2002 NEC

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The 2002 *National Electrical Code* has been published by the National Fire Protection Association, and will be enacted into law by many states and local jurisdictions on January 1, 2002. The 2002 *NEC* has been significantly revised in both content and format. Article 690 on photovoltaic power systems received some attention, and the significant changes will be presented in this column, and in my column in *HP87.*

About 40 people in the PV industry worked on a set of 32 submissions to the 2002 *NEC.* Others inside and outside the industry proposed changes, as can anyone who takes the time to properly fill out the required form.

Many of these other proposals were not well substantiated, and were rejected on the first cycle of the three-year process. Several changes were made during the public comment phase. The Code Making Panel (CMP-3) had their say, and then the NFPA Technical Correlating Committee made the final revisions and edits.

The exact contents of Article 690 for the 2002 *NEC* will not be repeated here due to space restrictions. Everyone designing and installing PV systems is encouraged to get a copy of the complete 2002 *NEC,* and better yet, the 2002 *NEC Handbook.*

690.2 Definitions
Note the new decimal format instead of the old 690-2. The definitions for "Bipolar Photovoltaic Array," "Photovoltaic Systems Voltage," and "Stand-Alone System" were slightly revised for clarity. A new definition was added for "Diversion Charge Controller," and it covers diverting excess energy to DC or AC loads. Those installations using diversion controllers face some new requirements; see the next *Code Corner* in *HP87.*

690.3 Other Articles
Article 690 still dominates when it conflicts with another article (but not over the local inspector). Reference is made to sections 705.14, 705.16, 705.32, and 705.43, which require additional markings and some other restrictions when there is more than one source of power. These other articles generally won't affect PV installations other than requiring some system labels that are required by Article 690 anyway. The UL-listed inverters used in PV systems are generally more robust, and exceed the hardware requirements listed in the 700 series articles.

690.5 (B) Disconnection of Conductors
This section on ground-fault protection equipment was reworded to correct a grammatical error and to better match the actions of existing equipment. There are no changes from the detailed requirements established back in the 1987 *NEC* for this fire protection device that must be used in PV systems mounted on the roofs of dwellings. It still must detect the ground fault, indicate that a ground fault has occurred, interrupt the fault current, and disconnect the faulted PV array.

690.7 (E) Bipolar Source and Output Circuits
A new section was added to allow the DC voltage-to-ground to be defined as the system voltage on certain types of bipolar systems that meet specific grounding requirements. Only a new type of inverter will ever use this type of bipolar system. Currently no available inverters use bipolar PV arrays, although the recent vintage Omnion inverters did. Most bipolar systems require that the system voltage be measured not-to-ground, but between the two highest voltage conductors.

690.8 (B) Ampacity and Overcurrent Device Ratings
Wording was added to designate that PV currents are to be considered continuous (lasting more than three hours). This is important to the PV design process because the solar irradiance usually exceeds the standard test conditions of 1,000 watts per square meter for three hours or more around solar noon. This is the reason for the 125 percent multiplier on current that has been discussed in other *Code Corner* columns. The section was revised and reformatted for clarity.

690.8 (D) Sizing of Module Interconnection Conductors
This section was added to ensure that the module cables have sufficient ampacity when only one overcurrent device is used to protect two or more strings of modules. This is a complex subject (covered

in some detail in previous *Code Corner* columns) and is oversimplified in the *NEC.* Normally, an overcurrent device will be needed for each module or series string of modules. The conductors and overcurrent devices will be sized as discussed in other Code *Corner columns.*

690.9 (C) Photovoltaic Source Circuits
This section was modified to indicate that supplementary overcurrent devices are available in 1 amp increments up to 15 amps. Both DC listed fuses and circuit breakers are available in these values. Some of the new thin-film modules may require overcurrent protection as low as 1 to 2 amps.

690.9 (E) Series Overcurrent Protection
It is now permitted (note that the language is permissive and not mandatory) to use only a single overcurrent device in a series string of modules. This sounds trivial, but some inspectors were asking for one fuse per module or a module fuse and a conductor fuse in a series string. PV installers have, for the most part, always known this common sense item.

690.14 Additional Provisions
In an attempt to remove a misleading reference to Article 230, CMP-3 (the Code Making Panel) revised this section to put the requirements of Part 230F into Article 690. There are no real changes in the requirements, but now 690.14 requires that the PV disconnect be readily accessible outside the building or immediately inside the building at the point of first entry. Also, this disconnect must be grouped with the disconnects for other sources of power for the building.

This will restrict the current practice of running PV conductors through the roof inside the attic and house to a first disconnect near the batteries. The PV source circuits must now be run outside the building to a readily accessible point outside the building or immediately inside the building to the first disconnect. Readily accessible means that it must not be necessary to use ladders to get to disconnects mounted on the roofs or other high locations, or to move parts of the building to get to the switches. PV disconnect switches cannot be mounted in bathrooms due to the obvious shock hazards.

Grouping the disconnects is a very old requirement and means that the disconnects for the PV, wind, utility, hydro, generator, etc. shall all be grouped in the same location and not spread throughout the facility. The *NEC* does not consider a battery bank as a source of power. But most inspectors and electricians correctly consider it to be. The battery disconnect should be grouped with the means of disconnect for other source circuits. Good luck if you have more than six sources of power, since you are only allowed a total of six disconnects. A label will need to be installed on the outside of the building indicating where the disconnects are located if they are not readily visible.

All of these requirements have been in the code for years, but they are now specifically spelled out in Article 690. They allow quick and ready access to power disconnects in the event of emergencies such as fires or gas leaks.

Summary
Most of the changes in Article 690 of the 2002 *NEC* make it somewhat clearer. The revisions to the comments in the 2002 *NEC Handbook* should also make it easier for the people to understand the rationale behind the code requirements. The remainder of the 2002 *NEC* changes in Article 690 will be addressed in *HP87.*

Questions or Comments?
If you have questions about the *NEC,* or the implementation of PV systems that follow the requirements of the *NEC,* feel free to call, fax, e-mail, or write me. Sandia National Laboratories sponsors my activities in this area as a support function to the PV industry. This work was supported by the United States Department of Energy under Contract DE-FC04-00AL66794. Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy.

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