FM Approvals

CLASS NUMBER 4470

Examination Standard for Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction

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Foreword

This standard 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 this standard is to present the criteria for examination of various types of products and services.

Examination in accordance with this standard shall demonstrate compliance and verify that quality control in manufacturing shall ensure a consistent and reliable product.

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1. INTRODUCTION

1.1. PURPOSE

1.1.1. This standard states testing and certification requirements for single-ply, polymer-modified bitumen sheet, built-up roof (BUR) and liquid applied roof assemblies.

1.1.2. Certification criteria may include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a surveillance program.

1.2. SCOPE

1.2.1. This standard applies to all single-ply, polymer-modified bitumen sheet, BUR and liquid applied roof assemblies intended to protect the building and its occupancy from the weather elements of nature.

1.2.2. The performance of a roof assembly depends on all components that make up the assembly, beginning with the deck and its securement to the structure to the uppermost layer exposed to the weather. It is therefore necessary to evaluate the entire roof assembly as a single entity.

1.2.3. This 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. This standard evaluates single-ply, polymer-modified bitumen sheet, BUR and liquid applied roof assemblies for their performance in regard to fire from above and below the structural deck, simulated wind uplift, susceptibility to hailstorm damage, water leakage, foot traffic, corrosion of metal parts, susceptibility to heat damage, puncture resistance (optional) and solar reflectance (optional). An optional noncombustible core rating for roof insulation is also included.

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 and loss control specialists was also considered.

1.3.2. Meeting these requirements will qualify a single-ply, polymer-modified bitumen sheet, BUR or liquid applied roof assembly as certified. A certified roof assembly is not a significant fire hazard and can withstand wind uplift forces, hail stones, etc., when installed in accordance with all certification requirements. Products and assemblies which meet all the requirements identified in this standard may not be certified if other conditions which adversely affect performance exist or if the intent of this standard is not met. Certification requirements prohibit substitution of components in the roof assembly without prior authorization from the certification agency.

1.3.3. Products and assemblies having characteristics not anticipated by this standard which do not conform to these requirements shall be permitted to be certified if performance equal, or superior, to that required by this standard is demonstrated, or they meet the intent of this standard.

1.4. BASIS FOR CERTIFICATION

Certification is based upon satisfactory evaluation of the product when used in a roof assembly and the manufacturer in the following major areas:

1.4.1. Examination and tests on production samples to evaluate:

- the suitability of the component product for use in a roof assembly;
- the performance of the component product as part of a roof assembly as specified by the manufacturer and required by the certification agency; and, as far as practical,
- the durability and reliability of the component product when used as part of a roof assembly.

1.4.2. An examination of the manufacturing facilities and audit of quality control procedures may be 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. Subsequent surveillance may be required by the certification agency in accordance with the certification scheme to ensure ongoing compliance.

1.5. BASIS FOR CONTINUED CERTIFICATION

The basis for continual certification may include, but is not limited to, the following based upon the certification scheme and requirements of the certification agency:

- production or availability of the component product as certified;
- the continued use of acceptable quality control procedures;
- satisfactory field experience;
- compliance with the terms stipulated in the certification report;
- satisfactory re-examination of production samples for continued conformity to requirements; and
- satisfactory surveillance audits conducted as part of the certification agencies product surveillance program.

1.6. EFFECTIVE DATE

The effective date of this certification standard mandates that all products tested for certification after the effective date shall satisfy the requirements of this standard.

The effective date of this standard is eighteen (18) months after the publication date of the standard for compliance with all requirements.

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. Conversion of U.S. customary units is in accordance with ANSI/IEEE/ASTM SI 10.

1.8. NORMATIVE REFERENCES

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the cited edition applies:

AISI (American Iron and Steel Institute)	North American Specification for the Design of Cold-Formed Steel Structural Members, 2012 Edition, AISI S100-200
ASTM International (American Society for Testing and Materials)	Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Reflectometer, ASTM C1549 Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter, ASTM D240 Standard Test Method for Ash from Petroleum Products, ASTM D482 Standard Test Method for Tensile Properties of Plastics, ASTM D638 Standard Test Methods for Coated Fabrics, ASTM D751 Standard Test Method for Apparent Density of Rigid Cellular Plastics, ASTM D1622 Standard Test Method for Climbing Drum Peel for Adhesives, ASTM D1781 Standard Test Method for Determining Ignition Temperature of Plastics, ASTM D1929 Heat Of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (Precision Method), ASTM D4809-00(2005) Standard Test Method for Gross Calorific Value of Coal and Coke, ASTM D5865-04 Standard Test Method for the Gross Calorific and Ash Value Of Waste Materials, ASTM D5468-02 Standard Test Method for Dynamic Puncture Resistance of Roofing Membrane Specimens, ASTM D5635 Standard Test Method for Corrosion Resistance of Ferrous Metal Fastener Assemblies Used in Roofing and Waterproofing, ASTM D6294 Standard Test Method for Determining Water Migration Resistance Through Roof Membranes, ASTM D7281 Standard Test Method for Fire Tests of Roof Coverings, ASTM E108 Gross Calorific Value Of Refuse-Derived Fuel By The Bomb Calorimeter, ASTM E711-87(2004) Standard Test Methods for Measurement of Synthetic Polymer Material Flammability Using a Fire Propagation Apparatus (FPA), ASTM E2058 Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials, ASTM G154 Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis, ASTM E1252 Standard Practice for General Techniques of Gas Chromatography Infrared (GC/IR) Analysis. ASTM E1642
EN	Test Procedure, EN 13823, Reaction To Fire Tests For Building Products - Building Products Excluding Floorings Exposed To The Thermal Attack By A Single Burning Item
EOTA, European Organisation for Technical Approvals	System of Mechanically Fastened Flexible Roof Waterproofing Sheets - EAD 030351-00-0402

FM APPROVALS	FM 4451, *Examination Standard for Profiled Steel Panels for use as Decking in Class 1 Insulated Roof Construction*. ANSI FM 4473 - *Impact Resistance Testing of Rigid Roofing Materials by Impacting with Freezer Ice Balls*. ANSI/FM Approvals 4474, *Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures*. FM 4880, *Examination Standard for Class 1 Fire Ratings of Insulated Wall or Roof/Ceiling Panels, Interior Finish Materials or Coatings and Exterior Wall Systems*. FM 4882, *Examination Standard for Roof Maintenance Coatings*
ISO (International Organization for Standardization)	Reaction to Fire Tests for Building Products - Determination of the Heat of Combustion, ISO 1716:2002 Reaction to Fire Tests for Building Products - Non-Combustibility Test, ISO 1182
NFPA (National Fire Protection Association)	Standard Method of Fire Tests for Determining the Heat Release Rate of Roofing Assemblies with Combustible Above-Deck Roofing Components, NFPA 276

1.9. TERMS AND DEFINITIONS

For purposes of this standard, the following terms apply:

