are inadequately covered by this article due to the absence of stringent requirements typical to emergency-class systems.

6) Paralleling distribution gear that is not paralleled with utility has no other governing code article configured to serve as code guidance, but could be addressed in article 705 if revised to do so. NFPA 110 has some requirements associated with paralleling gear but there are the following gaps;

a. NFPA 110 scope indicates that its application is to emergency and standby systems (e.g. Article NEC Article 700 and 701 systems). However, this may be construed to exclude the following power system types, ;

(1) Stored Energy Power Supply System circuit in accordance with NFPA 111. Note that NFPA 111 uses a different context for the term "parallel", and does not address the context of paralleling power supply systems.

(2) Essential Electrical System circuits in accordance with Article 517. Note that Article 517 references NFPA 110 but that NFPA 110 does not identify Essential Electrical Systems of 517 in its own application of scope described in 1.1 and in the standard's title. The only reference in the NFPA 110 to Essential Electrical Systems is in its Appendix A.4.4.1. The 517 Essential Electrical System consists of the following sub-system branches as follows;

(A) Life Safety Branch
(B) Critical Branch
(C) Equipment Branch
i. Equipment Branch A
ii. Equipment Branch B

(3) Emergency system circuit in accordance with Article 700.
(4) Legally required standby system circuit in accordance with Article 701.
(5) Optional standby system circuit in accordance with Article 702.
(6) Critical Operations Power system circuit in accordance with Article 708
(7) Fuel cell power supply system circuit, when used as a power source for power system type (3) through (7) above.
(8) A multi-source power system type derived to strictly serve fire pumps in accordance with Article 695. With its alternate source, as permitted from a power source type (1) through (7) above, or an EPSS (per NFPA 110), or derived from an alternate normal power service to satisfy reliability requirements in accordance with Article 695.

b. NFPA 110 does not address the types of installation, operation, and maintenance considerations that may be suited to the NEC to address when load criticality is suited to addition stringency. As is addressed in NEC Article 700.

7) Paralleling gear covered by this article that serves emergency, critical or essential power systems has none of the usual material, design and install considerations that must otherwise comply to an elevated class of resilience due to load criticality, such as is covered in Article 700, or in lesser degree NFPA 110.

8) As written, paralleling gear covered by Article 705 that serves emergency, critical or essential power systems has no clearly stated disallowance of power source type(s) nor disallowance of power system type(s) that are to be supplied by the paralleling system. As such, this Article may be applied as an alternate compliance means to other articles where an Automatic Transfer Switch is meant to be used and listed for emergency use. Nor does it contain any constraint to any form of use other than an ATS in regards to essential-class power systems.

9) Essential power supply system equipment that supplies and distributes multi-source paralleled power to emergency, critical or essential power systems is not yet distinctly addressed in the NEC. A portion of this Article 705 could serve to address this application of paralleling equipment.

10) Paralleling distribution equipment is not yet consistent with other code intent for equipment meant to operate as an elevated class of resilience due to load criticality (e.g. "for emergency use"). When a set of ATSs for emergency use all have their alternate source power supplied by the same paralleling system, such a paralleling system can be the weak link when it has no stringent code requirements for resiliency. EPSS grade requirements for paralleling gear could be stated as a sub-part of Article 705. For example, paralleling system equipment, when applied to essential-class power systems, could be subject to the following types of elevated robustness;

a. The breakers and switches for EPSS grade paralleling applications can be correlated to some

elevated level of resiliency, such as 'Electrically operated and mechanically held', which is applied for emergency (NEC 700, 701, 708) and for all healthcare (NEC 517, NFPA 20).

b. Circuit breakers and switches can be rated to withstand the number of load break operations for the life of the equipment, as is done for transfer switches meant to distribute essential-class power.

c. Circuit breakers and switches can be rated to perform a close and latch function to the available fault, as is done for transfer switches meant to distribute essential-class power.

d. For closed-transition switch schemes, where designed interrupting ratings rely upon a fault not drawing fault current from multiple sources concurrently, due to the brevity of switching sequence or for any other reason, it could be addressed in code text to help ensure safe practices are followed.

e. Where there exists a potential for manual or automatic mis-operation of the equipment to exceed the designed maximum available fault or exceed the interrupting rating for any system or component, it could be addressed in code text to help ensure safe practices are followed.

f. Where equipment is series rated, and there exists a potential for manual or automatic mis-operation of the equipment to exceed the designed maximum, it could be addressed in code text to help ensure safe practices are followed.

11) Grounding for multiple-source equipment, if not designed specifically to the equipment and conditions, will manifest in many problematic ways and can effectively make ground fault detection untenable. Minimum requirements should be addressed.

12) The equipment guidelines in item-10 above refers to proposed code text edits (see Public Comment), which, in the current status of the Public Comment, is only being applied to essential-class power systems. However, certain aspects of these and other proposed edits could be crafted to also apply to normal power paralleling systems, either in whole or part. Such supplemental revisions may help ensure particular safe practices are followed for the normal power system equipment as well.

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Public Input No. 2529-NFPA 70-2020 [Section No. 705.1]

705.1 Scope.

This article covers installation of one or more electric power production sources operating in parallel with a primary source(s) of electricity, and installations not connected to an electric power production and distribution network ..

Informational Note: Examples of the types of primary sources include a utility supply or an on-site electric power source(s).

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13)
Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

The Scope had to be modified to align with the inclusion of Article 710 into this combined article.

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Public Input No. 4440-NFPA 70-2020 [Section No. 705.1]

705.1 Scope.

This article covers installation of one or more electric power production sources operating in parallel with a primary source(s) of electricity.

Informational Note: Examples of the types of primary sources include a utility supply or an on-site electric power source(s).

Informational Note Figure 705.1(a) Identification of Interconnected Electric Power Production Source Components in Common Configurations.

{see attachment for new image}

Note:

(1) These diagrams are intended to be a means of identification for system components, circuits, and connections.

(2) The system disconnect in these diagrams separates the system from all other systems.

(3) Not all disconnecting means required are shown.

(4) System grounding and equipment grounding are not shown.

(5) Custom designs occur in each configuration, and some components are optional.

Additional Proposed Changes

File Name	Description	Approved
705_1_IN_Figure_1a_correct.pdf	New suggested image	

Statement of Problem and Substantiation for Public Input

This PI is submitted in conjunction with the related PI which illustrates PV System DC Circuits definitions. PV Power Source is not a defined term in 690, and the use of this term on the diagram generates confusion. Article 705 uses the term “Power Source” to refer to the AC output of a power system, while this diagram currently uses the term to point to the DC side of a PV system. Substituting a term that is defined, PV System DC Circuit(s) improves the usability of these diagrams. In addition, swapping the “electric power production and distribution network” label for a more succinct and generalized term “Other Power Sources” will lessen confusion.

Additionally, making these diagrams more generic (not PV system specific) and moving them to 705 will allow them to be referenced for any type of power production source operating in parallel with a primary source.

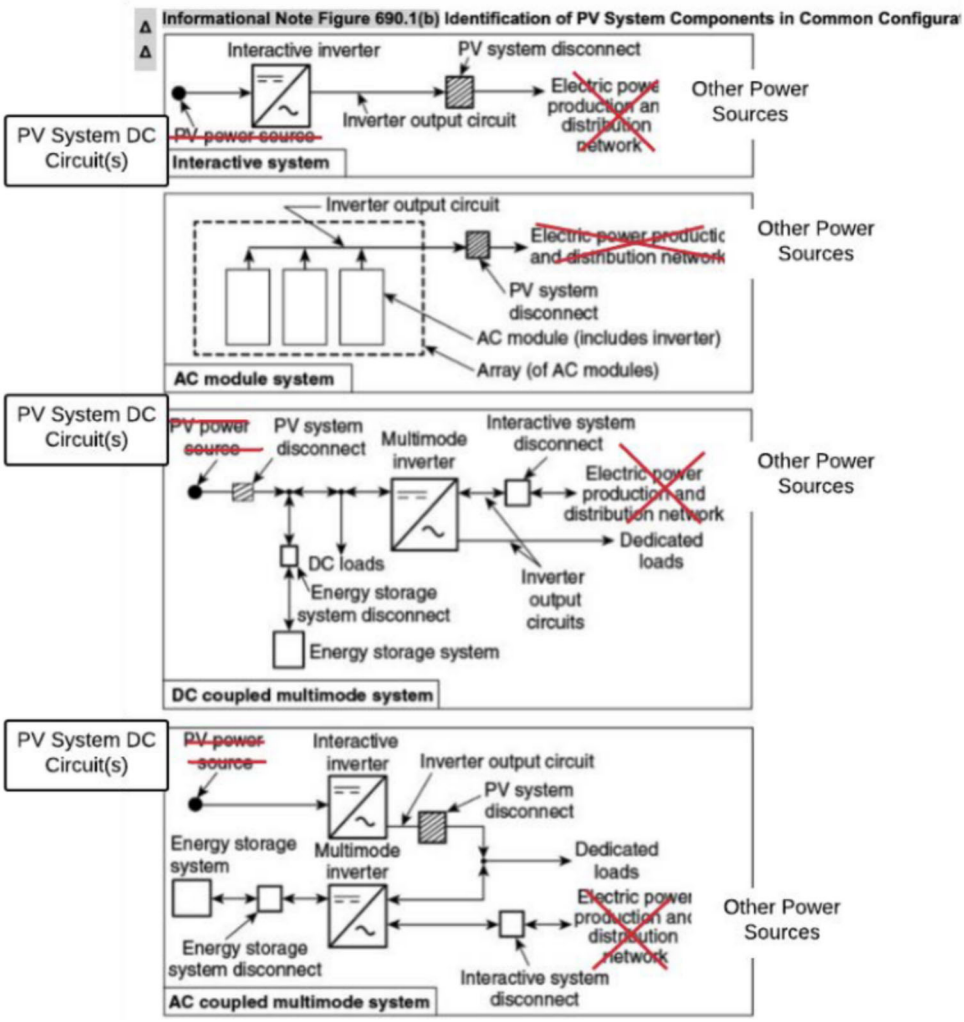
The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each

individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate and their inclusion here is not necessarily an endorsement of all the PI's submitted.
Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain, P.E., SEIA; Bill Brooks, PVICC; John Berdner, PVICC, Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing, Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower; Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

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Informational Note Figure 705.1(a) Identification of Interconnected Electric Power Production Source Components in Common Configurations.



Notes on action:

Revised 690.1(b) / new 705.1(a) diagram with following changes:

- Change “PV Power source” ” to “PV System DC Circuits” on diagram
- Deleted Stand-Alone System Diagram

Public Input No. 2572-NFPA 70-2020 [New Section after 705.2]

705.3 Other Articles

Microgrid and stand-alone systems shall also comply with the applicable provisions of Table 705.3. Where requirements in this article differ from those in Table 705.3, the requirements in the other article shall apply.

Table 705.3 Other Articles

Equipment/Occupancy	Article
Health Care Facilities	517
Fire Pumps	695
Emergency Systems	700
Legally Required Standby Systems	701
Critical Operations Power Systems (COPS)	708

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

The addition of this section helps ensure that those areas that may reference sources of power that fall under the provisions of Article 705 when used for such installations as Emergency Systems, Legally Required Power Systems and other similar systems may modify some of the requirements in Article 705 such as those pertaining to sizing of the source.

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Public Input No. 3874-NFPA 70-2020 [Section No. 705.2]

705.2 Definitions.

The definitions in this section shall apply within this article and throughout the *Code*.

Microgrid Interconnect Device (MID).

A device that enables a microgrid system to separate from and reconnect to operate in parallel with a primary power source.

Informational Note: Microgrid controllers typically are used to measure and evaluate electrical parameters and provide the logic for the signal to initiate and complete transition processes. IEEE Std 2030.7-2017, *IEEE Standard for the Specification of Microgrid Controllers*, and IEEE Std 2030.8-2018, *IEEE Standard for the Testing of Microgrid Controllers*, provide information on microgrid controllers. IEEE Std 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*, provides information on interconnection requirements.

Microgrid System.

A premises wiring system that has generation, energy storage, and load(s), or any combination thereof, that includes the ability to disconnect from and parallel with the primary source.

Informational Note: The application of Article 705 to microgrid systems is limited by the exclusions in 90.2(B)(5) related to electric utilities. Additional information may be found in IEEE 1547, IEEE 2030.7, and IEEE 2030.8.

PV Output Source (PVOS)

A source of power generated by a photovotaic system

Large Scale PV Output Source (PVO-LS)

A source of power from a large scale photovoltaic system

Generator Output Source (GOS)

A source of power generated from a prime mover system

Utilty Power ~~Source Output Circuit.~~

~~The conductors between power production equipment and the service or distribution equipment.~~

Production Source (UPPS)

A source of power from a commercial utility.

Fuel Cell Output (FCO)

A source of power from a fuel cell system.

Wind Electric Source (WES)

A source of power from a wind electric system

Statement of Problem and Substantiation for Public Input

The terms used in 705 can be very confusing. The definitions I provided would enable the wording in Article 705 as well as 690, 691, 692, 694 to be substantially more clear. Consistency in those code section would assist the electricians and inspectors.

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Committee: NEC-P04

Public Input No. 3955-NFPA 70-2020 [Section No. 705.2]

(Relocate all definitions in the 705. 2 to Article 100, arrange them in alphabetical order and without any subdivisions.)

705. 2 Definitions.

The definitions in this section shall apply within this article and throughout the *Code*.

Microgrid Interconnect Device (MID).

A device that enables a microgrid system to separate from and reconnect to operate in parallel with a primary power source.

Informational Note: Microgrid controllers typically are used to measure and evaluate electrical parameters and provide the logic for the signal to initiate and complete transition processes. IEEE Std 2030.7-2017, *IEEE Standard for the Specification of Microgrid Controllers*, and IEEE Std 2030.8-2018, *IEEE Standard for the Testing of Microgrid Controllers*, provide information on microgrid controllers. IEEE Std 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*, provides information on interconnection requirements.

Microgrid System.

A premises wiring system that has generation, energy storage, and load(s), or any combination thereof, that includes the ability to disconnect from and parallel with the primary source.

Informational Note: The application of Article 705 to microgrid systems is limited by the exclusions in 90.2(B)(5) related to electric utilities. Additional information may be found in IEEE 1547, IEEE 2030.7, and IEEE 2030.8.

Power Source Output Circuit.

The conductors between power production equipment and the service or distribution equipment.

Statement of Problem and Substantiation for Public Input

"The National Electrical Code has definitions in multiple parts in Article 100 and many definitions scattered through out the code many of them in the .2 section of the articles.
Most of the other standards under NFPA have their definitions in one location and this will allow the NEC the same requirement. The revisions to the NEC Style Manual require all the definitions to be relocated to Article 100. "

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Committee: NEC-P04

Public Input No. 2530-NFPA 70-2020 [Definition: Microgrid Interconnect Device (MID).]

Microgrid Interconnect Device (MID).

A device that enables a microgrid system to separate from and reconnect to operate in parallel with a primary power source, or to operate in island mode .

Informational Note: Microgrid controllers typically are used to measure and evaluate electrical parameters and provide the logic for the signal to initiate and complete transition processes. IEEE Std 2030.7-2017, *IEEE Standard for the Specification of Microgrid Controllers*, and IEEE Std 2030.8-2018, *IEEE Standard for the Testing of Microgrid Controllers*, provide information on microgrid controllers. IEEE Std 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*, provides information on interconnection requirements.

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13)
Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

Text added to align with Article 710 inclusion into this Article. Specifically, Section 710.1 Scope. Microgrid interconnect devices are used in microgrids to connect or disconnect with a utility. This change better aligns the definition with how it is used.

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Submittal Date: Mon Aug 24 12:01:23 EDT 2020
Committee: NEC-P04

Public Input No. 2531-NFPA 70-2020 [Definition: Microgrid System.]

Microgrid System.

A premises wiring system ~~that has generation, energy storage, and load(s), or any combination thereof, that~~ interconnected to an electric power production and distribution network or other primary power source that has any combination of generation and energy storage capable of operating in parallel and includes the ability to disconnect from ~~and parallel with~~ the primary source to operate in island mode .

Informational Note: The application of Article 705 to microgrid systems is limited by the exclusions in 90.2(B)(5) related to electric utilities. Additional information may be found in IEEE 1547, IEEE 2030.7, and IEEE 2030.8.

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

Clarifies that a microgrid system is a system interconnected with and interactive with another primary source such as a utility, that has capabilities of operating in island mode when isolated from that source. This is different from a Stand-alone system (as defined in the related PI).

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Committee: NEC-P04

Public Input No. 738-NFPA 70-2020 [Definition: Microgrid System.]

Microgrid System.

