module or panel and above the roof. Mounting equipment that prevents flame in the interstitial space is permitted to meet this requirement. The module or panel installation shall be installed with a minimum of 36 inches (910 mm) between the edge of the flame test apparatus and the edge of the PV mounting system, as defined by the PV module or a deflector in the direct flame path upon the test deck, whichever is closer to the leading edge of the test deck. The module or panel installation for steep sloped roofs shall be the measured baseline in accordance with 31.2.1.2 minus 12 inches (303 mm). Figure 31.2 illustrates how the baseline roof tests are used to establish the location of PV mounting system relative to the test flame. Figure 31.3 and Figure 31.4 illustrate where the test sample is to be located relative to the test flame, including application of deflector. The rating obtained for a 5-inch (127 mm) gap between the bottom of the module frame and the roof covering surface can be used for any other gaps allowed by the mounting instructions. This test is not required if the Installation Instructions require that the module or panel only be installed for slopes less than 2 inches/foot (167 mm/m).

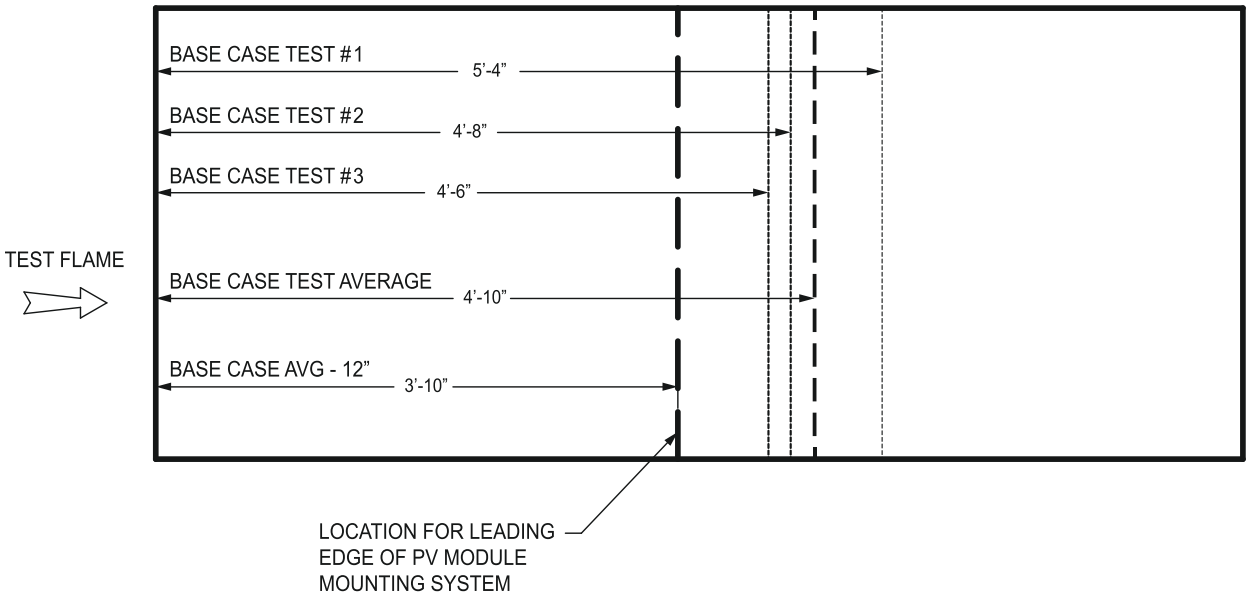
b) Spread of Flame at Roof and Module or Panel Interface Over Representative Low Sloped Roof. With the module or panel installed on a low slope roof as an assembly and oriented such that the fire growth from the roof covering materials advances to the interstitial space below the module or panel and above the roof. Mounting equipment that prevents flame in the interstitial space is permitted to meet this requirement. For low sloped roofs, the module or panel installation shall be installed with a minimum of 36 inches (910 mm) between the edge of the flame test apparatus and the edge of the PV mounting system, as defined by the PV module or a deflector in the direct flame path upon the test deck, whichever is closer to the leading edge of the test deck. The module or panel installation for low sloped roofs shall be the measured baseline in accordance with 31.2.1.2 minus 12 inches (303 mm). For products with asymmetrical edge configurations, these dimensions apply to each of the 3 tests described in 31.2.1.3. Figure 31.5 – Figure 31.12 illustrate where the test sample is to be located relative to the test flame, including application of deflector. If no gap height is specified in the manufacturer's instructions, a 5-inch (127 mm) gap between the bottom of the module frame and the roof covering surface shall be used with the module or panel parallel to the roof surface. The rating obtained for a 5-inch (127 mm) gap can be used for any other gaps allowed by the mounting instructions. This test is not required if the Installation Instructions require that the module or panel only be installed for slopes greater than 2 inches/foot (167 mm/m).

