FORM FOR COMMENT FOR 2014 NATIONAL ELECTRICAL CODE®

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Type or print **legibly**. Use a separate copy for each comment. Limit each comment to a **SINGLE** section. All comments **must be received by NFPA by 5 p.m., EDST, Wednesday, October 17, 2012**, to be considered for the 2014 National Electrical Code. Comments received after 5:00 p.m., EDST, Wednesday, October 17, 2012, will be returned to the submitter.

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Please indicate organization represented (if any)

1. Section/Paragraph 690.12

2. Comment on Proposal No. (from ROP): 4-253

3. Comment recommends (check one): ☐ new text ☒ revised text ☐ deleted text

4. Comment (include proposed new or revised wording, or identification of wording to be deleted): [Note: Proposed text should be in legislative format; i.e., use underscore to denote wording to be inserted (inserted wording) and strike-through to denote wording to be deleted (~~deleted wording~~).

Replace the text of 4-253 with the modified text as shown:

~~690.12 PV Arrays on Buildings Response to Emergency Shutdown.~~
~~For PV Systems installed on roofs of buildings, photovoltaic source circuits shall be deenergized from all sources within 10 seconds of when emergency shutdown is initiated or when the PV power source disconnecting means is opened. When the source circuits are deenergized, the maximum voltage at the module and module conductors shall be 80 volts.~~

690.12 Rapid Shutdown of PV Systems on Buildings.
PV system circuits installed on or in buildings shall include a rapid shutdown function that controls specific conductors in accordance with 690.12(A) through (D).

(A) Requirements for controlled conductors apply only to PV system conductors of more than 1.5 meters (5 feet) in length inside a building, or more than 3 meters (10 feet) from a PV array.
(B) Controlled conductors shall be limited to no more than 30 volts and 240VA within 10 seconds of rapid shutdown initiation. Voltage and power shall be measured between any two conductors and between any conductor and ground.
(C) The rapid shutdown initiation methods shall be labeled in accordance with 690.56(B).
(D) Equipment that performs the rapid shutdown shall be listed and identified.

5. Statement of Problem and Substantiation for Comment: (Note: State the problem that would be resolved by your recommendation; give the specific reason for your Comment, including copies of tests, research papers, fire experience, etc. If more than 200 words, it may be abstracted for publication.)

1. This comment is the result of a consensus process established among three groups of stakeholders: 1) CMP4 Firefighter Safety Task Group, 2) the SEIA Codes and Standards Working Group, and 3) the PV Industry Forum. Participants in these groups include the following individuals:

CMP4 Firefighter Safety Task Group

1. Ward Bower, CMP4 representing SEIA
2. Bill Brooks, CMP4 representing SEIA and Chair of Task Group
3. Bob Davidson, Davidson Code Concepts
4. Mark Earley, Secretary, NFPA
5. Bob James, UL
6. Matt Paiss, City of San Jose Fire Department
7. Jim Rogers, CMP4 representing IAEI
8. Todd Stafford, CMP4 representing IBEW
9. Ronnie Toomer, Chair of CMP4
10. Peter Willse, Global Asset Protection Services

SEIA Codes and Standards Working Group

1. Mark Albers, SunPower
2. Mark Baldassari, Enphase Energy
3. Ward Bower, SEIA

4. Bill Brooks, Brooks Engineering/SEIA
5. Joe Cain, Chair of SEIA Codes and Standards Working Group
6. Keith Davidson, SunTech
7. Tilak Gopalarathnam, REFUsol Incorporated
8. Darrel Higgs, Dow Solar
9. Lee Kraemer, First Solar
10. Carl Lenox, SunPower
11. Charles Luebke, Eaton
12. Martin Mesmer, E.ON
13. Steve Pisklak, Dow Solar
14. Robert Rynar, First Solar
15. Michael Schenck, First Solar
16. John Smirnow, SEIA
17. Kris VanDerzee, First Solar
18. Leo Wu, SolarCity

PV Industry Forum

1. Mark Albers, SunPower
2. Greg Ball, DNV
3. Bill Brooks, Brooks Engineering, lead for 690.12
4. Mark Baldassari, Enphase Energy
5. Ward Bower, SEIA
6. Michael Coddington, NREL
7. Marv Dargatz, SolarEdge
8. Chris Flueckiger. UL
9. Joerg Grosshennig, SMA
10. Darrel Higgs, Dow Solar
11. Dan Lepinski, Exeltech
12. Carl Lenox, SunPower
13. Charles Luebke, Eaton
14. Matt Paiss, City of San Jose Fire Department
15. Steve Pisklak, Dow Solar
16. Jim Rogers, Town of Oak Bluffs
17. Jon Sharp, Ampt
18. Bhima Sheridan, SolarCity
19. John Smirnow, SEIA
20. Holly Thomas, U.S. Dept. of Energy
21. Phil Undercuffler, Outback Power
22. John Wiles, NMSU, Secretary of PV Industry Forum
23. Leo Wu, SolarCity
24. Tim Zgonena, UL

The individuals listed above have worked together to develop a consensus comment on proposals 4-167 and 4-253. Consensus was established among these individuals to make substantial improvements in the safety of PV arrays as it relates to emergency response personnel in the 2014 National Electrical Code (NEC) cycle. The comment period has afforded these organizations and individuals the opportunity to see CMP4's response to proposals in this area and to deliberate on the impact that these proposals will have on safety and the solar industry in general. There is consensus that key elements of proposals of 4-167 and 4-253, both of which were accepted in principle by CMP4, need to be included in the 2014 NEC. This comment focuses on the details of the methods used to provide the desired safety levels. Included in these comments are the broader perspectives of electrical worker safety, system reliability of safety components, and needed standards development to advance these important safety capabilities.