A premises wiring system that has generation, energy storage, and load(s), or any combination thereof, that ~~includes the~~ may or may not include the ability to disconnect from and parallel with the primary source.

Informational Note: The application of Article 705 to microgrid systems is limited by the exclusions in 90.2(B)(5) related to electric utilities. Additional information may be found in IEEE 1547, IEEE 2030.7, and IEEE 2030.8.

Statement of Problem and Substantiation for Public Input

There are microgrid systems, in the Department of Defense for example, that are not connected to a utility. It could be that the only microgrid systems that are covered by NFPA70 are those that can also be connected to a utility. In that case, perhaps adding another sentence to the definition as follows: "A microgrid that does not have the ability to interconnect with a utility is not covered by this Code."

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Committee: NEC-P04

Public Input No. 2532-NFPA 70-2020 [Definition: Power Source Output Circuit.]

Power Source Output Circuit.

The conductors between power production equipment and the service or ~~distribution equipment~~ other systems .

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

The definition was modified to align with the intent of a power source output circuit being those conductors in the alternative energy system up to where it connects with other systems such as at the service or any other location as part of a premises wiring systems such as distribution equipment or feeders found in these locations.

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Submittal Date: Mon Aug 24 12:10:13 EDT 2020
Committee: NEC-P04

Public Input No. 2533-NFPA 70-2020 [Section No. 705.6]

705.6 Equipment Approval.

All equipment shall be approved for the intended use ~~.~~ 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

Interactive equipment intended to operate in parallel with electric power production sources including, but not limited to, interactive inverters, engine generators, energy storage equipment, and wind turbines shall be listed for interactive function or be evaluated for interactive function and have a field label applied, or both.

Informational Note: Inverters identified as "multimode" and "stand-alone" are specifically identified and certified to operate in this application. Stand-alone inverters operate in island mode. Multimode inverters operate in either island mode (previously called "stand-alone mode") or interactive mode, if it has been installed with the optional utility grid connection. A multimode inverter will only operate in island mode if it is never connected to an electric utility supply. Stand-alone inverters are not evaluated for and are not intended for connection to export power in parallel with an electric utility.

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

Language was added from 710.6 as this language is appropriate and applies to all alternative energy source systems as a general requirement which aligns with the new Article 705.

With this action 712.4 is effectively merged into 705 and deleted from Article 712. The new language is not exactly what was found in 712.4 but is all encompassing ensuring the proper equipment is used for the correct application and is listed as such.

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Submittal Date: Mon Aug 24 12:12:20 EDT 2020
Committee: NEC-P04

Public Input No. 3956-NFPA 70-2020 [Section No. 705.6]

705.6 Equipment ~~Approval~~ for Interactive Use .

~~All equipment shall be approved for the intended use. Interactive~~ Interactive power production equipment intended to operate in parallel with electric power production sources including, but not limited to, interactive inverters, engine generators, energy storage equipment, and wind turbines shall be listed for interactive function or be evaluated for interactive function and have a field label applied, or both. Distribution equipment listed for the purpose of interconnecting interactive power production equipment with other systems shall not be required to meet the requirements of 705.12(B)(3) where installed in accordance with the manufacturer's instructions.

Statement of Problem and Substantiation for Public Input

The general requirement for approval for all equipment has been struck as unnecessary since it does not modify general requirements in 90.4. The defined term power production equipment is used here to add clarity. An allowance for distribution equipment listed specifically for the purpose of interconnecting interactive power production equipment has been added to recognize that equipment that may have ratings and other features not typically found in other distribution equipment. This equipment should not be scrutinized for busbar compliance in 705.12(B)(3) as these issues have been addressed as part of the listing. Several problems have surfaced in the field where AHJs have questioned and disallowed properly installed listed equipment because they perceive it violates 705.12(B)(3).

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate and their inclusion here is not necessarily an endorsement of all the PI's submitted.
Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain, P.E., SEIA; Bill Brooks, PVICC; John Berdner, PVICC, Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing, Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower; Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Ben Chamberlain, Olivewood Energy; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener,

SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

Submitter Information Verification

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Submittal Date: Wed Sep 09 16:17:05 EDT 2020
Committee: NEC-P04

Public Input No. 4005-NFPA 70-2020 [Section No. 705.6]

705.6 Equipment Approval.

All equipment shall be approved for the intended use. Interactive equipment intended to operate in parallel with electric power production sources including, but not limited to, interactive inverters, engine generators, energy storage equipment, and wind turbines shall be listed for interactive function or be evaluated for interactive function and have a field label applied, or both.

Informational Note: For further information on interactive equipment, see ANSI/UL 1741, Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources.

Statement of Problem and Substantiation for Public Input

Substantiation – Interactive products are still being designed, built and listed (certified) using the incorrect product safety standards for the grid interactive applications. Grid interactive applications place power conversion equipment between two significantly sized and potentially hazardous power sources. It is critical that this equipment operate safely under normal and foreseeable abnormal fault conditions. The UPS and motor drive standards do not evaluate for fault conditions using two power sources and are not representative of failure modes in grid interactive applications. It is safety critical that listed equipment be evaluated to the correct standard. This informational note is similar to the one used in 625 and 706 to provide guidance to the appropriate safety standard for the application.

Submitter Information Verification

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Committee: NEC-P04

Public Input No. 580-NFPA 70-2020 [Section No. 705.6]

705.6 Equipment Approval.

~~All equipment shall be approved for the intended use.~~

Interactive equipment intended to operate in parallel with electric power production sources including, but not limited to, interactive inverters, engine generators, energy storage equipment, and wind turbines shall be listed for interactive function or be evaluated for interactive function and have a field label applied, or both.

Statement of Problem and Substantiation for Public Input

My intention was only to delete the first sentence, but Terra had other plans.
Section 110.2 already covers the issue.

Submitter Information Verification

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Submittal Date: Mon Mar 02 15:00:08 EST 2020
Committee: NEC-P04

Public Input No. 478-NFPA 70-2020 [Section No. 705.8]

705.8 System Installation.

Installation and maintenance of one or more electrical power production sources operating in parallel with a primary source(s) of electricity 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

The code needs to address that maintenance of these systems also needs to be performed by qualified persons.

Submitter Information Verification

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Committee: NEC-P04

Public Input No. 2535-NFPA 70-2020 [Section No. 705.10]

705.10 Identification of Power Sources.

A permanent plaque or directory shall be installed at each service equipment location, or at an approved readily visible location. Where the building is not supplied by a service, a permanent plaque or directory shall be installed at an approved readily visible location. The plaque or directory shall denote the location of each power source disconnecting means for the building or structure and be grouped with other plaques or directories for other on-site sources. ~~The~~ Where multiple sources supply the building, the plaque or directory shall be marked with the wording "CAUTION: MULTIPLE SOURCES OF POWER." ~~Any posted diagrams shall be correctly oriented with respect to the diagram's location.~~ The marking shall comply with 110.21(B).

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

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

This text replaces what is found in 712.10, "Directory". With the creation of 705 as a general requirement, this language incorporates the directory requirements found in Article 710 and Article 712 in sections 710.10 and 712.10 respectively. The requirement to orient the diagram "correctly" as found in 705 lacks the clarity necessary to ensure this is enforced uniformly. This new text that was added in the 2020 cycle has caused confusion and is not necessary since all markings require approval

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2982-NFPA 70-2020 [Section No. 230.2(E)]	
Public Input No. 2994-NFPA 70-2020 [Section No. 480.7(G)]	
Public Input No. 2995-NFPA 70-2020 [Section No. 690.56]	

Submitter Information Verification

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Submittal Date: Mon Aug 24 12:15:49 EDT 2020
Committee: NEC-P04

Public Input No. 3583-NFPA 70-2020 [Section No. 705.10]

705.10 Identification of Power Sources.

A permanent plaque or directory shall be installed at each service equipment location, or at an approved readily visible location. The plaque or directory shall denote the location of each power source disconnecting means for the building or structure, indicate the name and emergency telephone number of the company currently servicing power source systems, and be grouped with other plaques or directories for other on-site sources. The plaque or directory shall be marked with the wording “CAUTION: MULTIPLE SOURCES OF POWER.” Any posted diagrams shall be correctly oriented with respect to the diagram's location. The marking shall comply with 110.21(B).

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

Statement of Problem and Substantiation for Public Input

This PI is one of three submitted on behalf of the NFPA 1/ NEC PV Joint Task Group. The Task Group is comprised of Ken Bush – NFPA 1 (Technical Committee Chair), Shane Clary – NFPA 1, Rebekah Hren – NEC Panel 4, Bruce Johnson – NFPA 1 (Task Group Chair) and Jim Rogers – NEC Panel 4 Chair. Three consensus proposals are being submitted by the Task Group with the purpose of fully harmonizing the PV system and power source labeling and marking requirements of the NEC with those of the Fire Code. Slight variations that have existed in color, formatting, and marking language requirements between the Fire Code and the NEC have made it unnecessarily difficult for enforcement and inspections agencies to align. As an example, the requirement for a yellow background on the Rapid Shutdown label in the NEC as compared to a red background in NFPA 1 could result in a jurisdiction requiring two labels serving the same purpose, though by their dual presence possibly causing confusion. Clearly this is not practical or desirable and the Codes should be harmonized. This PI specifically aligns the requirement for installer emergency information labeling as required in NFPA 1 11.12.2.1.5.

Submitter Information Verification

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Committee: NEC-P04

Public Input No. 3983-NFPA 70-2020 [Section No. 705.11]

705.11 Supply-Side Source Connections.

An electric power production source, where connected on the supply side of the service disconnecting means as permitted in 230.82(6), shall comply with 705.11(A) through (~~E~~ F).

(A) Output Rating.

The sum of the power source continuous current output ratings on a service, other than those controlled in accordance with 705.13, shall not exceed the ampacity of the service conductors.

Informational Note: See Article 100 definition for Service Conductors.

(B) Conductors.

The power source output circuit conductors from the service conductors point of connection to the first overcurrent protection device shall be sized in accordance with 705.28 and in no case sized smaller than 6 AWG copper or 4 AWG aluminum. These conductors shall be installed in accordance with 230.30 or 230.43.

(C) Overcurrent Protection.

The power source output circuit conductors shall be protected from overcurrent in accordance with 705.30. If fuses are not integral with the disconnecting means, the disconnecting means shall be located on the service side of the fuses. Where the power source output circuit conductors make their connection to the service outside of a building, they shall be protected by overcurrent devices in a readily accessible location outside the building or at the first readily accessible location where the power source conductors enter the building. 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

(D) Connections.

The connection of power source output circuit conductors to the service conductors shall be made using listed connectors as described in 110.14 and comply with all enclosure fill requirements Any modifications to existing equipment shall be made in accordance with the manufacturer's instructions or the modification must be evaluated for the application and have a field label applied. 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.

(E) Ground-Fault Protection.

For connections rated 1000 amperes or more to solidly grounded wye services exceeding 150 volts to ground but not exceeding 1000 volts, phase-to-phase, ground-fault protection meeting the requirements of 230.95 shall be provided.

(F) Disconnecting Means

Disconnecting means rated 1000 volts or less shall be listed as suitable for use as service equipment.

Statement of Problem and Substantiation for Public Input

Connections to the line side of a service have the same hazards that are encountered for services.

Requiring the disconnecting means to be listed as suitable for use as service equipment ensures that sufficient barriers are in place to give the same level of safety to the electrical worker as for service equipment.

Submitter Information Verification

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Submittal Date: Wed Sep 09 16:41:32 EDT 2020
Committee: NEC-P04

Public Input No. 4295-NFPA 70-2020 [Section No. 705.11]

705.11 Supply-Side Source Connections.

An electric power production source, where connected on the supply side of the service disconnecting means as permitted in 230.82(6), shall comply with 705.11(A) through (~~E~~ F).

(A) Output Rating.

The sum of the power source continuous current output ratings on a service, other than those controlled in accordance with 705.13, shall not exceed the ampacity of the service conductors.

Informational Note: See Article 100 definition for Service Conductors.

(B) Conductors.

The power source output circuit conductors from the service conductors point of connection to the first overcurrent protection device shall be sized in accordance with 705.28 and in no case sized smaller than 6 AWG copper or 4 AWG aluminum. These conductors shall be installed in accordance with 230.30 or 230.43.

(C) Overcurrent Protection.

The power source output circuit conductors shall be protected from overcurrent in accordance with 705.30. If fuses are not integral with the disconnecting means, the disconnecting means shall be located on the service side of the fuses. Where the power source output circuit conductors make their connection to the service outside of a building, they shall be protected by overcurrent devices in a readily accessible location outside the building or at the first readily accessible location where the power source conductors enter the building. 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

(D) Connections.

The connection of power source output circuit conductors to the service conductors shall be made using listed connectors as described in 110.14 and comply with all enclosure fill requirements Any modifications to existing equipment shall be made in accordance with the manufacturer's instructions or the modification must be evaluated for the application and have a field label applied. 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.

(E) Ground-Fault Protection.

For connections rated 1000 amperes or more to solidly grounded wye services exceeding 150 volts to ground but not exceeding 1000 volts, phase-to-phase, ground-fault protection meeting the requirements of 230.95 shall be provided.

(**F**) Grounding and Bonding

All metal enclosures, metallic wiring methods, and metal parts associated with the power source output circuit conductors shall be connected to the grounding electrode system for the service with only one of the following methods:

(1) Grounded Conductor Brought to Power Source Disconnecting Means. Where a grounded service conductor is brought to the power source disconnecting means, the grounded conductor shall be connected to the disconnecting means grounded conductor terminal or bus. A bonding conductor shall connect the grounded service conductor to each metal enclosure for the power source output circuit conductors . This bonding conductor shall be sized in accordance with 250.102 based on the size of the power source output circuit conductors.

(2) Grounded Conductor not Brought to Power Source Disconnecting Means. Where a grounded service conductor is not brought to the power source disconnecting means, each metal enclosure for the power source output circuit conductors shall be bonded using a separate bonding conductor sized in accordance with 250.102 based on the size the power source output circuit conductors. This separate bonding conductor shall be connected to the grounding electrode system.

Statement of Problem and Substantiation for Public Input

This language was removed by an appeal and floor action at the NFPA annual meeting. There was no technical substantiation submitted for the removal of this language just a concern that CMP 5 should be addressing bonding and grounding. This language was developed with a great deal of thought and input from various affected industries and the enforcement community. I have also submitted this to CMP 5 into 250.25 to see what their reaction is to this language.

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Submittal Date: Thu Sep 10 09:37:38 EDT 2020
Committee: NEC-P04

Public Input No. 4519-NFPA 70-2020 [New Section after 705.11(B)]

(B) Disconnecting Means

The power source disconnecting means shall meet the requirements 705.20. The power source disconnecting means shall not be considered a service disconnecting means as required by 230.70. The requirements of 230.71 and 230.72 shall apply to the power source disconnecting means that are installed in accordance with 230.2(A)(5) or 230.40, Exception No. 5. The conductors connected to the service conductors shall be terminated on the line side of the disconnect. Equipment containing a power source disconnecting means rated 1000 volts or less shall be listed as suitable for use as service equipment.

Statement of Problem and Substantiation for Public Input

This language was approved 17-1 by CMP4 in the 2020 NEC. The requirements in this section are consistent with the requirements of 250.35(B) for non-separately derived generators. Any source on the supply side of the service disconnecting means must not be separately derived since it is physically impossible to be separately derived and also connected to the service conductors at the same time. This language was struck during the Annual meeting at nearly midnight without the benefit of proper review. CMP4 was obligated to reject the motion approved at the Annual meeting. This substantiation further clarifies why the language approved in the second draft was correct as it agrees with the language of 250.35(B). Since this section refers to 705.11(F), that section needs to be returned to the second draft language as well. The word “ahead” in the third sentence of the approved 2nd draft language is changed to “on the supply side” as the term ahead is not used elsewhere in 705.11.

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This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF’s effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI’s as they deem appropriate and their inclusion here is not necessarily an endorsement of all the PI’s submitted.
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Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

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Committee: NEC-P04

Public Input No. 3292-NFPA 70-2020 [Section No. 705.11(C)]

(C) Overcurrent Protection.

The power source output circuit conductors shall be protected from overcurrent in accordance with 705.30. If fuses are not integral with the disconnecting means, the disconnecting means shall be located on the service side of the fuses. Where the power source output circuit conductors make their connection to the service outside of a building, they shall be protected by overcurrent devices in a readily accessible location outside the building or at the first readily accessible location where the power source conductors enter the building. 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~~ 66 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

20 meters does not in any way round to 71 feet. This should show 66 feet if the 20 meter distance is correct. If the 71 feet is correct, then the 20 meters should be 22 meters.

