Fire Ratings of PV Systems: A Guide for Stakeholders

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DISCLAIMER

- This is an educational presentation intended to help various stakeholders impacted by the changes in the fire performance requirements of the building codes and standards.
- This is not intended to create new requirements or dictate to test laboratories or authorities having jurisdiction (AHJs) how they must perform their duties.
- The codes and standards, as written, must be read and interpreted. This presentation is intended to help all those charged with reading and interpreting, some level of additional education.

Guide to Fire Rating of PV Modules

- The U.S. Dept. of Energy, through the National Renewable Energy Laboratory (NREL) is funding the development of this guide for stakeholders on fire performance of PV systems.

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Guide to Fire Rating of PV Modules

- The guide is written specifically to the following stakeholders:

1. Labs certified to perform UL1703 fire tests
2. PV Module Manufacturers
3. PV Mounting System Manufacturers
4. PV Installing Contractors
5. AHJs Enforcing Code Requirements

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Guide to Fire Rating of PV Modules -Outline

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Guide to Fire Rating of PV Modules -Outline (cont.)

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Background

- New language in the 2012 IBC requires the PV system to match the required fire rating of the roof.
- The general requirement for roofing systems in the IBC is for Class C fire rating.
- California has the most Class A and B roof fire rating requirements.
- Class A or B is required for areas such as Wildland/Urban Interface areas (WUI) and for very high fire severity areas.
- Many of these areas are found throughout the western United States.

Changes in Building Code Requirements

- Prior to the 2012 IBC requirement, the controversy surrounded language in the UL Whitebook.
- *"Installation of modules on or integral to a building's roof system may or may not adversely affect the roof-covering materials' resistance to external fire exposure if the module has a lesser or no fire-resistance rating. Roof-covering materials will not be adversely affected when the modules have an equal or greater fire-resistance rating than the roof-covering material"*
- This statement caused some AHJs to question installations six or more years ago.

Changes in Building Code Requirements

- The Whitebook statement prompted a research project administered by SolarABCs to investigate the issue.
- After 5 years of evaluation and well over 100 fire tests, the UL1703 test standard was updated.
- The new UL1703 standard with the updated fire test was published in October of 2013.

Changes in Building Code Requirements-- Changes to 2012 I-Codes

- *2012 IBC Code language:*
  - 1509.7.2 Fire classification. Rooftop mounted photovoltaic systems shall have the same fire classification as the roof assembly required by Section 1505.
- Different language was approved in the IRC.
- *2012 IRC Code language:*
  - M2302.2.1 Roof-mounted panels and modules. Where photovoltaic panels and modules are installed on roofs, the roof shall be constructed to support the loads imposed by such modules. Roof-mounted photovoltaic panels and modules that serve as a roof covering shall conform to the requirements for roof coverings in Chapter 9. Where mounted on or above the roof coverings, the photovoltaic panels and modules and supporting structure shall be constructed of noncombustible materials or fire-retardant-treated wood equivalent to that required for the roof construction.

California Building Codes Language

- The 2013 California Building and Residential Codes, which are generally based on the 2012 I-codes, is worded in a more consistent and better way.
- CBC Section 1505.9 and CRC Section R902.4 have been revised to read as follows:
- ***1505.9 Photovoltaic panels and modules.*** *Effective January 1, 2015, Rooftop mounted photovoltaic systems shall be tested, listed and identified with a fire classification in accordance with UL 1703. The fire classification shall comply with Table 1505.1 based on the type of construction of the building.*
- ***R902.4 Photovoltaic panels and modules.*** *Effective January 1, 2015, Rooftop mounted photovoltaic panels and modules shall be tested, listed and identified with a fire classification in accordance with UL 1703. The fire classification shall comply with Table 1505.1 of the California Building Code based on the type of construction of the building.*

California Building Codes Language

- Due to the lack of available Class A and B fire rated PV products tested to the new UL1703, CalFire petitioned to delay enforcement of the 2013 CBC and CRC requirements until January 1, 2015.
- This gives a short, but meaningful, reprieve to the PV industry so that products can be evaluated to the new UL1703 fire performance standard.

