NEC 2017 Updates for PV Systems

By Bill Brooks, PE

The 2017 edition of *NFPA 70: National Electrical Code* dramatically changes the practical safeguards for PV systems. It introduces more changes to Article 690, "Solar Photovoltaic (PV) Systems," than any revision cycle since 1984, when the *NEC* first adopted Article 690.

Since the number of PV installations is booming, my colleagues and I on *Code*-Making Panel (CMP) 4—which oversees *NEC* Articles 225, 230, 690, 692, 694 and 705—understood that this was a critical revision cycle for *NFPA 70*. Thanks to the dedicated efforts of dozens of solar industry stakeholders who proposed a solid set of *Code* changes, the development process for *NEC 2017* was very productive.

From a purely statistical perspective, for example, CMP 4 reduced the word count in Article 690 by more than 20%, from nearly 11,000 words in *NEC 2014* to just over 8,000 words in *NEC 2017*. This streamlining is even more impressive when you consider that rapid-shutdown requirements in Section 690.12 actually increased ninefold, from 133 words in the 2014 edition to more than 1,100 words in 2017. Excluding 690.12, CMP 4 actually managed to reduce the length of Article 690 by nearly 30%.

In this article, I explain how it was possible to simplify Article 690 so dramatically. I also preview the *Code* revisions that are most relevant to PV system designers and installers, and explore how some of these changes will expedite permitting, inspection and O&M activities. Though the National Fire Protection Association (NFPA) will not formally adopt *NEC 2017* until its technical meeting in June 2016, the development process is substantially complete. Therefore, the excerpts I present here are unlikely to vary substantially from the published standard. Based on previous revision cycles, the NFPA will start shipping *NEC 2017* to customers around October 2016.

Narrowed Scope and Definition

For more than 30 years, Article 690 has covered numerous topics that are beyond the scope of the PV generating system. These items include dc loads, ac loads in stand-alone systems and battery storage systems. As part of the 2017 revision cycle, the DC Task Group of the *NEC* Correlating Committee proposed adding new articles to the *Code*. These new articles appear in Chapter 7, "Special Conditions," and deal specifically with energy storage systems (Article 706), stand-alone systems (Article 710) and dc microgrids (Article 712). With the advent of the new articles, CMP 4 was able to strip out extraneous materials from Article 690. It also eliminated redundant sections in 690 that duplicated language from Article 692, "Fuel Cell Systems," and Article 694, "Wind Electric Systems."

As members of CMP 4 worked to narrow the scope of Article 690, we realized it was imperative that we define the term *PV system* much more clearly. If you ask different industry professionals to identify where a PV system starts and stops, you will get different answers—which is a problem. To deal with this inconsistency, CMP 4 introduced a new set of figures to Section 690.1 and a new definition in 690.13.

PV system disconnect. In *NEC 2017,* Section 690.13 clarifies that the *PV system disconnect* is the disconnecting means that separates the PV system conductors from all other conductors associated with all other electrical systems. In this context, other electrical systems include energy storage systems, multimode inverters, wind systems, load distribution wiring and so forth. The diagrams in Figure 1 and Figure 2 (p. 36) indicate where the PV system disconnect is located in a variety of system configurations and architectures.

Note that the PV system disconnect in these diagrams is not always located at the end of what we traditionally think of as the PV system. On one hand, the PV system disconnect

