
Public Inputs and Remaining Processes for the 2017 *National Electrical Code*®

for

Solar America Board for Codes and Standards

Stakeholder Meeting: September 17, 2015

At Solar Power International 2015

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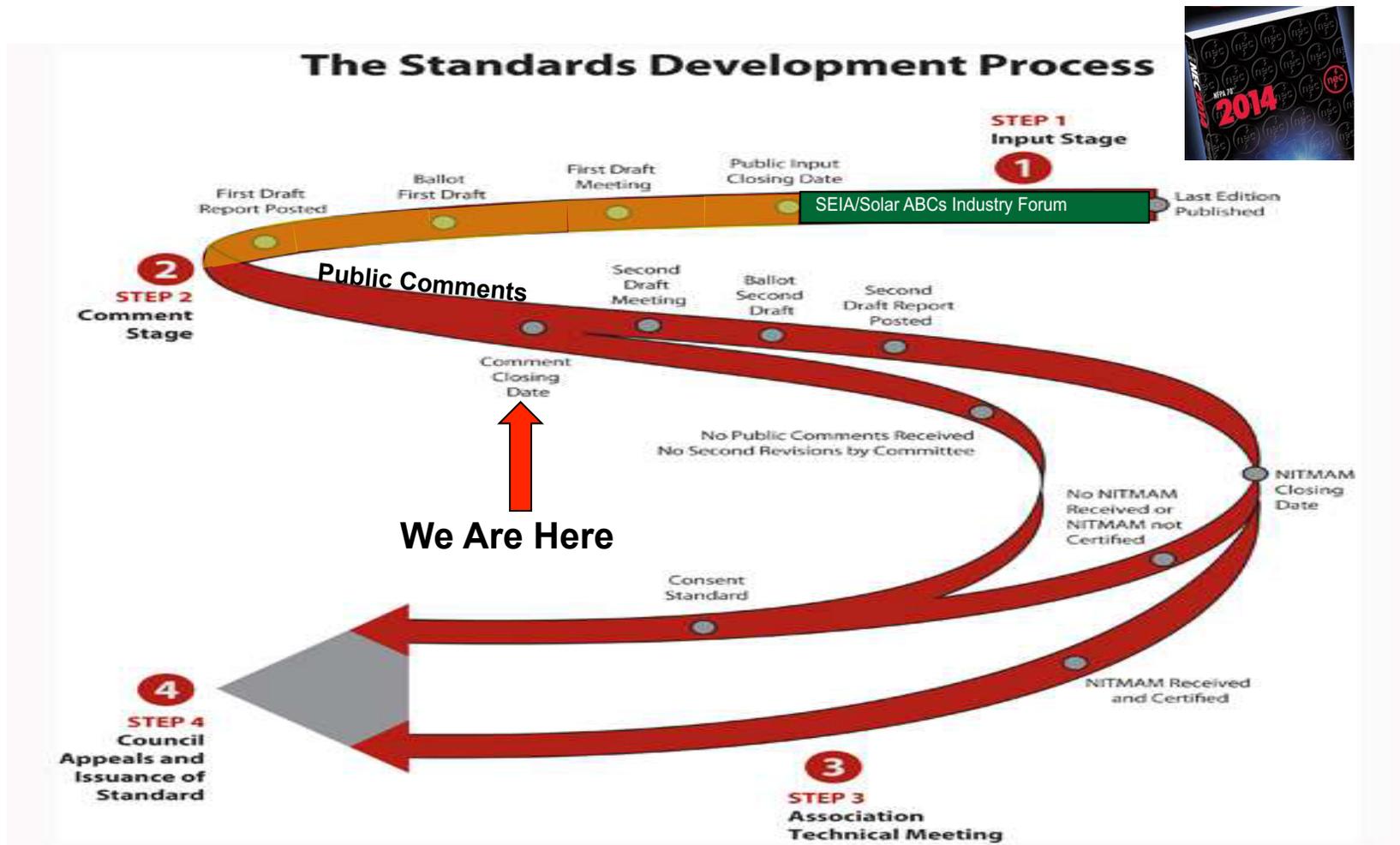
Introduction



- The remaining processes for the **2017NEC**®
- The SEIA/Solar ABCs “Public Input” record
- What’s New, Changed, Moved, Deleted
 - Actions related to PV installations
 - As published in the NFPA “First Revision”
 - “Public Comments” WILL result in some changes
- Impacts of additions/changes/deletions
- Thanks for **OUTSTANDING** industry work!