UL 1703 Fire Performance Tests Tutorial

- The original UL1703 fire performance tests included two tests borrowed from the roof fire rating standard, UL790.
- These two tests were (1) the burning brand test on the surface of the module, and (2) the spread of flame test on the top surface of the module.
- The original version of the fire performance tests required that these test be performed over a fire rated roof in section 16 of the UL1703 standard.
- Due to pass/fail criteria, the roof covering did not impact the tests and was not used in the tests.

Why Do We Have Class C PV modules?

- Primarily due to the burning brand test that specified that any material that came off the back of the module in the form of glowing embers indicated a fail of the test.
- Glass-on-polymer constructions have only been able to pass the smallest burning brand test—Class C (1″ x 1″ brands)
- Class A brands (12″x 12″) and Class B brands (6″x6″) have only been passed by glass-on-glass construction PV modules.

Why the need for new fire performance tests?

- The earlier UL1703 tests had two main deficiencies:
  - 1. It did not take into account the benefit of a fire rated roof under the PV system in the burning brand test.
  - 2. It did not test how fire on a roof could spread into a PV array.
- To fix these deficiencies, the UL1703 STP developed a more comprehensive set of tests to better evaluate a PV system for fire performance.
- The new fire test protocol requires the same two fire tests for the module required by the old UL1703—for TYPE. It requires up to four tests with the mounting system if the mounting system is designed for steep and low-slope roofs.

Required tests for System Fire Class Rating of PV Module or Panel with Mounting System in Combination with Roof Coverings—Table 31.2

Test	Tests Over Representative Roof Coverings		
	Class A	Class B	Class C
Spread of Flame On Top Surface of Module or Panel (Section 31.1.2)[a]	Flame Spread less than 6 ft. in 10 minutes	Flame spread less than 8 ft. in 10 minutes	Flame spread less than 13 ft. in 4 minutes
Spread of Flame at Roof and Module or Panel Interface Over Representative Steep Sloped Roof (Section 31.2.2.1a)[b]	Pass	Pass	Pass
Spread of Flame at Roof and Module or Panel Interface Over Representative Low Sloped Roof (Section 31.2.2.1b)[b]	Pass	Pass	Pass
Burning Brand on Surface Over Representative Steep Sloped Roof (Section 31.2.3.1a)[b]	A Brand	B Brand	C Brand
Burning Brand Between Module or Panel and Representative Steep Sloped Roof (Section 31.2.3.1b)[b]	Pass	Pass	Pass

[a] Requirement can be met by either with a type tested module (16.4) or by performing the test in Section 31.1.2 on the top surface of a module or panel in the mounting system being qualified in 31.2. For non-type tested products, the product must pass two consecutive tests for each required test.

[b] Two consecutive tests for each test must be passed unless not required by the terms of Sections 31.2.1.2, 31.2.2, or 31.2.3. For the purpose of this standard, Steep and Low Sloped Roof are defined in Sections 31.2.1.1.

The Development of PV Module Types Instead of Fire Classified PV Modules

- The old version of UL1703 provided a fire performance classification for the PV module, and the UL Whitebook provided a description that the module had to be mounted over a fire rated roof of the same or higher fire class. (Class C module over Class C, B, or A roof).
- The new version of UL1703 introduces the concept of a PV module Type. Type is based on 4 construction parameters and 2 fire performance parameters.
- Goal of module typing is to provide a way to certify a mounting system that will provide similar fire performance for many different modules.
- Without module types, each different module would be required to be tested with each mounting system (thousands of tests per mounting system).

PV Module Type Evaluation

- Construction is categorized by 4 items
  - 1) the superstrate material;
  - 2) the encapsulant material;
  - 3) the substrate material; and,
  - 4) the frame type and geometry (if any).
- Fire Performance is categorized by two items (same as old UL1703 test)
  - 1) spread of flame on the top surface of the module; and,
  - 2) burning brand on the top surface of the module.

PV Module Type Matrix

- October 2013 version of UL1703 provided an example of 3 types and defined how types could be created.
- May 2014 revision provided a matrix of 15 types based on the permutations of the first three types.
- Many have misunderstood the reason for the matrix and have perceived that the matrix is a proliferation of test requirements. NOT SO. The matrix simply made it unnecessary for a test lab to define new types for the 3 most common module constructions.

