Comment on Proposal 4-253 and 4-167 (NEC-P04)

Comment submitted by: Bill Brooks, on behalf of the PV Industry Forum 690.12 Task Group **

690.12 Response to Emergency Shutdown.

All dc PV conductors penetrating buildings shall be deenergized from all sources, either outside the building or within 6 feet of the point of entry into the building, within 10 seconds of when emergency shutdown is initiated.

For PV systems with dc PV circuits mounted on buildings, PV source circuits greater than 100 meters (330 feet) total circuit length, PV source circuits on dwellings, and PV output circuits greater than 10 meters (33 feet) total circuit length shall be deenergized from all sources within 10 seconds when emergency shutdown is initiated. When the source circuits are deenergized, the maximum voltage between any two PV source circuit conductors, or a PV source circuit conductor and ground shall be 80 volts.

Emergency shutdown ~~may~~ shall be initiated by one or more of the following means:

1. loss of utility power,
2. opening of PV output circuit disconnecting means, or
3. operation of an emergency shutdown switch.

All equipment required to perform emergency shutdown must listed and identified for the purpose.

Substantiation:

- The PV Industry Forum 690.12 Task Group supports the 4-253 proposal, but would like to clarify the language of what circuits are deenergized so that the requirements can be effectively and explicitly verified.
- The PV Industry Forum 690.12 Task Group also supports the 4-167 proposal that requires fully deenergizing all dc PV conductors entering a building.
- Rather than setting a current level on when deenergizing circuit is required for PV systems mounted on buildings as in 4-167, the PV Industry Forum recommends that the shutdown requirements be a tiered approach for this code cycle to permit the industry time to develop cost effective module level solutions for larger scale installations. The

tiered approach would set specific limits on the distances and locations of PV circuits on buildings before deenergization is required. These limits are:

- 100 meters (330 feet) for all source circuits
- source circuits on dwellings, and
- PV output circuits greater than 10 meters (33 feet)

The purpose of these limits are to reduce the exposure of emergency personnel to energized PV circuits on buildings while allowing options that do not require module-level control in specific and limited situations. The 100 meter limit for all source circuits will allow 1000Volt source circuits to be wired to nearby combiner boxes without requiring module-level control. All source circuits on dwellings would require segmenting to 80 Volts maximum voltage which will require module-level control for the most common PV module configurations. The limit of 10 meters for PV output circuits is to allow short distance circuits from combiners to inverters without requiring deenergization so that roof-mounted inverters can be mounted on non-dwellings without additional deenergization requirements.

- A simplified definition is used for deenergization of PV source circuits to that used in 4-253 to allow for multiple lower-voltage modules to be wired in series to be segmented into groups rather than individual modules.
- The original intent of proposal 4-253 was not fully realized in the panel rewording for how deenergization is accomplished. Loss of utility power due to firefighter utility control should be an allowed singular method to activate emergency shutdown. This provision was removed from the 4-253 language in favor of the 4-167 language about the PV Power Source Disconnect. Both options should be allowed in addition to an emergency shutdown switch that is listed and identified for the purpose.
- Access pathways and ventilation clearances in the 2012 International Fire Code for roof mounted PV systems help to allow firefighters to carry out required operations without directly contacting PV modules or PV array wiring.
- The PV Industry Forum is also concerned that this proposal will result in a decrease in reliability of PV systems resulting in an increase in the number of required service calls throughout the life of a PV system. Each service call that requires a technician to access a roof increases the likelihood of injuries to service personnel. Firefighter safety must be balanced against service technician safety. This proposal represents more of a balance between these two important safety concerns.

** A SEIA/PV Industry Forum meeting was held at UL in Northbrook on August 27, 2012. A 690.12 task group was formed to develop this comment/proposal by consensus. The task group includes representatives from:

John Doe
Jane Doe
Jane Smith
John Smith

NOTE TO PV INDUSTRY FORUM TASK GROUP ON 690.12:

This proposal includes input from all comments to date. The proposal will continue to progress from input from those on the task group and those outside the task group. This version is considerably different from the last circulated version based on several key inputs. These key inputs include:

1. Concerns that the options for initiating a shutdown were not sufficiently broad enough to allow simple methods and more complex methods. More complex methods, such as an emergency shutdown switch are necessary when backup power is desired for normal utility outages. Allowing emergency shutdown for a utility outage is also an important option so that additional switch actions are not required by firefighters to initiate emergency shutdown. Lastly, it is unclear whether allowing the PV output circuit disconnecting should be allowed as a singular shutdown method without also labeling this switch the "emergency shutdown switch". We need to discuss this.
2. Concerns that allowing PV output circuits below 100-amps could be run for long distances without any control or protection—thus the 10 meter limitation on all PV output circuits and 100 meters for all source circuits. Also, since these emergency shutdown requirements are primarily focused on shock hazards, the amount of current in the circuit is less important than the amount of exposure of that circuit to emergency personnel. Limiting source circuits on non-dwellings to 100 meters before segmentation is required will either limit source circuit length accordingly or allow designs to install longer source circuits provided array voltage segmentation is installed as is required for dwellings.
3. This version provides written substantiation for the group to begin to word-smith.
4. Also, "PV on Buildings" is no longer needed in the title since this section would apply to ground-mounted systems with PV conductors penetrating buildings. Our proposal must also address the somewhat unlikely situation where the dc conductors from a ground-mounted system could be attached or run up and over a structure to take the shortest path to the inverter. This is not currently addressed in any of the proposals.
5. The words "approachable and contactable" were removed in preference of the simpler language limiting the voltage anywhere between two conductors to 80 volts. Clearly this is not favorable to Dow's concerns, but enforcement of "approachable and contactable" is likely to be too complicated. This language allows products like Dow's BIPV product to be segmented into 80-volt groups rather than requiring individual module control as the language in the panel language suggests.
6. WE ARE NOT DONE YET.

COMMENTS BY JOHN WILES:

1. In off grid systems and multimode, U-I systems with battery backup, the PV system dc conductors are already inside the building. The first sentence will require an automated disconnect at the batteries. Was that your intent? Keep in mind that smart

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grid applications with energy storage (batteries) are starting to pop up as installed systems and battery backup PV installations are increasing.

2. I suggest that the second paragraph be broken down into numbered subparagraphs. It may also clarify the intent if Informational Notes along the lines of the substantiations be added to each subparagraph to indicate what is allowed or not allowed since the lengths alone will have little meaning to AHJs.

3. You may want to consider a qualified person only maintenance override on the Emergency Shutdown function. In many maintenance actions, the DC Output Disconnect needs to be opened and the source circuits need to be operationally connected for troubleshooting.

4. This Response to Emergency Shutdown will have to be considered in light of the actions required by ground fault detection systems and the DC PV AFCI requirements. It appears that they may need to be, to some extent independent, and the automatic actions required by one should not interfere with the actions of another requirement.

5. Your group may want to consider the words: "Deenergize from all sources within 10 seconds". The focus is disconnects at the module, but remember in a U-I inverter system and possibly a charge controller system, the conductors to the utilization equipment will be energized and in the case of the inverter that can be up to five minutes. It would appear that some sort of automatic disconnect will be required at the input terminals of the utilization equipment (inverter or charge controller or other) to meet this requirement. Just disconnecting the modules will not be sufficient.

6. While I understand the need to have this equipment to work effectively and reliably, the listing "for the application" may be a little stiff. A listed dc shunt-trip breaker may be very effective, but it is not listed for the Emergency Shutdown application, And we will need a new UL Standard to address this.