New NFPA Input/Comment Process



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New NFPA Input/Comment Process – Important Dates

Public Input Closing Date for Paper Submittal	10/3/2014
Public Input Closing Date for Online Submittal (e-PI)	11/7/2014
Final date for First Draft Meeting	1/12-24/2015
Posting of First Draft and Panel Ballot	3/13/2015
Final date for Receipt of CC First Draft ballot	7/3/2015
Final date for Receipt of CC First Draft ballot – recirc	7/10/2015
Post Final First Draft for Public Comment	7/17/2015
Public Comment Closing Date for Paper Submittal	8/21/2015
Public Comment Closing Date for Online Submittal	9/25/2015
Final date for Second Draft Meeting	11/2-14/2015
Post Final Second Draft	4/8/2016

Remaining 2017 NEC Processing Schedule

Process Step	Date
Public comment closing date if using the submission tool (e-PC)	September 25, 2015
Second draft meeting (San Diego)	November 2-14, 2015
Posting of second draft and panel ballot	January 4, 2016
Final date for receipt of second draft ballots	January 15, 2016
Final date for receipt of recirculation	January 22, 2016
Posting of second draft for Correlating Committee	February 5, 2016
Correlating Committee meeting	February 22-26, 2016
Post final draft for NITMAM review	April 8, 2016
Notice of intent to make a motion closing date	April 29, 2016
2017 NEC Published	No OFFICIAL DATE but effective 1/1/2017!

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Moving Forward Using the NFPA First Revision*

Status of SEIA/Solar ABCs Public Inputs

What's New!

What's Changed

What's Moved

~~What's Deleted~~

***THIS PRESENTATION USES MATERIAL AVAILABLE IN THE
NFPA FIRST REVISION FOR THE 2017 NEC. CHANGES ARE
EXPECTED AS A RESULT OF THE UPCOMING PUBLIC
COMMENTS AND PANEL ACTIONS***