PV Module Type Additions and Simplifications

- As new PV module constructions come to market (e.g. framed glass-on-glass modules) new types can be developed if it makes sense. A single module construction, with no competing options, can be tested by itself and does not require a type to be developed.
- As experience is gained through testing, certification labs will be able to predict the results of test for different types based on this experience. (we are not there yet)

Summary of the Fire Performance Testing Process

- A PV module is type tested—the type of the module and the performance in the spread of flame test is transferred to the mounting system process.
- If a PV module is Type 1, the spread of flame test on the top surface of the module has already passed the first required mounting system test (If the module is Type 7, the top surface spread of flame test can be performed in the mounting system, in case the mounting system can improve the top surface performance).
- If the mounting system is capable of mounting modules on both steep and low slope roofs, all remaining tests must be performed. (Steep and Low interface, Burning Brand above and below module)

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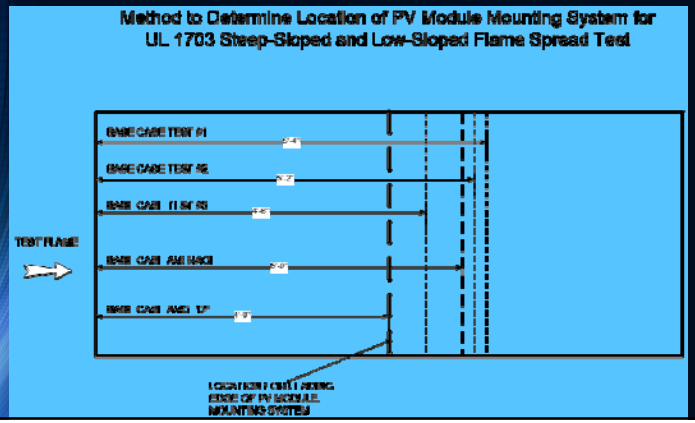
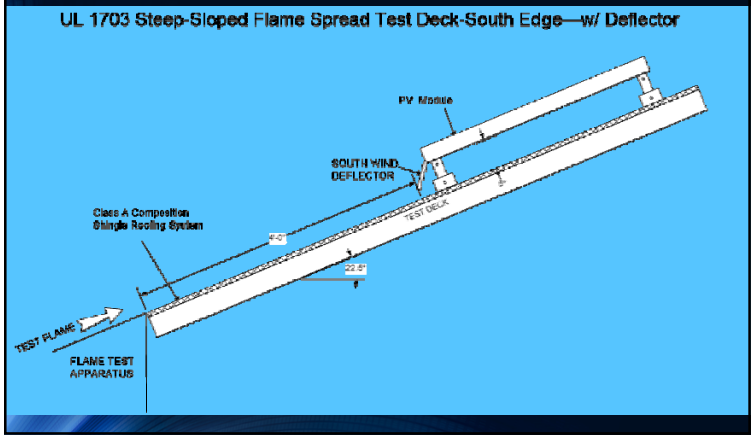
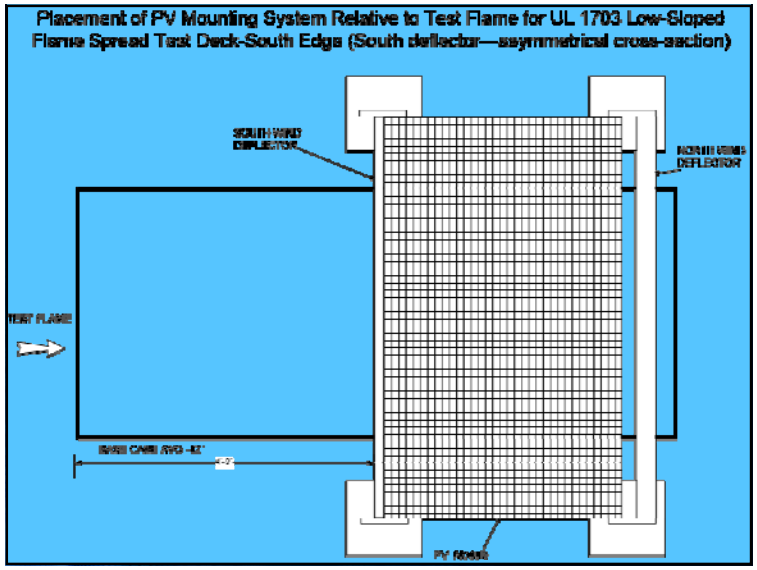
AT THE LAB