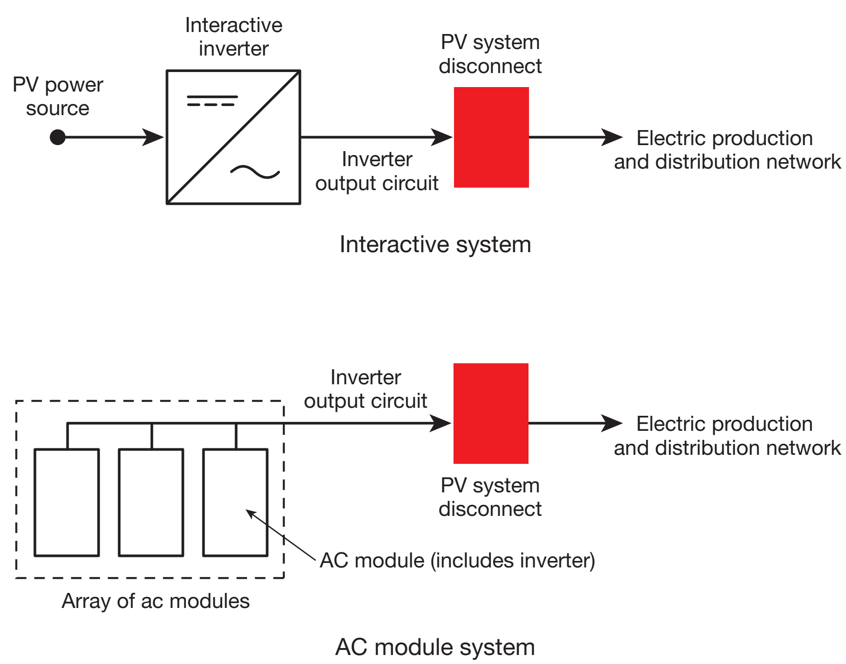

Figure 1 It is easy to locate the PV system disconnect, which separates PV system conductors and equipment from all other electrical systems, in simple interactive and ac module systems.

location is relatively self-evident in interactive and ac module systems. The PV system disconnect locations in Figure 1 (p. 35), for example, correspond with what we think of as the end of the PV system. On the other hand, the PV system disconnect location is more obscure in multimodule and stand-alone systems. As the complexity of the electrical power system increases, the PV system disconnect may not be located at what we think of as the end of the electrical system, as shown in Figure 2.

To identify the PV system disconnect in these complex electrical systems, you need to differentiate between conductors associated with different power sources. In dc-coupled multimode and stand-alone systems, for instance, we have traditionally considered the inverter and energy storage components as part of the PV system. Now, separate *Code* articles cover energy storage systems and PV power systems. This change means that the PV system disconnect is necessarily located upstream from energy storage conductors and equipment, perhaps at a charge-controller circuit breaker or similar. In an ac-coupled multimode system, meanwhile, the PV system disconnect is necessarily located upstream from any utilization load circuits. Here again, the energy storage and multimode inverter components are no longer defined as part of the PV power system.

By more narrowly defining the scope and definition of a PV power system, CMP 4 was able to eliminate the source of much confusion in Article 690 and remove language duplicated in other articles. While the new figures in Section 690.1(B) by no means present an exhaustive treatment of the many possible system permutations, they provide good guidance regarding the PV system disconnect location. Simply put, if you open what you think is the PV system disconnecting means and look toward the PV array, there should be no other conductors or equipment from other electrical systems on the PV side of that disconnect. If conductors and equipment associated with other power sources and electrical systems are upstream, then you are not at the PV system disconnect. Keep CONTINUED ON PAGE 38