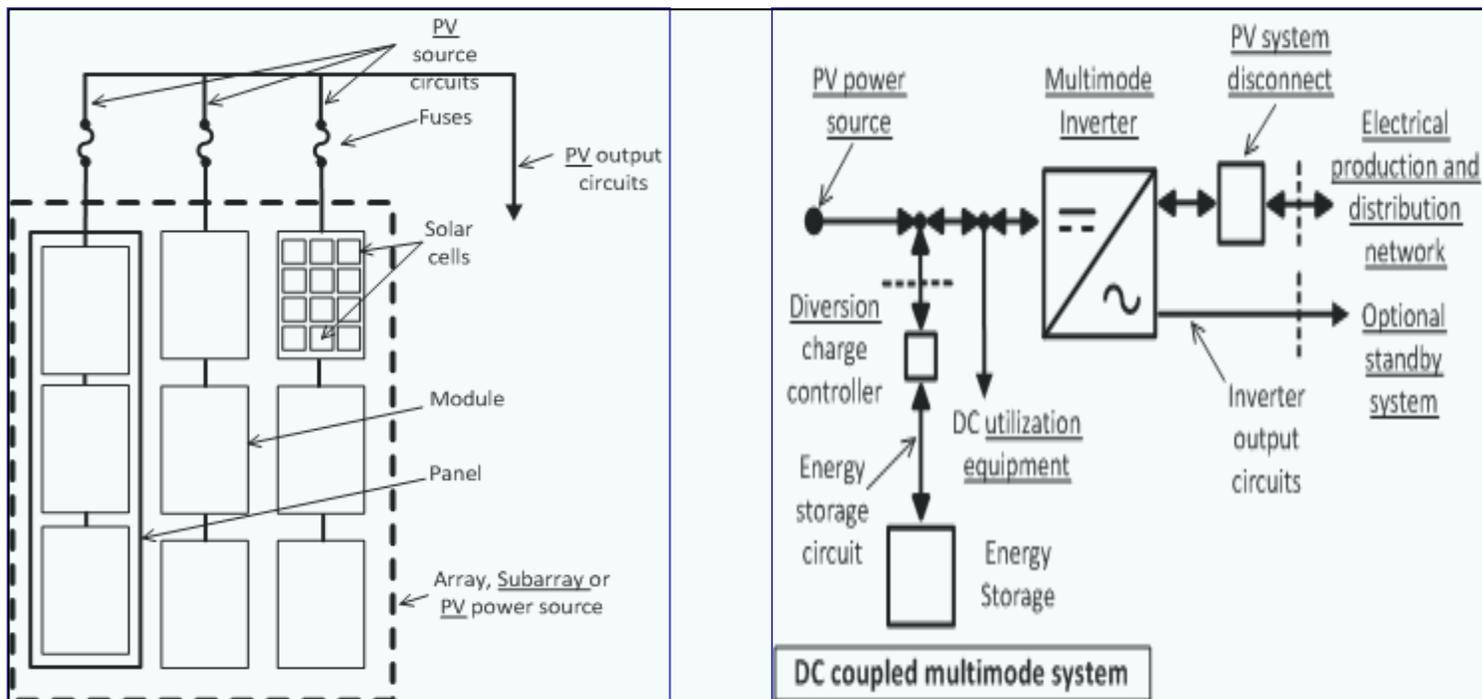
SEIA/Solar ABCs Public Inputs

- **Article 690 (PV Systems)**
 - 72 from SEIA/Solar ABCs (6 Resolved)
 - 163 from other than SEIA/ABCs (50 Resolved)
- **Article 691 (New “Large Scale PV Electric Supply Stations” (>5kW))**
- **Article 705 (Interconnected Elec PPS)**
- **Other New Articles -**
 - Article 706 (Energy Storage Systems)
 - Article 712 (Direct Current Microgrids)



NEW Diagrams in Article 690

- There are six new & changed diagrams with notes in 690.1 Fig 1(a) and (b)