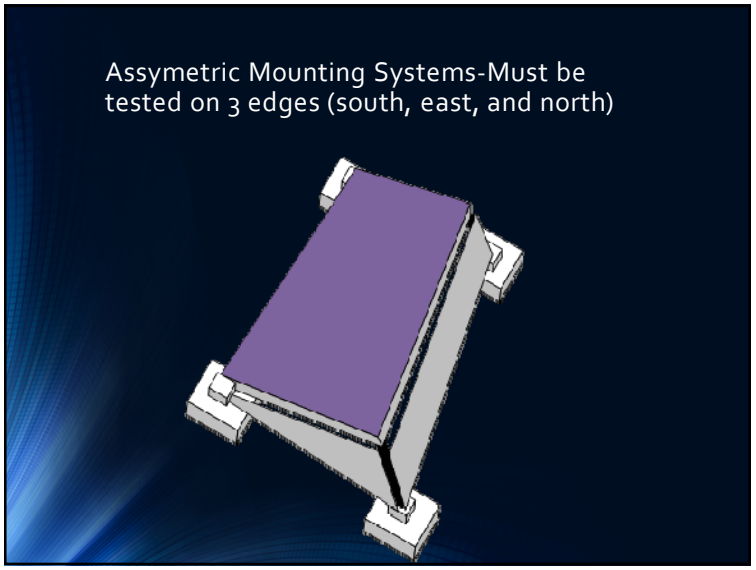
- Lab must test 3-baselines on selected roofing system to confirm that the baselines meet the requirements of the standard.

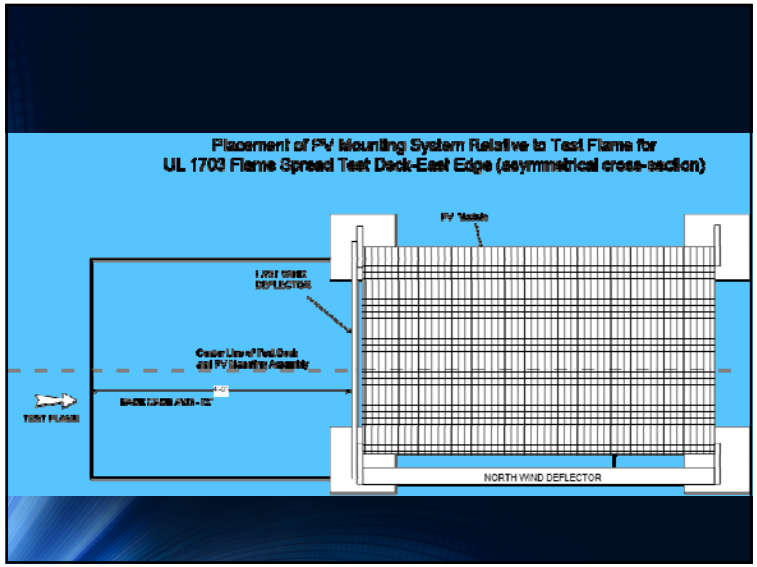


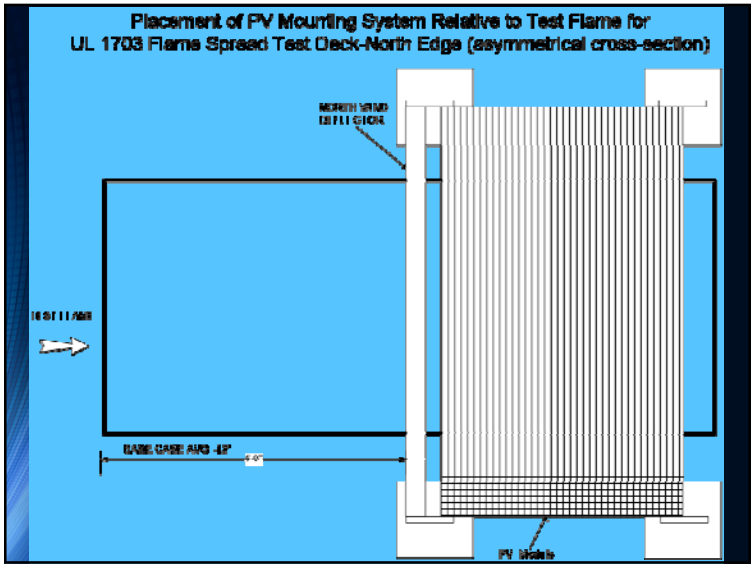
Position of PV System on Test Deck-Steep-Sloped

