RESEARCH FOUNDATION

RESEARCH FOR THE NFPA MISSION

PROJECT SUMMARY

Development of Fire Mitigation Solutions for Photovoltaic (PV) Systems Installed on Building Roofs

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Background: The installation of large PV systems on commercial building roofs is an emerging risk due to a favorable value proposition attracting building owners to install the technology.

With these systems, the likelihood of a rooftop fire significantly increases since electrical breakdown – leading to arc faults, ground faults, and short circuits - can occur anywhere across the system. Any electrical fault can be accompanied by ensuing fire.

The rooftop placement is beyond the building fixed fire protection and detection features. This can mean delayed fire detection and no fixed fire protection.

In addition, combustible features of the module and other components add fuel to support a fire. Where a fire develops below PV modules, the modules will reflect heat from a fire back down towards the roof enhancing the combustion rate of conventional roof materials. Roof assemblies traditionally considered "noncombustible" become combustible or fast-burning.

With these types of systems, the fire service takes a cautious approach as power generated by the panels cannot be turned off. Even at night, fire service scene lighting has been identified as sufficient to generate an electrical shock hazard. Defensive fire service actions – spraying water from a distance - have been found to have reduced impact as the PV panels conceal and shield the fire below.

The challenges introduced by this emerging risk require further research. This project is specifically directed at concerns with rooftop fire spread and identifying additional means to limit fire spread to allow the fire service time to implement a responsible final fire extinguishment plan.

Research Goal: The overall goal of this research will be to identify features to mitigate fire spread between and within PV arrays installed on roof tops. The objective of this phase will be to develop a test plan to explore this topic to be implemented in a later phase.

Project Tasks:
This phase of the project involves the following tasks:

1. Summarize information from any previous fire testing of PV systems installed on building roofs with a focus on the parameters used for previous testing. A reference for this task is the

Foundation report: Commercial Roof-Mounted Photovoltaic Systems Installation Best Practices Review and All Hazard Assessment.

2. Establish the general parameters for the large-scale test configuration. This project will focus on flat and low-slope roofs with PV modules.

    a. Identify the size of the main and target arrays. The proposed project will be large-scale with a configuration such as:

        i. Three or more rows of PV modules in a main array at least four modules long

        ii. One target array separated by a walkway from the main array side-of-row

        iii. One target array separated by a walkway from the main array end-of-row

    b. Identify the ignition source to be used. An ignition source is needed to quickly develop a fire under the PV modules involving both the roof assembly and PV modules. The objective is to understand spread of an established fire and the effectiveness of solutions to mitigate fire spread.

    c. Identify the airflow to be used. Airflow should represent an appropriate level of wind.

3. Establish the roof assemblies to be tested and how they will be set up.

    a. Roof covers considered may include:

        i. Rubber single-ply membrane

        ii. Modified bitumen

        iii. Built-up cover

    b. While there are a number of single-ply membrane roof covers, it is anticipated that the rubber membrane will present the greatest fire challenge. As modified bitumen and built-up roof covers are applied hot, they will not be applied direct to the polyisocyanurate insulation. A material - such as perlite board - will be provided to protect the polyisocyanurate insulation from the heat of the hot applied cover. It is anticipated the perlite board may favorably influence the fire behavior of these popular roof covers.

    c. The initial focus is polyisocyanurate foam insulation. It may be desirable to direct additional focus towards extruded polystyrene and expanded polystyrene insulations.

4. Develop a test plan to evaluate the following:

    a. Limiting fire spread with walkways. Evaluate walkway widths needed to avoid fire spread between PV arrays. This includes spread between parallel rows and end-of-rows. Access walkways are required by codes to provide separations between PV arrays. Typical walkways are 4 feet wide. An objective is to evaluate the performance of walkways to avoid fire spread between PV arrays. This includes fire spread between parallel rows and fire spread between ends-of-rows.

b. Limiting fire spread with noncombustible cover board. Evaluate the impact of noncombustible cover board upon reducing fire spread between PV arrays and within PV arrays. Noncombustible cover board is a solution developed by FM Global. It is a solution well suited to new installations. It is proposed to conduct large-scale tests to understand the performance of this as a stand-alone solution.

c. Limiting fire spread with other methods. Beyond noncombustible cover board and walkways, identify other methods to evaluate that may favorably reduce the spread of fire within or beyond a PV array. An example of an "other method" is vertical barriers provided within a PV array; however, use of vertical barriers must not interfere with rain water drainage from roofs. Other methods would ideally include retrofit solutions for use within existing PV arrays. Other methods may be used in conjunction with methods evaluated in "a" and "b" above.

Implementation: This research program will be conducted under the auspices of the Research Foundation in accordance with Foundation Policies and will be guided by a Project Technical Panel who will provide input to the project, recommend contractor selection, review periodic reports of progress and research results, and review the final project report.

Schedule: The final report for this study will be available in June of 2016.