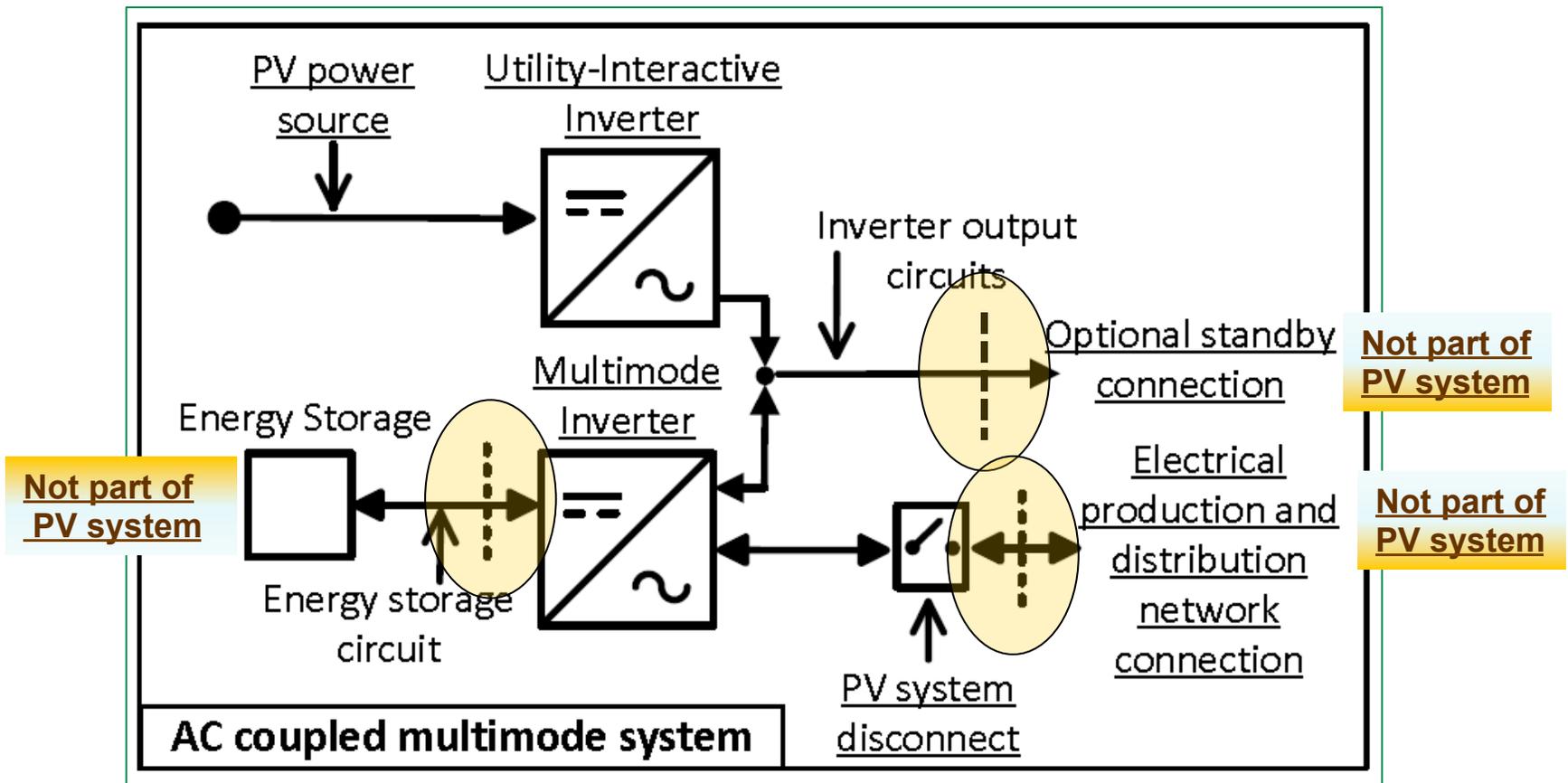
Identification of PV components

PV-Related Definitions

Green=Change- Underline=New-Red ~~Cross-out~~ =Deleted

As published in NFPA First Revision for 2017	
Array	Bipolar Array
Blocking Diode	Building Integrated PV
<u>DC-DC Converter Output Circuit</u>	<u>DC-DC Converter Source Circuit</u>
<u>Engineering Supervision</u>	<u>Field Labeled (for evaluated products)</u>
<u>Generating Capacity</u>	<u>Generating Station</u>
<u>Intentionally Islanded System</u>	<u>Interactive Inverter Output Circuit</u>
Interactive System	Inverter Input Circuit
Inverter Output Circuit	<u>Island Interconnection Device (IID).</u>
Multimode Inverter	<u>Photovoltaic Circuit</u>
<u>Photovoltaic Modules/Shingles</u>	<u>Photovoltaic System Circuit</u>
<u>Reference Grounded PV System</u>	<u>Stand-alone System</u>
<u>Utility Distribution System</u>	<u>Utility Transmission System</u>

NEW PV SYSTEM BOUNDARIES



690.5(A) Ground-Fault Detection and Interruption

- 690.5 MOVED TO 690.41(B)



Reference Grounded PV System

Reference Grounded

Now in 690.41 System Grounding

“NOT HARD GROUNDED”

Fuse or Resistor
Circuit Breaker
Listed Electronic GFP
Non-isolated
Grounded Circuit

“NOT UNGROUNDED”

A PV system that has an electrical reference to ground that is not solidly grounded.

Informational Note: The reference to ground is often a fuse, circuit breaker, resistance device, non-isolated grounded ac circuit, or electronic means that is part of a listed ground-fault protection system. Conductors in these systems that are normally at ground potential may have voltage to ground during fault conditions.



690.11. Arc-Fault Circuit Protection

Direct Current



For 2017 the requirements {PV Systems with >80V must be protected with AFP – Includes ground-mount systems}

PV systems with dc source circuits, dc output circuits, or both, operating at a PV system maximum system voltage of 80 volts or greater, shall be protected by a listed **(dc) and labeled** PV arc-fault circuit interrupter, PV type, 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 dc PV source and dc PV output circuits.