A deflector is defined as a continuous flame mitigation device which has a significant impact on the flame path and/or air flow direction. Breaks are permitted if no change in the impact on the flame path and/or air flow direction can be expected. The deflector cannot be used to adjust the offset distance by more than 6 inches (152.4 mm). If the deflector is greater than 6 inches away from the module edge, then the edge of the PV mounting system is considered to be 6 inches away from the module frame. For the purposes of defining test configurations, the deflector shall be installed as described by the installation manual on the leading edge only.

Note: Testing during the development of fire testing procedures suggest that 5 inches (127 mm) is a worst case condition.

Figure 31.2

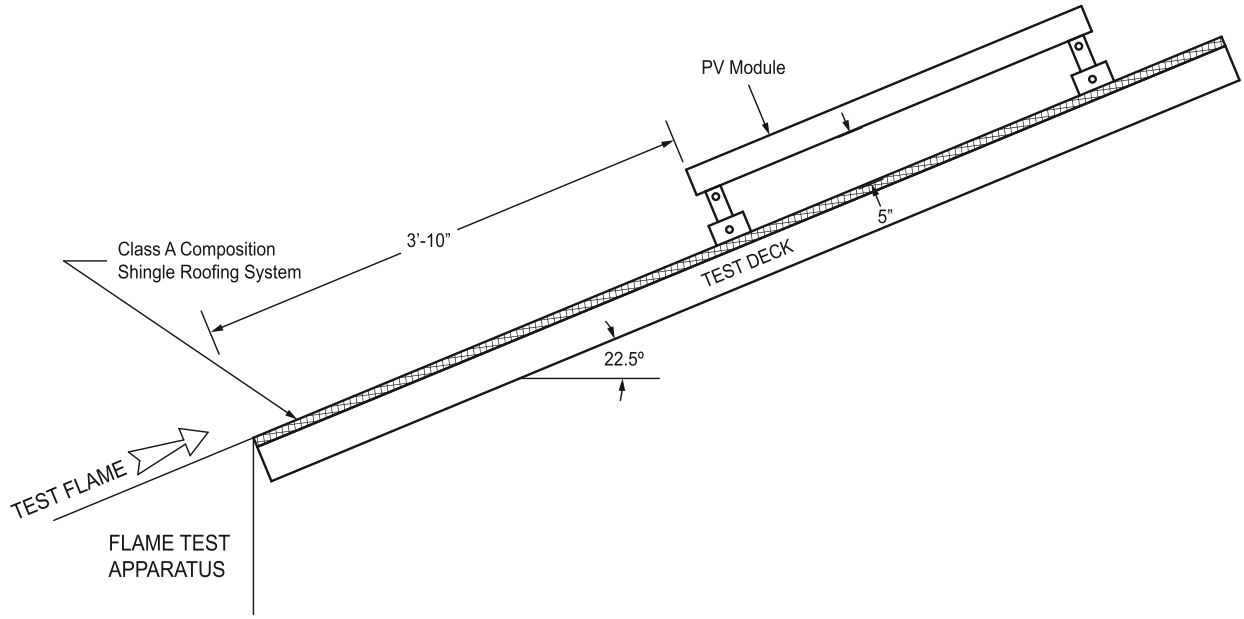
Method to determine location of PV module mounting system for steep-sloped and low-sloped flame spread test