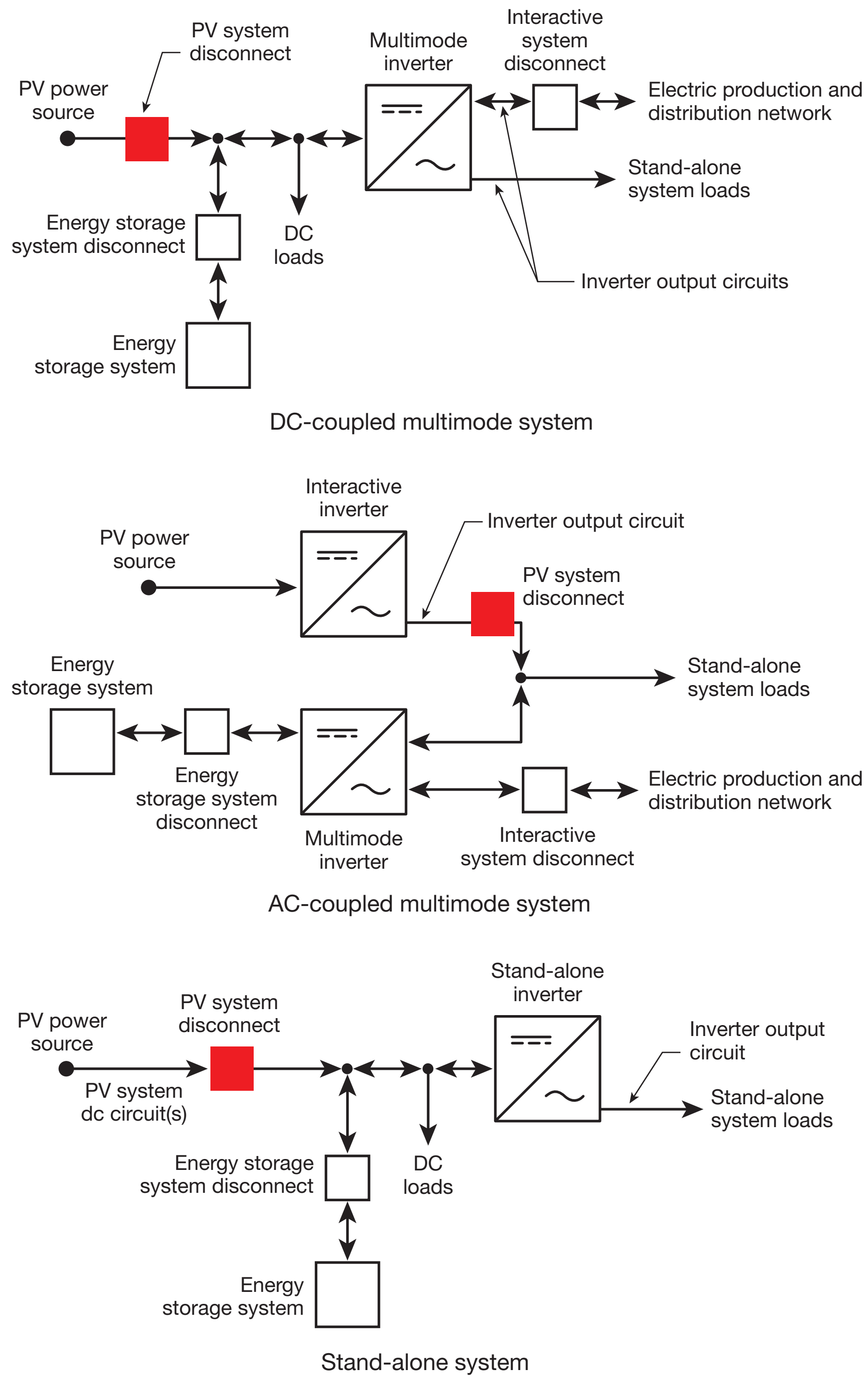

Figure 2 In multimode and stand-alone systems, you have to look for the PV system disconnect upstream from conductors and equipment associated with other electrical systems. Since *NEC 2017* includes new articles that deal directly with other dc electrical systems—for instance, energy storage systems, stand-alone systems and dc microgrids—components such as batteries, multimode inverters and dc utilization loads are no longer considered part of a PV power system.

moving toward the array until you are at a location where there are clearly no other electrical systems on the array side of the switch.

Significant Changes

Table 1 (p. 40) provides a high-level overview of the vast number of changes to and extensive reorganization of Articles 690 and 705 implemented during the 2017 revision cycle. Since I cannot address all of these revisions in detail, here I focus on the most important changes related to PV system design and deployment. Some of these changes address long-standing pain points for installers and inspectors. In jurisdictions where PV system stakeholders and AHJs have an open dialogue, it may be possible to defer to the most recent revisions to *NFPA 70* in certain circumstances.

FUNCTIONAL GROUNDING

Article 100 of the *NEC* defines *solidly grounded* as "connected to ground without inserting any resistor or impedance device." Solidly grounded ac electrical systems are the most common way to supply power to loads in the US. When PV systems were new to the *NEC*, it was important that we design them in a similar fashion, with a solidly grounded system conductor, as doing so increased AHJ acceptance.

As the number of fielded PV systems grew, industry stakeholders realized the importance of dc ground-fault protection. The *NEC* first codified requirements for dc ground-fault protection in the 1990s; subsequent revision cycles extended these requirements to cover virtually all PV systems. Early dc ground-fault protection systems used an overcurrent-protection device in the grounded conductor-to-ground bond. The implementation of this simple design effectively replaced solidly grounded PV systems with not so solidly grounded PV systems. However, everyone continued to refer to these as *grounded* PV systems, out of fear that AHJs would otherwise cry foul.

NEC 2017 frees us from this confusion by introducing a new definition under 690.2. It defines a *functional grounded PV system* as one "that has an electrical reference to ground that is not solidly grounded." This definition adopts terminology commonly used in Europe to describe how PV systems are referenced to ground in practice. An informational note further clarifies: "A functional grounded PV system is often connected to ground through a fuse, circuit breaker, resistance device, non-isolated grounded ac circuit, or

Topher Donahue

Functional grounded
A new definition in 690.2 clarifies that both transformer-isolated and non-isolated inverters are *functional grounded* rather than solidly grounded.

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." In other words, virtually all of the PV systems installed over the last two decades are functional grounded rather than solidly grounded systems.