Adhesive	A product used to adhere two 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.
Air Retarder	A layer or layers of material or a laminate used to reduce the flow of air from the building interior into a roof assembly. An air retarder is sealed to the underside of the roof cover at all penetrations and around the entire perimeter of the roof.
Bitumen	A class of amorphous black or dark colored (solid, semi-solid, or viscous) substances, natural or manufactured, composed principally of high molecular weight hydrocarbons, soluble in carbon disulfide, and found in petroleum asphalts, coal tars and pitches, wood tars and asphalts.
Board Stock Insulation	A panel with or without facers and a core of, or is comprised of, one of the following materials: APA-rated oriented strand board (OSB), asphalt/glass, glass-based, gypsum; mineral wool, perlite, polyisocyanurate/polyurethane foam, expanded polystyrene foam (EPS), extruded polystyrene foam (XPS), wood fiber or other suitable material. The material, the number of board stock layers, and the position of the product within an assembly will determine whether it is further classified as an insulation, cover board or thermal barrier.
Built-Up Roof (BUR)	A continuous semi-flexible roof cover consisting of multiple plies of saturated felts, coated felts, fabrics, or mats assembled in place with alternate layers of bitumen or cold adhesive.
Cementitious Panel Roof Deck	A factory fabricated roof deck consisting of a cementitious binder with or without reinforcing. The reinforcing, if present, may be organic or inorganic.
Cover Board	A board stock product used over insulation. It is applied as the top layer of some multilayer insulation assemblies.
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 ultimate 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. In the case of an insulation board, often a crack will form on the opposite face.
Deck	The structural components of the roof assembly to which the roof system is secured.
Delamination	Separation of the plies in a roof cover or system in any laminated roofing material or component, e.g., laminated layers of rigid insulation or the felt plies in a BUR roof or separation of any cover from the substrate to which it is adhered.
Fastener	A mechanical securement device used alone or in combination with a stress distributor to secure various components of a roof assembly.
Fully Adhered	Describes roof components that have been bonded to the substrate using a compatible adhesive throughout the entire surface of the roof.
Gypsum Roof Deck	Roof decks which consist of a slurry of gypsum cement placed over steel reinforcing mesh and permanent form boards.
Heat Weld	A method of melting and fusing together the overlapping edges of separate sheets or sections of polymer modified bitumen or thermoplastic roof covers by the application of heat and pressure.
Insulation	Any of a variety of materials designed to reduce the flow of heat, either from, or into, a building.
Lightweight Insulating Concrete Insulation	A type of insulation comprised of portland cement, lightweight aggregate or preformed foam or hybrid combination of these. It may be applied with or without the use of EPS board encapsulated within the lightweight insulating concrete.
Liquid Applied Roof Cover	Arrive on the roof in a liquid state and are spray, brush or roller applied using proprietary procedures and could include a reinforcing fabric.
Maintenance Coating	A liquid applied product with or without reinforcements that is applied over a functioning roof system. Maintenance coatings do not increase the fire, wind, or hail resistance performance of the existing roof. Maintenance coatings are evaluated for combustibility from above the roof deck only. These products are evaluated per FM 4482 - Examination Standard for Roof Maintenance Coatings
Mechanically Fastened	Describes components that have been attached to the substrate, deck or structure 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.
Multi-Ply Roof Cover	A system consisting of zero or one base ply layer, zero to many plies and zero or one cap ply layer adhered to each other with an adhesive and together form a thick multi-layer weatherproof roof covering. For assemblies with base sheets (mechanically attached), the base sheet is not included when defining the number of plies of the roof cover. Multi-ply covers contain a minimum of two plies.
Noncombustible	The property of a material to not ignite or burn. Not capable of igniting and burning under the conditions described in Section 4.9.
Partially Adhered	Components that have been bonded to the substrate using a compatible adhesive applied in spots or ribbons across the surface of the roof.
Plastic Roof Deck	These decks may be thermoplastic or thermoset with or without reinforcement.

Polymer modified Bitumen Roof Cover	Factory produced sheets which generally consist of an asphaltic and rubber or plastic blend reinforced with glass and/or polyester mats.
Presecurement	The use of insulation with certain mechanically fastened single ply roof covers requires preliminary attachment of the insulation to the deck.
Recover	New roof components are installed over the existing roof cover. For the purposes of this standard only one existing roof is allowed.
Re-Roof	Stripping off the existing roof system of all covers, insulations, fasteners, etc., down to bare roof deck. For steel deck re-roof, in some cases, up to 15 lbs/sq ft (0.72 kg/sq m) of asphalt can remain on the deck.
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 layer of a roof assembly designed to protect the building components from the weather.
Roof System	A system of interacting roof components (not including the roof deck) designed to weatherproof and, normally, to insulate a building's top surface.
Service Wind Load	The uplift load resulting from a windstorm that a roof assembly must resist. The service load is equal to one half of the rated load in psf (kPa).
Single Ply Roof Cover	Factory produced sheets typically consisting of EPDM, PVC, TPO, CSPE or several variations of these. Modified bitumen covers applied in a single layer (no base or ply sheets) are considered single ply roof covers.
Solar Reflectance	The fraction of incident solar radiation upon a surface that is reflected from the surface.
Spray Foam Insulation	The field applied spray foam insulation systems consist of multiple components delivered to the job site where they are mixed and sprayed in place prior to applying the roof cover.
Steel Roof Deck	Corrugated metal used as a structural component to support a roof system.
Stress Distributor (Plate/Batten Bar)	A metal or plastic disk or bar which is used in conjunction with a fastener to secure roof components and designed to distribute a concentrated load over a larger surface area.
Structural Concrete Roof Deck	Are generally monolithic, cast in place decks or precast concrete plank. These decks have a minimum compressive strength of 2500 psi (17.2 mPa) and a density of approximately 150 lb/ft3 (2400 kg/m3). Roof assemblies on structural concrete are considered noncombustible on the deck underside.
Structure	Is the building framework to which the roof deck, or in some instances the roof cover, is fastened.
Surfacing	Is the top layer or layers of a roof assembly, specified or designed to protect the underlying roofing from direct exposure to the weather.
Thermoplastic	Polymers which soften when heated and harden when cooled. This process is repetitive provided the material is not heated above the point at which decomposition occurs.
Thermoset	A material that solidifies or ‘‘sets’’ irreversibly when heated. This property is usually associated with cross linking of the molecules induced by heat, chemical reaction or radiation.

Treated Wood Roof Deck	Fire-retardant treated lumber or plywood. These decks are factory treated to reduce fire spread on the underside of the deck.
Thermal Barrier	A board stock insulation placed on the roof deck to slow the temperature rise to the roof system during an interior building fire and to delay involvement of the roof system in the fire.
Vapor Retarder	A layer or layers of material or a laminate used to reduce the flow of water vapor into a roof assembly. A vapor retarder is not sealed to the underside of the roof cover.
Weld	A type of securement whereby metal or plastic products are joined together through heat or solvent fusion.
Wind Uplift	The force generated by wind on a roof system or components in a roof system resulting from wind-induced pressure.