su1526

Figure 31.3

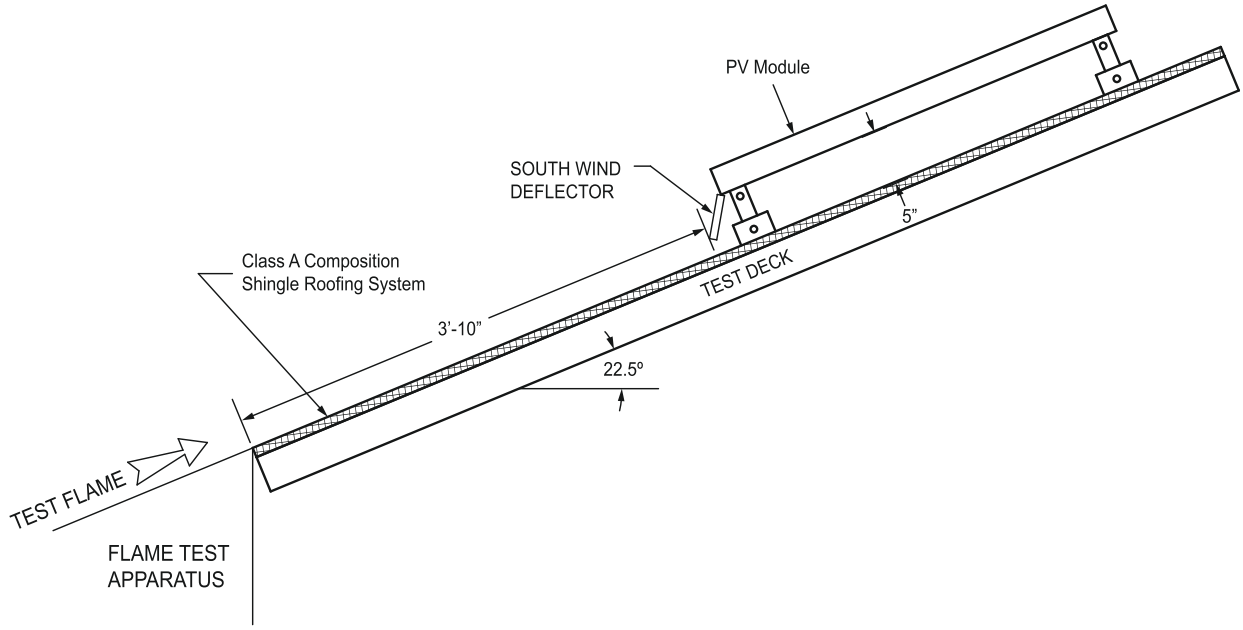
Steep-sloped flame spread test deck-south edge



su1527

Figure 31.4

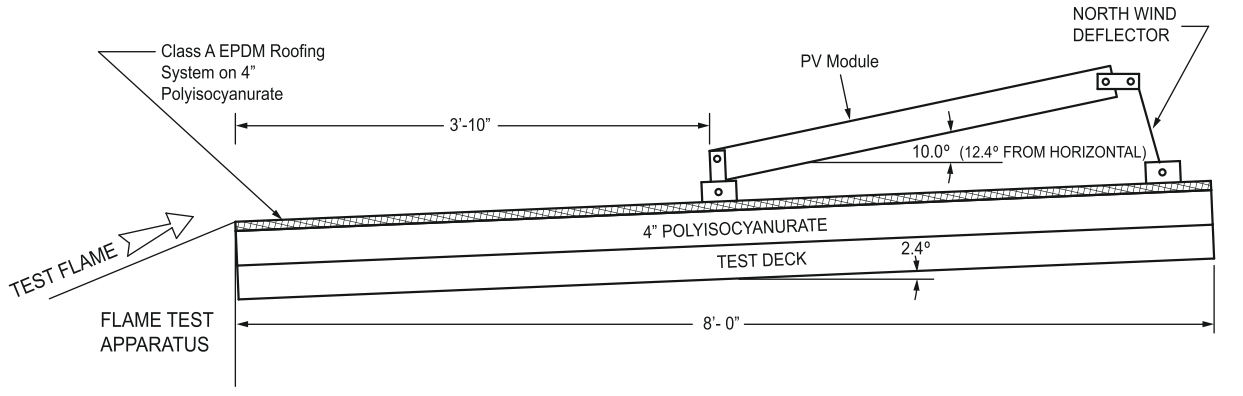
Steep-sloped flame spread test deck-south edge with deflector



su1528

Figure 31.5

Low-sloped flame spread test deck-south edge (asymmetrical cross section)



su1529

Figure 31.6

Placement of PV mounting system relative to test flame for flame spread test deck-south edge (no south deflector-asymmetrical cross-section)