Design implications. This simple change in our understanding of PV system grounding has profound design implications. Not only does it impact where you place disconnects and overcurrent protection in PV circuits, but it also allows for a unified approach to these parameters. As long as we treated one subset of PV systems as solidly grounded and another subset as ungrounded, for example, you needed to have two sets of design standards.

By acknowledging that all modern PV systems are not solidly grounded (ungrounded or functional grounded), CMP 4 was able to eliminate 690.35, "Ungrounded PV Systems," in its entirety. We then defined a single set of CONTINUED ON PAGE 41

Summary of *NEC 2017* Revisions for PV Systems

Article 690	2017 *NEC* Change
690.1	Removes large-scale PV from scope of Article 690; revised figures clarify the end point of a PV system.
690.2	New and revised definitions for dc-to-dc circuit, PV system dc circuit, generating capacity, inverter input/output circuit, functional grounded PV system.
690.4(D)	Clarifies that multiple PV systems, not just multiple inverters, are allowed on a single building.
690.5 and 690.35(C)	Moved to 690.41(B); consolidates grounding and ground-fault protection issues.
690.7	Reorganized and adds voltage calculation method for larger PV systems.
690.8	Revised to cover dc-to-dc converter circuits; allows for additional calculation method for PV circuit currents.
690.9	Revised to cover all PV systems, including ungrounded systems; requires only one overcurrent device per circuit.
690.10	Stand-alone systems moved to new Article 710.
690.11	Revised to exempt PV output circuits on ground-mounted systems from arc-fault protection in some cases.
690.12	Dramatically increases details in 690.12 and includes requirements for rapid shutdown within the array.
690.13	Clarifies that there are only two types of disconnects in PV systems: (1) the PV system disconnecting means (690.13) and (2) the disconnects for equipment (690.15).
690.15	Removes all of 690.16, 690.17 and 690.18 and places the necessary requirements in 690.13 and 690.15; introduces "isolating devices"; requires that disconnects open both positive and negative conductors on the dc side of the PV system.
690.31	Reorganized and revised; single set of requirements cover all wiring methods, including ungrounded systems.
690.31(B)(1)	Disallows use of white wire on the dc side of a PV system for anything except solidly grounded PV systems, which are rare.
690.31(C)(1)	Type USE-2 and PV Wire are now permitted as single-conductor cable for grounded and ungrounded PV systems.
690.31(D)	Requires that multiconductor cables be listed for the application.
690.31(E)	Permits flexible PV Wire with trackers, provided it has sufficient number of strands; adds new wire strand table.
690.41 and 690.42	Introduces concept of functional grounded PV systems to 690; requires ground-fault protection for all PV systems that are not solidly grounded (vast majority of systems).
690.43	Reorganized for clarity; simplifies equipment-grounding requirements.
690.47	Completely reorganized and simplified; requires support structures to have a grounding electrode system; requires grounding conductor be connected to the local grounding electrode system; makes additional array electrodes optional.
690.53	Simplifies dc PV source markings by removing rated maximum power point voltage and current from signage.
690.56(C)	Details marking requirements for systems equipped with rapid shutdown.
Part VII	Simple reference to Article 705 replaces Part VII, "Connection to Other Sources."
Part VIII	A reference to new Article 706 replaces this content, other than requirement for self-regulated PV charge control.
Parts IX and X	Removes content about systems over 1,000 V and EV charging, as these are adequately covered elsewhere.

Article 705	2017 *NEC* Change
705.2	Adds new microgrid definition.
705.12	Simplifies whole section to cover just supply-side and load-side interconnections.
705.12(B)	Allows for the load-side interconnection of other equipment besides inverters.
705.12(B)(2)(3)(d)	Allows center-fed panels in dwellings to apply the 120% rule if power source connects at only one end of busbar.
705.12(D)(6)	Removes arc-fault detection requirement for small ac circuits.
705.23	New section to match the changes in Article 690 related to the PV system disconnecting means.
Part IV	Adds new part dedicated to microgrid systems.

Table 1 This table provides an overview of the *Code* changes impacting PV system design and deployment in Articles 690 and 705.