2. GENERAL INFORMATION

2.1. PRODUCT INFORMATION

Roof assemblies are constructed on site. They consist of several component layers beginning with a structural deck and ending with a weathering surface. Component layers that may be found in a roof assembly are coating or surfacing, roof covering, cover board, insulation, air or vapor retarder, thermal barrier and structural decking. Securements are used to hold the various components together and generally consist of a combination of adhesives, welds and/or mechanical fasteners.

2.2. CERTIFICATION APPLICATION REQUIREMENTS

The manufacturer shall provide the following preliminary information with any request for certification consideration:

- A complete list of all roof assembly combinations being submitted for certification consideration.
- The components that make up each roof assembly. These components include a roof covering, structural deck and one or more of the following: coating or surfacing, cover board, insulation, air or vapor retarder and thermal barrier and the method of securing all components for each separate assembly. Essentially, all components in the finished roof assembly shall be identified by manufacturer, product trade name, method of installation and the ratings desired for each combination.
- All ratings which are desired, or expected, for each assembly include:
  - ASTM E108 class A, B, or C with maximum roof slope;
  - Wind Uplift rating, Class 1-60, 1-75, etc.
  - Hail Damage Rating, Moderate, Severe or Very Severe Hail (MH, SH or VSH)
  - NCC (Noncombustible Core) Rated Roof Insulation (optional);
  - Dynamic Puncture Resistance Rating (optional)
  - Solar Reflectance of Roof Surfaces (optional)
- The number and location of manufacturing facilities.
- All documents shall contain the manufacturer's name, document number or other form of reference, title, date of last revision and revision level. All documents shall be provided with English translation.
- Manufacturer’s Specifications and Technical Bulletins may be needed to confirm certifications requested are in compliance with Paragraph 3.3.2.

2.3. REQUIREMENTS FOR SAMPLES FOR EXAMINATION

2.3.1. Following authorization of a certification examination, the manufacturer may be required to submit samples for examination and testing based on:

- the certifications requested;
- sample requirements to be determined by the certification agency.

2.3.2. Requirements for samples may vary depending on design features, results of prior or similar testing and results of any foregoing tests.

2.3.3. The manufacturer shall submit samples representative of production. Any decision to use data generated using prototypes is at the discretion of the certification agency.

2.3.4. It is the manufacturer's responsibility to provide any necessary test fixtures or special tools, such as those which may be required to evaluate the products for certification.

3. GENERAL REQUIREMENTS

3.1. REVIEW OF DOCUMENTATION

3.1.1. During the initial investigation and prior to physical testing, the manufacturer's specifications and roof assembly details shall be reviewed to assess the ease and practicality of installation and use. Each roof component shall be capable of being used within the limits of the final certification.

3.2. MARKINGS

3.2.1. 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 trade name as appropriate.

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

3.2.2. The product trade name, model number or model type identification shall correspond with the manufacturer's catalog designation and shall uniquely identify the certification agency's mark of conformity. The manufacturer shall not place this trade name or model number identification on any other product unless covered by a separate agreement with the certification agency.

3.2.3. The certification agency's mark of conformity shall be displayed visibly and permanently on the product and/or packaging as appropriate and in accordance with the requirements of the certification agency. The manufacturer shall exercise control of this mark as specified by the certification agency and the certification scheme.

3.2.4. All markings shall be legible and durable.

3.3. MANUFACTURER'S INSTALLATION INSTRUCTIONS AND SPECIFICATIONS

3.3.1. The manufacturer shall provide the user with printed instructions to demonstrate proper installation procedures to be followed by installers. As part of the certification examination, and at the sole discretion of certification agency, at least one inspection of the field installation during and/or after completion shall be required. In some cases, a continued program of inspections shall be necessary to assess the application procedures or changes within the application techniques.

3.3.2. No roof assembly shall be certified if is in conflict with the manufacturer's specifications and/or other written documentation such as technical bulletins.

3.4. CALIBRATION

3.4.1. Each piece of equipment used to verify the test parameters shall be calibrated within an interval determined on the basis of stability, purpose, and usage. A copy of the calibration certificate for each piece of test equipment is required. The certificate shall indicate that the calibration was performed against working standards whose calibration is certified and traceable to an acceptable reference standard and certified by an ISO/IEC 17025 accredited calibration laboratory. The test equipment shall be clearly identified by label or sticker showing the last date of the calibration and the next due date. A copy of the service provider's accreditation certificate as an ISO/IEC 17025 accredited calibration laboratory should be available.

3.4.2. When the inspection equipment and/or environment is not suitable for labels or stickers, other methods such as etching of control numbers on the measuring device are allowed, provided documentation is maintained on the calibration status of thus equipment.

4. PERFORMANCE REQUIREMENTS AND TESTS

This standard is intended to evaluate a finished roof assembly for its performance as it relates to fire (from above and below the structural deck), simulated wind uplift, corrosion of metal parts, susceptibility to hailstorm damage, water leakage, foot traffic, solar reflectance and puncture resistance.

Tests of alternate constructions may be waived if considered less hazardous than those previously tested.

Screening tests may be used to identify critical components for use in full scale testing or to evaluate components as alternate to those already tested and found to be satisfactory via the full-scale tests described in Sections 4.1 through 4.11 below. Alternate components must perform to an equal or higher level than the component qualified via large scale testing. Refer to the Appendix B of this Standard for acceptable screening tests. If the nature of a product requires the use of a test not shown in Appendix B, the test may be used at the sole discretion of the certification agency.

Confirming tests may be required, at the sole discretion of the certification agency., depending on design features and results of any foregoing tests.

Following a test failure, a re-test of an identical or similar assembly shall be at the sole discretion of the certification agency. and with a technical justification of the conditions or reasons for the failure. When a test specimen fails to meet the certification acceptance criteria for a given classification/rating, two successful test specimens of the same or similar construction must meet the certification acceptance criteria to qualify for the given classification/rating. For each failed specimen, two successful test specimens are required. Any test specimen that fails more than three times is no longer considered a candidate for certification.

Prior to testing, roof assemblies 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 Standard Test Methods for Fire Tests of Roof Coverings, ASTM E108, ASTM International. The tests shall include spread of flame, intermittent flame and burning brand as applicable.

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. Intermittent Spread of Flame and Burning Brand tests for Classes A, B, or C

There shall be no portion of the roof covering material blown or falling off 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.

4.2. COMBUSTIBILITY FROM BELOW THE ROOF DECK

Testing for combustibility from below the roof deck shall be in accordance with Standard Method of Fire Tests for Determining the Heat Release Rate of Roofing Assemblies with Combustible Above-Deck Roofing Components, NFPA 276 or in accordance with Examination Standard for Class 1 Fire Ratings of Insulated Wall or Roof/Ceiling Panels, Interior Finish Materials or Coatings and Exterior Wall System, FM Standard 4880.

4.2.1. Conditions of Acceptance for Combustibility from Below the Roof Deck

4.2.1.1. The roof assembly, when subjected to the NFPA 276 test, shall not exhibit fuel contribution rates in excess of the values shown in the following table.