~~(2) The disabled or disconnected equipment must be manually restarted.~~

~~(3) There is an annunciator that provides a visual indication that the circuit interrupter has operated. Indication shall not reset automatically.~~

690.11. Arc-Fault Circuit Protection

Direct Current

Informational Note: Annex A includes the reference for the Photovoltaic DC Arc-Fault Circuit Protection product standards.

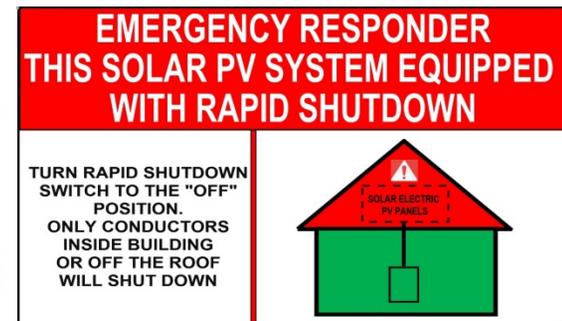
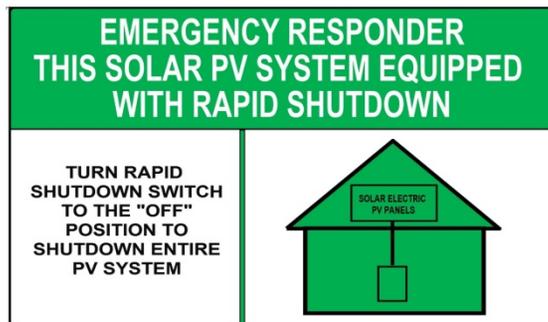
Exception: DC output circuits installed in listed raceway or enclosed cable tray, or cables listed for direct buried, are permitted to be omitted from arc fault circuit protection.



690.12 Rapid Shutdown of PV Systems on Buildings

**PHOTOVOLTAIC SYSTEM
EQUIPPED WITH
RAPID SHUTDOWN**

Much more in the next presentation



dreamstime.com

690.13 PV System Disconnect Means

Disconnect PV system from ALL other systems!

Location: Readily Accessible but May be Remote from the Point of Entry into Buildings (New 690.12)

Marking: Marked to ID it is a Disconnect. Indicate OPEN OR CLOSED. Marked with warning if energized from both sides.

Suitable for Use: Not required service equipment unless supply-side

Max Disconnects: Single PV disconnect for combined output of multiple inverters or AC Modules

Interrupting Rating: Sufficient for maximums at terminals of the PV System disconnect.

Grouping: Now covered in Maximum Disconnects above

Type: Simultaneous disconnect from all conductors of other circuits and suitable for backfeed.

690.15 Disconnection of PV Equipment

The section has been modified and with additions to include:

Isolating Devices or Disconnecting Means:

1. Location- Isolating devices required for all equipment from conductors not solidly grounded (disconnects may be isolating devices and markings are required)
2. Interrupt Rating- For Isolating devices (not required) but for Disconnecting Means (required)
3. Isolating device not required to simultaneously disconnect all current carrying conductors
4. Equipment Disconnecting Means; disconnects all conductors not solidly grounded. Externally operable within 10ft and required for systems >30A.



Part IV Wiring Methods

31(A) Conductors in raceway or Type MC cable allowed in readily accessible locations

31(B)(1) PV ~~source circuits~~ system circuit conductors shall be identified at all accessible points of termination, connection, and splices.

The means of identification shall be permitted by separate color coding, marking tape, tagging, or other approved means. Only solidly grounded PV system circuit conductors shall be marked in accordance with 200.6. PV system circuit conductors that are not solidly grounded shall not be marked white unless part of a multiconductor cable assembly.

Flexible PV Wire is permitted for tracking PV

~~Table 31(E) is no longer referenced - needs a public comment~~

Part IV Wiring Methods

31(C)(1) General. Single-conductor cable **Type USE-2, and single-conductor cable** listed and labeled as photovoltaic (PV) wire shall be permitted in exposed outdoor locations in PV source circuits. PV wire shall be installed in accordance with 338.10(B)(4) (b) and 334.30.