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Public Input No. 3841-NFPA 70-2020 [Section No. 705.11(C)]

(C) Overcurrent Protection.

The power source output circuit conductors shall be protected from overcurrent in accordance with 705.30. If fuses are not integral with the disconnecting means, the disconnecting means shall be located on the service side of the fuses. Where the power source output circuit conductors make their connection to the service outside of a building, they shall be protected by overcurrent devices in a readily accessible location outside the building or at the first readily accessible location where the power source conductors enter the building. 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~~ 66 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

Informational Note: Cable limiters are distinguished from fuses by their intended purpose of providing only short circuit response: they are not designed to provide overload protection, under normal or fault conditions. In applications where three of more conductors are used in parallel, the need for additional cable limiters at the opposite end of the circuit may be necessary to protect the conductors from some fault conditions.

Statement of Problem and Substantiation for Public Input

There are two changes in this PI.
The first change corrects an inaccurate unit conversion between SI and imperial. In compliance with 90.9(D) this new proposed value is a more accurate approximation.

The second change addresses an issue where this Code allows conductors to be interconnected on the supply side of services through the use of cable limiters on the utility end of the conductors. While this requirement is not intended to negate other requirements applying to cable limiters, there have been reports from the field that this would not require that cable limiters be located elsewhere in these circuits. Since the use of three or more conductors in parallel will likely require the use of cable limiters at both ends of the conductors, this information note is being suggested to clarify that other factors may impact where and how cable limiters are used.

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Public Input No. 4515-NFPA 70-2020 [New Section after 705.11(D)]

(D) Bonding and Grounding.

All metal enclosures, metal wiring methods, and metal parts associated with the power source output conductors in 705.11(B) shall be bonded in accordance with 250.92(B). The grounding terminal or bus for the disconnecting means in 705.11(F) shall be connected to a supply side bonding jumper, sized in accordance with 250.102, based on the size of the conductors in 705.11(B). The supply side bonding jumper shall be connected to the grounded service conductor within or on the supply side of the service disconnecting means. If the power production equipment requires a grounded conductor, no connection shall be made between the supply side bonding jumper and the grounded conductor at the disconnecting means in 705.11(F).

Statement of Problem and Substantiation for Public Input

This language was approved 17-1 by CMP4 in the 2020 NEC. The requirements in this section are consistent with the requirements of 250.35(B) for non-separately derived generators. Any source on the supply side of the service disconnecting means must not be separately derived since it is physically impossible to be separately derived and also connected to the service conductors at the same time. This language was struck during the Annual meeting at nearly midnight without the benefit of proper review. CMP4 was obligated to reject the motion approved at the Annual meeting. This substantiation further clarifies why the language approved in the second draft was correct as it agrees with the language of 250.35(B). Since this section refers to 705.11(F), that section needs to be returned to the second draft language as well. The word “ahead” in the third sentence of the approved 2nd draft language is changed to “on the supply side” as the term ahead is not used elsewhere in 705.11.

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Committee: NEC-P04

Public Input No. 2425-NFPA 70-2020 [Section No. 705.11(D)]

(D) Connections.

The connection of power source output circuit conductors to the service conductors shall be made using listed connectors as described in 110.14 and comply with all enclosure fill requirements. Any modifications to existing equipment shall be made in accordance with the manufacturer's instructions or the modification must be evaluated for the application and have a field label applied. For meter socket enclosures or other equipment under the exclusive control of the electric utility, only connections approved by the electric utility shall be permitted.

Statement of Problem and Substantiation for Public Input

sentence period missing between "requirements Any"

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Committee: NEC-P04

Public Input No. 4050-NFPA 70-2020 [New Section after 705.11(E)]

TITLE OF NEW CONTENT

Type your content here ...

705.11 Supply-Side Source Connections. An electric power production source , where connected on the supply side of the service disconnecting means as permitted in 230.82(6), shall comply with 705.11(A) through ~~(E)~~ (F).

(F) Grounding and Bonding . Power source output equipment grounding circuits and neutral circuits (if any) shall comply with the following.

(1) The power source output equipment grounding conductor or raceway shall be connected to the equipment grounding system in the service equipment.

(2) The power source neutral shall not be bonded to the equipment grounding system in any required power source disconnecting or metering equipment .

(3) The power source neutral shall be connected to the service neutral.

Statement of Problem and Substantiation for Public Input

Since power source output circuits cannot be defined as services and the Code does not specifically address how grounding and bonding should be addressed for these circuits, electricians, PV installers, and AHJs develop differing opinions on the requirements. Some of these opinions may lead to installations that may violate other NEC requirements and create safety issues such as unwanted neutral currents in the equipment grounding circuits.

The proposed language maintains the safety of the equipment grounding system. It also establishes that there should be no connection between the power source neutral and ground outside the service equipment where the main bonding jumper is located. This will eliminate the potential for unwanted neutral currents in the equipment grounding system.

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Committee:	NEC-P04

Public Input No. 4093-NFPA 70-2020 [Section No. 705.11(E)]

(E) Ground-Fault Protection.

~~For~~ ~~connections rated 1000 amperes or more to~~ Where power source connections rated at 1000 amperes or more are connected to solidly grounded wye ~~-~~ services exceeding 150 volts to ground but not exceeding 1000 volts, phase-to-phase, ground ~~-~~ fault ~~protection meeting the~~ protection on the power source circuits meeting the requirements of 230.95 shall be provided.

Statement of Problem and Substantiation for Public Input

As written, this section in the 2020 NEC does not clearly state that the ground fault protection is to be installed on the power source output circuit and not on the service conductors. The section should clearly state that the conductors that are to be protected from high ground faults originating from the utility service are the power source output conductors and other equipment connected to those circuits. The reference to Section 230.95 may cause confusion that could result in a second, unneeded installation of GFP equipment on the service conductors.

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Public Input No. 2307-NFPA 70-2020 [Section No. 705.11 [Excluding any Sub-Sections]]

An electric power production source, where connected on the supply side ~~of the service disconnecting means as permitted in~~ shall be connected through a service disconnect installed in accordance with 230.82(6) ~~,~~ and shall comply with 705.11(A) through (E).

Statement of Problem and Substantiation for Public Input

Section 705.11 deals with interconnection of solar photovoltaic systems, fuel cell systems, wind electric systems, energy storage systems, or interconnected electric power production sources connected on the supply side of the service. Because of the change in the definition of Service in the 2020 NEC and the proposed change in 230.82 (6), this item is to be revised. As discussed during the Electrical Section Meeting and the resultant Annual Meeting Floor action on this section, these alternate energy systems should be connected through a service disconnect meeting all of the requirements in Article 230 which would include the requirements in Part IV of Article 230 specifically for a service disconnect. This action would significantly reduce the confusion in the industry about how these systems should be interconnected with the electric utility.

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Committee:	NEC-P04

Public Input No. 3951-NFPA 70-2020 [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 and are capable of supplying multiple branch circuits or feeders, or both, the interconnecting equipment shall comply with 705.12(A) through (E). Where a power control system (PCS) is installed in accordance with 705.13, the setting of the PCS controller shall be considered the power-source output circuit current in 705.12(A) through (E).

(A) Dedicated Overcurrent and Disconnect.

Each source interconnection of one or more power sources installed in one system shall be made at a dedicated circuit breaker or fusible disconnecting means.

(B) Bus or Conductor Ampere Rating.

The power source output circuit current multiplied by 125 percent shall be used in ampacity calculations for 705.12(B)(1) through (B)(3).

(1) Feeders.

Where the power source output connection is made to a feeder, the feeder shall have an ampacity greater than or equal to 125 percent of the power-source output circuit current. Where the power-source output connection is made to a feeder at a location other than the opposite end of the feeder from the primary source overcurrent device, that portion of the feeder on the load side of the power source output connection shall be protected by one of the following:

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

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

(2) Taps.

Where power source output connections are made at feeders, all taps shall be sized based on the sum of 125 percent of all power source(s) output circuit current(s) and the rating of the overcurrent device protecting the feeder conductors for sizing tap conductors using the calculations in 240.21(B).

(3) Busbars.

One of the following methods shall be used to determine the 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 ampacity of the busbar.

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

(2) 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 ampacity of the busbar. 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 CONNECTION—

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:

THIS EQUIPMENT FED BY MULTIPLE SOURCES.

TOTAL RATING OF ALL OVERCURRENT DEVICES

EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE

SHALL NOT EXCEED AMPACITY OF BUSBAR.

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

(4) 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 current rating of the busbar.

(5) Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 705.12(B)(3)(1) through (B)(3)(4) where designed under engineering supervision that includes available fault-current and busbar load calculations.

(6) Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors. The feed-through conductors shall be sized in accordance with 705.12(B)(1). Where an overcurrent device is installed at the supply end of the feed-through conductors, the busbar in the supplying panelboard shall be permitted to be sized in accordance with 705.12(B)(3)(1) through 705.12(B)(3)(3).

705.30 (~~C~~ E) Marking.

Equipment containing overcurrent devices in circuits supplying power to a busbar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources.

705.30 (~~D~~ F) Suitable for Backfeed.

Fused disconnects, unless otherwise marked, shall be considered suitable for backfeed. Circuit breakers not marked “line” and “load” shall be considered suitable for backfeed. Circuit breakers marked “line” and “load” shall be considered suitable for backfeed or reverse current if specifically rated.

705.30 (~~E~~ G) Fastening.

Listed plug-in-type circuit breakers back-fed 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 requirements in subdivisions (C) through (E) are general requirements to all interconnections, not just load side. These are moved to new subdivisions within section 705.30 as they apply to the overcurrent protection device installation so that is a more suitable location.

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Committee: NEC-P04

Public Input No. 3932-NFPA 70-2020 [Section No. 705.12(A)]

~~**(A)** Dedicated Overcurrent and Disconnect.~~

~~Each source interconnection of one or more power sources installed in one system shall be made at a dedicated circuit breaker or fusible disconnecting means.~~

Statement of Problem and Substantiation for Public Input

The language in this section is not needed since disconnection and overcurrent protection requirements are adequately covered within 705.20 and 705.30.

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Public Input No. 2245-NFPA 70-2020 [Section No. 705.12(B)(2)]

(2) Taps.

Where power source output connections are made at feeders, ~~all taps~~ tap conductors in accordance with 240.21(B)(1) and (5) shall be sized based on the of 125 percent of all power source(s) output circuit current(s). Tap conductors in accordance with 240.21(B)(2) and (4) shall be sized based on the sum ~~of~~ of the of 125 percent of all power source(s) output circuit current(s) ~~and~~ and the rating of the overcurrent device protecting the feeder conductors ~~for sizing tap conductors using the calculations in 240~~ . ~~21(B).~~

Statement of Problem and Substantiation for Public Input

Article 705.12(B)(2) modifies all of the tap sizing rules in 240.21(B) by requiring the sum of the OCPD protecting the feeder and 125% of power source output circuit to be used for sizing all tap conductors under all installation conditions. As currently written in the 2020 NEC, the tap conductors installed under provisions 240.21(B)(1) and (5) would actually have to be larger than the actual feeder conductors under the modified requirements in 705.12(B)(2). Applying 705.12(B)(2) to 240.21(B)(1) in the 2020 NEC would not a allow a tap conductor less than 10 feet to be sized to the provisions in (1)(a) or (b) and would require a tap conductor for the connection of a 32A inverter to a 200A feeder to be sized for 240A. This would require a 250 kcmil copper tap conductor connection to a 3/0 AWG copper feeder conductor.

The modification to 705.12(B)(2) would allow tap conductors less than 10 feet in length or outside taps to be sized to just 125% of the power source output rating. Taps that are over 10 feet but up to 25 feet, and taps over 25 feet and up to 100A would still be calculated based of the sum of the feeder OCPD and 125% rating of the power source output circuit.

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Committee: NEC-P04

Public Input No. 3293-NFPA 70-2020 [Section No. 705.12(B)(2)]

(2) Taps.

Where power source output connections are made at feeders, all taps shall be sized based on the ~~sum of~~ larger of 125 percent of all power source(s) output circuit current(s) ~~and the rating of the overcurrent device protecting the feeder conductors for sizing tap conductors using the calculations in~~ or as calculated in accordance with 240.21(B).

Statement of Problem and Substantiation for Public Input

The proposed change would simply require tap conductors to have an ampacity per the larger of the power production source's output current (multiplied by 125%) OR the minimum required ampacity for feeder taps found in NEC 240.21(B). This is not any different than the requirements currently found in the Section 705.28(B) of the 2020 NEC. Similar requirements can also be found in Section 705.65(C) of the 2017 NEC. The problem with the current wording of NEC 705.12(B)(2) (found in the 2020 NEC) is that strict reading of the section requires the tap conductors for power production output connections must be rated per the SUM of 125% the power production source (such as an inverter) output current AND the rating of the OCPD protecting the feeders being tapped. The current wording is problematic since it will essentially require that the tap conductors be larger than the feeder wires they are tapping onto. FOR EXAMPLE: A 3800W inverter with a rated output of 16A multiplied by 125% will require an OCPD of 20A. If making connection with taps onto existing feeder wires that are 3/0 copper (with the feeder wire OCPD rated 200A), the combined 20A of inverter output AND the 200A feeder OCPD requires the tap wires themselves to have an ampacity of not less than 220A. Such ampacity would require not smaller than 4/0 copper conductors for the tap wires (assuming temperatures of conductors and terminals at 75 degree C, per NEC Table 310.16). Since the "tap" conductors are now larger than the actual feeder wires being tapped onto, the "tap" wires no longer meet the definition of "tap conductor" per the definition found at the beginning of Article 240. Nor is there a definition of "taps" found in Article 705. Even if an AHJ would disregard any definition of taps currently found in the NEC and still try to enforce the current wording found in NEC 705.12(B)(2), there's still the issue with size and ratings of terminals that the "taps" would connect to. In the example given above, one could not simply install a 60A (or less) rated disconnect for the 20A fuses since the 60A disconnect does not have terminals large enough for the required 4/0 "tap" conductors. So, with the example system given, the installer would have to purchase a 200A rated disconnect (for the 20A fuses that act as the OCPD for the inverter). The 200A rated disconnect would have terminals large enough for the 4/0 "tap" wiring. This makes absolutely no sense at all and no solid justification has ever been given to justify the current wording in the NEC. In short, the wording found in 705.12(B)(2) of the 2020 NEC (and other similar wording found in past editions of the NEC) has caused much confusion and unnecessary over-rating of equipment and wiring. This submitter strongly encourages Panel 4 to update the current language of 705.12(B)(2) with requirements that are enforceable and make sense.

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Committee: NEC-P04

Public Input No. 3834-NFPA 70-2020 [Section No. 705.12(B)(3)]

(3) Busbars.

One of the following methods shall be used to determine the 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 ampacity of the busbar.

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

(2) 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 ampacity of the busbar. 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

~~CONNECTION—~~

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:

~~THIS~~

EQUIPMENT FED BY MULTIPLE SOURCES.

TOTAL RATING OF ALL OVERCURRENT DEVICES

EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE

SHALL NOT EXCEED AMPACITY OF BUSBAR.

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

(4) 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 current rating of the busbar.

(5) Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 705.12(B)(3)(1) through (B)(3)(4) where designed under engineering supervision that includes available fault-current and busbar load calculations.

(6) Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors. The feed-through conductors shall be sized in accordance with 705.12(B)(1). Where an overcurrent device is installed at the supply end of the feed-through conductors, the busbar in the supplying panelboard shall be permitted to be sized in accordance with 705.12(B)(3)(1) through 705.12(B)(3)(3).

Statement of Problem and Substantiation for Public Input

This change is intended to reduce the amount of text on this required label, without changing its meaning or effectiveness.

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K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Ben Chamberlain, Olivewood Energy; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

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Public Input No. 4188-NFPA 70-2020 [Section No. 705.12(B)(3)]

(3) Busbars.

~~One~~ Choose only one of the following methods ~~shall be used to~~ , according to the designed power source applications, to determine the ratings of busbars:

(1) The sum of 125 percent of the power source(s), 2 or more including the primary power source, output circuit current and the rating of the overcurrent device protecting the busbar shall not exceed the ampacity of the ~~busbar.~~

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

~~Where two sources~~

(2) busbar when no other overcurrent breakers are installed in the panelboard.

(3) Where three sources , one a primary power source and

~~the~~

- only two other

~~another~~

- power

~~source~~

- sources , 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 ampacity of the busbar. 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 CONNECTION—

DO NOT RELOCATE THIS OVERCURRENT DEVICE.

