



Member of the FM Global Group

Approval Standard for Flexible Photovoltaic Modules

Class Number 4476

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Foreword

The FM Approvals certification mark is intended to verify that the products and services described will meet stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of Approval Standards is to present the criteria for FM Approval of various types of products and services, as guidance for FM Approvals personnel, manufacturers, users and authorities having jurisdiction.

Products submitted for certification by FM Approvals shall demonstrate that they meet the intent of the Approval Standard, and that quality control in manufacturing shall ensure a consistently uniform and reliable product. Approval Standards strive to be performance-oriented. They are intended to facilitate technological development.

For examining equipment, materials and services, Approval Standards:

- a) must be useful to the ends of property conservation by preventing, limiting or not causing damage under the conditions stated by the Approval listing; and
- b) must be readily identifiable.

Continuance of Approval and listing depends on compliance with the Approval Agreement, satisfactory performance in the field, on successful re-examinations of equipment, materials, and services as appropriate, and on periodic follow-up audits of the manufacturing facility.

FM Approvals LLC reserves the right in its sole judgment to change or revise its standards, criteria, methods, or procedures.

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1 INTRODUCTION

1.1 Purpose

This standard states Approval requirements for flexible photovoltaic modules that are used with an FM Approved roof assembly.

1.2 Scope

1.2.1 This standard applies to all flexible photovoltaic modules when adhered to, or mechanically fastened through, an FM Approved 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 Single-ply, polymer-modified bitumen sheet, built-up roof, and liquid applied roof cover systems that do not contain flexible photovoltaic modules shall be qualified in accordance with Approval Standard 4470. Standing seam or metal panel roofs that do not contain flexible photovoltaic modules shall be qualified in accordance with Approval Standard 4471.

1.2.5 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.

1.2.6 This standard does not intend to qualify rigid photovoltaic modules that are mechanically fastened using clips or other types of fasteners through single-ply, polymer-modified bitumen sheet, built-up roof, liquid applied roof systems or to standing seam or metal roofs. Rigid photovoltaic systems are evaluated per FM Approvals Standard 4478.

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.

1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of flexible photovoltaic modules for the purpose of obtaining Approval. Products having characteristics not anticipated by this standard, may be FM Approved if performance is equal, or superior, to that required by this standard, or if the intent of the standard is met. Alternatively, products which meet all of the requirements identified in this standard may not be FM Approved if other conditions which adversely affect performance exist or if the intent of this standard is not met.

1.4 Basis for Approval

Approval is based upon satisfactory evaluation of the product when used as part of an FM Approved roof assembly.

1.4.1 Examination and tests on production samples shall be performed to evaluate:

- the suitability of the product for use in a roof assembly;
- the performance of the product as part of a roof assembly as specified by the manufacturer and required by FM Approvals; and as far as practical,
- the durability and reliability of the product.

1.4.2 Flexible photovoltaic modules shall be fabricated, tested and certified in accordance with recognized, international standards per current specification of either IEC/EN 61730 or ANSI/UL 1703 for electrical safety and IEC/EN 61646 for electrical performance.**1.4.3** An examination of the manufacturing facilities and audit of quality control procedures is made to evaluate the manufacturer's ability to consistently produce the product which is examined and tested and the marking procedures used to identify the product. These examinations may be repeated as part of FM Approvals' product follow-up program.**1.5 Basis for Continued Approval**

Continued Approval is based upon:

- production or availability of the product as currently FM Approved;
- the continued use of acceptable quality assurance procedures;
- satisfactory field experience;
- compliance with the terms stipulated in the Master Agreement and Approval report;
- satisfactory re-examination of production samples for continued conformity to requirements; and
- satisfactory Facilities and Procedures Audits (F&PAs) conducted as part of FM Approvals' product follow-up program.

Also, as a condition of retaining Approval, manufacturers may not change a product or service without prior authorization by FM Approvals.

1.6 Effective Date

The effective date of an Approval Standard mandates that all products tested for Approval after the effective date shall satisfy the requirements of that Standard. Products FM Approved under a previous edition shall comply with the new version by the effective date or else forfeit Approval.

This standard shall be effective upon publication.

1.7 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.

1.8 Applicable Documents

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

- *Approval Standard for Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Systems for use in Class 1 and Noncombustible Roof Deck Construction, Class Number 4470.* FM Approvals LLC, PO Box 9102, Norwood, MA 02062.
- *Approval Standard for Class 1 Panel Roofs, Class Number 4471.* FM Approvals LLC, PO Box 9102, Norwood, MA 02062.
- *Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures,* American National Standard, ANSI/FM Approvals 4474
- *Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval,* International Standard IEC/EN 61646, International Electrotechnical Commission / European Norm
- *Photovoltaic (PV) module safety qualifications – Part 2: Requirements for Testing,* International Standard IEC/EN 61730-2, International Electrotechnical Commission / European Norm
- *Flat Plate Photovoltaic Modules and Panels,* American National Standard, ANSI/UL 1703
- *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
- *Test Procedure, 12 x 24 ft Wind Uplift Tests for Single Ply and Multi Ply Roof Coverings using Negative Static Pressure,* FM Approvals, LLC
- *Test Procedure, 12 x 24 ft Wind Uplift Tests for Standing Lap Seam and Composite Panel Roof Coverings,* FM Approvals, LLC
- *Test Procedure, 1 x 4 ft Wind Uplift Tests for Flexible Photovoltaic Modules adhered to Standing Lap Seam and Composite Panel Roof Coverings,* FM Approvals, LLC
- *Test Procedure, 5 x 9 ft Wind Uplift Tests for Single Ply and Multi Ply Roof Coverings using Negative Static Pressure,* FM Approvals, LLC
- *Test Procedure, Test Method for Determining the Susceptibility to Hail Damage of Flexible Photovoltaic Modules,* FM Approvals, LLC
- *Test Procedure, Membrane Delamination Tests for Roofing Membranes and Substrates Using Tensile Loading,* FM Approvals, LLC
- *Test Procedure, Pull Through Tests for Roofing Membranes and Substrates Using Tensile Loading,* FM Approvals, LLC
- *Test Procedure, Tests for Measuring Heat Aging Effects of Flexible Photovoltaic Modules on Roof Coverings,* FM Approvals, LLC

1.9 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 membrane or metal roof panel.

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 roof coverings or photovoltaic modules that have been bonded to the substrate using a compatible adhesive throughout the entire surface of the roof.

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.

Photovoltaic Module – A device that converts solar energy into electricity using the photovoltaic effect.

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 can be 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.