Time Interval	Maximum Fuel Contribution Rate	
Min	**Btu/ft2/min**	**(kW/m2)**
3	410	(77.6)
5	390	(73.8)
10	360	(68.1)
Avg. (30 min)	285	(54.0)

4.2.1.2. There shall be no dropping of flaming particles into the furnace or uncontrolled flaming on the exterior surface of the sample.

4.2.1.3. The roof assembly, when evaluated in accordance with Approval Standard for Class 1 Fire Ratings of Insulated Wall or Roof/Ceiling Panels, Interior Finish Materials or Coatings and Exterior Wall System, FM Standard 4880 shall meet the fire performance requirements of FM Standard 4880.

4.3. WIND UPLIFT RESISTANCE

Testing for wind uplift resistance shall be in accordance with ANSI/FM Approvals 4474, Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures. The tests shall include the 12 x 24 ft (3.7 x 7.3 m) simulated wind uplift pressure test, the 5 x 9 ft (1.5 x 2.7 m) simulated wind uplift pressure test or the simulated wind uplift pull test. The minimum rating required for certification is Class 1-60. The maximum rating available is Class 1-990. Ratings between 1-60 and 1-990 are available in increments of 15. The rating assigned to the assembly shall be the maximum simulated uplift resistance pressure which the assembly maintains for one (1) minute without failure. **In addition, the assembly must maintain the service wind load for one (1) minute without visible cracking or visible creasing of the insulation or cover board.**

- Multiple cracks or creases in the same insulation or cover board, which would impair performance is indicative of ultimate failure, shall not be permitted.
- Crack or crease length in the same insulation or cover board, in excess of one half the minimum board dimension; e.g., 24 in. (1220 mm) for a 48 x 96 in. (1220 x 2440 mm) board shall not be permitted.

4.3.1. 12 x 24 ft (3.7 x 7.3 m) Simulated Wind Uplift Pressure Test

The 12 x 24 ft (3.7 x 7.3 m) simulated wind uplift pressure test procedure is used to determine the simulated wind uplift resistance of the following types of roof assemblies:

1) Assemblies other than those evaluated via the uplift pull test or 5 x 9 ft uplift pressure test.

2) Assemblies that utilize mechanical fasteners, adhesives, hot asphalt, heat welding, self-adhesive components, or combination thereof, to secure insulations, a base ply, plies or a cap ply sheet, exterior coverings and other components, in single or multi-layered constructions, to one another and to the roof deck.

Note: Adhesive and hot asphalt securement to steel roof deck is not permitted.

3) Assemblies that utilize steel, FR treated wood, structural concrete, cementitious panel, plastic or gypsum roof decks having a minimum thickness of 2 in. (51 mm).

4) Assemblies that utilize batten bars or rows of fasteners spaced less than or equal to 144 in. (3660 mm) on center with maximum in-row securement spacing of 48 in. (1220 mm).

5) Assemblies that utilize an air retarder. For wind ratings of Class 1-90 and below, the assembly must also meet the service load (half of the rated load) without the air barrier in place. For wind ratings above Class 1-90, the assembly must perform to the rated level with and without the air barrier in place.

6) For new construction on steel deck, assemblies that do not overstress the structural deck when subjected to service wind loads. Stresses induced to steel roof decking shall be determined by rational analysis using Allowable Strength Design (ASD) principles and shall not exceed the allowable stresses per the North American Specification for the Design of Cold-Formed Steel Structural Members, AISI S100 and Approval Standard for Profiled Steel Panels for use as Decking in Class 1 Insulated Roof Construction, FM Standard 4451.

7) The test sponsor shall supply calculations used to determine the stresses.

4.3.1.1. Conditions of Acceptance for 12 x 24 Simulated Wind Uplift Pressure Test

4.3.1.1.0. All fasteners and stress distributors shall: a) remain securely embedded into, or through, the roof deck and other structural substrates to which they are being fastened to or through; b) not pull through, become dislodged, disconnected, or disengaged from stress distributors, seams or substrates; c) not fracture, separate or break.

4.3.1.1.1. All insulations and cover boards shall: a) not fracture, break or pull through/over, fastener heads or stress distributors; b) not delaminate or separate from their facers or adjacent components to which they have been adhered; c) be permitted to deflect between points of mechanical securement provided that the insulation boards do not fracture, crack or break.

EXCEPTIONS: Visible cracking or visible creasing of the insulation or cover board, as indicated by the top surface of the roof cover, when less than or equal to one half the minimum board dimension, shall be permitted provided ultimate failure does not occur as noted in Section 4.3.

4.3.1.1.2. All membranes shall: a) not tear, puncture, fracture or develop any through openings; b) not delaminate or separate from adjacent components.

EXCEPTIONS: 1) Mechanically fastened membranes shall be permitted to separate and deflect from adjacent components at locations where they are not fastened, 2) partially adhered membranes shall be permitted to separate and deflect from adjacent components at locations where adhesive placement was not intended, 3) tearing of membrane at fastener/stress distributors is allowed up to ultimate failure, 4) minor delamination is allowed provided it does not continue to grow in size by more than 50% from the end of one pressure level through the end of the following pressure level.

4.3.1.1.3. All adhesives shall maintain full contact with all the surfaces of all components to which it has been applied to, or comes in contact with, without any separation, delamination, fracture, cracking or peeling of the adhesive or its bond.

EXCEPTION: Minor delamination is allowed provided it does not continue to grow in size by more than 50% from the end of one pressure level through the end of the following pressure level.

4.3.1.1.4. All roof decks shall: a) maintain their structural integrity during the entire classification period; b) not fracture, split, crack or allow for fastener withdrawal.

4.3.1.1.5. For new construction, stresses induced to steel roof decking shall be determined by rational analysis, supplied by the test sponsor, and shall not exceed the allowable stresses per the *North American Specification for the Design of Cold-Formed Steel Structural Members,* AISI S100-2012 and *Approval Standard for Profiled Steel Panels for use as Decking in Class 1 Insulated Roof Construction*, FM Standard 4451

4.3.1.1.6. All other components, including seams, base sheets, base plies, plies and cap plies, shall not tear, puncture, fracture, disengage, dislodge, disconnect, delaminate or develop any through openings.

4.3.1.1.7. The theoretical load per fastener (pressure x contributory area) does not exceed the pullout resistance of the fastener per Section C.6.1.

4.3.2. 5 x 9 ft (1.5 x 2.7 m) Simulated Wind Uplift Pressure Test

The 5 x 9 ft (1.5 x 2.7 m) simulated wind uplift pressure test procedure is used to determine the simulated wind uplift resistance of the following types of roof assemblies with a maximum wind uplift rating of Class 1-90:

1) Assemblies that utilize mechanical fasteners, adhesives, hot asphalt, heat welding, self-adhesive components or combination thereof, to secure insulations, a base ply, plies or a cap ply sheet, exterior coverings and other components, in single or multi-layered constructions, to one another and to the roof deck. Note: Adhesive and hot asphalt securement to steel roof deck is not permitted.