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

~~The~~

-
- Where there are other overcurrent breakers are installed in the panelboard for the premisis wiring and there is a primary power source and two or more other power sources, the sum of the ampere ratings of all overcurrent devices on panelboards, both load and supply devices, excluding the rating of the overcurrent device protecting the busbar, shall not exceed the ampacity of the busbar. The rating of the overcurrent device protecting the busbar shall not exceed the rating of the busbar. Permanent warning labels shall be applied to distribution equipment displaying the following or equivalent wording:

  WARNING:

  THIS EQUIPMENT FED BY MULTIPLE SOURCES.

  TOTAL RATING OF ALL OVERCURRENT DEVICES

  EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE

  SHALL NOT EXCEED AMPACITY OF BUSBAR.

  The warning sign(s) or label(s) shall comply with 110.21(B) .
- 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 current rating of the busbar.
- Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 705.12(B) (3)(1) through (B)(3)(4) where designed under engineering supervision
  ~~that~~
-
- , manufactures specifications and Listing and Labeling that includes available fault-current and busbar load calculations.
- Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors. The feed-through conductors shall be sized in accordance with 705.12(B)(1) . Where an overcurrent device is installed at the supply end of the feed-through conductors, the busbar in the supplying panelboard shall be permitted to be sized in accordance with 705.12(B)(3) (1) through 705.12(B)(3) (3).

Statement of Problem and Substantiation for Public Input

The application must be specific to the concept and design. Code reference compliance should not be based on Random selection of moving variables. the design constitutes the Code application.

This information brings clarity to an AHJ for an installation.

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Public Input No. 4202-NFPA 70-2020 [Section No. 705.12(B)(3)]

(3) Busbars.

One of the following methods shall be used to determine the 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 ampacity of the busbar.

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

(2) 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 ampacity of the busbar. 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 CONNECTION—

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:

THIS EQUIPMENT FED BY MULTIPLE SOURCES.

TOTAL RATING OF ALL OVERCURRENT DEVICES

EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE

SHALL NOT EXCEED AMPACITY OF BUSBAR.

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

(4) 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 current rating of the busbar.

(5) Connections shall be permitted on ~~switchgear, switchboards, and panelboards in configurations other than those permitted in 705.12(B) (3)(1) through (B)(3)(4) where designed under engineering supervision that includes available fault-current and busbar load calculations.Connections shall be permitted on~~

(6) 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(B)(1) . Where an overcurrent device is installed at ~~the supply~~

(7) either end of the feed-through conductors, the ~~busbar in the supplying~~

(8) panelboard busbars shall be permitted to be sized in accordance with 705.12(B)(3) (1) through 705.12(B)(3) (3).

(9) Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 705.12(B) (3)(1) through (B)(3)(5) where designed under engineering supervision that includes available fault-current and busbar load calculations.

Additional Proposed Changes

File Name	Description	Approved
705.12-B-3_correct_text.pdf	Correct legislative text	

Statement of Problem and Substantiation for Public Input

When this new text was introduced into the 2020 NEC, it was written such that the power production source was assumed to be connected ahead of the initiation point of the feed-through conductors, and not interconnected at a subpanel after the termination point of the feed- through conductors. However this assumption was not clearly stated in the text nor was it made clear to enforcement or system designers. The revision to this section clarifies that the connection may made prior to the initiation or the at the termination point of the feed-through conductors without affecting the safety of the installation or conductor sizing provisions.
List items 5 and 6 are also flipped in order along with the reference added in old 6 to also include old 5, which was an oversight from the 2020 cycle that should have permitted engineering supervision for all the relevant options within the list of this section.

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This collaborative effort has resulted in the consensus development of numerous solar-related Public

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Committee: NEC-P04

(~~6~~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(B)(1). Where an overcurrent device is installed at either ~~the supply~~ end of the feed-through conductors, ~~the busbar in the supplying~~ panelboard busbars shall be permitted to be sized in accordance with 705.12(B)(3)(1) through 705.12(B)(3)(3).

(~~5~~6) Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 705.12(B)(3)(1) through (B)(3)(~~4~~5) where designed under engineering supervision that includes available fault-current and busbar load calculations.

Public Input No. 4689-NFPA 70-2020 [Section No. 705.12(B)(3)]

(3) Busbars.

One of the following methods shall be used to determine the 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 ampacity of the busbar.

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

(2) 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 ampacity of the busbar. 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 CONNECTION—

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:

THIS EQUIPMENT FED BY MULTIPLE SOURCES.

TOTAL RATING OF ALL OVERCURRENT DEVICES

EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE

SHALL NOT EXCEED AMPACITY OF BUSBAR.

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

(4) 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 current rating of the busbar.

(5) Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 705.12(B)(3)(1) through (B)(3)(4) where designed under engineering supervision that includes available fault-current and busbar load calculations.

(6) Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors. The feed-through conductors shall be sized in accordance with 705.12(B)(1). Where an overcurrent device is installed at the supply end of the feed-through conductors, the busbar in the supplying panelboard shall be permitted to be sized in accordance with 705.12(B)(3)(1) through 705.12(B)(3)(3).

(7) Where all power production sources for a premises are connected on the load side of feed-through conductors, the busbar in the supplying panelboard shall be permitted to be sized not less than the sum of all power production overcurrent device ratings plus the sum of all load overcurrent devices located in the supply panelboard, excluding the rating of the overcurrent device protecting the busbar and, if present, the rating of the overcurrent device protecting the feed-through conductors. The feed-through conductors shall be sized in accordance with 705.12(B)(1). Permanent warning labels shall be applied to distribution equipment displaying the following or equivalent wording: WARNING: THIS EQUIPMENT FED BY MULTIPLE SOURCES. TOTAL RATING OF ALL OVERCURRENT DEVICES EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE SHALL NOT EXCEED AMPACITY OF BUSBAR. The warning sign(s) or label(s) shall comply with 110.21(B).

Statement of Problem and Substantiation for Public Input

Many residential dwellings use a meter combination panel which includes a meter, service disconnect, small distribution busbar, and feed through lugs. The feed through lugs often feed both loads and power production sources in one or multiple downstream subpanels. When applying 705.12 (B)(3)(3) to the main panel in this condition, it is unclear what value should be used for the feed through conductors because there may be no overcurrent device at either the supply or load end of the feed through conductors. Based on ambiguity, different interpretations arise. The language in (B)(3)(6) does not clarify this condition, as it points back to (B)(3)(3) to size the supplying busbar. The suggested addition clarifies exactly how to interpret this conduction. When all power production sources are backfeeding the supplying busbar through the feed through conductors, then any load overcurrent devices connected to the feed through conductors can be ignored in the sum of overcurrent device calculation.

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Public Input No. 92-NFPA 70-2019 [Section No. 705.12(B)(3)]

(3) Busbars.

One of the following methods shall be used to determine the 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 ampacity of the busbar.

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

(2) 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 ampacity of the busbar. 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 CONNECTION—

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, and excluding one overcurrent device of the smallest size present, shall not exceed the ampacity of the busbar. The rating of the overcurrent device protecting the busbar shall not exceed the rating of the busbar. Permanent warning labels shall be applied to distribution equipment displaying the following or equivalent wording:

WARNING:

THIS EQUIPMENT FED BY MULTIPLE SOURCES.

TOTAL RATING OF ALL OVERCURRENT DEVICES

EXCLUDING MAIN SUPPLY OVERCURRENT DEVICE

AND EXCLUDING ONE OVERCURRENT DEVICE OF THE SMALLEST SIZE PRESENT

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 current rating of the busbar.

(5) Connections shall be permitted on switchgear, switchboards, and panelboards in configurations other than those permitted in 705.12(B)(3)(1) through (B)(3)(4) where designed under engineering supervision that includes available fault-current and busbar load calculations.

(6) Connections shall be permitted on busbars of panelboards that supply lugs connected to feed-through conductors. The feed-through conductors shall be sized in accordance with 705.12(B)(1). Where an overcurrent device is installed at the supply end of the feed-through conductors, the busbar in the supplying panelboard shall be permitted to be sized in accordance with 705.12(B)(3)(1) through 705.12(B)(3)(3).

Statement of Problem and Substantiation for Public Input

The current language is unnecessarily restrictive and the proposed limited expansion provides an additional allowance of practical use. For example, in a solar combiner panel, this change would allow the addition of a single extra breaker for the connection of solar monitoring equipment.

To start, consider an arrangement allowed by the current section: a panel with a 100A busbar, a 100A main breaker, and (5) 20A breakers. At any given time, each breaker may be a supply or a load, but not both. Physics requires that the sum of the load currents equals the sum of the supply currents; this sum is the busbar current. Then as long as each breaker's current does not exceed its rating, there is no way for the busbar current to exceed the busbar rating. The highest achievable bubar current would be 100A, for the case of a 100A supply and (5) 20A loads, or vice versa. A supply current exceeding 100A would require the 100A breaker and at least one 20A breaker to be supplies; but that leaves only (4) 20A breakers to be loads, meaning the bubar current would actually be limited to 80A.

This argument extends to the case of (6) 20A breakers in the panel, rather than (5), which is the point of my proposed change. There are only two ways to reach a supply current above 100A: (a) all (6) 20A breakers are supplies, or (b) the 100A breaker and one 20A breaker are supplies. In case (a), the load current is limited to 100A by the 100A breaker. In case (b), the load current is limited to 100A by the (5) 20A breakers. Thus in both cases the busbar current is limited to 100A, and the busbar is protected.

While this is just one example, it illustrates the general argument. Relative to the configurations currently allowed, adding one additional breaker, not larger than any of the other breakers, can not overload the bus, as that breaker can only be a supply or a load, not both. So with just one additional breaker, there is no avenue to also increase the complementary load or supply, respectively, that would be necessary to actually increase the busbar current.

Finally, for the case of a panel with just 3 breakers (including the main breaker), the proposed change brings this section in line with section 705.12(B)(1)(b) on feeders. Consider for example a 100A feeder supplied by a 100A breaker from the utility; having a 100A connection from a second power source in the middle of the feeder; and terminating on a 100A main breaker protecting a panelboard with loads. This arrangement is electrically equivalent to a 100A panelboard with (3) 100A breakers in it, with the busbar being the feeder. The current language of 705.12(B)(3)(3) prohibits the arrangement for a busbar, while the language of 705.12(B)(1)(b) allows the arrangement for a feeder. My proposed change eliminates

this logical inconsistency by allowing the arrangement for a busbar.

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Public Input No. 4201-NFPA 70-2020 [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 and are capable of supplying multiple branch circuits or feeders, or both, the interconnecting equipment shall comply with 705.12(A) through (E). Where a power control system (PCS) is installed in accordance with 705.13, the setting of the PCS controller shall be considered the power-source output circuit current in 705.12(A) through (E). Equipment listed for the purpose is permitted to be installed in accordance with its ratings and installation instructions.

Statement of Problem and Substantiation for Public Input

An allowance for equipment listed specifically for the purpose of interconnecting interactive power production equipment has been added to recognize that equipment may have ratings or other features that could differ from the general rules contained within this section.

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This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate and their inclusion here is not necessarily an endorsement of all the PI's submitted.
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Public Input No. 4108-NFPA 70-2020 [Section No. 705.13(E)]

(E) Access to Settings.

The access to settings of the PCS shall be restricted to qualified personnel in accordance ~~with the requirements of~~ with 240.6(C).

Statement of Problem and Substantiation for Public Input

Deleting the words "the requirements of" does not change the meaning of the section.

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Public Input No. 3959-NFPA 70-2020 [Section No. 705.13 [Excluding any Sub-Sections]]

A power control system (PCS) shall be listed and evaluated to control the output of one or more power production sources, energy storage systems (ESS), energy management system, and other equipment. The PCS shall limit current and loading on the busbars and conductors supplied by the PCS.

For the circuits connected to a PCS, the PCS shall limit the current to the ampacity of the conductors or the ratings of the busbars to which it is connected in accordance with 705.13(A) through (E).

Statement of Problem and Substantiation for Public Input

Power control systems do not only control power sources, some also interface with energy management systems for load management. By recognizing this interface within the language in this section, it is made clearer that the compatibility of these two systems needs to be evaluated through the listing of the PCS, to ensure that functional safety is maintained throughout the operation of both systems.

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Public Input No. 4046-NFPA 70-2020 [New Section after 705.14]

TITLE OF NEW CONTENT

705.15 Interconnection or Transfer Equipment.

705.15(A) General.

Interconnection or transfer equipment shall be listed, suitable for the intended use, and shall prevent the inadvertent interconnection of sources of supply not designed to operate in parallel with one another.

Exception: Temporary connection of a portable generator without transfer equipment shall be permitted where conditions of maintenance and supervision ensure that only qualified persons service the installation and where the normal supply is physically isolated by a lockable disconnecting means or by disconnection of the normal supply conductors.

705.15(B) Transfer Switches.

(1) Reconditioned. Transfer switches shall not be permitted to be reconditioned.

(2) Meter-Mounted Transfer Switches. Transfer switches installed between the utility meter and the meter enclosure shall be listed meter-mounted transfer switches.

Informational Note: For more information, see UL 1008M, *Transfer Switch Equipment, Meter Mounted* .

Statement of Problem and Substantiation for Public Input

The requirements in this new section of Article 705 are to parallel to the requirements in Article 702 for consistency. This section provides for the use of transfer equipment and interconnection equipment necessary to prevent the inadvertent interconnection of sources is a key safety factor when supplying loads during an interruption of the normal source. These functions are often found in multimode inverters or microgrid interconnect devices, but standard transfer switch may also be used to perform this function. Systems which meet the appropriate code requirements for paralleling of sources typically refer to the equipment which separates or isolates the connection to the normal source as interconnection equipment rather than transfer equipment. This change would make this section apply generally and maintain the safety requirement for inadvertent source interconnection.

The addition of 705.15(B) groups the existing requirements for transfer switches in Article 702 into the same section in Article 705 for ease of use.

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Public Input No. 3850-NFPA 70-2020 [Section No. 705.14]

705.14 Output Characteristics.

The output of a power production source operating in parallel with an electrical supply system shall be compatible with the voltage, wave shape, and frequency of the system to which it is connected. ~~Synchronous~~ Each power source shall be marked with the rated output current and the nominal operating voltage at a readily visible location. Synchronous generators operating in parallel with an electrical supply system shall be provided with the necessary equipment to establish and maintain a synchronous condition.

~~Informational Note: The term *compatible* does not necessarily mean matching the primary source wave shape.~~

Statement of Problem and Substantiation for Public Input

There are marking requirements for PV systems included in Section 690.54 that relate to the compatibility and ratings of a PV system's interconnection with other systems. These requirements should be a requirement for any interconnected power systems, not just PV. Since Article 705 is the Article that is used to where different sources will interconnect, this is a more appropriate location. These requirements should be able to be met by manufacturer's markings, and not require field markings in all cases. A requirement that any markings be readily visible ensures that where it is not possible to use a nameplate etc., a field marking would be needed.

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Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate and their inclusion here is not necessarily an endorsement of all the PI's submitted.
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Public Input No. 2536-NFPA 70-2020 [Section No. 705.16]

~~**705.16** Interrupting and Short-Circuit Current Rating.~~

~~Consideration shall be given to the contribution of fault currents from all interconnected power sources for the interrupting and short-circuit current ratings of equipment on interactive systems.~~

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

Interrupting rating requirements and SCCR requirements are handled as part of 110.9 and 110.10 of the NEC. All equipment must be able to either interrupt or withstand maximum available fault current as required by the NEC.

The definitions of fault current and fault current, available add the clarity necessary for proper application of electrical equipment in any system.

712.72 is also being deleted for same reasons.

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Public Input No. 4681-NFPA 70-2020 [Section No. 705.16]

705.16 Interrupting and Short-Circuit Current Rating.

Consideration shall be given to the contribution of fault currents from all interconnected power sources for the interrupting and short-circuit current ratings of equipment on interactive systems.

Exception: Systems engineered to be interconnected for less than 100ms.

Statement of Problem and Substantiation for Public Input

If a system, like a closed-transition ATS, is engineered to be interconnected with two sources of power for a very brief amount of time, it should not be required to be sized to account for both power sources' fault currents.

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Public Input No. 2537-NFPA 70-2020 [Section No. 705.20]

705.20 Disconnecting Means, Source.

Means shall be provided to disconnect power source output circuit conductors of electric power production equipment from conductors of other systems. ~~The disconnecting means shall comply with the following:~~

- ~~Be one of the following types:~~
  - (1) ~~A manually operable switch or circuit breaker~~
  - (2) ~~A load-break-rated pull-out switch~~
  - (3) ~~A power-operated or remote-controlled switch or circuit breaker that is manually operable locally and opens automatically when control power is interrupted~~
  - (4) ~~A device listed or approved for the intended application~~
- ~~Simultaneously disconnect all ungrounded conductors of the circuit~~
- ~~Located where readily accessible~~
- ~~Externally operable without exposed live parts~~
- ~~Enclosures with doors or hinged covers with exposed live parts when open that require a tool to open or are lockable where readily accessible to unqualified persons~~
- ~~Plainly indicate whether in the open (off) or closed (on) position~~
- ~~Have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals~~

~~Be~~ Where the line and load terminals are capable of being energized in the open position, the disconnect shall be marked in accordance with the warning in 690.13(B) ~~, where the line and load terminals are capable of being energized in the open position~~ .