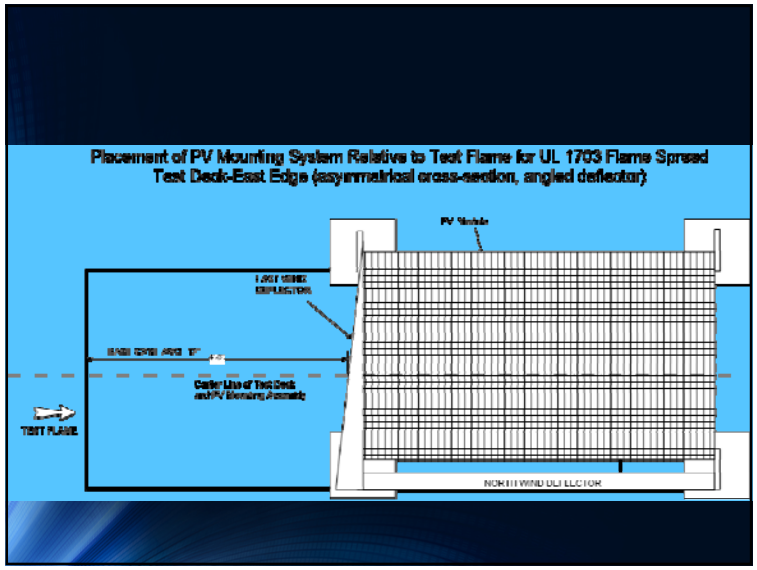


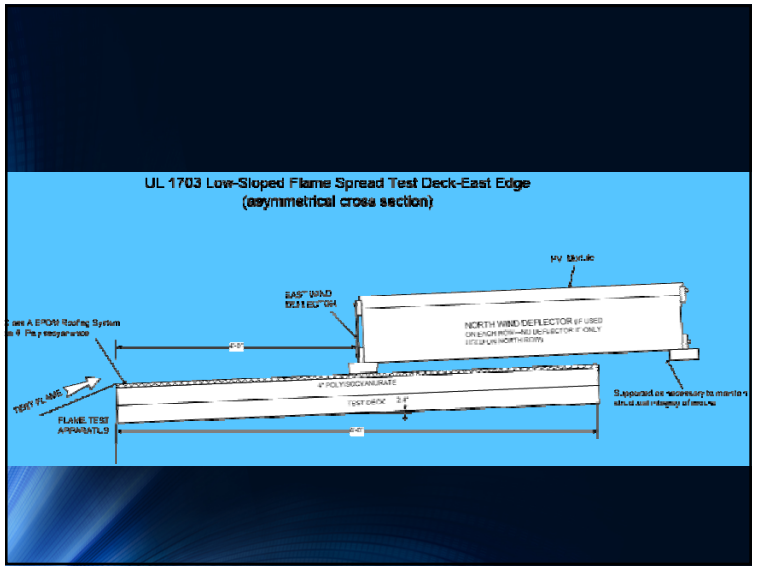

Placement of PV Mounting System Relative to Test Flame for UL 1703 Low-Sloped Flame Spread Test Deck-South Edge (South deflector—asymmetrical cross-section)
SOUTH WIND DEFLECTOR
NORTH WIND DEFLECTOR
TEST FLAME
BASE CASE AHJ -4.2°
4'-0"
PV Module


Assymetric Mounting Systems-Must be tested on 3 edges (south, east, and north)


Placement of PV Mounting System Relative to Test Flame for UL 1703 Flame Spread Test Deck-East Edge (asymmetrical cross-section)
PV Module
EAST WIND DEFLECTOR
Center Line of Test Deck and PV Mounting Assembly
4'-0"
BASE CASE AHJ -4.2°
TEST FLAME
NORTH WIND DEFLECTOR