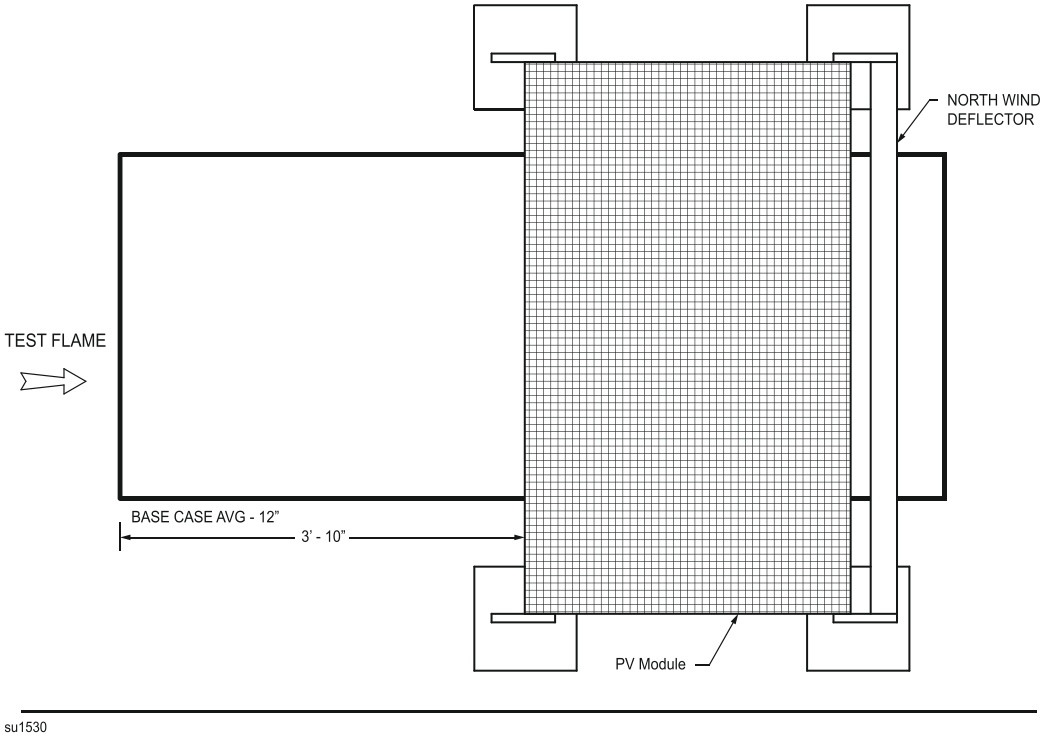


Figure 31.7

Placement of PV mounting system relative to test flame for low-sloped flame spread test deck-south edge (south deflector – asymmetrical cross-section)

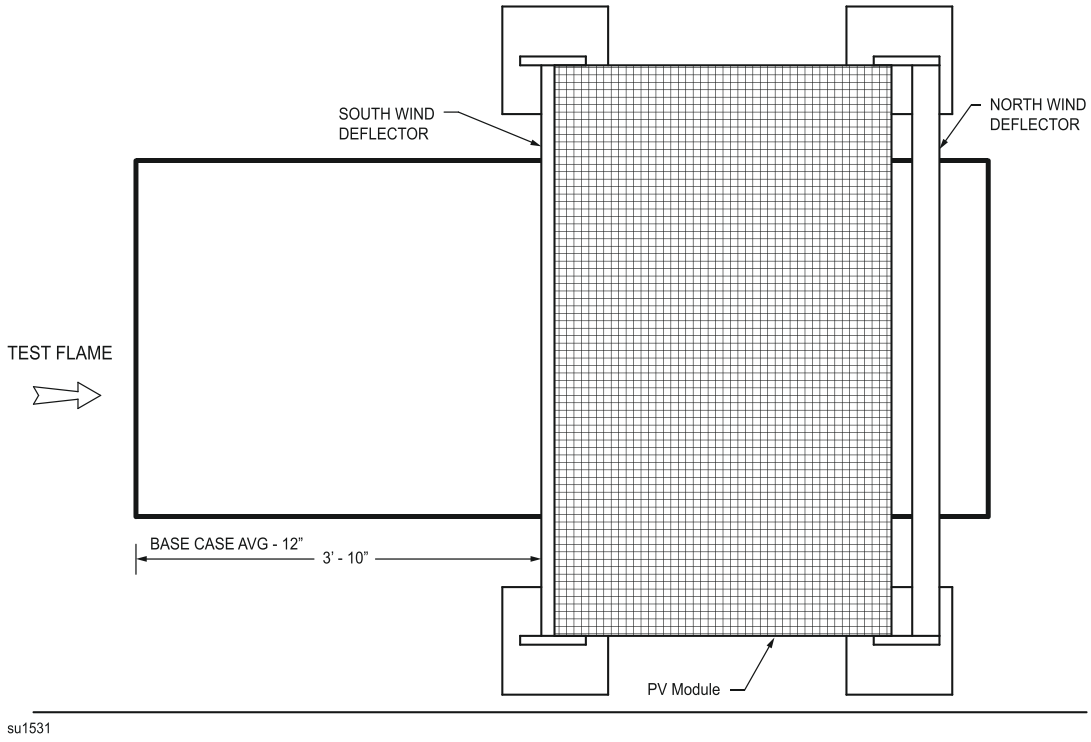


Figure 31.8

Low-sloped flame spread test deck-north edge (asymmetrical cross-section)

