



Member of the FM Global Group



American National Standard for Flexible Photovoltaic Modules

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Foreword

NOTE: This foreword is introductory only and is not part of American National Standard FM 4476.

This standard is intended to verify that the product as described will meet minimum specific stated conditions of performance, safety and quality, useful in determining the potential suitability for end-use conditions of these products. It describes minimum performance requirements for materials that are intended for use in roof assemblies by evaluating the ability of the materials and, in turn, the system components to withstand simulated wind uplift resistance.

This American National Standard has been developed according to the essential requirements of due process for standards development of the American National Standards Institute (ANSI). FM Approvals is an ANSI-accredited standards developer (ASD).

Approval of an American National Standard requires verification by ANSI that the principles of openness and due process have been followed and that a consensus of those directly and materially affected by the standard has been achieved. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution. Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached.

The American National Standards Institute does not develop standards nor will it in any circumstances give an interpretation of any American National Standard. Requests for interpretations of this test standard should be addressed to FM Approvals.

ANSI regulations require that this American National Standard shall be revised, reaffirmed or withdrawn within five years of the date of publication.

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1 INTRODUCTION

1.1 Purpose

This standard states test requirements for flexible photovoltaic modules that are used with a roof assembly.

1.2 Scope

- 1.2.1** This standard applies to all flexible photovoltaic modules when adhered to, or mechanically fastened to or through, a single-ply, polymer-modified bitumen sheet, built-up roof, liquid applied or metal roof cover assembly.
- 1.2.2** The standard is intended to evaluate only those hazards investigated and is not intended to determine suitability for the end use of a product.
- 1.2.3** This standard evaluates flexible photovoltaic modules for their performance in regard to fire from above the structural deck, simulated wind uplift, susceptibility from hail storm damage, and heat aging effects on the substrate.
- 1.2.4** This standard only addresses the photovoltaic module and does not address any other electrical component utilized to supply the generated electrical power to the building.
- 1.2.5** This standard does not intend to qualify rigid photovoltaic modules.

1.3 Basis for Requirements

- 1.3.1** The requirements of this standard are based on experience, research and testing, and/or the standards of other organizations. The advice of manufacturers, users, trade associations, jurisdictions and/or loss control specialists was also considered.

1.4 System of Units

Units of measurement used in this Standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Appendix A lists the selected units and conversions to SI units for measures appearing in this standard. Conversion of U.S. customary units is in accordance with *Standard for Use of the International System of Units (SI): The Modern Metric System*, BSR/IEEE/ASTM SI 10.

1.5 Applicable Documents

The following standards, test methods, and practices are referenced in this standard:

- *Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures*, American National Standard, ANSI/FM Approvals 4474
- *Fire Tests of Roof Coverings*, ASTM E108, ASTM International
- *Standard Test Methods for Sampling and Testing of Modified Bituminous Sheet Material*, ASTM D5147, ASTM International
- *Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials*, ASTM G 154, ASTM International

1.6 Definitions

For purposes of this standard, the following terms apply:

Adhesive – Adhesive is used in roof construction to adhere roof coverings to roof coverings as in lap construction. It is also used to bond roof coverings to the substrate below, to adhere insulation to the substrate or to adhere flexible photovoltaic modules to the roof covering. Depending on the use, the adhesive could be in either a liquid form, semi liquid form or a solid form as in a seam tape or as in hot asphalt which is solid until heated

Deck - The deck is the structural component of the roof assembly to which the roof system is secured.

Delamination - Separation of the plies in a roof membrane or system in any laminated roofing material or component, e.g., laminated layers of rigid insulation or the felt plies in a built-up roof or separation of any membrane from the substrate to which it is adhered. This includes the separation of the photovoltaic modules from the roof cover.

Fasteners - A fastener is a mechanical securement device used alone or in combination with a stress distributor to secure various components of a roof assembly.

Fully Adhered - Fully adhered describes components such as photovoltaic modules that have been bonded to the substrate using a compatible adhesive throughout the entire surface.

Mechanically Fastened - Mechanically fastened describes roof covers, base sheets or photovoltaic modules that have been attached to the substrate at defined intervals using fasteners with or without stress distributors.

Minor delamination – In wind uplift testing, an area approximately 1% of the test sample. For a 12 x 24 ft (3.7 x 7.3 m) test an area of 3 ft² (0.28 m²); for a 5 x 9 ft (1.5 x 2.7 m) test an area of 0.5 ft² (0.05 m²), whereby two adhered components which are intended to be in contact are not in contact.