Placement of PV Mounting System Relative to Test Flame for UL 1703 Flame Spread Test Deck-North Edge (asymmetrical cross-section)
NORTH WIND DEFLECTOR
TEST FLAME
BASE CASE AHJ -4.2°
4'-0"
PV Module





New Burning Brand Tests

- Not performed on mounting systems only for low-sloped roofs—fire barrier required on these systems.
- The new test includes the fire rated roof under the PV system. Pass/fail is failure of the roof deck, not failure of the PV module.
- The new test more accurately addresses the intention of the burning brand test which is to test the resistance of a roofing system from prevent a fire brand from penetrating a roof and igniting the attic construction materials that are often quite flammable.
- Additional 6"x6" brand test is performed with burning brand between the PV system and the roof. Intent is to simulate burning debris under a PV array. (not required with perimeter guard with ¼" or less holes)

How the Revised Building Code Relates to the New Test Standard

- 2012 IBC references the old version of UL1703 because the building codes require a specific version of a code to be adopted. This creates a need for a local AHJ to voluntarily accept the newer version of the standard. While this is commonly accepted by AHJs it is not required or automatic.
- This section of the document has 2 scenarios for steep-sloped and low-sloped applications.

Action Items for each Stakeholder Group—Laboratories Performing UL1703 Fire Tests

- Staff training and experience is key for consistent enforcement of the standard.
- As expected with any new testing protocols, mistakes have been made by each lab.
- Difficulties in applying the standard create needs for interpretations or adjustments by the lab.
- Issues of consistent misinterpretation or difficulties in testing need to be assembled for another revision of the standard.

Action Items for each Stakeholder—PV Module Manufacturers

- New products coming to market need to be evaluated by the new Typing process so they can be easily installed in a fire-rated mounting system.
- Most PV modules currently certified as Class C modules will only need to perform one fire test and provide information on the thickness of their glass, encapsulant, and substrate backsheet to obtain a Type number. The one fire test to be evaluated is the spread of flame test on the surface of the module.
- Module should be marked "Module Fire Performance: Type 1" (or whatever number) so that contractors and inspectors can easily identify the type.

Action Items for each Stakeholder—PV Rack Manufacturers

- The key action item for the rack manufacturer is to determine if their existing products can be used in Class A, B, or C fire rated PV systems, or if modifications are necessary to bring their products into compliance.
- Several Type 1 and Type 2 PV modules are now available, so these two types, with the mounting system, should be evaluated as soon as possible.
- As other types become more common (particularly Type 7 and 8) these will also be important for Class B required fire ratings.

Action Items for each Stakeholder—PV Installing Contractors

- The key action item for installing contractors is to work with their equipment suppliers to make sure that the PV modules and support structures they typically use are actively in the process of getting their products certified to the new fire performance requirements in UL1703.
- If not, the contractor needs to consider an alternative supplier that is actively fire rating their mounting systems.
- Review any supplied documentation from equipment suppliers to see if it clearly states how to install the equipment to get a Class A, B, or C rating. This documentation is critical to show to the AHJ.

Action Items for each Stakeholder— PV Installing Contractors

- At Plan Review:
  - Review supplied documentation in permit packages from equipment suppliers to see if it clearly states how to install the equipment to get a Class A, B, or C fire rating.
- In the Field:
  - Observe the PV module type, if required to achieve a specific fire class rating. The listing label should have the Type.
  - Check to make sure any additional features required for fire performance are correctly installed on the mounting system.

What to do about existing PV modules?

- UL 1703 allows the listing of PV modules with a Class A, B, or C fire rating up to the effective date of October 25, 2016.
- While few, if any Class A or B modules are currently manufactured, it is possible new modules could comply (e.g. new framed glass-on-glass modules)
- Existing Class C PV modules could be installed over fire rated roofs if the roof fire rating requirement is Class C (most of California and the United States. This meets the current 2012 IBC requirement.

What about the California, January 1, 2015 date?

- For areas of California that require Class A or B fire performance, most PV modules will need to be typed and installed in a Class A or B fire rated mounting system using the new UL1703 standard.
- For areas requiring Class C fire performance, existing Class C PV modules could be installed over fire rated roofs if the roof fire rating requirement is Class C.
- The Office of the State Fire Marshal in California is currently drafting a new informational bulletin outlining how to enforce the requirements that become effective in 2015.