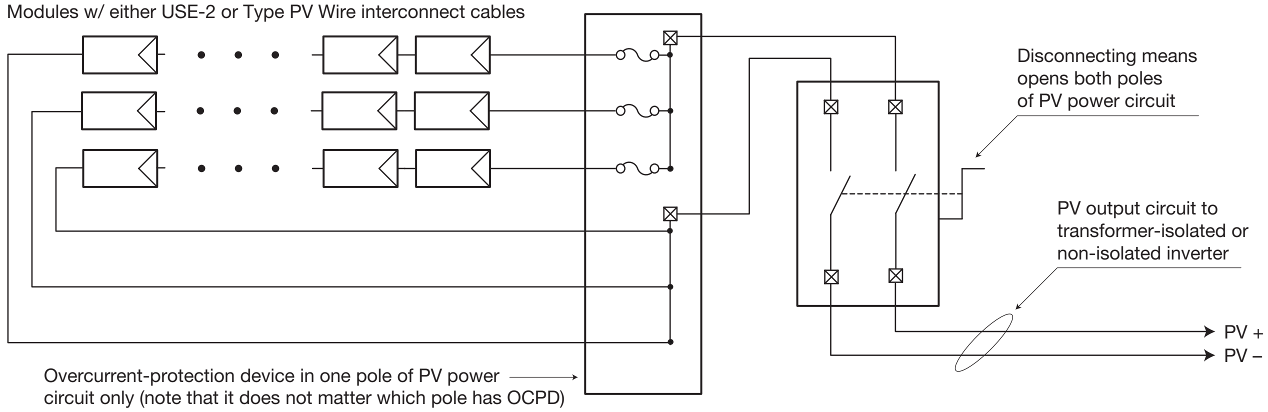

Figure 3 The line drawing illustrates the new design standards for functional grounded PV systems. *NEC 2017* allows for both USE-2 and PV Wire single-conductor cable, regardless of inverter topology. It requires that disconnecting means open both poles of the array, even though overcurrent protection is required in one side only.

design standards, shown schematically in Figure 3, that apply to the dc side of a functional grounded PV system:

- Overcurrent protection is required in only one leg of a PV circuit [690.9(C)]
- Disconnecting means are required in both legs of a PV circuit [690.15]
- USE-2 or PV Wire is allowed as single-conductor cable in a PV array [690.31(C)]

These unified design standards solve a number of problems for installers and inspectors. As long as we treated some PV systems as solidly grounded, for example, opening the "grounded" conductor created the appearance of a *Code* violation in the minds of many AHJs and inspectors due to requirements in Article 240. However, if a ground fault occurs in a fuse-grounded PV system and the "grounded" conductor is bolted rather than switched, the only safe way for a field technician to service the system is to work at night. The CMP addressed this issue in *NEC 2014* by creating an exception to 690.17(D) that allowed a disconnect switch for opening an accessible grounded conductor. Only qualified persons could access the switch, which was dedicated to PV array maintenance only. In *NEC 2017,* the revised language in 690.15 eliminates all of this confusion. It not only improves safety in the field but also eliminates the need for at least three previously required warning signs, including 690.5(C), 690.7(E) and 690.35(F).

The replacement of legacy grounded inverters with new and improved transformerless inverters is an important pain point that *NEC 2017* addresses. Though legacy grounded inverters are susceptible to blind spots in ground-fault detection, earlier *Code* cycles held these systems to less-restrictive wiring method requirements than "ungrounded" systems with transformerless inverters, even though the latter offer improved ground-fault protection. Both USE-2 and PV Wire were *Code*-compliant single-conductor wiring methods for grounded inverters, whereas only PV Wire was compliant with transformerless inverters. The unified design standards in *NEC 2017* eliminate this distinction and allow installers to replace grounded inverters with transformerless inverters without having to upgrade single-conductor wiring. To bring a legacy system into compliance with *NEC 2017,* installers need only rewire or replace the dc disconnects.

SIMULATING VOLTAGE AND CURRENT

NEC 2017 provides new options for calculating voltage and current in a PV array. Specifically, Section 690.7(A) now allows a licensed engineer to use a simulation to calculate the maximum PV source and output voltage for a PV system with a capacity greater than 100 kW. A revision to 690.8 similarly allows engineers to simulate the maximum PV source and output current for systems over 100 kW. When an engineer uses a simulation for current, the calculated value may not be less than 70% of the value as determined by the traditional approach (1.25 x Isc).

The benefit of simulating voltage and current is that it enables much more accurate calculations. Array ampacity, for example, is based on continuous load, defined in Article 100 as "the maximum current expected to continue for 3 hours or more." Computer modeling can accurately simulate this maximum 3-hour current value for a specific PV array based on its location and orientation. By comparison, the traditional method of calculating PV circuit currents significantly oversizes conductors, especially given recent improvements in short-circuit protection. The new calculation method will reduce conductor and conduit costs, which make up an increasing percentage of the overall costs in large PV systems.