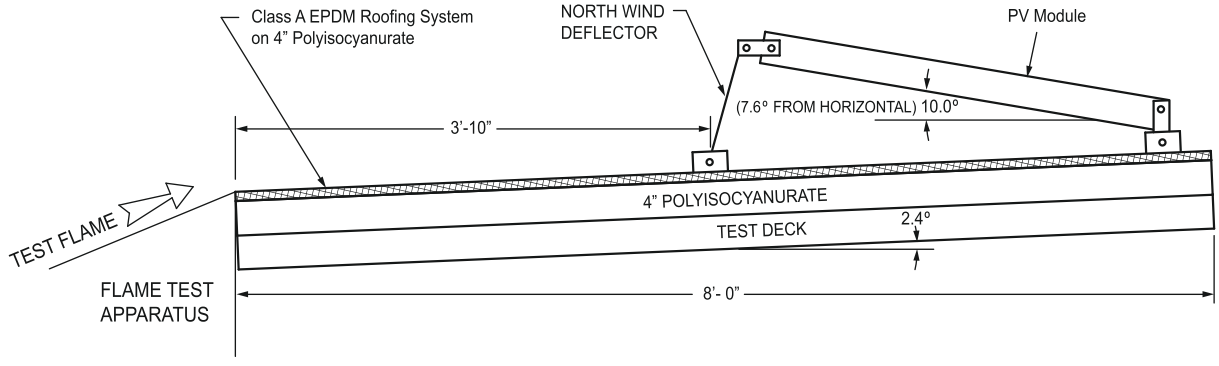


Figure 31.9

Placement of PV mounting system relative to test flame for flame spread test deck-north edge (asymmetrical cross-section)

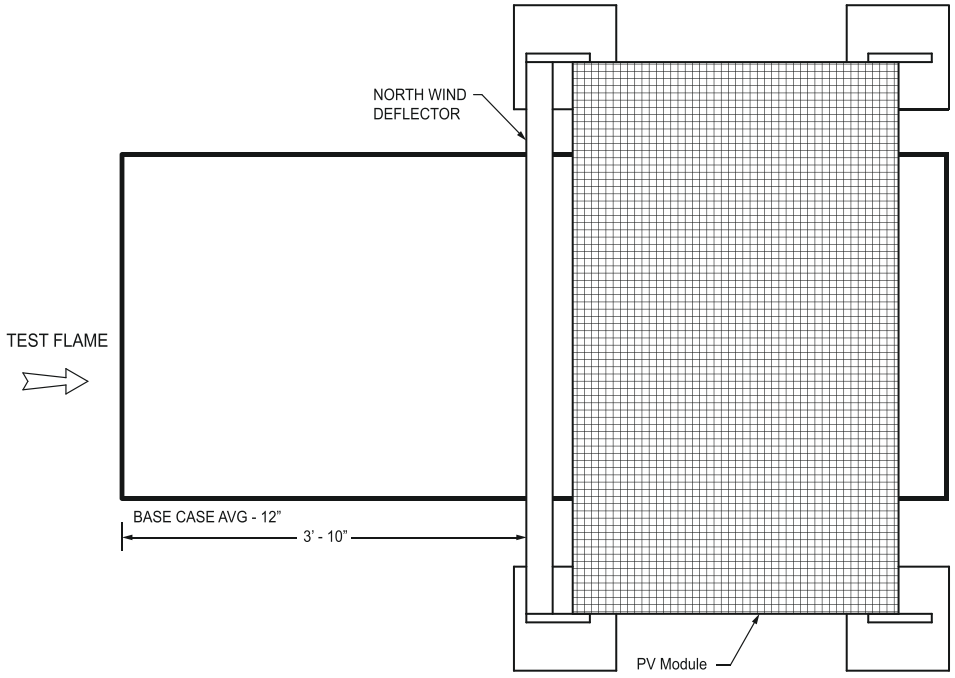


Figure 31.10

Low-sloped flame spread test deck-east edge (asymmetrical cross section)