Informational Note: With interconnected power sources, some equipment, including switches and fuses, is likely to be energized from both directions. See 240.40 .

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

As a general requirement, it is stated here that a means must be provided to disconnect power source output circuit conductors from the conductors of other systems.

The specific requirements for this disconnect are found in the specific Articles focused on various alternative sources of power. These sections include the following:

ARTICLE 445 Generators, 445.18 Disconnecting Means and Emergency Shutdown.

ARTICLE 625 Electric Vehicle Power Transfer System, Part III. Installation, 625.43 Disconnecting Means.

ARTICLE 690 Solar Photovoltaic (PV) Systems Part III. Disconnecting Means

ARTICLE 692 Fuel Cell Systems, Part III. Disconnecting Means

ARTICLE 694 Wind Electric Systems, Part III. Disconnecting Means

ARTICLE 706 Energy Storage Systems, Part II. Disconnecting Means

As a result, the language being deleted is not required as part of the general requirements as the specifics may vary based upon the supply. While there may be installations that require multiple disconnects, it is important that this section not imply that this is a requirement, or that it modifies other article in this area. The language addressing disconnects that may have load terminals energized when open has been kept since this language is not consistently addressed in the other power source articles

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Submitter Full Name: Thomas Domitrovich
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Submittal Date: Mon Aug 24 12:19:38 EDT 2020
Committee: NEC-P04

Public Input No. 2810-NFPA 70-2020 [Section No. 705.20]

705.20 Disconnecting Means, Source.

(A) General. Means shall be provided to disconnect power source output circuit conductors of electric power production equipment from conductors of other systems.

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) Enclosures with doors or hinged covers with exposed live parts when open that require a tool to open or are lockable where readily accessible to unqualified persons

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

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

(8) Be marked in accordance with the warning in 690.13(B) , where the line and load terminals are capable of being energized in the open position

Informational Note: With interconnected power sources, some equipment, including switches and fuses, is likely to be energized from both directions. See 240.40 .

(B) Labeling. The disconnecting means for the power source output circuit conductors from a multimode inverter shall be field labeled "INTERCONNECTED ELECTRIC POWER PRODUCTION SOURCE DISCONNECT". The label shall not be handwritten and shall comply with 110.21(B).

Additional Proposed Changes

File Name	Description	Approved
705.20_B_2023_NECdocx.docx	Clean Word doc version of the proposed PI	

Statement of Problem and Substantiation for Public Input

This PI seeks to add a new labeling requirement in a new (B). Any language that has been underlined in (A) is a glitch in Terra View.

With the increased installations of smart multimode inverters there needs to be additional requirements for the labeling of the inverters ac output power source disconnecting means. These types of disconnecting means only isolate the multimode inverter connection to the normal power source, and do not serve as a PV System or ESS disconnect. When the ac output power source disconnect is opened, the multimode inverter will switch to island mode and will allow an ESS or PV system to remain operational. The improper labeling of this ac output power source disconnect can lead to safety issues

with first responders trying to remove all sources of power to a building.

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Committee: NEC-P04

705.20 Disconnecting Means, Source.

(A) General. Means shall be provided to disconnect power source output circuit conductors of electric power production equipment from conductors of other systems.

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. Enclosures with doors or hinged covers with exposed live parts when open that require a tool to open or are lockable where readily accessible to unqualified persons
6. Plainly indicate whether in the open (off) or closed (on) position
7. Have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals
8. Be marked in accordance with the warning in 690.13(B), where the line and load terminals are capable of being energized in the open position

Informational Note: With interconnected power sources, some equipment, including switches and fuses, is likely to be energized from both directions. See 240.40.

(B) Labeling. The disconnecting means for the power source output circuit conductors from a multimode inverter shall be field labeled "INTERCONNECTED ELECTRIC POWER PRODUCTION SOURCE DISCONNECT". The label shall not be handwritten and shall comply with 110.21(B).

Public Input No. 3866-NFPA 70-2020 [Section No. 705.20]

705.20 Disconnecting Means, Source.

Means shall be provided to disconnect power source output circuit conductors of electric power production equipment from conductors of other systems.

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) Enclosures with doors or hinged covers with exposed live parts when open that require a tool to open or are lockable where readily accessible to unqualified persons

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

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

(12) Be marked in accordance with the warning in 690.13(B), where the line and load terminals are capable of being energized in the open position

(13) Be lockable

Informational Note: With interconnected power sources, some equipment, including switches and fuses, is likely to be energized from both directions. See 240.40 .

Statement of Problem and Substantiation for Public Input

In our area, the utility companies do not use production meters and as such the PV companies are using the breaker in the panel as a disconnecting means. The breaker needs to be lockable in emergency situations, as well as for use by the utility to service their equipment if they do have production meters. Currently some jurisdictions are allowing a locking means on an external panel to serve as a means to lock out the PV breaker, however by placing a lock on the entire panel, you now eliminate the access for use of the rest of the breakers. The locking means should be a separate method than locking the entire panel such as a breaker or disconnect that is not located in the main panel, or a permanent locking means on the breaker itself.

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Submittal Date:	Wed Sep 09 14:20:30 EDT 2020
Committee:	NEC-P04

Public Input No. 3942-NFPA 70-2020 [Section No. 705.20]

705.20 Disconnecting Means, Source.

Means shall be provided to disconnect power source output circuit conductors of electric power production equipment from conductors of other systems. ~~The disconnecting means shall comply with the following:~~

- ~~Be one of the following types:~~
  - (1) ~~A manually operable switch or circuit breaker~~
  - (2) ~~A load-break-rated pull-out switch~~
  - (3) ~~A power-operated or remote-controlled switch or circuit breaker that is manually operable locally and opens automatically when control power is interrupted~~
  - (4) ~~A device listed or approved for the intended application~~
- ~~Simultaneously disconnect all ungrounded conductors of the circuit~~
- ~~Located where readily accessible~~
- ~~Externally operable without exposed live parts~~
- ~~Enclosures with doors or hinged covers with exposed live parts when open that require a tool to open or are lockable where readily accessible to unqualified persons~~
- ~~Plainly indicate whether in the open (off) or closed (on) position~~
- ~~Have ratings sufficient for the maximum circuit current, available fault current, and voltage that is available at the terminals~~

~~Be marked in accordance with the warning in 690.13(B) , where the line and load terminals are capable of being energized in the open position A single handle or other action is permitted to operate multiple disconnecting means from a single source or multiple sources. 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.~~

Where the line and load terminals are capable of being energized in the open posi tion 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).

Informational Note: With interconnected power sources, some equipment, including switches and fuses, is likely to be energized from both directions. See 240.40 .

Statement of Problem and Substantiation for Public Input

Note that the informational note is not new despite the appearance of the legislative text.

Several requirements are removed from this section since they are not necessary as the unique requirements for each power source disconnect(s) are addressed in the specific source articles, not in 705. The presence of these requirements here are not only duplicative, but cause confusion or create conflicts since in some cases it will be unclear which article modifies which.

Clarification is added to allow a single handle or throw to operate multiple disconnecting means where applicable.
Language addressing backfed circuit breakers is revised for clarity. The warning label from 690.13 has been added instead of a pointer to better convey the requirement.
The requirement to secure hinged covers and doors has been deleted since 110.27 should provide requirements for guarding of all electrical equipment. See related PI.

See the following sections for disconnection requirements for each source:
ARTICLE 445 Generators, 445.18 Disconnecting Means and Emergency Shutdown.
ARTICLE 625 Electric Vehicle Power Transfer System, Part III. Installation, 625.43 Disconnecting Means.
ARTICLE 690 Solar Photovoltaic (PV) Systems Part III. Disconnecting Means
ARTICLE 692 Fuel Cell Systems, Part III. Disconnecting Means
ARTICLE 694 Wind Electric Systems, Part III. Disconnecting Means
ARTICLE 706 Energy Storage Systems, Part II. Disconnecting Means

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate and their inclusion here is not necessarily an endorsement of all the PI's submitted.
Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain, P.E., SEIA; Bill Brooks, PVICC; John Berdner, PVICC, Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing, Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower; Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Ben Chamberlain, Olivewood Energy; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3926-NFPA 70-2020 [New Section after 110.27(C)]	Guarding of certain equipment
Public Input No. 3926-NFPA 70-2020 [New Section after 110.27(C)]	

Submitter Information Verification

Submitter Full Name: Evelyn Butler
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Affiliation: PV Industry Forum (PVIF)
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Submittal Date: Wed Sep 09 16:00:56 EDT 2020
Committee: NEC-P04

Public Input No. 4006-NFPA 70-2020 [Section No. 705.20]

705.20 Disconnecting Means, Source.

Means shall be provided to disconnect power source output circuit conductors of electric power production equipment from conductors of other systems.

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) Enclosures with doors or hinged covers ~~with~~ containing exposed live parts when ~~open that~~ the door or cover is open, shall require a tool to open or ~~are lockable~~ shall be locked where readily accessible to unqualified persons

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

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

(12) Be marked in accordance with the warning in 690.13(B), where the line and load terminals are capable of being energized in the open position

Informational Note: With interconnected power sources, some equipment, including switches and fuses, is likely to be energized from both directions. See 240.40.

Statement of Problem and Substantiation for Public Input

Substantiation – This proposal is intended to provide similar electric shock protection as required by 690.13(A). The existing 705.20 (5) text mentions that the enclosure is to be lockable, but as it is written it does not require it to be locked, which is different from 690.13(A). “Shall” was introduced to make this list item a requirement.
It is important to note that utility interactive inverter outputs are not evaluated for touch safety when in a grid interactive output current cessation condition, such as when a inverter output disconnect is open. In this case, if the inverter is energized from its input source, the grid interactive output is paused from exporting current. Grid interconnection performance standards only require a cessation of current during abnormal grid events, and do not require a touch safe output evaluation, which has a significantly different criteria and safety evaluation.
As indicated by the inverter warning markings, an inverter that has been disconnected from all of it input and output power sources, (including the AC grid terminals/conductors), may take up to 5 minutes to discharge to levels that are safe to touch.

Please note that I did not modify (a-d) under item (1). Terraview underlined that text for some unknown reason to show it as modified or added.

Submitter Information Verification

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Submittal Date: Wed Sep 09 17:06:49 EDT 2020
Committee: NEC-P04

Public Input No. 4076-NFPA 70-2020 [Section No. 705.20]

705.20 Disconnecting Means, Source.

Means shall be provided to disconnect power source output circuit conductors of electric power production equipment from conductors of other systems.

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) Enclosures with doors or hinged covers with exposed live parts when open that require a tool to open or are lockable where readily accessible to unqualified persons

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

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

(12) ~~Be marked in accordance with the warning in~~ 690.13(B) ~~, where the~~ Where the line and load terminals are capable of being energized in the open position, shall be marked with the following words or equivalent:
WARNING ELECTRIC SHOCK HAZARD TERMINALS ON THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION

Informational Note: With interconnected power sources, some equipment, including switches and fuses, is likely to be energized from both directions. See 240.40.

Statement of Problem and Substantiation for Public Input

With the proposed placement of Article 705 as the new Article 689, a reference to the Solar PV article 690 seems unnecessary. In this case, 690 should now reference the new Article 689.

Submitter Information Verification

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Submittal Date: Wed Sep 09 20:12:45 EDT 2020
Committee: NEC-P04

Public Input No. 2946-NFPA 70-2020 [Section No. 705.25]

705.25 Wiring Methods.

(A) General.

All raceway and cable wiring methods ~~included in Chapter~~ that comply with either (1) or (2) shall be permitted:

(1) raceway and cable wiring methods found in Chapter 3 of this *Code* ~~and other wiring systems and~~

(2) wiring methods and fittings specifically listed, ~~intended,~~ and identified for use with power production systems and equipment ~~shall be permitted~~ .

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

Information Note: See 300.15 (E)

(B) Flexible Cords and Cables.

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

(C) Multiconductor Cable Assemblies.

Multiconductor cable assemblies used in accordance with their listings shall be permitted.

Informational Note: See UL 3003, *Distributed Generation Cables*, for additional information on DG Cable, Distributed Generation Cable. An ac module harness is one example of a multiconductor cable assembly.

Statement of Problem and Substantiation for Public Input

705.25(A) was revised for clarity and for usability.

Submitter Information Verification

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Submittal Date: Thu Sep 03 13:27:49 EDT 2020
Committee: NEC-P04

Public Input No. 3825-NFPA 70-2020 [Section No. 705.25]

705.25 Wiring Methods.

Power Source Output Circuit conductors shall comply with 705.25 (A) through (C).

(A) General.

All raceway and cable wiring methods included in Chapter 3 of this *Code* and other wiring systems and fittings specifically listed, intended, and identified for use with power production systems and equipment shall be permitted. Where wiring devices with integral enclosures are used, sufficient length of cable shall be provided to facilitate replacement.

(B) Flexible Cords and Cables.

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

(C) Multiconductor Cable Assemblies.

Multiconductor cable assemblies used in accordance with their listings shall be permitted.

Informational Note: See UL 3003, *Distributed Generation Cables*, for additional information on DG Cable, Distributed Generation Cable. An ac module harness is one example of a multiconductor cable assembly.

Statement of Problem and Substantiation for Public Input

This proposed text simply adds a sentence before the first level subdivision to ensure it is clear that the requirements within this section apply to the power source output conductors only, and are not intended to apply to other circuits within the power source systems.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate and their inclusion here is not necessarily an endorsement of all the PI's submitted.
Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain, P.E., SEIA; Bill Brooks, PVICC; John Berdner, PVICC, Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing, Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower; Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural

Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Ben Chamberlain, Olivewood Energy; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

Submitter Information Verification

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Submittal Date: Wed Sep 09 13:42:52 EDT 2020
Committee: NEC-P04

Public Input No. 1869-NFPA 70-2020 [Section No. 705.28]

705.28 Circuit Sizing and Current.

(A) Calculation of Maximum Circuit Current.

~~Where not elsewhere required or permitted in this *Code* , the maximum current for the circuit~~ The maximum current for the circuit, at the circuit nominal system voltage, shall be the continuous output current rating of the power production equipment.

(B) Conductor Ampacity.

Where not elsewhere required or permitted in this *Code*, the circuit conductors shall be sized to carry not less than the largest of the following:

(1) The maximum currents in 705.28(A) multiplied by 125 percent without adjustment or correction factors

(2) The maximum currents in 705.28(A) with adjustment and correction factors

(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

(C) Neutral Conductors.

Neutral conductors shall be permitted to be sized in accordance with either 705.28(C)(1) or (C)(2).

(1) Single-Phase Line-to-Neutral Power Sources.

Where not elsewhere required or permitted in this *Code*, the ampacity of a neutral conductor to which a single-phase line-to-neutral power source is connected shall not be smaller than the ampacity in 705.28(B).

(2) Neutral Conductor Used Solely for Instrumentation, Voltage, Detection, or Phase Detection.

A power production equipment neutral conductor used solely for instrumentation, voltage detection, or phase detection shall be permitted to be sized in accordance with 250.102.

Statement of Problem and Substantiation for Public Input

I deleted the leading text since it is too vague and I suggest adding the text about the current based on the circuit nominal system voltage, since power production equipment often has multiple output currents listed, based on the output nominal system voltage to which it is connected.

Submitter Information Verification

Submitter Full Name: Mike Holt
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Submittal Date: Mon Jul 13 10:11:35 EDT 2020
Committee: NEC-P04

Public Input No. 201-NFPA 70-2019 [Section No. 705.28(B)]

(B) Conductor Ampacity.

Where not elsewhere required or permitted in this *Code*, the circuit conductors shall ~~be sized to carry~~ have an ampacity not less than the ~~largest of the following:The~~ larger of 705.28(B)(1), (B)(2), or (B)(3) and shall comply with 110.14(C).

(1) The minimum circuit conductor size shall have an ampacity not less than t he 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 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).

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

(2) The minimum circuit conductor size shall have an ampacity not less than the calculated maximum currents in 705.28(A)

~~with adjustment and correction factors~~
after the application of any adjustment or correction factors in accordance with 310.14.