RAPID SHUTDOWN

The process of updating Section 690.12, "Rapid Shutdown of PV Systems on Buildings," was by far the most contentious part of the 2017 revision cycle related to Article 690. The rapid-shutdown requirements in *NEC 2014* represent a compromise between fire service representatives, who wanted to control conductors within the array, and PV industry stakeholders, who felt that it was too early to do so, based on concerns about technology costs and reliability. As expected, the 2017 revision cycle reopened this debate about whether to impose additional requirements for reducing hazards within the PV array.

Fire service representatives submitted a proposal to control conductors within the array to 80 V or less. The Solar Energy Industries Association (SEIA) submitted a competing proposal to refine the *NEC 2014* requirements and make them more enforceable. This heated debate continued during the public comment period, as stakeholders developed new concepts for addressing electrical hazards within the PV array. As a result of this debate, the fire service and SEIA proposals found more common ground by the end of the comment period. The SEIA proposal focused on reducing hazards within the PV array by requiring listed and labeled or field-labeled rapid-shutdown PV arrays, a concept that NFPA's Fire Fighter Safety and PV Systems Task Group developed. The fire service included this same requirement as a compliance option added to its original proposal.

After the public comment period, it was up to CMP 4 to decide how to proceed. After much deliberation—far more than for any other topic—CMP 4 combined the SEIA and fire service proposals and added language allowing for building-integrated glass or polymeric PV arrays with completely concealed wiring. The revised rapid-shutdown requirements in 690.12(B)(2) provide three compliance options for reducing hazards within a PV array.

- Option 1: List and label or field-label PV array as a rapid-shutdown PV array.
- Option 2: Limit control conductors within the array boundary to 80 V or less within 30 seconds of rapid-shutdown initiation.
- Option 3: Install nonmetallic PV array with no exposed wiring and array more than 8 feet from any grounded metal parts.

To implement Option 1, industry stakeholders need to develop a product safety standard for rapid-shutdown PV arrays. To allow time for this standard's development

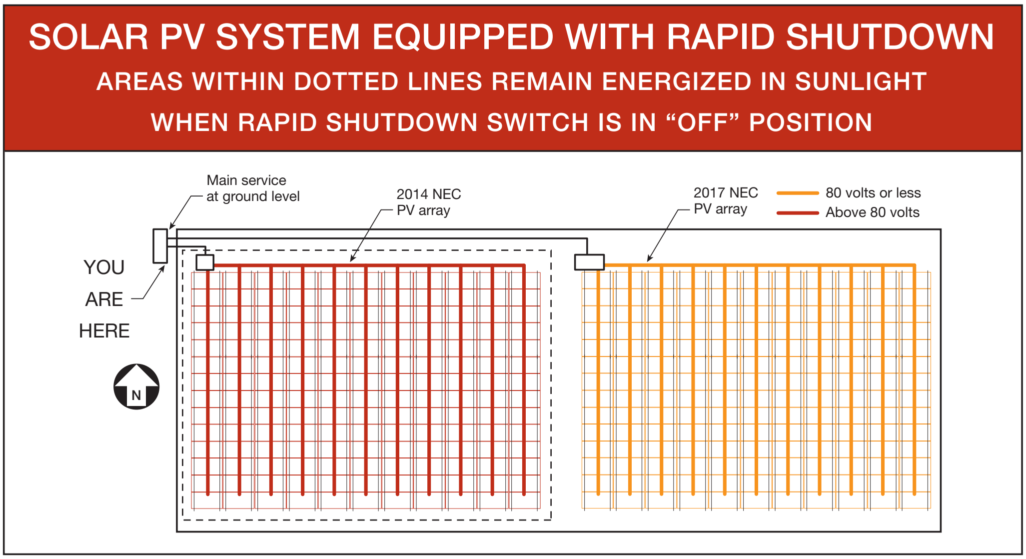

Figure 4 The field-applied labeling required to meet the revised rapid-shutdown requirements must differentiate between various hazard levels. In this case, the subarray on the left complies with *NEC 2014* and controls conductors outside the dotted lines, whereas the subarray on the right complies with *NEC 2017* and controls conductors within the array.

process, CMP 4 added a delayed adoption date, specifying that 690.12(B)(2) "shall become effective January 1, 2019." One benefit of codifying Options 2 and 3 is that these provide stakeholders with some guidance on developing a consensus for the rapid-shutdown PV array certification standard.