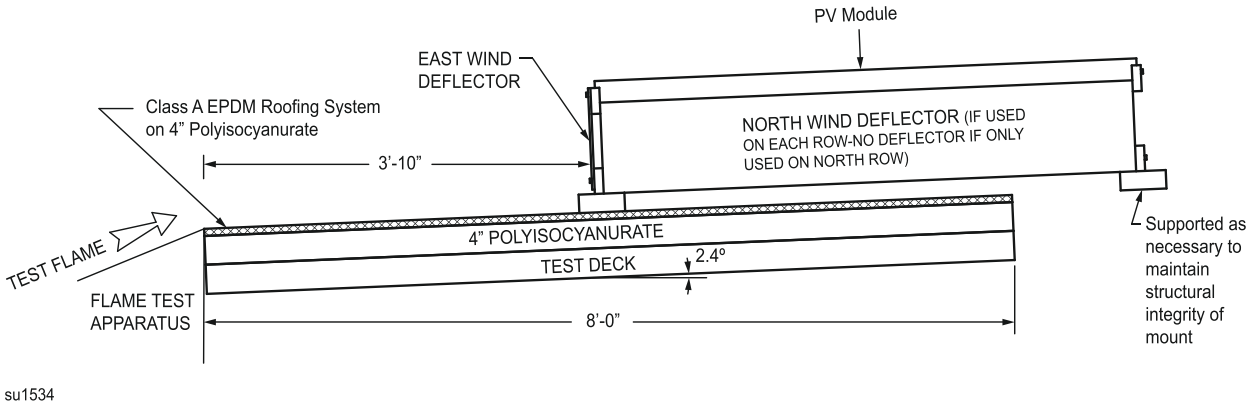


Figure 31.11

Placement of PV mounting system relative to test flame for flame spread test deck-east edge (asymmetrical cross-section)

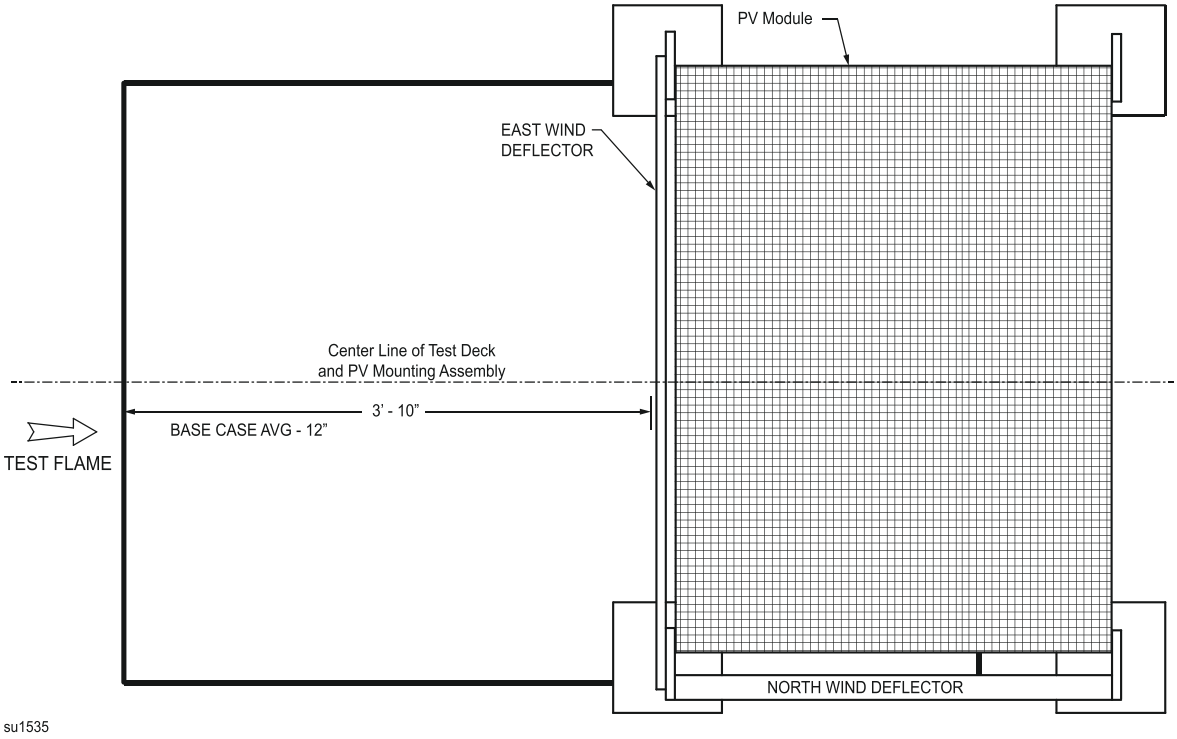
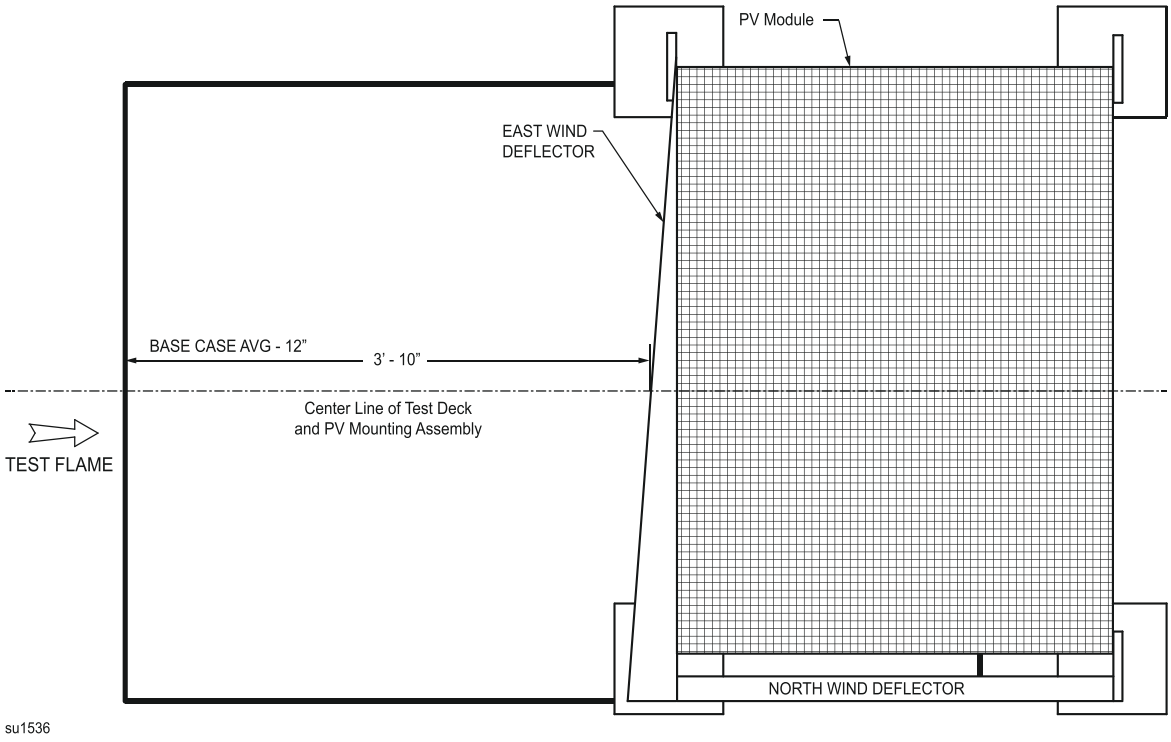


