Fire Testing That Helped Develop the Current Proposal for Fire Rating of PV Modules

Bill Brooks, PE
Brooks Engineering
Code Official Panel Lead
Solar America Board for Codes and Standards (Solar ABCs)

September 14, 2012
Issue

- What is the impact of a PV array on the fire classification of a rated roof?
- Building code and fire officials looking for answers and regulations to enforce
Roof Fire Safety

• Reduce fire movement across the roof of a building
• Prevent fire penetration into the building
Roof Fire Class Rating

• International Building Code requires that roofs have a fire classification rating (Class A, Class B, Class C)
• Different buildings have different fire classification rating requirements
• States or local jurisdictions may enforce stricter requirements than the IBC
Solar ABCs Research Project

Investigate whether and how the presence of standoff-mounted PV arrays may affect the fire class rating of common roof covering materials.
Phases of Project

- Phase 1: Develop an understanding of the Spread of Flame test flame.
- Phase 2: Test PV modules over roofs and document the results. (Bulk of testing)
Phases of Project (cont.)

• Phase 2a: Determine if mitigation methods can cause PV modules to survive the test.
• Phase 2b: Test PV modules at angles, directly on roof, and understand heat load of burning brands.
Phases of Project (cont.)

- Phase 3: Characterization of PV Materials—Critical Radiant Flux
- Phase 4: Test the 3 SEIA 2015 IBC proposals to see if they address fire rating.
- Phase 5: Test concept of first to ignite, second to ignite concept—module/roof perimeter interface.
Phase 1: Develop an understanding of the Spread of Flame test flame.

- Use non-combustible materials to understand heat flux and temperature that fire presents to the materials tested.
- Establish baseline data of fire exposure on roof deck samples without PV according to UL 790.
Phase 1: Develop an understanding of the Spread of Flame test flame.

• Understand the effect of PV module stand-off height above the roof and leading edge distance

• Determine if rail orientation impacts PV module fire performance
Instrumentation

Angles secured with screws/bolts to roof & PV module to set air gaps of 3/4, 2 1/2, 5 & 10 in.

- Bidirectional probe
- Open bead TC mounted on the exposed surfaces of the roof & PV module @ 1/3, 1/2 & 2/3 the length of the deck
- Open bead TC positioned @ 2/3 the length of the deck & at the midpoint of the air gap
- Hot wire anemometer to measure air velocity at the midpoint of the gap @ 2/3 the length of the deck
- Heat flux gauges mounted on the exposed surface of the roof @ 1/3 and 2/3 the length of the deck (if available)
Test Fixture for Non-Combustible Tests
Results

• 5” Gap is Worst Case (10” best, 2.5” next)
• 5” is most consistent with installation methods—best cooling relative to aesthetics
• Much greater challenge to both PV and roof by conducting test with PV at leading edge.
• 12” and 24” setback decreased intensity of flame—still higher than roof alone.
Results

Class C PV & Shingled Roof @ 5” Gap
Horizontal Rails

Not compliant (Class A, B or C)

Class C PV & Shingled Roof @ 5” Gap
Vertical Rails

Not compliant (Class A, B or C)
Results

The fire classification rating of the PV module is NOT a good predictor of the fire class rating of the PV module and roof as a system.
Further Tests

- Mitigation strategies
- Low slope roofs
- Characterize materials
- Test SEIA proposed exceptions