2) Assemblies that utilize air pervious decks to include cementitious panel, steel, wood, or fiber reinforced plastic roof decks.

3) Assemblies with mechanically secured roof covers with securement row spacing less than, or equal to 48 in. (1220 mm) on center with maximum in-row securement spacing of 24 in. (610 mm).

4) Assemblies with mechanically secured roof covers with securements (spot or grid affixed) spacing less than or equal to 24 in. (610 mm) in one direction x 48 in. (1220 mm) on center in the other.

5) Assemblies with roof covers adhered to mechanically secured insulation (maximum 48 x 96 in. (1220 x 2440 mm) board) with a maximum contributory securement area of 5.33 ft^2 (0.50 m^2) per fastener, e.g. 6 fasteners on a 48 x 96 in. (1220 x 2440 mm) board size.

4.3.2.1. Conditions of Acceptance for 5 x 9 Simulated Wind Uplift Pressure Test

4.3.2.1.0. All fasteners and stress distributors shall: a) remain securely embedded into, or through, roof decks and other structural substrates to which they are being fastened to or through; b) not pull through, become dislodged, disconnected, or disengaged from distributors, seams or substrates; c) not fracture, separate or break.

4.3.2.1.1. All insulations and cover boards shall: a) not fracture, break or pull through/over, fastener heads or distributors; b) not delaminate or separate from their facers or adjacent components to which they have been adhered; c) be permitted to deflect between points of mechanical securement provided that the insulation boards do not fracture, crack or break.

EXCEPTIONS: Visible cracking or visible creasing of the insulation or cover board, as indicated by the top surface of the roof cover, when less than or equal to one half the minimum board dimension, shall be permitted provided ultimate failure does not occur as noted in Section 4.3.

4.3.2.1.2. All membranes shall: a) not tear, puncture, fracture or develop any through openings; b) not delaminate or separate from adjacent components.

EXCEPTIONS: 1) Mechanically fastened membranes shall be permitted to separate and deflect from adjacent components at locations where they are not fastened, 2) partially adhered membranes shall be permitted to separate and deflect from adjacent components at locations where adhesive placement was not intended, 3) tearing of membrane at fastener/stress distributor is allowed up to ultimate failure, 4) minor delamination is allowed provided it does not continue to grow in size by more than 50% from the end of one pressure level through the end of the following pressure level.

4.3.2.1.3. All adhesives shall maintain full contact with all the surfaces of all components to which it has been applied to, or comes in contact with, without any separation, delamination, fracture, cracking or peeling of the adhesive or its bond.

EXCEPTION: minor delamination is allowed provided it does not continue to grow in size by more than 50% from the end of one pressure level through the end of the following pressure level.

4.3.2.1.4. All roof decks shall: a) maintain their structural integrity during the entire classification period; b) not fracture, split, crack, or allow for fastener withdrawal.

4.3.2.1.5. For new construction, stresses induced to steel roof decking shall be determined by rational analysis, supplied by the test sponsor, and shall not exceed the allowable stresses per the North American Specification for the Design of Cold Formed Steel Structural Members, AISI S100and *Approval Standard for Profiled Steel Panels for use as Decking in Class 1 Insulated Roof Construction*, FM Standard 4451.

4.3.2.1.6. All other components, including seams, base sheets, base plies, plies and cap plies, shall not tear, puncture, fracture, disengage, dislodge, disconnect, delaminate, or develop any through openings.

4.3.2.1.7. The theoretical load per fastener (pressure x contributory area) does not exceed the pullout resistance of the fastener per Section C.6.1.

4.3.3. Simulated Wind Uplift Pull Test

The simulated wind uplift pull test procedure is used to determine the simulated wind uplift resistance of the following types of roof assemblies:

1) Assemblies with components (cover board, insulation, vapor retarder) either partially or fully adhered to monolithic structural concrete roof decks or gypsum or lightweight concrete cast over monolithic structural concrete. When substrates are partially adhered in ribbons, the adhesive is applied in rows no greater than 12 in. (305 mm) on center.

2) Assemblies where the single ply roof cover is fully adhered to a cover board, insulation or deck noted in No. 1 above.

3) Assemblies where the multi ply roof cover is fully or partially adhered to a cover board, insulation or deck noted in No. 1 above. When partially adhered in ribbons, the adhesive is applied in rows spaced less than, or equal to, 12 in. (305 mm) on center.

4) Assemblies with a base sheet partially adhered to an insulation or deck noted in No. 1 above and with a rigid insulation adhered above the base sheet.

Assemblies with a maximum rigid insulation board size of 48 x 48 in. (1220 x 1220 mm).

EXCEPTION: Boards with thicknesses less than or equal to 0.625 in. (16 mm) and with sufficient flexibility so they will lay flat, without curling or bending to ensure complete adhesion can be up to 48 x 96 in. (1220 x 2440 mm) at the sole discretion of the certification agency.

NOTE: For assemblies with all components fully adhered, the final rating for the assembly is determined by dividing the maximum pressure load maintained for 60 seconds by 0.85 and rounding down to the next increment of 15 psf (0.7 kPa) up to a maximum rating of 1-990.

4.3.3.1. Conditions of Acceptance for Simulated Wind Uplift Pull Test

4.3.3.1.0. All insulations shall a) not fracture or break; b) not delaminate or separate from their facers or adjacent components to which they have been adhered.

4.3.3.1.1. All membranes shall not delaminate or separate from adjacent components.

4.3.3.1.2. All adhesive shall maintain full contact between all the surfaces of all components to which it has been applied to, or comes in contact with, without any separation, delamination, fracture, cracking or peeling of the adhesive or its bond.

4.3.3.1.3. All other components, including seams, base sheets, base plies, plies and cap plies, shall not tear, puncture, fracture, disengage, dislodge, disconnect, delaminate or develop any through openings.

4.4. HAIL DAMAGE RESISTANCE

Testing for hail damage resistance shall be as follows: The minimum rating required for certification is Class 1-MH.

For MH and SH, two identical samples are prepared with the roof cover applied to the selected substrate.

The first sample is unconditioned and tested as follows:

1. The sample is subjected to a minimum of ten impacts from the 1.19 lb (1 kg) steel ball.
2. For SH, the ball is dropped from a height of 141.5 in. (3595 mm), generating an impact energy of approximately 14 ft-lb (19 J).
3. For MH, the ball is dropped from a height of 81 in. (2057 mm), generating an impact energy of approximately 8 ft-lb (10.8 J).
4. The second sample is conditioned (weathered) for 1000 hours in an Ultraviolet Weathering Cabinet. The sample is then subjected to impact testing as described above.

For VSH three identical samples are prepared as above. Sample 1 is unconditioned, Sample 2 is either UV conditioned as above or heat aged.

Roof surface temperature shall be 40-45°F (4-7°C). All samples are subjected to a minimum of three ice ball impacts, as noted in the table below. The 2 in (51 mm) ice balls are prepared per ANSI FM 4473 - *Impact Resistance Testing of Rigid Roofing Materials by Impacting with Freezer Ice Balls*.