Figure 31.12

Placement of PV mounting system relative to test flame for flame spread test deck-east edge (asymmetrical cross-section, angled deflector)



31.2.2.2 For the Spread-of-Flame Tests, Section 31.2.2, at no time during the tests shall:

a) Any portion of the module or panel be blown off or fall off the test deck in the form of flaming or glowing brands;

b) Portions of the roof deck fall away in the form of glowing particles;

c) The flame spread on the roof surface, or module or panel surfaces beyond 6 ft (1.8 m). The flame spread is to be measured from the leading edge of the test deck. Spread-of-flame includes flaming on both the top and bottom surface of the module or panel; or

d) There be significant lateral spread-of-flame on the module or panel. Significant lateral spread shall be considered to have occurred when surface flaming extends laterally on the mounting system or the module or panel to the full 40-inch (1016 mm) width of the test deck assembly. Lateral flame spread includes flame spread under or along the equipment under test, but not the roof surface.

With respect to (a), any piece of PV module or panel, that continues to glow or flame for 5 seconds or more upon landing on the test room floor is a glowing or flaming brand, respectively. A module or panel is not required to be usable after any of the tests of this Section.

31.2.3 Burning-brand tests for steep sloped mounting systems

31.2.3.1 Burning brand tests are to be conducted on PV modules or panels designed for steep sloped applications. The modules or panels shall be evaluated in combination with the intended mounting systems as described in the accompanying manufacturer's installation instructions. Tests are to be

conducted as described in the Standard Test Methods for Fire Tests of Roof Coverings, UL 790. The tests shall be modified as described in this Section, using the steep sloped roof covering as described in 31.2.1.2, and the Class A burning brand plywood test deck as described in UL 790, Figure 4.5. The module or panel is to be mounted with the longer dimension coinciding with the width of the test deck and with the horizontal and vertical joints on the test deck intersecting the center of the module or panel in both dimensions. For modules or panels with a short dimension in excess of 52 inches (1321 mm), the module or panel leading edge shall match the leading edge of the test deck. For modules or panels, which are only to be installed according to manufacturer's installation instruction with the shorter dimension coinciding with the width of the test deck, the module or panel shall be tested with the shorter dimension coinciding with the width of the test deck and the module or panel leading edge shall match the leading edge of the test deck. The test shall be applied as follows:

a) Burning Brand on Surface Over Representative Steep Sloped Roof. With a Class A , B, or C brand(s) positioned on the top of the module or panel that has a gap of 5 inches (127 mm) above the surface of the test deck. If the installation instructions do not allow a gap of 5 inches (127 mm), then the module shall be installed above the surface of the test deck according the installation instructions. The brand is to be positioned with its upper edge 25.5 inches (648 mm) from the leading edge of the test deck and centered laterally with respect to the vertical joint in the test deck. The brand is to be placed so that the strips in both the upper and lower layers are parallel to the direction of air flow. The brand is to be secured to the module using a No. 18 B&S gage (0.82 mm^2) soft-iron wire secured to the deck.