Labeled vs. identified. The *NEC 2017* requirements for "listed and labeled" rapid-shutdown equipment meaningfully revises *NEC 2014,* which requires "listed and identified" equipment. Article 100 defines the term *identified* as "suitable for the specific purpose, function, use, environment, application, and so forth." By contrast, the definition of *labeled* in Article 100 "indicates compliance with appropriate standards or performance in a specified manner." The latter is more prescriptive and narrowly defined than the former.

In practice, this means that installers can use off-the-shelf electrical components to meet *NEC 2014* rapid-shutdown requirements so long as the conditions of use are consistent with the equipment ratings. For example, under *NEC 2014,* you could locate a contactor combiner at the edge of a PV array and use this to meet Section 690.12 as long as the combiner was rated for the outdoor environment and the PV voltage and current characteristics. *NEC 2017* will require that this contactor combiner be specifically listed to a rapid-shutdown PV array standard and labeled accordingly. Revised language in 690.12(D) states: "Equipment that performs the rapid-shutdown functions, other than initiation devices such as listed disconnect switches, circuit breakers or control switches, shall be listed and labeled for providing rapid-shutdown protection."

This is an important distinction. Some jurisdictions—including New Jersey, New Mexico and Washington—have misinterpreted *NEC 2014* requirements and asked installers and vendors to prove that rapid-shutdown solutions comply with a rapid-shutdown safety standard. As of today, no such standard exists. Until the *NEC 2017* is adopted, there is no requirement that equipment used for rapid shutdown be listed and labeled specifically for the rapid shutdown of PV arrays. Installers can use any listed equipment to provide rapid shutdown, so long as they field the equipment in a manner consistent with the product listing.

Plaque or directory. One of the most important parts of the rapid-shutdown requirements is properly communicating the level of hazard to emergency responders. Section 690.56(C) details the revised field-labeling requirements for PV systems equipped with rapid shutdown, which will help first responders differentiate between systems designed to meet *NEC 2014* versus *NEC 2017.* In the event that a building hosts PV systems built to different *Code* standards—such as no rapid shutdown (pre *NEC 2014*), *NEC 2014* compliant or *NEC 2017* compliant—the field-applied plaque or directory needs to show a plan view of the building with a dotted line around array areas that remain energized after initiation of rapid shutdown, as illustrated in Figure 4 (p. 43).

ARC-FAULT PROTECTION WAIVER

In the 2014 revision cycle, CMP 4 implemented a subtle but significant change to 690.11 by removing the words "on buildings," which meant that *NEC 2014* essentially required all PV systems operating above 80 V to have dc arc-fault protection. Unfortunately, the product safety standard for dc arc-fault circuit protection, UL 1699B, CONTINUED ON PAGE 46


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at this time covers products working at currents up to 40 A only. It is difficult, if not impossible, to find arc-fault detectors for larger 200 A–400 A PV output circuits.

NEC 2017 addresses this problem by providing a dc arc-fault protection exemption for larger PV output circuits where these are not installed on buildings and the conductors are either underground or in metallic raceways or enclosures. The bad news is that this exception does not allow for the use of larger PV output circuits on buildings. The good news is that system designers are deploying 20 kW–50 kW 3-phase string inverters with integral string-level dc arc-fault detectors on most large rooftop PV installations.

NEW ARTICLE FOR LARGE-SCALE PV

With all the gnashing of teeth around rapid shutdown, many stakeholders may be unaware of a more significant revision that will be welcome news to anyone working on utility-scale PV systems. Specifically, *NEC 2017* introduces Article 691, "Large-Scale PV Electric Supply Stations," which provides a means of differentiation between requirements for decentralized building-mounted PV applications (Article 690) from those governing large-scale PV power stations that supply merchant power to the electricity grid (Article 691).

To clearly differentiate these two articles, the scope of Article 691 has very restrictive criteria. Per Section 691.1, "This article covers the installation of large-scale PV electric supply stations with a generating capacity of no less than 5,000 kW, and not under exclusive utility control." Two informational notes follow. The first clarifies that facilities covered by Article 691 "have specific design and safety features unique to large-scale PV facilities and are operated for the sole purpose of providing electric supply to a system operated by a regulated utility for the transfer of electric energy." The second informational note provides a reference to the *National Electrical Safety Code* (ANSI/IEEE C-2-2012); this code covers utility-controlled electric supply stations, which Section 90.2(B) designates as outside the scope of the *NEC.*

The rationale for developing Article 691 was that large-scale PV electric supply stations have more in common with power plants than with typical residential and commercial roof-mounted PV systems. Some of these PV power stations have capacities as large as 500 MW. Without any clear direction in the *NEC* on how to deal with these large facilities, some AHJs find themselves trying to enforce Article 690 requirements on these massive projects and questioning items such as grounding lugs and conductor sizing.