Flexible Photovoltaic Module – A device that converts solar energy into electricity using the photovoltaic effect. Flexible modules are generally not installed with a frame system. They are installed over a solid, supporting substrate such as a roof cover.

Roof Assembly - A system of interacting roof components (including the roof deck) designed to weatherproof and, normally, to insulate a building's top surface.

Roof Cover - The exterior surface of a roof assembly designed to protect the building components from the weather.

Roof System - A group of interacting roof components (not including the roof deck) designed to weatherproof and, normally, to insulate a building's top surface.

Stress Distributor/Plate - A stress distributor/plate is metal or plastic disk or bar designed to distribute a concentrated load over a larger surface area.

2 GENERAL INFORMATION

2.1 Product Information

Flexible photovoltaic modules are submitted in either sheet or roll form. They are installed using either mechanical fasteners and plates or adhesives. Modules that are mechanically fastened are installed on site during or after the installation of the roof system. Modules that are installed using adhesives can be adhered to the roof cover during the manufacturing process or installed on site during or after the installation of the roof system.

3 GENERAL REQUIREMENTS

3.1 Review of Documentation

During the initial investigation and prior to physical testing, the manufacturer's specifications and details of installation shall be reviewed.

3.2 Calibration

All examinations and tests performed in evaluation to this standard shall use calibrated measuring instruments traceable and certified to acceptable national standards.

3.3 Markings

3.3.1 Marking on the product or, if not possible due to size, on its packaging or label accompanying the product, shall include the following information:

- name and address of the manufacturer or marking traceable to the manufacturer;
- date of manufacture or code traceable to date of manufacture or lot identification;
- model number, model type, and/or product name, as appropriate.

When hazard warnings are needed, the markings shall be universally recognizable and permanent.

3.3.2 The product trade name, model number, or model type identification shall correspond with the manufacturer's catalog designation. The manufacturer shall not place this trade name or model type identification on any other product unless covered by a separate agreement.

3.3.3 All markings shall be legible and durable.

3.4 Manufacturer's Installation Instructions

The manufacturer shall provide the user with printed instructions to demonstrate proper installation procedures to be followed by installers.

3.5 Test Sample Production

All products submitted for testing shall be representative of production run material.

4 PERFORMANCE REQUIREMENTS

This standard is intended to evaluate a flexible photovoltaic module as part of a finished roof assembly for its performance as it relates to fire from above the structural deck, simulated wind uplift, susceptibility from hail storm damage and heat aging effects on the roof cover.

Tests of alternate constructions are permitted to be waived if considered less hazardous than those previously tested.

The use of screening tests are permitted to be used to determine critical components to be used for full scale testing or to evaluate components as alternate to those already tested and found to be satisfactory via the full the scale tests described in sections 4.1 through 4.5 below. Alternate components must perform to an equal or higher level than the component qualified via full scale testing.

When a test specimen fails to meet the acceptance criteria for a given classification or rating, two successful test specimens of the same or similar construction must meet the acceptance criteria to qualify for the given classification or rating.

Prior to testing, samples shall be permitted to cure for a maximum period of 28 days.

4.1 Combustibility From Above the Roof Deck

Testing for combustibility from above the roof deck shall be in accordance with ASTM E108, *Fire Test of Roof Coverings*.

4.1.1 Conditions of Acceptance for Combustibility from Above the Roof Deck

4.1.1.1 Spread of Flame test

- For Class A, the maximum flame spread of the sample materials shall not exceed 72 in (1830 mm).
- For Class B, the maximum flame spread of the sample materials shall not exceed 96 in (2440 mm).
- For Class C, the maximum flame spread of the sample materials shall not exceed 156 in (3960 mm).
- There shall be no excessive lateral flame spread which is defined as flames extending to the two lateral edges of the exposed roof covering or coating beyond 12 in (305 mm) from the ignition source.
- There shall be no portion of the roof covering material blown or falling off of the test deck in the form of flaming or glowing brands that continue to glow after reaching the floor.
- There shall be no portion of the roof deck that fall in the form of particles that continue to glow after reaching the floor.

4.1.1.2 For assemblies constructed over combustible decks, Intermittent Spread of Flame and Burning Brand tests shall be performed for Classes A, B, or C

- There shall be no portion of the roof covering material blown or falling off of the test deck in the form of flaming or glowing brands that continue to glow after reaching the floor.
- There shall be no exposure of the deck or sustained flaming on the underside of the deck.
- There shall be no portion of the roof deck that fall in the form of particles that continue to glow after reaching the floor.