



technical bulletin

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Photovoltaic Systems and Low-slope Commercial Roofs

Introduction

The push toward sustainable building practices has led design professionals to look at roofs as more than just the waterproofing element. They view the roof as space for renewable energy sources such as photovoltaic (PV) systems. While PV systems can offer benefits to both the environment and the building owner, their impact on roof membrane performance is an important issue. Due to its inherent durability, bituminous membrane roofing is well suited as a platform for PV systems provided that proper design, installation and maintenance are practiced.

Safety and Product Handling

When proper precautions and protective equipment are used, PV systems can be installed safely and without incident. Areas requiring attention are listed below.

- **Fall Hazards:** As with all roofing systems, working at heights can be dangerous. Follow all necessary precautions, safety guidelines and OSHA regulations in conjunction with proper roofing trade practices, including the use of appropriate fall protection/fall arrest equipment.
- **Shock/Electrocution Hazard:** PV modules generate electric current. Observe safe electrical practices at all times. Follow all local codes and current National Electrical Code requirements. Comply with the manufacturer's installation instructions and cautionary recommendations.
- **Proper Installation is Critically Important:** Not only must the PV system be installed in accordance with the PV manufacturer's instructions, but any contact / adhesion / penetration of the roof assembly by the PV system must be in accordance with recommendations of the roofing manufacturer. In the event that the specific roofing manufacturer is unknown, generally accepted roofing practices should be followed.
- **Standards Used to Evaluate PV Modules:** Refer to applicable building codes, standards and requirements such as ICC-ES AC365; IEC 61646 Edition 2.0, 2005-05, IEC International Standard "Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval;" NRCA's "Guidelines for Roof-mounted Photovoltaic System Installations;" and NEC Article 690.

Design, Installation, and Maintenance

Design Considerations

- To maximize the concurrent service life of the PV and roof membrane systems, PV systems should be installed in conjunction with a new roof membrane system. If consideration is given to the installation of a PV system over an existing roof, a roofing professional should be consulted before installing a PV system over an existing roof membrane

system to evaluate the age and condition of the membrane and underlying components.

- The roof membrane may absorb additional heat when building integrated photovoltaic (BIPV) panels are adhered to the membrane due to their dark color, combined with heat generated.

Generally speaking, increased heat load and life expectancy of roofing systems are inversely proportional, and at elevated temperatures all commercial roof membrane systems will exhibit the negative effects of accelerated aging. The decision to add materials to the roof system that elevate its surface temperature should be carefully planned and executed.

- Prior to installing a PV system, it is recommended that the roof structure be inspected by a licensed structural engineer to ensure the building is able to support the loads imposed (dead, wind, seismic) by the PV system.
- Consult the roofing system manufacturer for the minimum allowable slope for its membrane product. Proper drainage will help minimize accumulation of dirt and debris under the PV system.
- When designing a PV system, ensure positive roof drainage is maintained. Altering the rate and direction of water flow intended in the original design may cause dirt and debris to build up around the obstructions and accelerate the deterioration of the roof membrane.
- PV systems require periodic inspections. Designated walkways or traffic pads around the PV systems protect the roofing system from damage. Consult the membrane manufacturer for compatible products.

Installation

- Roof-mounted PV systems may be installed using one of the following methods: rack-mounted, ballasted, or adhesive. Be sure to carefully read and follow the PV system manufacturer's installation instructions.
- Contact the roofing manufacturer for installation and waterproofing best practices and recommendations for detailing and installation affecting the membrane system. Prior to PV system installation, the roofing manufacturer should be contacted for recommended practices to protect the roofing system.
- Ensure the installation method and associated equipment and materials are compatible with, and do not affect, the roofing manufacturer's limited warranty.
- When planning the location and arrangement of PV panels on a roof, consult with the PV manufacturer for guidelines while taking wind and fire resistance requirements into consideration. Adequate space should be maintained between the walls, base flashings and penetrations to facilitate inspection and maintenance.

Maintenance

- Consult the PV, racking (if applicable), and roofing system manufacturers for recommended inspection and maintenance programs.

Rooftop PV Standards and Testing Approvals

UL1703 — Flat-Plate Photovoltaic Modules and Panels

Scope: These requirements cover flat-plate photovoltaic modules and panels intended for installation on or integral with buildings, or to be freestanding (that is, not attached to buildings), in accordance with the National Electrical Code, NFPA 70, and ICC Model Building Codes.

ICC-ES AC365 — Acceptance Criteria for Building-Integrated Photovoltaic (BIPV) Roof Covering Systems

Scope: This criteria is applicable to BIPV roof modules, shingles and panels complying with UL 1703, used in roof covering systems. The electrical safety requirements and solar energy performance of the BIPV roof modules, shingles and panels are outside the scope of this criteria.

ICC-ES AC428 — Acceptance Criteria for Modular Framing Systems Used to Support Photovoltaic (PV) Modules

Scope: This acceptance criteria applies to metal modular framing systems intended for installation of PV module arrays on roofs and walls of buildings (flush-mount system) and installation of freestanding PV module arrays that are not attached to buildings, but are intended for ground mounting (freestanding system). The acceptance criteria specifies the structural design load requirements for modular framing systems under both the International Building Code (IBC) or the International Residential Code, based on the provisions cited in Chapter 16 of the IBC. The criteria also contains test procedures for qualifying PV module connections to the framing system where the composition or configuration of the connection is such that calculation of the connection capacity cannot readily be made in accordance with the provisions of the code. This criteria does not address evaluation requirements for the methods of attachment of the flush-mount modular framing system to buildings or the

attachment of freestanding systems to a foundation. The capacity of the PV module to resist structural loads is also outside the scope of this criteria, as are systems subject to vibratory loads. Electrical safety, grounding provisions and grounding continuity for the PV modules and framing system are outside the scope of this criteria.

References

FM 4476 – “Approval Standard for Flexible Photovoltaic Modules,” FM Approvals

FM 4478 – “Approval Standard for Rigid Photovoltaic Modules,” FM Approvals

“Guidelines for Roof-mounted Photovoltaic System Installations,” National Roofing Contractors Association (NRCA)

ICC-ES AC365 – “Acceptance Criteria for Building-Integrated Photovoltaic (BIPV) Roof Covering Systems,” International Code Council

ICC-ES AC428 – “Acceptance Criteria for Modular Framing Systems Used to Support Photovoltaic (PV) Modules,” International Code Council

IEC 61646 – “Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval,” IEC International Standard, Edition 2.0, 2005-05

UL1703 – “Flat-Plate Photovoltaic Modules and Panels,” Underwriters Laboratories

International Residential Code (IRC)

International Building Code (IBC)

Article 690, National Electrical Code (NEC)

Occupational Safety & Health Administration, OSHA

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