Sample	Impact Locations
Fully adhered roof cover over mechanically fastened substrate	1 – field-fabricated seam 1 – field of roof cover 1 – fastener/stress plate
Fully adhered roof cover over fully adhered substrate	1 – field-fabricated seam 2 – field of roof cover
Fully adhered roof cover over partially adhered (ribbon applied) substrate	1 – field-fabricated seam 1 – field of roof cover directly over ribbon 1 – field of roof cover between ribbons
Partially adhered roof cover over fully adhered substrate	1 – field-fabricated seam 1 – field of roof cover directly over ribbon 1 – field of roof cover between ribbons
Partially adhered roof cover over partially adhered (ribbon applied) substrate	1 – field-fabricated seam 1 – field of roof cover directly over ribbon 1 – field of roof cover between ribbons
Mechanically fastened roof cover over loose laid substrate	1 – field-fabricated seam 1 – field of roof cover 1 – fastener/stress plate
All other assemblies	Minimum of three impacts at critical locations as determined by engineer.

The kinetic energy must be between 53 – 58 ft-lb (72 – 79 J). Impacts with kinetic energy greater than 58 ft-lb (79 J) are considered acceptable if the impact area meets the acceptance criteria.

4.4.1. Conditions of Acceptance for Hail Damage Resistance

Unconditioned (unweathered); conditioned (weathered) and heat aged (VSH only) samples of roof cover are inspected for damage. Neither the roof cover nor the field seam (if present) shall show any signs of cracking or splitting under 10x magnification. The field seam shall not show any signs of cracking, splitting, separation, or rupture when examined under 10X magnification. Under adhered conditions, minor separation of the roof cover from the substrate directly under the impact area is acceptable for monolithic decks only (i.e. structural concrete or gypsum) or lightweight insulating concrete insulation. For VSH ratings, the substrate below the roof cover shall not crack. Minor surface indentations in the substrate are allowed at the point of impact.

4.5. WATER LEAKAGE RESISTANCE TEST

Testing for water leakage resistance shall be in accordance with Standard Test Method for Determining Water Migration Resistance Through Roof Membranes, ASTM D7281, ASTM International.

4.5.1. Conditions of Acceptance for Water Leakage Resistance

There shall be no signs of water leakage during the 7 day period. In addition, there shall be no signs of water leakage during, or after, the pressure cycles.

4.6. FOOT TRAFFIC RESISTANCE TESTS

Testing for foot traffic resistance shall be as follows:

A 3 in. (76 mm) square steel plate with rounded corners is placed on the sample. A 200 lb (91 kg) load is imposed on the plate five times.

4.6.1. Conditions of Acceptance for Foot Traffic Resistance

Roof Cover - There shall be no sign of tearing or cracking of the roof cover causing exposure of the substrate.

Insulation - The top surface of the roof insulation shall resist puncture. Under this same loading the roof insulation shall not fracture over rib openings of the steel deck.

4.7. CORROSION RESISTANCE TEST

Testing for corrosion resistance shall be in accordance with Standard Test Method for Corrosion Resistance of Ferrous Metal Fastener Assemblies Used in Roofing and Waterproofing, ASTM D6294, ASTM International or EOTA System of Mechanically Fastened Flexible Roof Waterproofing Sheets - EAD 030351-00-0402.

4.7.1. Conditions of Acceptance for Corrosion Resistance

Through visual inspection, the amount of red rust is determined. Staining is not considered red rust. A sample passes the corrosion test when no specimen has a corrosion area of greater than 15%. Any sign of coating blistering, peeling, or cracking is cause for failure.

1) For threaded fasteners, the measure of rust is based on the fastener area above the substrate through which the threads are driven.

2) For hammered fasteners, the measure of rust is based on the fastener area above the substrate into which the fastener is hammered. It excludes the portion impacted by the hammering device.

3) For stress plates, the measure of rust is based on the top and bottom surfaces. It excludes 1/16 in. (1.6 mm) inward from the outside perimeter of the top and bottom surfaces and 1/32 in. (0.8 mm) concentrically outward from the perimeter edge of the center hole on the top and bottom surface.

4) For batten bars, the measure of rust is based on the top and bottom surfaces. It excludes 1/16 in. (1.6 mm) inward from the outside perimeter of the top and bottom surfaces and 1/32 in. (0.8 mm) concentrically outward from the perimeter edge of all holes on the top and bottom surface.

4.8. SUSCEPTIBILITY TO HEAT DAMAGE TEST

The susceptibility to heat damage test procedure is used to assess the damage to roof insulation from exposure to radiant heat as a result of an interior building fire. Susceptibility to heat damage testing is for insulations applied directly to decks other than concrete.

Testing for susceptibility to heat damage shall be as follows:

A 16 × 16 in. (406 × 406 mm) piece of insulation is placed on 20 gauge steel sheet.

The sample is exposed to the following rising temperature conditions (Table 1).

Table 1		
Time minutes	**Temperature °F**	**Temperature (°C)**
0	Ambient	Ambient
5	425	(218)
10	475	(246)
15	500	(260)
20	500	(260)

NOTE: The Susceptibility to Heat Damage Test is not required for roof assemblies which have demonstrated satisfactory performance for combustibility from below the roof deck per Section 4.2.1.3 rather than Sections 4.2.1.1 and 4.2.1.2.

4.8.1. Conditions of Acceptance for Susceptibility to Heat Damage

The insulation shall not be decomposed, discolored or otherwise damaged beyond a depth of 1⁄8 in. (3 mm). There shall also be no curling or bowing of the sample.

4.9. NCC (NONCOMBUSTIBLE CORE) RATED ROOF INSULATION (OPTIONAL RATING)

4.9.1. Homogeneous and non-homogeneous roof insulation may be rated as NCC (noncombustible core) when it meets the requirements shown below. Individual layers of non-homogeneous insulation boards must meet the requirements shown below when the layer thickness is greater than or equal to 0.10 in. (2.5 mm).

4.9.2. Testing for Noncombustible Core Rated Roof Insulation shall be permitted to be in accordance with Test Procedure, ASTM E2058, Measurement of Synthetic Polymer Material Flammability Using a Fire Propagation Apparatus (FPA) and with Test Procedure, ISO 1716, Reaction-to-Fire Tests for Building Products - Determination of the Heat of Combustion, ASTM D482, Standard Test Method for Ash from Petroleum Products.

4.9.3. Conditions of Acceptance for NCC (Noncombustible Core) Rated Roof Insulation

Per ASTM D482, *Standard Test Method for Ash from Petroleum Products*, the samples shall have a minimum content of 90% ash. When a single test produces a result of less than 90%, two (2) additional tests shall be permitted to be conducted. The results of all three (3) tests shall be averaged. When averaged, the result shall not be less than 90% ash.