In order to show that the revised language is consistent with the original focus of the CMP4 Firefighter Safety Task Group (TG), here is the main focus and research areas of this task group as outlined by Michael Johnston, Chair of the TCC, on February 2, 2011:

1. The scope of this TG is to address concerns of first responders (fire fighters and others) in regards to the PV system remaining energized after the service disconnecting means has been opened during an emergency event.
2. We should look at the possibility of including disconnects for the DC output circuits in the same location as the normal service disconnects for the building or structure served.
3. Another alternative to look at is to require some type of interlock that provides a means of disconnect for DC output circuits when the service disconnect is opened in an emergency condition.
4. Another item to look at is providing a control circuit disconnect for a PV system output relay. This control circuit disconnect could be clearly marked and located at the normal service disconnection means so an emergency responder could readily disconnect the PV output from the building.
5. Another item to look at is additional marking requirements in Article 230 and 690 that alert first responders and instruct them as to the appropriate course of action to remove the output power from the PV system.
6. We suggest that the panel review the electrical protection requirements in Article 690 to ensure that they provide adequate electrical protection during fault conditions.

The CMP4 Firefighter Safety Task Group has acted consistently with the original focus of task group. The current wording in this comment meets the intent as directed by NFPA.

2. Proposal 4-167 (accepted in principle) provides for shutdown of all dc conductors entering a building. The consensus of the group is that this provision is a substantial and necessary safety improvement. This requirement is also consistent with many local fire service rules that currently exist.

3. Proposal 4-167 (accepted in principle) limits the control of exterior circuits on buildings to larger circuits of 100-amps and higher. Since the concern is shock hazard not limited to current flow, the consensus of the group is that shutdown requirements be consistent regardless of the current levels involved. Therefore the recommendation is that the shutdown safety requirements relate to all systems on buildings.

4. Proposal 4-253 (accepted in principle) establishes a voltage of 80-volts for modules. This requires devices connected to every module which greatly increases the number required switches to create a safe environment for firefighters. Since the product standards for the safety and reliability of these devices have yet to be developed, the safety and reliability issues related to these future devices are likely to be significant over the next several years. Poor reliability will not only negatively impact public perception of the solar industry, but it will expose technicians to greater safety hazards as they will be required to make many more service calls to address product defects. These service calls are often in areas where fall and electrocution hazards are high, increasing the likelihood of workplace accidents. While firefighter safety is the primary focus of these code changes, electrical worker safety needs to be a strong consideration of such large system design changes.

5. Proposal 4-253 proposes 80-volts as a potentially safe condition for firefighters. While 80-volts is certainly safer than 600-volts or 1000-volts. It is not a touch safe condition and still remains as a shock hazard. Rather than supporting a voltage level that is somewhat hazardous, this provision should establish a touch-safe zone that is clearly defined for emergency responders. This allows products to be developed that can create a touch safe environment for the required areas and also allows product development that will enable manufacturers to go well beyond the requirements and develop fully touch safe PV arrays.

6. The consensus of the stakeholders recommends that the Emergency Shutdown, renamed Rapid Shutdown, instead establish a safe zone around a PV array using concepts already introduced in other ROPs and elsewhere in the NEC. This safe zone would be unambiguous and enable personnel to confidently enter buildings without fear of contacting live conductors. Most significantly, the devices used to create a safe zone can be placed in enclosures away from the hot PV modules, greatly improving their reliability and life expectancy.

7. A voltage limit of 30-volts and a power limit of 240VA is established as a safe power limited environment, consistent with international standards including IEC61730, *Photovoltaic (PV) Module Safety Qualification*, that establish safety of PV modules. It also allows for 24-volt control circuits throughout the array that are currently used in products that employ contactors for shutting down combiner boxes.

8. ROP 4-167 (accepted in principle) introduces a requirement for conductors entering a building to become deenergized. This intent is incorporated into the current proposal.

9. ROP 4-325 (accepted) introduces a distance of 1.5m (5 feet) to disconnection means of indoor battery-backup wiring. This distance is recognized as an acceptably short conduit length that allows for best practices in workmanship, and can be applied to PV wires entering a building in addition to conductors in and out of inverters and conductors coming out of a battery.

10. ROP 4-167 (accepted in principle) introduces a requirement to reduce fault current. It is recommended that the IEC 61730 value of 240VA be used in lieu of a new current requirement.

11. The 2012 IFC requires labeling of conduit every 10 feet, which is used here as the boundary for the safe zone in the recommendation. This distance is sufficiently large to include row-to-row spacing on commercial arrays.

12. Both ROP 4-167 (accepted in principle) and ROP 4-253 (accepted in principle) introduce a timing requirement of 10 seconds for the shutdown. This is intended to allow dc-side capacitor banks time to discharge with means other than contactors and shunt-trip devices, and has been acknowledged by the solar industry stakeholders as reasonable.

13. Although NEC section 100 defines the phrase “Voltage to Ground” for ungrounded systems as ”the greatest voltage between the given conductor and any other conductor of the circuit”, this does not align with the phrase itself and has caused confusion. The phrase “measured between any two conductors and between any conductor and ground” was added for this reason.

14. The means for rapid shutdown was a topic of much discussion at the ROP meeting and among the stakeholders during the comment period and it was decided among the stakeholders that the devices and methods of compliance should be left open to the standards process so long as proper markings are provided and that special products developed to meet the requirement be listed and identified for the purpose.

15. ROP 4-320 (accepted) revises 690.56(B) to include labels for the rapid shutdown function. This is referenced for clarity. A separate comment addresses the need to reword the 4-320 proposal for consistency with this comment.

16. NEC section 100 defines “listed” and “identified”. The use of these terms will allow much of the existing hardware already on the market to be used without additional certification, which in turn enables faster implementation in the field.

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