(3) Where connected to feeders, if smaller than the feeder conductors, the minimum conductor size with an ampacity as calculated in 240.21(B) based on the over-current device protecting the feeder

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

Changes made to align conductor ampacity with language found in Articles 210 and 215 focused on the same. Allowances for similar exceptions and language format to that found in Articles 210 and 215 help add clarity and consistency with the Code.

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Public Input No. 4380-NFPA 70-2020 [Section No. 705.30(A)]

(A) Circuit and Equipment.

Power source output circuit conductors and equipment shall be provided with overcurrent protection. Circuits connected to more than one electrical source shall have overcurrent protective devices located to provide overcurrent protection from all sources. Electronic power converters that are capable of operating in island mode and connected to the premises wiring system by flexible cords and cables or multiconductor cable assemblies not protected by a raceway shall be provided with listed electronic overcurrent and ground fault protection for the circuit connected to each electronic power converter.

Statement of Problem and Substantiation for Public Input

Added the word “protective” between overcurrent and device to align with the terms in Article 100 since these devices are not overcurrent devices, but rather overcurrent protective devices. Added a new sentence to clarify overcurrent protection needs for the output of electronic power converters that can operate in island mode versus interactive equipment. Other sections of the code, such as 690.8(A)(1)e, rely on the output rating of the listed electronic power converter for circuit sizing. Section 690.9(A)(1) even identifies where “overcurrent protection” for circuits is not required. Section 690.9(A)(2) specifies where overcurrent protection is only required at one end, which assumes the system is also connected to a primary source. The new sentence clarifies protection needs for power cords or multiconductor cables not protected by a raceway and are connected to the output of electric power production equipment that can operate in island mode. For these systems, the high fault currents from the grid and the utility interactive function of interactive electronic power converters will not work together to quickly remove ground faults since the grid is not present and the inverter does not have this interactive function in island mode. When the power production equipment is operating in island mode, the output current will be limited to its rating, which protects the wiring from overload but could allow continual sourcing of current to ground faults. Therefore, listed electronic ground fault detection and protection is needed to mitigate the fire risk from cable systems not installed in raceways. The term raceway was purposely chosen since the protection could be accomplished by non-metallic conduit, metallic conduit or a wire protection system as part of the equipment.

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Public Input No. 3409-NFPA 70-2020 [Section No. 705.30(C)]

(C) Power Transformers.

Transformers with sources on each side shall be provided with overcurrent protection in accordance with 450.3. The primary shall be the side connected to the largest source of available fault current. ~~Secondary protection~~ Transformer secondary conductors shall ~~not be required for a transformer secondary that has a current rating not less than the sum of the rated continuous output currents of the power sources connected to that secondary.~~ be protected in accordance with 240.21(C).

Statement of Problem and Substantiation for Public Input

Transformer secondary conductors require overcurrent protection per 240.21(C) even when the only source of potential fault current is the utility supply to the primary. Why would the addition of a second supply of potential fault current to the secondary (the inverter) alter the general rule of Article 240? A line-to-line or line-to-ground fault between the conductors from the transformer secondary to the inverter would be supplied by both the inverter and the utility.

The basis for the current requirement 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.

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.

Identification of what constitutes the primary is needed clarification but substantiation for modification of Article 240 rules has not been provided. The existing language references overcurrent protection of the transformer (450.3) but not overcurrent protection for transformer secondary conductors [240.21(C)].

Providing all required Article 450 and 240 transformer related overcurrent protection is not a hardship because overcurrent protection for the utility supplied primary conductors and overcurrent protection for the inverter output conductors is already required. If rated and located properly, these overcurrent devices will also provide the protection required by 450.3 and 240.21(C).

The suggested revision would provide the necessary clarity for proper enforcement of all applicable transformer circuit rules.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3408-NFPA 70-2020 [Section No. 690.9(D)]	
Public Input No. 3408-NFPA 70-2020 [Section No. 690.9(D)]	

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Public Input No. 4354-NFPA 70-2020 [Section No. 705.30(C)]

(C) Power Transformers.

Transformers with sources on each side shall be provided with overcurrent protection in accordance with 450.3. The primary shall be the side connected to the largest source of available fault current. Secondary protection shall not be required for a transformer secondary that has a current rating not less than the sum of the rated continuous output currents of the power sources connected to that secondary.

Exception: Where the only purpose of installating the transformer is to provide a neutral reference point for inverter controls, the requirements in 450.5(A)(2) shall not be required.

Statement of Problem and Substantiation for Public Input

The proposed new exception is intended to address situations where a zig-zag connected transformer has been installed only to provide a neutral reference point for inverter controls and there is no neutral current flow. Because there is no amendment in Articles 690 or 705, per 90.3, 450.5(A)(2) applies.

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Public Input No. 2538-NFPA 70-2020 [Section No. 705.32]

705.32 Ground-Fault Protection.

Where ground-fault protection of equipment is installed ~~in accordance with~~ ~~230.95~~ as required elsewhere in this Code , the output of ~~an interactive system~~ interconnected power production equipment shall be connected to the supply side of the ground-fault protection.

Exception: Connection shall be permitted to be made to the load side of ground-fault protection, if there is ground-fault protection for equipment from all ground-fault current sources.

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

Added “of Equipment” to align with other areas in the NEC where this terminology is used.

Minor changes to add clarity. Removed the reference to 230.95 an made a general reference to where GFPE is provided regardless.

The work of this task group included modifying the definition of interactive system such that the term no longer exists. The modification made removes the conflict should the public input that modifies the term be accepted.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2684-NFPA 70-2020 [Definition: Interactive System.]	Definition change / term

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Public Input No. 4056-NFPA 70-2020 [Section No. 705.40]

705.40 Loss of Primary Source.

The output of interactive electric power production equipment shall be automatically disconnected from all ungrounded conductors of the ~~interconnected systems~~ primary source when one or more of the phases of the primary source to which it is connected opens. The electric power production equipment shall not be reconnected until all the phases of the ~~interconnected system~~ primary source to which it is connected are restored. This requirement shall not be applicable to electric power production equipment providing power to an emergency or legally required standby system.

Exception: A listed interactive inverter shall trip or shall be permitted to automatically cease exporting power when one or more of the phases of the ~~interconnected system~~ 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 shall be permitted to operate in island mode to supply loads that have been disconnected from the electric power production and distribution network.

Statement of Problem and Substantiation for Public Input

The way this section is written, it is not clear that the intent is related to the loss of phase or phases from the primary source. The title is "Primary Source" but the language talks about interconnected sources as if there were only one primary source and one interactive source. By changing interconnected source to primary source in the proper locations, the intent is clarified.

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Public Input No. 4392-NFPA 70-2020 [Section No. 705.40]

705.40 Loss of Primary Source.

The output of interactive electric power production equipment shall be automatically disconnected from all ungrounded conductors of the interconnected systems when one or more of the phases to which it is connected opens. The interactive electric power production equipment shall not be reconnected until all the phases of the interconnected system to which it is connected are restored. This requirement shall not be applicable to interactive electric power production equipment providing power to an emergency or legally required standby system.

Exception: A listed interactive inverter shall trip or shall be permitted to automatically cease exporting power when one or more of the phases of the interconnected system opens and shall not be required to automatically disconnect all ungrounded conductors from the primary source. A listed interactive inverter shall be permitted to automatically or manually resume exporting power to the interconnected system once all phases of the source to which it is connected are restored.

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 shall be permitted to operate in island mode to supply loads that have been disconnected from the electric power production and distribution network.

Statement of Problem and Substantiation for Public Input

The word “interactive” was added to the first paragraph to align with the statement in the last paragraph and make it clear that only interactive equipment is required to meet this requirement. Equipment operating in island mode is not required to meet this requirement.

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Public Input No. 3456-NFPA 70-2020 [New Section after 705.45]

705.46 Energy Management Systems (EMS)

Where a listed energy management system that controls multiple loads up to a maximum total ampere rating is connected to a feeder or service, a single value equal to the maximum ampere setpoint of the EMS shall be permitted to be used in load calculations for all loads controlled by the EMS where the following conditions are met:

(1) The EMS shall include monitoring and controls that disconnect the managed loads upon system malfunction

(2) The access to settings of the EMS shall be restricted to qualified personnel in accordance with the requirements of 240.6(C)

(3) The setpoint value of the EMS shall be considered a continuous load for the purposes of load calculations

(4) Loads not controlled by the EMS connected to the same feeder or service shall be included in load calculations for that feeder or service

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

The electrification of homes and businesses is dramatically increasing the loads that must be served from electrical distribution systems. Widespread adoption of electric vehicles chargers, conversion of heating and cooling systems from oil and gas to heat pumps, and the adoption of onsite power sources such as solar and energy storage continues at a rapid pace. As these loads are connected to electrical distribution systems, the capacity of these distribution systems is becoming a barrier toward this electrification progress. Technologies in energy management systems are being developed, listed, and installed to help address these challenges. Advanced systems from large microgrids serving multiple buildings to residential systems supplying a single home are being built today with advanced load management functions to ensure that conductors and distribution equipment are used within their ratings, and that owners of these systems benefit from a reliable and efficient supply of power when it is needed. Increasingly these load management systems are adding features not only to prevent operation in different system states (i.e. backup priority), but also to schedule loads (i.e. for time of use) or to make loads non-coincident (i.e. optimize backup capacity). Additionally, energy management systems are increasingly being used for demand response programs in concert with utilities to support a smart grid. Historically this Code has provided allowances for alternative equipment sizing where our buildings are built to energy codes (220.12(B)), or when sizing an optional standby system (702.4(B)(2)(b)), or when adding some types of EV chargers (625.42). There is also a recognition of loads that are “unlikely” to be in use simultaneously (220.60) along with an allowance for power source control where the output of multiple power sources connected in parallel are controlled to a specified total output limit (705.13).

This public input seeks to build upon those specific allowances to provide a new option in Part I of Article 705 for any load connected to a feeder or service conductor where those loads are controlled to a maximum limit that effectively restricts the total loads operated at one time. Inputs addressing this issue in Article 220 are also being submitted in Parts 3 and 4 of that article. If the technical committees decide that those locations are more appropriate for this language then this new section in 705 is not necessary (though would not conflict, only duplicate).

Providing this option is important to allow electric distribution systems to be utilized, in a safe and effective manner, in order to provide reasonable accommodation for property owners to further pursue electrification without requiring extensive electrical system equipment upgrades that are not necessary in

all use cases. For those cases where loads do not need to be operated at the same time, load management will likely be preferred to equipment replacement to save costs and downtime of existing equipment.

Since safety is critical to ensure overcurrent does not occur, requiring that such a system be listed and that loads are disconnected during any malfunction will ensure fail-safe operations. To ensure that the setpoints for the EMS are protected, the same requirements for adjustable-trip circuit breakers is included. The current limit of the EMS is treated as continuous for the purposes of conductor sizing to recognize the connection of continuous and non-continuous duty loads is not restricted in this section. If other loads not controlled by the EMS are connected to the same feeder or service, a requirement to ensure those are also included in the load calculations is included here without any novel adjustments.

This public input does not modify Article 750 so restrictions on specific loads such as for emergency systems and fire pumps still apply as called out in Article 750.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3448-NFPA 70-2020 [New Section after 220.80]	EMS additions to 220
Public Input No. 3454-NFPA 70-2020 [New Part after IV.]	EMS additions to 220

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Committee: NEC-P04

Public Input No. 769-NFPA 70-2020 [New Section after 705.45(B)]

TITLE OF NEW CONTENT

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705.46 Electromagnetic Pulse (EMP) Protection. Protection for interconnected electric power production sources against the effects of electromagnetic pulses shall be provided at a minimum of Level 2. See 709.7 for levels of electromagnetic pulse protection.

Exception: The requirements of 709.7(A)(5) and 709.7(B)(3) shall not apply.

This requirement shall become effective January 1, 2026.

Statement of Problem and Substantiation for Public Input

A devastating electromagnetic pulse (EMP), caused by a sun-spot or a nuclear bomb exploded high in the atmosphere, can impress 50,000 volts per meter on unprotected electrical and electronic equipment. It is similar to a radio wave impressing a very small voltage on a radio antenna, only orders of magnitude larger. The problem is that a significant EMP will fry every electrical/electronic component or piece of equipment that is not protected.

The EMP won't directly harm or injure people, but because there is no longer a working electrical infrastructure, which may take years to repair/rebuild, people will die from the lack of clean water, medicine, food, fuel, and eventual rioting due to the breakdown of society. Unclassified studies, referenced at the end of this substantiation, have estimated from 66% to 90% of the US population will die within one year if a significant sun spot were to occur or if a nuclear explosion were to occur 25 to 250 miles over the Midwest.

Our US military already "hardens" systems/buildings so that our country's critical defensive capabilities are not completely destroyed. There are two major methods of protecting electrical/electronic systems. The first is that surge protective devices are installed on all "incoming" power and communications cables, shunting overvoltages to ground. The second is that Faraday cages are installed around equipment/rooms, preventing the EMP from reaching critical equipment/components.

The NEC® needs to address EMP protection for equipment, systems and special occupancies that are critical to our survival. Electrical and electronic equipment can and must be protected, as has been achieved by our military. Unfortunately, there are no requirements to protect civilian electrical and electronic equipment/systems from EMPs.

The NEC Correlating Committee has informally advised that an EMP Protection Article, if passed and adopted into the NEC®, would be most appropriately located after Article 708 (COPS). Thus, Public Input 756 has suggested a new Article 709 under jurisdiction of CMP 13, which already has purview over Emergency Systems (Article 700), Legally Required Standby Systems (Article 701), Optional Standby Systems (Article 702), and Critical Operations Power Systems (Article 708).

Levels of protection and associated protection requirements listed in the Public Input(s) are based upon the unclassified National Cybersecurity and Communications Integration Center report "Electromagnetic Pulse (EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment". This study explains electromagnetic pulses and provides the necessary protective measures. It also contains estimates of the costs associated with properly protecting our electrical infrastructure.
The following table contains critical infrastructure components/special occupancies and the maximum time for outages caused by an EMP. Electrical components/infrastructure that is not functioning for periods longer than shown in this table may begin to cause injury or death to people and harm to society/economy.
Critical Infrastructure Component/Special Occupancy Permitted Outage Time
Branch banking facilities 10 hours

Critical Operations Power Systems 10 minutes
Data centers 10 minutes
Direct current microgrids 10 hours
Drug stores/distribution centers 10 hours
Electrically driven or controlled irrigation machines 1 week
Elevators, dumbwaiters, escalators, moving walks, platform lifts, and stairway chairlifts See facility requirements
Emergency systems 10 hours
Energy storage systems 10 hours
Fire alarm systems 1 week
Fire houses/stations 10 hours
Fire pumps 10 hours
Food processing and storage facilities 10 hours
Fuel cell systems 10 hours
Generators 10 hours
Grocery stores 10 hours
Hardware stores/home centers 10 hours
Healthcare facilities See NFPA 99
Information technology equipment 10 minutes
Interconnected electric power production sources 10 minutes
Jails and prisons 10 minutes
Large-scale photovoltaic (PV) electric supply stations 10 hours
Legally required standby systems 10 hours
Modular data centers 10 minutes
Motor fuel dispensing facilities 1 week
Motors, motor circuits, and controllers See facility requirements
Nuclear reactors 10 seconds
Optional standby systems 1 week
Petrochemical plants/facilities 10 hours
Pharmaceutical plants/facilities 10 hours
Police stations 10 minutes
Solar photovoltaic (PV) systems 10 hours
Stand-alone systems 10 hours
Storage batteries See facility requirements
Transformers See facility requirements
Waste water treatment facilities 10 minutes
Water supply facilities 10 hours
Wind electric systems 10 hours

An effectivity date of January 1, 2026 is chosen to allow time for engineering and industry to adequately pan and prepare for the required changes.

Opponents of EMP protection requirements will likely charge that it is too costly to protect our critical infrastructure, and that the NEC® is not a war-time document. A close reading of 90.1 reveals that there is no mention of the “cost” of safeguarding persons and property. Neither does 90.1 mention that safeguarding persons and property is only required during peacetime. Additionally, a significant EMP event, caused by a sunspot, would be an act of God, not an act of war.

The novel, “One Second After”, provides an understanding of what happens when the majority of all unprotected electrical and electronic equipment/systems is destroyed during an EMP event. An audio version of this book is available in two parts, for free, on YouTube.