Exception: Single-conductor cable Type USE-2 shall be permitted in solidly grounded PV systems.

690.41(A) System Grounding

(A) PV System Grounding Configurations.

One or more of the following employed:

(1) Reference grounded 2-wire PV systems with one conductor referenced to ground.

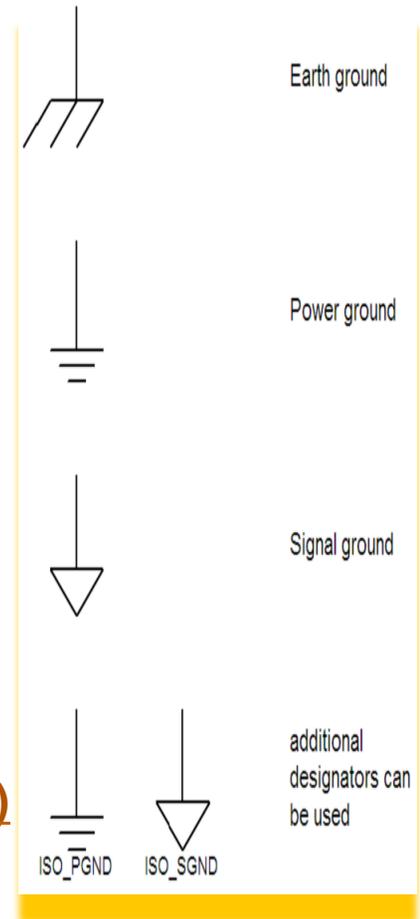
(2) Reference grounded bipolar PV systems with the reference (center tap) conductor referenced to ground and meets the requirements of 690.7(C)

(3) PV systems not isolated from the inverter output circuit

(4) Ungrounded PV systems

(5) Solidly grounded PV systems permitted in 690.41(B) Exception.

(6) PV systems that use other methods that accomplish equivalent system protection in accordance with 250.4(A) with equipment listed and identified for the use.



690.41(B) Ground-Fault Protection

DC PV arrays shall be provided with dc ground-fault protection meeting the requirements of **690.41(B)(1) and (2)** to reduce fire hazards.

Exception: Ground-mounted or pole-mounted PV arrays with not more than two paralleled source circuits and isolated from buildings shall be permitted without GFP. PV systems w/no GFP shall be solidly grounded.

1) GFP shall **detect ground fault(s) in the PV array dc current-carrying conductors and components, including any reference grounded conductors, and be listed for providing PV ground-fault protection.**

2) **Isolate faulted circuits by disconnecting current-carrying wires of the faulted circuit or automatically disconnecting inverters / charge controllers**



690.47 Grounding Electrode System

690.47(A) A building or structure supporting a PV system shall have a grounding electrode system installed in accordance with Part III of Article 250.

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

~~Additional Auxiliary Electrodes for Array Grounding is deleted~~



~~What's Gone from 690!~~

- ~~690.3 Wherever the requirements of other articles of this Code and Article 690 differ, the requirements of Article 690 shall apply and, if operated in parallel with a primary source(s), the requirements in 705.14 , 705.16 , 705.32 , and 705.143 shall apply.~~
- ~~690.16 &.17 Identification & Operations of Fuses and Disconnects~~
- ~~690.18 Installation and Service of and Array~~
- ~~690.35 Ungrounded PV Power Systems~~
- ~~690.47 Grounding Electrode System [All but (A) Buildings and Structures Supporting PV and (B) Additional Auxiliary Electrodes permitted for Array Grounding AND referenced to Article 250~~
- ~~690 Part VIII Storage Batteries (Installation, Charge Control and Battery Interconnections)~~
- ~~Part IX Systems over 1000V – Now in 490 “Systems > 1000V~~
- ~~Part X Electric Vehicle Charging~~



New Article 691 - Large Scale PV Electric Supply Stations

- Accessible only to qualified personnel for maintenance/ops
- Access restricted (fencing or structure compliant with NEC)
- Dedicated connection to the Utility.
- Electrical loads limited to auxiliary equipment for the generation of the PV power.
- Large-scale PV electric supply stations **NOT** installed on buildings.
- PV Systems < **5MW** ac are not Large-Scale
- Engineering Supervision. Designed and approved by a PE competent in the area under supervision.



