



Member of the FM Global Group

Approval Standard for Roof-Mounted Rigid Photovoltaic Module Systems

Class Number 4478

December 2016

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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.

TABLE OF CONTENTS

1 INTRODUCTION	1
1.1 Purpose.....	1
1.2 Scope	1
1.3 Basis for Requirements	1
1.4 Basis for Approval	2
1.5 Basis for Continued Approval	2
1.6 Effective Date.....	2
1.7 System of Units	2
1.8 Applicable Documents	3
1.9 Definitions.....	4
2 GENERAL INFORMATION.....	6
2.1 Product Information	6
2.2 Approval Application Requirements	6
2.3 Requirements for Samples for Examination.....	6
3 GENERAL REQUIREMENTS.....	7
3.1 Review of Documentation.....	7
3.2 Markings	7
3.3 Manufacturer's Installation Instructions.....	7
3.4 Calibration.....	7
3.5 Test Sample Production.....	7
3.6 Seismic Loads (Optional).....	7
4 PERFORMANCE REQUIREMENTS	10
4.1 Combustibility From Above the Roof Deck.....	10
4.2 Wind Uplift Resistance for Rigid Photovoltaic Module with the Panel Attached at the Same Slope as the Roof Cover.	11
4.3 Wind Uplift Resistance for Rigid Photovoltaic Module with the Panel Attached at a Different Slope than the Roof Cover.	13
4.4 Wind Uplift Resistance for Rigid Photovoltaic Module Loose Laid and Ballasted.	13
4.5 Hail Damage Resistance Test.....	14
4.6 Electrical Performance	14
4.7 Electrical Safety	14
4.8 Gravity Load Resistance Test.....	14
5 OPERATIONS REQUIREMENTS	17
5.1 Demonstrated Quality Control Program.....	17
5.2 Surveillance Audit.....	18
5.3 Installation Inspections.....	18
5.4 Manufacturer's Responsibilities	18
APPENDIX A: UNITS OF MEASUREMENT	19

1 INTRODUCTION

1.1 Purpose

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

1.2 Scope

- 1.2.1 This standard applies to all rigid photovoltaic module systems intended to be 1) mechanically fastened through or attached to an FM Approved single-ply, polymer-modified bitumen sheet, built-up roof, liquid applied roof cover or steep slope roof (mechanically attached only), 2) mechanically fastened to a metal panel roof cover assembly using clamps or other types of fasteners or 3) loose laid and ballasted over an FM Approved fully adhered single-ply, polymer-modified bitumen sheet or built-up roof cover assembly.
- 1.2.2 This standard also applies to panels secured to racks and/or rack framing which are independently secured to the building structure, roof deck or metal roof cover or ballasted. It also applies to the rack itself and its securement.
- 1.2.3 This standard evaluates rigid roof-mounted photovoltaic module systems as part of a finished roof assembly for their performance in regard to fire from above the structural deck, simulated wind uplift, susceptibility from hail damage, seismic performance requirements and gravity load resistance. The standard is intended to evaluate only those hazards investigated and is not intended to determine suitability for the end use of a product.
- 1.2.4 Single-ply, polymer-modified bitumen sheet, build-up roof and liquid applied roof cover systems used with rigid photovoltaic modules shall be qualified in accordance with FM Approval Standard 4470. Metal panel roofs used with rigid photovoltaic modules shall be qualified in accordance with FM Approval Standard 4471. Steep slope roofs used with rigid photovoltaic modules shall be qualified in accordance with FM Approval Standard 4475.
- 1.2.5 This standard only addresses the photovoltaic module system and does not address any other electrical component utilized to supply the generated electrical power to the facility.
- 1.2.6 This standard does not qualify flexible photovoltaic modules. Flexible photovoltaic systems are evaluated per FM Approval Standard 4476.

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 rigid photovoltaic modules for the purpose of obtaining FM Approval. Products having characteristics not anticipated by this standard are permitted to 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 Rigid 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 61215 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' Surveillance Audit 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 Surveillance Audits conducted as part of FM Approvals' product surveillance program.

Also, as a condition of retaining Approval, manufacturers may not change a product or service without prior written 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.

The 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:

American National Standard Institute

- *Evaluating the Simulated Wind Uplift resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures*, ANSI/FM Approvals 4474.
- *Flat Plate Photovoltaic Modules and Panels*, ANSI/UL 1703

American Iron and Steel Institute

- *North American Specification for the Design of Cold-Formed Steel Structural Members*, 2007 Edition, AISI S100-200

International Electrotechnical Commission

- *Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval*, International Standard IEC/EN 61215-1, IEC/EN 61215-1-1, and IEC/EN 61215-2.
- *Photovoltaic (PV) module safety qualifications – Part 2: Requirements for Testing*, International Standard IEC/EN 61730-2.

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- *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.
- *Approval Standard for Class 1 Panel Roofs*, Class Number 4471.
- *Approval Standard for Class 1 Steep Slope Roof Covers*, Class Number 4475.
- *Test Procedure, Wind Uplift Tests for Rigid Mechanically Fastened Photovoltaic Modules*.
- *Test Procedure, Test Method for Determining the Susceptibility to Hail Damage of Photovoltaic Modules*.
- *Test Procedure, Structural Tests for Fasteners to Secure Rigid PV Panels Using Tensile Loading*.
- *Test Procedure, Gravity Load Tests for Rigid Mechanically Fastened Photovoltaic Modules*.
- *Test Procedure, External Fire Tests of Rigid Photovoltaic Panels*.
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- *Wind Design*, FM Global Property Loss Prevention Data Sheet 1-28, -October 2015
- *Earthquakes*, FM Global Property Loss Prevention Data Sheet 1-2, July 2012
- *Roof Mounted Solar Photovoltaic Panels*, FM Global Property Loss Prevention Data Sheet 1-15, October 2014

- *Roof Deck Securement and Above-Deck Roof Components*, FM Global Property Loss Prevention Data Sheet 1-29, April 2016
- *Panel Roof Systems*, FM Global Property Loss Prevention Data Sheet 1-31, July 2016

1.9 Definitions

For purposes of this standard, the following terms apply:

Adhesive – Adhesive is used in construction to adhere components together. Depending on the use, the adhesive could be in either a liquid form, semi liquid form, reactive liquid form or a solid form as in a tape or as in hot asphalt which is solid until heated.

Anchored – for the purpose of this document, an anchored system is a system that is secured to the roof structure or any part of the roof assembly.

Ballast – heavy material used to impede movement of the photovoltaic module or frame. For the purposes of this document, the only acceptable ballast shall be concrete paver blocks.

Coefficient of Friction – The ratio between the friction force that resists the movement of an object and the normal force between the object and the surface.

Crack – During wind uplift testing, when a component is stressed to the point that it separates from itself while continuing to maintain the applied uplift pressure without catastrophic failure of the test assembly.

Crease - During wind uplift testing, when a component is stressed to the point that it bends at a sharp, defined angle, without breaking. Often a crack will form on the opposite face of the component.

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

External Seam Clamps – A securement for attaching photovoltaic modules or racking to the seam of a standing seam roof, the clamps are specific to the seams of the standing seam roof.

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

Frame or Racking System – used to fix solar panels on surfaces.

Lap Seam Roof Cover – A lap seam roof cover consists of metal or plastic panels which are through fastened to structural members. A lap seam occurs where overlapping materials are seamed, sealed or otherwise bonded.

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

Metal Panel — (1) A single metal sheet formed into a specified profile. (2) A composite assembly formed to a specified profile and consisting of an insulating core or batten material with an exterior metal skin.

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 (2.8 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.