Per ASTM E2058, *Standard Test Methods for Measurement of Synthetic Polymer Material Flammability Using a Fire Propagation Apparatus (FPA)*, when tested at an applied heat flux of 50 kW/m^2 in air enriched to 40% oxygen. . No visible flaming of the insulation core material (without adhesive or facers) shall occur during the entire test. The test shall be terminated at 15 minutes if the mass loss from the sample has ceased and/or if visible vapors (if present) have ceased to be generated. If, at 15 minutes, the sample still exhibits mass loss and/or visible vapors, the test shall continue until the mass loss and/or visible vapors cease. Testing shall be in accordance with *Test Procedure, ASTM E2058, Measurement of Synthetic Polymer Material Flammability Using a Fire Propagation Apparatus (FPA)*.

Per ISO 1716:2002, *Reaction to Fire Tests for Building Products - Determination of the Heat of Combustion*, the insulation core shall have a maximum heat of combustion of 2.0 kJ/g (860 BTU/lb). When a single test produces a result of greater than 2.0 kJ/g (860 BTU/lb), two (2) additional tests shall be permitted to be conducted. The results of all three (3) tests shall be averaged. When averaged, the result shall be less than 2.0 kJ/g (860 BTU/lb). Testing shall be in accordance with *Test Procedure, ISO 1716, Reaction-to-Fire Tests for Building Products - Determination of the Heat of Combustion*.

4.10. DYNAMIC PUNCTURE RESISTANCE RATING OF ROOF COVERS (OPTIONAL RATING)

Testing for the Dynamic Puncture Resistance Rating of Roof Covers shall be permitted to be in accordance with ASTM D5635, Standard Test Method for Dynamic Puncture Resistance of Roofing Membrane Specimens.

4.10.1. Ratings for the Dynamic Puncture Resistance Rating of Roof Covers

The energy rating for the Dynamic Puncture Resistance Rating of Roof Covers shall be the maximum energy attained for which three successive test specimens do not puncture when tested in accordance with ASTM D5635, *Standard Test Method for Dynamic Puncture Resistance of Roofing Membrane Specimens*. The Dynamic Puncture Resistance Ratings available are shown as 5 J (Joule) through 50 J (Joule) in the following table:

Test Mass [lbm / kg]	Rating		Test Mass [lbm / kg]	Rating
Not Rated	NR		12.1 / 6.5	27.5 J
2.2 / 1.0	5 J		13.2 / 7.0	30 J
3.3 / 1.5	7.5 J		14.3 / 7.5	32.5 J
4.4 / 2.0	10 J		15.4 / 8.0	35 J
5.5 / 2.5	12.5 J		16.5 / 8.5	37.5 J
6.6 / 3.0	15 J		17.6 / 9.0	40 J
7.7 / 3.5	17.5 J		18.7 / 9.5	42.5 J
8.8 / 4.0.	20 J		19.8 / 10.0	45 J
9.9 / 4.5	22.5 J		20.9 / 10.5	47.5 J
11.0 / 5.0	25 J		22.0 / 11.0	50 J

4.11. SOLAR REFLECTANCE OF ROOF SURFACES (OPTIONAL)

Testing for the Solar Reflectance of Roof Surfaces shall be permitted to be in accordance with ASTM C1549, Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Reflectometer.

4.11.1. Results for Solar Reflectance of Roof Surfaces

The measured solar reflectance, arithmetic average of the measured reflectance, and if appropriate, the standard deviation of the set of measurements will be reported when tested in accordance with ASTM C1549, *Standard Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Reflectometer*.

4.12. IDENTIFICATION TESTS - STANDARD PRACTICE FOR GENERAL TECHNIQUES FOR OBTAINING INFRARED SPECTRA FOR QUALITATIVE ANALYSIS, ASTM E1252

4.12.1. For polymer roof covers and adhesives and other components as applicable, FTIR spectra shall be determined and reported at the sole discretion of the certification agency1.

4.12.2. Test/Verification: Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis, ASTM E1252

NOTE 1: These tests are conducted for identification purposes. There are no limits on the values obtained.

4.13. IDENTIFICATION TEST – FM APPROVALS THERMAL DESORPTION GAS CHROMATOGRAPHY *MASS SPECTROMETRY (TD/GC/MS)*

4.13.1. For foam plastic and other applicable materials TD/GC/MS Spectrograms shall be determined and reported at the sole discretion of the certification agency [1].

4.13.2. Test/Verification: Standard Practice for General Techniques of Gas Chromatography Infrared (GC/IR) Analysis. ASTM E1642

NOTE 1: These tests are conducted for identification purposes. There are no limits on the values obtained.

5. OPERATIONS REQUIREMENTS

5.1. DEMONSTRATED QUALITY CONTROL PROGRAM

5.1.1. A quality assurance program is required to assure that the certified roof assembly components produced by the manufacturer shall present the same quality and reliability as the specific roof components examined. Design quality, conformance to design and performance are the areas of primary concern.

- Design quality is determined during the examination and tests, and is documented in the certification report.
- Continued conformance to this standard is verified by the certifier's surveillance program.
- Quality of performance is determined by field performance and by periodic reexamination and testing.

5.1.2. The manufacturer shall demonstrate a quality assurance program which specifies controls for at least the following areas:

- existence of corporate quality assurance guidelines;
- incoming quality assurance, including testing;
- in process quality assurance, including testing;
- final inspection and tests;
- equipment calibration;
- drawing and change control;
- packaging and shipping; and
- handling and disposition of non-conforming materials.

5.1.3. Documentation/Manual

There should be an authoritative collection of procedures/policies. It should provide an accurate description of the quality management system while serving as a permanent reference for implementation and maintenance of that system. The system should require that sufficient records are maintained to demonstrate achievement of the required quality and verify operation of the quality system.

5.1.4. Records

To assure adequate traceability of materials and products, the manufacturer shall maintain a record of all quality assurance tests performed, for a minimum period of two years from the date of manufacture.

5.1.5. Drawing and Change Control

- The manufacturer shall establish a system of product configuration control that shall allow no unauthorized changes to the product. Changes to critical documents, identified in the certification report, may be required to be reported to, and authorized by the certification agency prior to implementation for production.
- Records of all revisions to all certified products shall be maintained.

5.2. SURVEILLANCE AUDIT PROGRAM

5.2.1. An audit of the manufacturing facility is part of the certification investigation to verify implementation of the quality assurance program. Its purpose is to determine that the manufacturer's equipment, procedures, and quality program are maintained to ensure a uniform product consistent with that which was tested and certified.

5.2.2. Certified products or services shall be produced or provided at, or provided from, location(s) disclosed as part of the certification examination. Manufacture of products bearing a certification mark is not permitted at any other location prior to disclosure to the certification agency.

5.3. INSTALLATION INSPECTIONS

Field inspections may be conducted to review an installation. The inspections are conducted to assess practicality of application, and conformance to written specifications. When more than one application technique is used, one or all may be inspected at the discretion of the certification agency.

5.4. MANUFACTURER'S RESPONSIBILITIES

The manufacturer shall notify the certification agency of changes in product construction, components, raw materials, physical characteristics, coatings, component formulation or quality assurance procedures prior to implementation.