Other PV Related New Articles

706 - Energy Storage Systems

Article 712 - Direct Current Microgrids

- 706 applies to all permanently installed energy storage systems (ESS) that may be stand-alone or interactive with other electric power production sources.
- 712 applies to a dc microgrid not directly connected to an ac primary source of electricity, but some dc microgrids interconnect via one or more dc-ac bidirectional converters or dc-ac inverters.

Details of each are included in the informational slides

Impacts for “Proposed” Changes for the 2017 *NEC**

- More clarity for AHJs, designers and installers
- Better organization for many requirements
- Addresses safety – “Rapid Shutdown”
- Defined requirements/methods for how PV systems are grounded- (“Reference Grounding”)
- New/improved arc- & ground-fault requirements
- GES now in common locations in *NEC*
- Defined and allowed “Engineering Supervision” design for Large Scale PV (Article 691)
- Energy Storage/DC Microgrid in Common Articles



Thanks To!
Solar ABCs – SEIA
Photovoltaic Industry Champions

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Informational Slides



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Quick Overview of ePI

<http://www.nfpa.org>

Click on Codes and Standards

Proceed to Standards Development Process

Then proceed to Submitting Public Comments

Select Choose a Document (NFPA70)

Choose Next Edition and Sign In (Account Needed**)**

Follow Step-by-Step instructions

You will have to establish and account!

690.47 Grounding Electrode System

690.47(A) A building or structure supporting a PV system shall have a grounding electrode system installed in accordance with Part III of Article 250.

The PV system equipment grounding conductors shall be connected to the grounding electrode system of the building or structure supporting the PV system by means of the grounding electrode conductor, or the grounding bus of associated equipment connected to the grounding electrode conductor. This connection shall be in addition to any other equipment grounding conductor requirements in 690.43(C) . The PV system equipment grounding conductors shall be sized in accordance with 690.45.

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

Article 705

- **New Definitions: Intentionally Islanded System, Island Interconnection Device, Stand-alone System.**
- **Equipment Approval expanded to include all equipment intended to parallel w/utility**
- **Directory Requirements**
- **Greater than 100kW requirements**
- ~~**(D)(6) AFCI for wire harnesses not installed in raceway**~~

New Article 706 Energy Storage Systems

- Applies to all permanently installed energy storage systems (ESS) that may be stand-alone or interactive with other electric power production sources.
- Much of the old 690 Part VIII [Storage Batteries] is now dispersed throughout 706. (Since energy storage is no longer considered part of a PV system)
 - 690.71 [Storage Battery Installation]
 - 690.72 [Charge Control]
 - 690.74 [Battery Interconnections]
- A lot definitions taken from other parts of the NEC including 690
- A lot of new definitions [Battery, Energy Storage System (ESS), Intercell Connector, Nominal Voltage (Battery or Cell)]

New Article 712

Direct Current Microgrids

Direct Current Microgrid (DC Microgrid) Definition.

A direct current microgrid is a power distribution system consisting of one or more interconnected dc power sources, dc-dc converters, dc loads, and ac loads powered by dc-ac inverters. A dc microgrid is typically not directly connected to an ac primary source of electricity, but some dc microgrids interconnect via one or more dc-ac bidirectional converters or dc-ac inverters.

Informational Note: Direct current power sources include ac-dc converters (rectifiers), bidirectional dc-ac inverters/converters, photovoltaic systems, wind generators, energy storage systems (including batteries), and fuel cells.

~~Installation~~ General Requirements

- 690.4(D) Multiple ~~Inverters~~ PV Systems. Multiple PV Systems shall be permitted to be installed in or on a single building or structure. Where remotely located from each other a directory is required (~~Requirements for directories deleted when disconnects are grouped at service panel~~)



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