One of my power plant engineering colleagues works for a company that has designed and installed numerous wind and solar power stations. He has observed that inspectors rarely visit the company's wind farms, whereas local AHJs inspect every single one of its PV power stations. While engineers have certainly made mistakes in large-scale solar facilities—just as they occasionally make mistakes in large coal and nuclear power plants—the idea that a local AHJ should enforce design and installation standards on these engineered merchant power plants makes no sense. Article 691 solves this problem for facilities that meet specific criteria.

Courtesy Array Technologies and Affordable Solar

Article 691 *NEC 2017* introduces a new article that details engineering and construction supervision requirements for large-scale PV electric supply stations. Qualifying facilities are behind-the-fence applications, 5 MW and larger, that are not under utility control but supply power directly to the grid at medium- or high-voltage levels.

In addition to providing these strict qualification guidelines, Article 691 details the design and construction documentation requirements for large-scale PV electric supply stations. For example, Section 691.6, "Engineered Design," clarifies that upon request developers must provide

Courtesy San Diego Gas & Electric

Microgrid systems While Article 705 now includes content related to microgrid systems, exclusions in 90.2(B)(5) limit the application of these requirements on utility-controlled microgrid systems, such as this SDG&E facility in Borrego Springs, CA.

to the AHJ design drawings and an independent engineering report that details compliance with Article 690, as well as any alternative methods that deviate from those described in Article 690 or other *Code* sections if applicable. To comply with 691.7, "Conformance of Construction to Engineered Design," developers must document that PV plant construction complies with the engineered design and must provide an independent engineering verification report to the AHJ upon request.

Lastly, Article 691 provides brief direction on four areas where engineers are most likely to employ alternative design methods. These relevant sections include 691.8, "DC Voltage Calculations"; 691.9, "PV Equipment Disconnects"; 691.10, "Arc-Fault Protection"; and 691.11, "Grounding of Fences."

ARTICLE 705 CHANGES

The three most important changes to Article 705 relate to center-fed panelboards, ac arc-fault protection for wire harnesses, and microgrids.

Center-fed panelboards. Connecting interactive PV systems to center-fed panelboards has become a persistent point of contention for residential installers, particularly those in western states where these panelboards are common. Many AHJs have required that installers remove and replace these panelboards to make a load-side connection, which not only is an unnecessary expense but also does nothing to improve system safety.

To eliminate this problem, CMP 4 added language to 705.12 that specifically addresses center-fed panelboards. Section 705.12(B)(2)(3)(d) now states: "A connection at either end, but not both ends, 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."

Arc-fault protection for micro-inverter wire harnesses. During the 2014 revision cycle, CMP 4 added ac arc-fault protection requirements for utility-interactive inverters with exposed wire harnesses or output cables in 705.12(D)(6). There are two problems with this requirement. The first problem is that no listed ac AFCI protection equipment exists to meet this requirement. When required equipment is not available, language in Section 90.4 empowers AHJs to "permit the use of the products, constructions, or materials that comply with the most recent previous edition of this *Code*." The second problem is that some AHJs have not deferred to 90.4 and have instead required that installers put microinverter ac cable systems in conduit. Since these wire harness and cable systems are not compatible with conduit, 705.6(D) has inadvertently disallowed microinverter systems in some jurisdictions.

To eliminate future opportunities for misinterpretation, CPM 4 removed 705.6(D) as part of the 2017 cycle of revisions. In addition, industry stakeholders have filed for a tentative interim amendment (TIA) that would officially remove this requirement from *NEC 2014*.

Microgrid systems. A significant structural change is the addition of Part IV, "Microgrid Systems." A new term in Section 705.2 defines a *microgrid* as 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." An informational note clarifies that exclusions detailed in Section 90.2(B)(5) limit the application of Article 705 requirements to microgrid systems under the exclusive control of an electric utility. Since many microgrid systems include PV generation, the microgrid requirements will help installers and AHJs distinguish between requirements for these different electrical power systems.

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