This link provides the unclassified report “Electromagnetic Pulse (EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment”
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=2ahUKEwjQhp2-77DoAhXBHM0KHboOB2QQFjACegQIBRAC&url=https%3A%2F%2Fwww.cisa.gov%2Fsites%2Fdefault%2Ffiles%2Fpublications%2F19_0307_CISA_EMP-Protection-Resilience-Guidelines.pdf&usg=AOvVaw2n7jLtJAUJtOJKHPMqWsTE

This link provides the study predicting up to 90% of our population could die from an EMP event
http://www.firstempcommission.org/uploads/1/1/9/5/119571849

/nuclear_emp_attack_scenarios_and_combined-arms_cyber_warfare_by_peter_pry_july_2017.pdf

This link provides unclassified guidelines for facility EMP protection
https://info.publicintelligence.net/DHS-FacilitiesGuidelinesEMP.pdf

These links provide Parts 1 and 2 of a national plan for EMP protection.
https://interferencetechnology.com/a-national-plan-for-emp-protection-part-1/
https://interferencetechnology.com/national-plan-emp-protection-part-2-protection-buildings/

We have all just witnessed the chaos and pain caused by not having the “protections” in place to quickly defeat the Covid-19 virus. As unfortunate, costly, painful, and deadly as Covid-19 was, it would be child’s play when compared to a significant EMP event if our critical electrical/electronic infrastructure remains unprotected. Quite simply, NEC® requirements to protect electrical and electronic equipment from an EMP event, could literally save millions of American lives.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 756-NFPA 70-2020 [New Section after 708.64]	
Public Input No. 756-NFPA 70-2020 [New Section after 708.64]	

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Public Input No. 2884-NFPA 70-2020 [New Section after 705.50]

705.55 Microgrid Commissioning.

Microgrid systems shall be commissioned upon installation per 110.17 to confirm system operation.

Statement of Problem and Substantiation for Public Input

Common requirements for device and system commissioning are being proposed to Article 110 in PI 2844 that will help drive consistency in the actions necessary prior to devices and systems being placed into service. This public input is part of a series of revisions proposed throughout the code to include commissioning where system verification is warranted.

Microgrid systems require setup and initial performance verification for devices and equipment necessary for proper system operation and safety to confirm the installation. In addition to verifying operational controls and sequence of operation, this revision also adds clarity that overcurrent and protective devices must have settings that have been adjusted and verified when inspected by the AHJ. The requirement to include as-built documentation and a record of the actions taken to correct any shortcomings will enhance the safety of those who will operate, maintain, and service the equipment.

The term commissioning is defined in 708.2 and applies throughout the code.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2844-NFPA 70-2020 [New Section after 110.16]	
Public Input No. 2894-NFPA 70-2020 [New Section after 712.4]	
Public Input No. 2887-NFPA 70-2020 [Definition: Commissioning.]	
Public Input No. 2894-NFPA 70-2020 [New Section after 712.4]	

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Public Input No. 2539-NFPA 70-2020 [Section No. 705.50]

705.50 System Operation.

~~Microgrid~~ Microgrid systems shall be ~~permitted to disconnect from the~~ interconnected to and capable of operating in interactive mode with a primary source of power or ~~other interconnected~~ an electric power production and distribution network. Microgrid systems shall be permitted to disconnect from other sources and operate ~~as an isolated microgrid system operating~~ in island mode.

Informational Note: Microgrid 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 was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

Requirements in 705 Part 1 still apply. See 705.6 for listing of equipment. 705.14 for compatibility of parallel sources, 705.16 for SCC rating etc., 705.20 for disconnects, 705.28 for ampacities, 705.40 for loss of primary source, etc.

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Public Input No. 899-NFPA 70-2020 [Section No. 705.50]

705.50 System Operation.

Microgrid systems shall be permitted to disconnect from the primary source of power or other interconnected electric power production sources and operate as an isolated microgrid system operating in island mode.

Informational Note: For additional information about microgrids see NECA 417-2019, *Recommended Practice for Designing, Installing, Operating and Maintaining Microgrids.*

Statement of Problem and Substantiation for Public Input

The proposed informational note provides users with a reference that assists with increasing understanding of microgrid installations and how they work. Many in the electrical field are not very familiar with these systems. As these installations become more common, this quality performance standard provides valuable insight that assists with this understanding.

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Public Input No. 2540-NFPA 70-2020 [New Section after 705.70]

705.75 Direct-Current Ground-Fault Detection

In addition to the requirements of 250.167, functionally grounded power source output circuit conductors in microgrids operating at greater than 60 volts dc to ground shall have ground fault detection that indicates that a fault has occurred. The ground fault equipment shall be marked in accordance with 250.167(C).

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

The requirements found in 712.55 was moved to new article 705. The language was modified slightly recognizing that there is an additional expanded requirement beyond that which is a part of 250.167 requiring ground-fault current detection on grounded systems greater than 60V where as 250.167 only recognizes a permission for this detection and not a requirement for this detection. Furthermore, the specific circuit conductors are now referenced to ensure this requirement is applied to the correct portions of the microgrid, which also contain circuits within any connected sources (i.e. battery circuits within an ESS that would be covered in Article 480 or 706).

The references to Ungrounded and reference grounded dc microgrids which are a part of the original 712.55 are not included here because ground fault detection equipment is included for the different types of sources covered in other articles related to those sources. Part VIII of Article 250 addresses the other dc sources / applications.

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Committee: NEC-P04

Public Input No. 2541-NFPA 70-2020 [New Section after 705.70]

Part III Systems Operating in Island Mode

705.8 0 Power Source Capacity.

The sum of all sources capable of parallel operation in island mode shall have a capacity complying with 705.80(A), (B) or (C) in accordance with Article 220 or by another approved method.

I nformational 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) Automatic Load Management.

Where load management is controlled automatically, the system shall have adequate capacity and rating sufficient to supply the maximum load that will be connected by the load management system at one period of time.

(A) Manual Load Management.

Where load management is controlled manually, the system shall have adequate capacity and rating for the supply of all equipment intended to be operated at one time. The user of the system shall be permitted to select the load connected to the system.

A permanent label shall be applied to the distribution equipment containing branch circuit overcurrent protection devices supplied by the system operating in island mode that states the total system capacity available to supply loads continuously and contains the following or equivalent wording:

NOTICE: Equipment is supplied by a power system incapable of operating all loads at one time. Manual disconnection of loads is required for system to operate independent of a utility source.

Informational Note: The opening of switches or circuit breakers to select loads is a common method of controlling loads manually.

(C) No Load Management .

Where load management is not used, the system shall have adequate capacity and rating equal to or greater-than the full load that is connected when the system is operating in island mode.

705.81 Circuit Sizing and Protection.

The circuit conductors between a source capable of operating in island mode 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.

705.82 Stand-Alone Systems with 120-Volt Supply.

Stand-alone 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).

705.83 Energy Storage or Standby Power System Requirements.

Energy storage or standby power supplies shall not be required except where otherwise required in this Code.

705.84 Back-fed Circuit Breakers.

Plug-in-type back-fed circuit breakers connected to an interconnected supply shall be secured in accordance with 408.36(D). Overcurrent devices shall comply with 705.12(D).

705.85 Voltage and Frequency Control.

Power sources operating in island mode shall be controlled so that output voltage and frequency remain within suitable limits for the connected loads.

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

This new Part III is a part of the effort to merge the requirements of Article 710 with Article 705.
705.80:
The changes in 705.80 include new language to replace the previous 710.15(A) and is largely based on 702.4(B)(1)&(2). The creation of the three options of automatic load management, manual load management, and no load management establish important options that provide flexibility for the designer and transparency for the owner. For systems operating in Island Mode, this new Section builds upon the base established in Article 702 while maintaining flexibility without losing transparency as to what methods have been selected. The IN was moved from 710.15(A).

705.82:
The language in 705.82 is the same as that found in 710.15(B).

705.83:
Langauge from 710.15(C) was moved over with some minor changes to account for its new location within Article 705. The title was changed and there was a removal of isolated microgrid. Isolated microgrid is not a defined term nor system. This allowance has historically only been applied to small stand-alone systems.

705.84:
Language from 710.15(E) was moved here with a minor change. added end of sentence to recognize applications like emergency systems where this may be a requirement.

705.85:
Language from 710.15(F) was moved here.

705.86:
Language from 710.15(G) was moved here. Minor modifications were made to apply to all sources in island mode, not just stand-alone.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3012-NFPA 70-2020 [Section No. 702.4]	

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Public Input No. 2566-NFPA 70-2020 [New Section after 705.70]

Part IV. Systems Over 1000 Volts ac, or 1500 Volts dc.

705.100 General.

Power source output circuits with a maximum voltage between conductors of over 1000 volts ac shall comply with the requirements in this Code applicable to installations rated over 1000 volts. Power source output circuits with a maximum voltage between conductors of over 1500 volts dc shall comply with the requirements in this Code applicable to installations rated over 1500 volts dc.

705.101 Wiring Systems.

All raceway and cable wiring methods shall be installed according to the applicable Chapter 3 requirements. Other wiring systems and fittings specifically listed for use in microgrid or stand-alone systems, and wiring as part of a listed system shall be permitted. Where wiring devices with integral enclosures are used, sufficient length of cable shall be provided to facilitate replacement.

Statement of Problem and Substantiation for Public Input

This Public Input is submitted on behalf of two correlating committee task groups, (Medium Voltage Task Group and Alternative energy Task Group. These two task groups consist of the following members:

Medium Voltgage Task Group: Robert Osborne (Chair), Paul Barnhart, Lou Grahor, David Temple, Donny Cook, Dean Hunter, Mike Querry, Roger McDaniel, Dave Burns, Rod Belisle, and Kevin Rogers.

Alternative Energy Task group: Thomas Domitrovich (Chair), Derrick Atkins (CMP 5), Greg Ball (CMP 13)
Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

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

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Public Input No. 4214-NFPA 70-2020 [Definition: Diversion Charge Controller.]

480.2 Diversion Charge Controller.

Equipment that regulates the charging process of an ESS by diverting power from energy storage to direct-current or alternating-current loads or to an interconnected utility service.

Statement of Problem and Substantiation for Public Input

It is no longer necessary to address individual components of these systems in Article 706.. Correlates with PI to add this language to Article 480.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF's effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI's as they deem appropriate and their inclusion here is not necessarily an endorsement of all the PI's submitted.
Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain, P.E., SEIA; Bill Brooks, PVICC; John Berdner, PVICC, Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing, Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower; Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson; Jason Bobruk, SolarEdge Technologies; Reid ; train, Savion; Charlie Dearie, McCalmont Engineering; Sumanth Lokanath, Ray Illuminati LLC; Yann Schwarz, Esdec Inc.; Joseph Armano, PanelClaw, Inc.; Michael Heinrich, PanelClaw, Inc.; Steve Wurmlinger, SMA Solar Technology AG; Thomas Wegener, SMA Solar Technology AG; Chris Flueckiger, Key Renewables; Matt Piantedosi, Ridgeline Energy Analytics; Samantha Doshi, Intertek; Kyle Breuning, Tesla; Charles Picard, Tesla; Steve Connolly, Tesla; Greg Ball, Tesla; Jake West, Tesla; Jamie Daggett, DNV GL; MinWah Leung, DNV GL; Bob White, Fimer SpA; Marvin Hamon, Pure Power Engineering; Milton Nogueira, Roof Tech; Peter Seidel, First Solar; Jason Smolko, Copperweld;

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Public Input No. 2828-NFPA 70-2020 [Article 710]

Article 710 Stand-Alone Systems

710.1 Scope.

This article covers electric power production systems that operate in island mode and installations not connected to an electric power production and distribution network.

Informational Note: These systems are capable of operating in island mode, independent from an electric power production and distribution network, and include isolated microgrid systems or interactive with other power sources. 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 equipment shall be approved for the intended use 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

Informational Note: Inverters identified as “multimode” and “stand-alone” are specifically identified and certified to operate in this application. Stand-alone inverters operate in island mode. Multimode inverters operate in either island mode (previously called “stand-alone mode”) or interactive mode, if it has been installed with the optional utility grid connection. A multimode inverter will only operate in island mode if it is never connected to an electric utility supply. Stand-alone inverters are not evaluated for and are not intended for connection to export power in parallel with an electric utility.

710.10 Identification of Power Sources.

A permanent plaque or directory shall be installed at a building supplied by a stand-alone system at each service equipment location, or at an approved readily visible location. The plaque 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, the plaque or directory shall be marked with the wording “CAUTION: MULTIPLE SOURCES OF POWER.” The marking shall comply with 110.21(B) .

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

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)** Back-fed Circuit Breakers.~~

~~Plug-in-type back-fed circuit breakers connected to an interconnected supply shall be secured in accordance with 408.36(D) . Circuit breakers marked “line” and “load” shall not be backfed.~~

~~**(G)** Voltage and Frequency Control.~~

~~The stand-alone or isolated microgrid supply shall be controlled so that voltage and frequency remain within suitable limits for the connected loads.~~

Statement of Problem and Substantiation for Public Input

This Public Input is submitted on behalf of two correlating committee task groups, (Medium Voltage Task Group and Alternative energy Task Group. These two task groups consist of the following members: Medium Voltgage Task Group: Robert Osborne (Chair), Paul Barnhart, Lou Grahor, David Temple, Donny Cook, Dean Hunter, Mike Querry, Roger McDaniel, Dave Burns, Rod Belisle, and Kevin Rogers. Alternative Energy Task group: Thomas Domitrovich (Chair), Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13).

This article is being deleted since the relevant requirements within it are being moved into Article 705, new Part III. The interconnection of power sources has always been covered under Article 705 and many stand-alone systems, and all microgrids, will have multiple power sources interconnected together.

Furthermore, the use of the term stand-alone within this Code has become confusing thus making the application of this Article unclear to many users. By moving this content into Article 705, users of this Code will have greater clarity what requirements should be placed on both stand-alone systems and microgrid systems capable of operating in island mode when their interactive connection to utility sources is not maintained.

The attached word document provides an overview of all of the changes in this effort to assemble a general requirements article for alternative energy applications. Each section in Article 710 was addressed and is shown as such to help the Code Panel account and verify each item being removed here has indeed been addressed by the task group.

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Public Input No. 1955-NFPA 70-2020 [Section No. 710.1]

710.1 Scope.

This article covers installations of electric power production systems that operate in island mode and ~~installations~~ are not connected to an electric power production and distribution network.

Informational Note No. 1 : These systems are capable of operating in island mode, independent from an electric power production and distribution network, and include isolated microgrid systems or interactive with other power sources. Stand-alone systems often include a single or a compatible interconnection of sources such as engine generators, solar PV, wind, ESS, or batteries.

Informational Note No. 2 : See Article 702 for more information on electric power production sources that can operate as optional standby systems.

Statement of Problem and Substantiation for Public Input

Clarity needs to be provided to the scope of Article 710 that a stand alone system is an electric power production system that operates 100% of the time in an off-grid application and no component of the system is connected to a utility source. A multimode inverter that can island upon the loss of the normal source of power would be an optional standby system. An optional standby system is defined as "Those systems intended to supply power to public or private facilities or property where life safety is not depend on the performance of the system. These systems are intended to supply on-site generated or stored power to selected loads either automatically or manually." A new informational note will provide guidance for code users that Article 702 has purview for Optional Standby Systems.

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Public Input No. 2200-NFPA 70-2020 [Section No. 710.1]

710.1 Scope.

This article covers electric power production systems that operate in ~~island mode and~~ installations not connected to an electric utility power production and distribution network.

Informational Note: These systems are capable of ~~operating in island mode,~~ operating independent from an electric utility power production and distribution network, and include isolated microgrid systems or interactive with other power sources. 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

Removing Island Mode from the Scope corolates the article for the installation and use. When there is an electric utility -power production connection, it is not possible to operate in Stand Alone Mode. The Grounded Conductor of any Serving Utility annuls the applying Stand Alone. The Grounded Conductor Connection is common to a PV, ESS, Wind or Battery system.

Unless there is a at minimum of a UL 1008 Automatic Transfer Switch that Switches the Grounded Conductor there by creating a Separately Derived System, any interconnection of any other system is not operating independently of the electric serving utility.

Island Mode is not an accurate application for 710.

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Committee: NEC-P04

Public Input No. 3116-NFPA 70-2020 [Section No. 710.6]

710.6 Equipment Approval.

All equipment shall be approved for the intended use 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

Informational Note: Inverters identified as “multimode” and “stand-alone” are specifically identified and certified to operate in this application. Stand-alone inverters operate in island mode. Multimode inverters operate in either island mode (previously called “stand-alone mode”) or interactive mode, if it has been installed with the optional utility grid connection. A multimode inverter will only operate in island mode if it ~~is never connected to an electric~~ is disconnected from the electric utility supply. Stand-alone inverters are not evaluated for and are not intended for connection to export power in parallel with an electric utility.

Statement of Problem and Substantiation for Public Input

The way the informational note was worded seemed confusing/contradictory to what was stated previously. A better way to word it would be to say that when in island mode, the inverter is always disconnected from the electric utility supply.