Exception: For systems using a Type 2 module and installed with a gap of 5 inches (127 mm), the burning brand test for part (a) shall be waived.

b) Burning Brand Between Module or Panel and Steep Sloped Roof. With a Class B brand positioned in the 5 inch (127 mm) interstitial space below the module or panel and on the surface of the roof. If the installation instructions do not allow a gap of 5 inches (127 mm), then the module shall be installed above the surface of the test deck according the installation instructions. The brand is to be positioned with its upper edge 24 inches (610 mm) from the leading edge of the test deck and centered laterally with respect to the vertical joint in the test deck. The brand is to be placed so that the strips in both the upper and lower layers are parallel to the direction of air flow. The brand is to be secured to the deck by a No. 18 B&S gage (0.82 mm^2) soft-iron wire.

Exception No. 1: For mounting systems with a guarded perimeter, the burning brand test for part (b) shall be waived. A guarded perimeter is defined as a perimeter that is protected with wire screen or other similar means including sheet metal. A guarded perimeter with openings shall not allow a 1/4-in (6.4-mm) diameter hemispherical tipped probe applied with a force of 1 lb (4.4 N) to pass through any opening. For mounting systems with a guarded perimeter, the burning brand test for part (b) shall be waived.

Exception No. 2: For systems installed with a fixed height of 2-1/2 inches (64 mm) or less between the system and the test deck as described in the installation instructions, the burning brand test for part (b) shall be waived.

31.2.3.2 At no time during the tests shall:

a) Any portion of the module or panel or be blown off or fall off the test deck in the form of flaming or glowing brands; or

b) There be sustained flaming of the underside of the plywood deck. Sustained flaming is considered any flaming which continues uninterrupted for 5 seconds or more.

With respect to (a), any piece of roof covering, or PV module or panel, that continues to glow or flame for 5 seconds or more upon landing on the test room floor is a glowing or flaming brand, respectively. A module or panel is not required to be usable after any of the tests of this Section.

31.2.4 Recording

31.2.4.1 The fire performance for modules or panels with mounting systems in combination with roof coverings shall be recorded as follows:

a) Observations of the burning characteristics of the PV module or panel with mounting system during and after test exposure;

b) Results of tests in Table 31.2 relative to the corresponding conditions of acceptance in 31.2.2.2 and 31.2.3.2; and

c) The class of PV module or panel mounting system achieved based on test results (Class A, B, or C).

32 General

32.1 *deleted*

32.2 *deleted*

32.3 *deleted*

32.4 *deleted*

33 Water Spray Test

33.1 A module or panel shall be subjected to a water spray test as described in 33.2 – 33.8. The test shall not result in water on uninsulated live parts or the collection of water in a compartment containing live parts. Immediately following the test, the module or panel shall comply with:

a) Dielectric Voltage-Withstand Test, Section 26; and

b) Leakage Current Test, Section 21.

Both the Dielectric Voltage-Withstand Test and the Leakage Current Test are to be conducted without any drying of the samples.

33.2 A module or panel is to be mounted and oriented in a manner representative of its intended use in the focal area of the apparatus described in 33.5. If the mounting or orientation of the module or panel under the water spray may affect the results, the test is to be conducted with the module or panel in those mountings and orientations deemed necessary to represent any application of the product, considering also that the mounting may be on a tracking frame which alters the module orientation.

33.3 If a module or panel is intended to be mounted as an integral part of the roof with an adjacent module or panel in an array using factory-designed joining sections, the test is to be conducted using the joining hardware in accordance with the installation instructions.

33.4 Field wiring connections are to be made in accordance with the wiring method specified in the installation instructions. When more than one wiring method is specified, the method least likely to restrict the entrance of water into the field wiring compartment is to be used.

33.5 The rain test apparatus is to consist of three spray heads mounted in a water supply rack as illustrated in Figure 33.1. Spray heads are to be constructed in accordance with Figure 33.2. The water pressure for all tests is to be maintained at 5 psig (34.5 kPa) at each head. The distance between the

center nozzle and the product is to be approximately 3 ft (0.9 m). The product is to be brought into the focal area of the three spray heads in such position and under such conditions so as to present the greatest quantity of water to entrances to the product. The spray is to be directed toward the module or panel at an angle of 45 degrees to the vertical.