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Public Input No. 3820-NFPA 70-2020 [Section No. 710.6]

710.6 Equipment Approval.

All equipment shall be approved for the intended use 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

Informational Note: Inverters identified as “multimode” and “stand-alone” are specifically identified and certified to operate in this application. Stand-alone inverters operate in island mode. Multimode inverters operate in either island mode ~~(previously called “stand-alone mode”)~~ or interactive mode, if it has been installed with the optional utility grid connection. A multimode inverter will only operate in island mode ~~if it is never connected to~~ where not operating in parallel with an electric utility supply. ~~Stand~~ Inverters identified only for stand-alone ~~inverters are~~ applications are not evaluated for and are not intended for connection to export power in parallel with an electric utility.

Statement of Problem and Substantiation for Public Input

This informational note language should be modified to more accurately describe how multimode inverters are certified, installed and operated. The use of the phrase “never connected” in the original text can cause confusion when applied to multimode inverters. Changes to the last sentence are made to further clarify the specific applications these inverters are evaluated for. The parenthetical text was removed as it is unnecessary since it refers to text used in older NFPA-70 revisions.

The PV Industry Forum (PVIF) is a collaborative initiative of several organizations dedicated to continually improving the installation safety of PV systems in the U.S. The organizations are the Solar Energy Industry Association (SEIA), the PV Industry Codes Council (PVICC), Solar Energy International (SEI), the Interstate Renewable Energy Council (IREC), and the Large-Scale Solar Association (LSA). This coalition has come together to organize, convene, support and mentor solar industry professionals through the NEC public input process, which is open to all solar industry participants.
This collaborative effort has resulted in the consensus development of numerous solar-related Public Input proposals for consideration. The list of task group members indicates those individuals who have contributed to the development of various Public Inputs in nine different tasks groups. A consensus process was used to develop each Public Input, therefore this list does not necessarily indicate that each individual or their representative organization participated in or has agreed with every proposed Public Input submitted under the PVIF effort. Each participant has agreed that any original proposal that they submitted and which was subsequently improved by our process is assigned as original and / or improved work to PVIF for submittal and release to NFPA as a proposed Public Input.
Members of the PVIF’s effort include the following representatives. Note that those noted below participated in specific task groups and not necessarily all task groups on specific items proposed. Each member is at their discretion to individually comment on PI’s as they deem appropriate and their inclusion here is not necessarily an endorsement of all the PI’s submitted.
Evelyn Butler, SEIA; Jason Fisher, SEIA; Ward Bower, Ward Bower Innovations LLC/SEIA; Joseph Cain, P.E., SEIA; Bill Brooks, PVICC; John Berdner, PVICC, Rebekah Hren, Solar Energy International; Brian Mehalic, Solar Energy International; Mark Rodriguez, Sunrun; Paul Joyce, Sunrun; Brian Ewing, Swinerton; Sumana Seshadri, Swinerton; Christian Eder, Fronius USA; Isaac Opalinsky, SunPower; Chris Fox, SunPower; James Cormican, RBI Solar; Dave Compaan, RBI Solar; Shawn Shaw, Natural Power; Cody Oram, Vivint Solar; Greg Elvestad, Vivint Solar; Mike Weimer, Westwood Professional Services; Doug Mutcher, Westwood Professional Services; Jeff Wang, Staubli; Colleen O'Brien, UL; John Doty, UL; Laurie Florence, UL; Tim Zgonena, UL ; Gokul Kalyan, FTC Solar; Ali Sedaghat, FTC Solar; K.C. Radford, Radian Generation; Jan Dominguez, LG Electronics; Ben Chamberlain, Olivewood Energy; Klaus Nicolaedis, Unirac Inc.; Leif Cook, Core Development Group; Martin Herzfeld, Herzfeld; Dave Click, esaSolar; Sean White, principal; Kate Collardson, BayWa r.e. Solar Systems; Bryan Holland, NEMA; Jack Lyons, NEMA; Mike Stone, NEMA; Evan Martin, BURNDY; Terry McKinch, Mortenson;

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Public Input No. 4100-NFPA 70-2020 [New Section after 710.10]

TITLE OF NEW CONTENT

Type your content here ...

710.11. Emergency Disconnects. For one- and two-family dwellings, each power source including PV systems, wind systems, batteries, energy storage systems, fuel cells, and hydropower systems shall have an emergency disconnecting means or shutdown means meeting (the following:

(A) Be located in a readily accessible and visible location outside the building.

(B) Be located within 1 m (3 ft) of all other emergency disconnecting or shutdown means and the plaque required by 710.10.

(C) If controlled remotely, the control system shall be “fail safe” where disconnects shall automatically open or the power source be automatically disabled on loss or control power or control signal.

Statement of Problem and Substantiation for Public Input

This proposal is one of several related, but separate proposals involving the 2020 NEC requirements for external (outside the building) emergency disconnects on one- and two-family dwellings for energy sources such as the utility service, batteries, energy storage systems (ESS), wind systems and also stand-alone PV systems plus PV rapid shutdown systems. The intent of these proposals is to establish uniform requirements where there is more than one of these emergency disconnects, that all such disconnects be grouped in one location to increase safety for Fire Service first responders.

Also, when remote activation of these disconnects is allowed, the proposal establishes an additional safety requirement that the remote controls be fail safe and in the event of loss of control power or control signal, the emergency disconnect shall automatically be opened. It has been determined that some inverter manufacturers are already starting to put inputs on their products to allow an external remote shutdown control system that is fail safe. Also, it has been determined that adding such a fail-safe remotely controlled emergency disconnect system is relatively inexpensive using voltage-trip circuit breakers and a relay on large battery banks or ESS.

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Public Input No. 3792-NFPA 70-2020 [Section No. 710.10]

710.10 Identification of Power Sources.

A permanent plaque or directory shall be installed at a building supplied by a stand-alone system at each service equipment location, or at an approved readily visible location. The plaque or directory shall denote the location of ~~each power~~ the stand-alone 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, ~~the plaque or directory shall be marked with the wording "CAUTION: MULTIPLE SOURCES OF POWER." The marking shall comply with 110.21(B)~~ .

~~*Exception: Installations with multiple co-located power production sources shall be permitted to be identified as a group(s). The plaque or directory shall not be required to identify each power source individually.*~~

markings shall comply with 705.10.

Statement of Problem and Substantiation for Public Input

This PI has no impact on installation requirements or enforcement, it is merely a simplification of the text to shorten the Code by redirecting to the requirements of 705.10 instead of replicating the 705.10 language in 710. This avoids the need to duplicate or perfectly synchronize the language as changes occur in 705.10.

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Public Input No. 4184-NFPA 70-2020 [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~~ shall have capacity to meet 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.~~

in accordance with Article 220.

.

Statement of Problem and Substantiation for Public Input

Any system sizing must be based upon the calculated loads of a system. Sizing a Power Supply system based upon a single load of a premises wiring system is inadequate and problematic. There are not any permissions for under sizing a power supply. Optional Stand By Systems must be sized using Full Load Scenarios with an Automatic Transfer.

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Public Input No. 4382-NFPA 70-2020 [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.~~

Statement of Problem and Substantiation for Public Input

Delete this section. Sizing loads should be governed by Article 220 and not by this section. In addition the code text as presently written is unclear about its overall intent. What does it mean when the calculated "general lighting loads shall not be considered as a single load." Why is this important? Why is lighting not to be considered a single load and not other equipment? Why should 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"? This language should be rewritten to its clear intent.

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Public Input No. 3847-NFPA 70-2020 [Section No. 710.15(F)]

~~(F)~~ ~~Back-fed Circuit Breakers.~~

~~Plug-in-type back-fed circuit breakers connected to an interconnected supply shall be secured in accordance with 408.36(D) . Circuit breakers marked "line" and "load" shall not be backfed.~~

Statement of Problem and Substantiation for Public Input

The requirements in 408.36(D) may apply to some breakers in a stand-alone system (i.e. a back-fed breaker supplying a load center), but not to others (i.e. the connection of a utility interactive inverter). Deleting this section does not alter the requirements in the Code but does remove potential confusion as-to when the retainer in 408.36(D) must be used. Language addressing when circuit breakers are suitable for reverse current is included in 705.12(D), which is the correct Article for this requirement as it applies where there are interactive sources.

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Public Input No. 777-NFPA 70-2020 [New Section after 710.15(G)]

TITLE OF NEW CONTENT

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710.20 Electromagnetic Pulse (EMP) Protection. Protection for stand-alone systems against the effects of electromagnetic pulses shall be provided at a minimum of Level 2. See 709.7 for levels of electromagnetic pulse protection.

Exception: The requirements of 709.7(A)(5) and 709.7(B)(3) shall not apply.

This requirement shall become effective January 1, 2026.

Statement of Problem and Substantiation for Public Input

A devastating electromagnetic pulse (EMP), caused by a sun-spot or a nuclear bomb exploded high in the atmosphere, can impress 50,000 volts per meter on unprotected electrical and electronic equipment. It is similar to a radio wave impressing a very small voltage on a radio antenna, only orders of magnitude larger. The problem is that a significant EMP will fry every electrical/electronic component or piece of equipment that is not protected.

The EMP won't directly harm or injure people, but because there is no longer a working electrical infrastructure, which may take years to repair/rebuild, people will die from the lack of clean water, medicine, food, fuel, and eventual rioting due to the breakdown of society. Unclassified studies, referenced at the end of this substantiation, have estimated from 66% to 90% of the US population will die within one year if a significant sun spot were to occur or if a nuclear explosion were to occur 25 to 250 miles over the Midwest.

Our US military already "hardens" systems/buildings so that our country's critical defensive capabilities are not completely destroyed. There are two major methods of protecting electrical/electronic systems. The first is that surge protective devices are installed on all "incoming" power and communications cables, shunting overvoltages to ground. The second is that Faraday cages are installed around equipment/rooms, preventing the EMP from reaching critical equipment/components.

The NEC® needs to address EMP protection for equipment, systems and special occupancies that are critical to our survival. Electrical and electronic equipment can and must be protected, as has been achieved by our military. Unfortunately, there are no requirements to protect civilian electrical and electronic equipment/systems from EMPs.

The NEC Correlating Committee has informally advised that an EMP Protection Article, if passed and adopted into the NEC®, would be most appropriately located after Article 708 (COPS). Thus, Public Input 756 has suggested a new Article 709 under jurisdiction of CMP 13, which already has purview over Emergency Systems (Article 700), Legally Required Standby Systems (Article 701), Optional Standby Systems (Article 702), and Critical Operations Power Systems (Article 708).

Levels of protection and associated protection requirements listed in the Public Input(s) are based upon the unclassified National Cybersecurity and Communications Integration Center report "Electromagnetic Pulse (EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment". This study explains electromagnetic pulses and provides the necessary protective measures. It also contains estimates of the costs associated with properly protecting our electrical infrastructure.
The following table contains critical infrastructure components/special occupancies and the maximum time for outages caused by an EMP. Electrical components/infrastructure that is not functioning for periods longer than shown in this table may begin to cause injury or death to people and harm to society/economy.
Critical Infrastructure Component/Special Occupancy Permitted Outage Time
Branch banking facilities 10 hours

Critical Operations Power Systems 10 minutes
Data centers 10 minutes
Direct current microgrids 10 hours
Drug stores/distribution centers 10 hours
Electrically driven or controlled irrigation machines 1 week
Elevators, dumbwaiters, escalators, moving walks, platform lifts, and stairway chairlifts See facility requirements
Emergency systems 10 hours
Energy storage systems 10 hours
Fire alarm systems 1 week
Fire houses/stations 10 hours
Fire pumps 10 hours
Food processing and storage facilities 10 hours
Fuel cell systems 10 hours
Generators 10 hours
Grocery stores 10 hours
Hardware stores/home centers 10 hours
Healthcare facilities See NFPA 99
Information technology equipment 10 minutes
Interconnected electric power production sources 10 minutes
Jails and prisons 10 minutes
Large-scale photovoltaic (PV) electric supply stations 10 hours
Legally required standby systems 10 hours
Modular data centers 10 minutes
Motor fuel dispensing facilities 1 week
Motors, motor circuits, and controllers See facility requirements
Nuclear reactors 10 seconds
Optional standby systems 1 week
Petrochemical plants/facilities 10 hours
Pharmaceutical plants/facilities 10 hours
Police stations 10 minutes
Solar photovoltaic (PV) systems 10 hours
Stand-alone systems 10 hours
Storage batteries See facility requirements
Transformers See facility requirements
Waste water treatment facilities 10 minutes
Water supply facilities 10 hours
Wind electric systems 10 hours

An effectivity date of January 1, 2026 is chosen to allow time for engineering and industry to adequately pan and prepare for the required changes.

Opponents of EMP protection requirements will likely charge that it is too costly to protect our critical infrastructure, and that the NEC® is not a war-time document. A close reading of 90.1 reveals that there is no mention of the “cost” of safeguarding persons and property. Neither does 90.1 mention that safeguarding persons and property is only required during peacetime. Additionally, a significant EMP event, caused by a sunspot, would be an act of God, not an act of war.

The novel, “One Second After”, provides an understanding of what happens when the majority of all unprotected electrical and electronic equipment/systems is destroyed during an EMP event. An audio version of this book is available in two parts, for free, on YouTube.

This link provides the unclassified report “Electromagnetic Pulse (EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment”
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=2ahUKEwjQhp2-77DoAhXBHM0KHboOB2QQFjACegQIBRAC&url=https%3A%2F%2Fwww.cisa.gov%2Fsites%2Fdefault%2Ffiles%2Fpublications%2F19_0307_CISA_EMP-Protection-Resilience-Guidelines.pdf&usg=AOvVaw2n7jLtJAUJtOJKHPMqWsTE

This link provides the study predicting up to 90% of our population could die from an EMP event
http://www.firstempcommission.org/uploads/1/1/9/5/119571849

/nuclear_emp_attack_scenarios_and_combined-arms_cyber_warfare_by_peter_pry_july_2017.pdf

This link provides unclassified guidelines for facility EMP protection
https://info.publicintelligence.net/DHS-FacilitiesGuidelinesEMP.pdf

These links provide Parts 1 and 2 of a national plan for EMP protection.
https://interferencetechnology.com/a-national-plan-for-emp-protection-part-1/
https://interferencetechnology.com/national-plan-emp-protection-part-2-protection-buildings/

We have all just witnessed the chaos and pain caused by not having the “protections” in place to quickly defeat the Covid-19 virus. As unfortunate, costly, painful, and deadly as Covid-19 was, it would be child’s play when compared to a significant EMP event if our critical electrical/electronic infrastructure remains unprotected. Quite simply, NEC® requirements to protect electrical and electronic equipment from an EMP event, could literally save millions of American lives.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 756-NFPA 70-2020 [New Section after 708.64]	
Public Input No. 756-NFPA 70-2020 [New Section after 708.64]	

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Public Input No. 3915-NFPA 70-2020 [Section No. 710.15(G)]

(G) Voltage and Frequency Control.

The stand-alone or isolated microgrid supply shall be controlled so that voltage and frequency ~~remain within suitable limits for the~~ operate within limits compatable with the connected loads and sources .

Informational Note: Electric power production systems generally operate within +/-10% for voltage and +/-2 Hz for frequency under normal operating conditions.

Statement of Problem and Substantiation for Public Input

This IN provides additional guidance if an AHJ wished to validate the base functionality of the assembled system in the field to ensure it maintains appropriate voltage and frequency levels for common loads.

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Public Input No. 3348-NFPA 70-2020 [Definition: Grounded, Functionally.]

This definition shall be relocated to Article 100. This identical definition is also found in Article 690. The revised Style Manual requires panel action to only have one definition.

Grounded, Functionally.

A system that has an electrical ground reference for operational purposes that is not solidly grounded.

Informational Note: Examples of operational reasons for functionally grounded systems include ground-fault detection and performance-related issues for some power sources.

Statement of Problem and Substantiation for Public Input

The identical definition for "Grounded, Functionally" is also used in Article 690.
This term may not be used elsewhere in the code and could apply for the entire document.
Review the Style Manual revisions for definitions and acronyms. 2.2.2.4 Terms with Multiple Definitions.

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Public Input No. 3522-NFPA 70-2020 [Part I.]

Part I. General

(Relocate Part I. General. to immediately follow the title and prior to section 230.1.)

Statement of Problem and Substantiation for Public Input

Relocating the Scope to immediately follow the title will bring this article into compliance with the revised Style Manual. When an article has multiple parts Section 2.2.1 States Where an article has multiple parts, the scope shall be the first section in Part I. Section 2.4.2.1 states Where an article has multiple parts, Part I. shall be titled “General”.

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