APPENDIX A

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APPENDIX B: SMALL SCALE TESTS

The following small-scale tests are used to screen and/or compare the properties of individual roof components or roof components used in combination with other components that make up complete roof assemblies. The purpose of these tests is 1) to identify via small scale test procedures critical combinations of components to include in large scale tests 2) to determine if certification may be extended to alternate components after full scale tests have been completed and 3) to assess physical characteristics necessary for the continued performance of a component when installed within a roof assembly. The decision to extend certification to any components via small scale testing shall be at the sole discretion of the certification agency. Alternate components must perform to an equal or higher level than the component qualified via large scale testing. If the nature of a product or change requires the use of a test not shown below, the test may be used at the sole discretion of the certification agency.

B.1 Pull Through Tests For Roofing Membranes Using Tensile Loading

Pull through tests for roofing membranes using tensile loading shall be as follows:

B.1.1 The test sample consists of a square piece of membrane with the fastener and stress plate pulled through the membrane at a constant speed of 2 in./min (51 mm/min).

B.1.2 The result shall be the highest force attained by the sample during the test.

B.1.3 The overall sample results shall be determined based on the average of three (3) tests. If the standard deviation of the three values divided by the mean (coefficient of variation) is greater than 20%, up to two (2) additional tests shall be conducted to bring the coefficient of variation to less than, or equal to, 20%. If after five (5) tests the coefficient of variation) remains greater than 20%, the results of all five (5) tests shall be used to determine the final average.

B.2 Pull Through Tests for Roof Insulation Using Tensile Loading

Pull through tests for roof insulation using tensile loading shall be in accordance with ANSI/SPRI/FM BPT-1 Test Standard for Comparative Pull-Through Strengths of Insulation Fastening Systems and Substrate Board Materials Used with Low Slope Roofing Systems

B.2.1 The result shall be the highest force attained by the sample during the test.

B.2.2 The overall sample results shall be determined per B.1.3.

B.3 Delamination 6 x 6 Tests for Roofing Adhesives and Substrates Using Tensile Loading

B.3.1 6 x 6 delamination tests for roofing adhesives and substrates using tensile loading shall be as follows: The test samples are prepared by adhering 6 x 6 in. (150 x 150 mm) samples of the substrate boards together using the adhesive being evaluated followed by 6 x 6 in. (150 x 150 mm) pieces of plywood adhered to both sides.

B.3.2 Force is exerted in a direct line perpendicular to the plane of the adhesive interface at a crosshead speed of 2 in./min (51 mm/min).

B.3.3 The result shall be the highest force attained by the sample during the test.

B.3.4 The overall sample results shall be determined per B.1.3.

B.4 Membrane Delamination Tests for Roofing Membranes and Substrates Using Tensile Loading

Membrane delamination tests for roofing membranes and substrates using tensile loading shall be as follows:

B.4.1 The test sample is prepared by adhering aa 20 x 2 in. (508 x 51 mm) strip of membrane to the substrate The center 6 x 2 in. (152 x 51 mm) of the membrane is adhered

B.4.2 Force is exerted in a direct line perpendicular to the plane of the adhesive interface at a crosshead speed of 2 in./min (51 mm/min).

B.4.3 The result shall be the highest force attained by the sample during the test.

B.4.4 The overall sample results shall be determined per B.1.3.

B.5 Membrane Peel Tests for Roof Membrane Seam or Cover Tape/Cover Strip Combination using Tensile Loading

Membrane peel tests for roof membrane seam or cover tape/cover strip combination using tensile loading shall be as follows:

B.5.1 The test sample is prepared by adhering a 3 in. (76 mm) wide lap at the end of two 9 x 1 in. (229 x 25 mm) strips of the product to be evaluated.

B.5.2 Force is exerted in a direct line perpendicular to the plane of the adhesive interface at a crosshead speed of 2 in./min (51 mm/min).

B.5.3 The result shall be the highest force attained by the sample during the test.

B.5.4 The overall sample results shall be determined per B.1.3.

B.6 Pull Out Tests for Fastener/Roof Deck Combinations and Pull Through Tests for Fastener/Stress Plate or Batten Bar Combinations using Tensile Loading

B.6.1 Pull out tests for fastener/roof deck combinations and pull through tests for fastener/stress plate or batten bar combinations using tensile loading shall be as follows: For fastener/deck combination prepare the test sample by driving the fastener to be evaluated into a piece of decking to be evaluated.

B.6.2 For fastener/stress plate or fastener/batten bar combinations prepare the test sample by placing the fastener through the hole in the stress plate or batten bar as appropriate.

B.6.3 Force is exerted in a direct line perpendicular to the plane of the sample holder and stress plate, batten bar or roof deck interface at a crosshead speed of 2 in./min (51 mm/min).

B.6.4 The result shall be the highest force attained by the sample during the test.

B.6.5 The overall sample results shall be determined per B.1.3.

B.7 Insulation Breaking Load Test using Tensile Loading

B.7.1 Insulation breaking load tests using tensile loading shall be as follows: The test sample consists of a piece of roof insulation up to 3.75 in. (95 mm) thick.

B.7.2 The sample is placed in a test jig. Force is exerted in a direct line parallel to the shank of the bolt at a crosshead speed of 2 in./min (51 mm/min).

B.7.3 The result shall be the highest force attained by the sample during the test.

B.7.4 The overall sample results shall be determined per B.1.3.

B.8 Pull Over Test Procedure for Roofing Membranes with Stress Distributor Plates Using Tensile Loading

B.8.1 Pull over test procedure for roofing membranes with stress plates using tensile loading shall be as follows: The test sample is prepared by cutting 6 in. (152 mm) wide by minimum 12 in. (305 mm) long samples of membrane. Place the factory edge of the membrane on the insulation when present or directly on the lumber/wood substrate. Place the stress plate on the roof cover and using a compatible fastener, secure it to the lumber/wood below.

B.8.2 The free end of the roof membrane and the substrate are attached to the tensile tester. Force is exerted in a direct line perpendicular to the plane of the membrane/stress plate interface at a crosshead speed of 2 in./min (51 mm/min).

B.8.3 The result shall be the highest force attained by the sample during the test.

B.8.4 The overall sample results shall be determined per B.1.3.

B.9 Small Scale Tube Pressure Test

The small scale tube pressure test is used to determine the relative delamination values of roof covers fully adhered over perforated base sheets. The test sample is comprised of an insulation board, a piece of perforated base sheet and a roof cover. Materials are assembled per the manufacturer's specifications.

B.9.1 Pressure is introduced via a tube through the center of the back side of the insulation. The pressure schedule follows ANSI/FM Approvals 4474, Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures.

B.9.2 Samples that meet all the Conditions of Acceptance as noted below shall receive an Adhesive Delamination load result. The result assigned to the sample shall be the maximum pressure which the sample maintained for 1 minute while continuing to meet the conditions of acceptance.

B.9.2.1 All areas in the field of the sample shall not become delaminated from the substrate.

B.9.2.2 No leaks shall open at any point in the sample.

B.10 EN 13823, Building Products Excluding Floorings Exposed to the Thermal Attack by a Single Burning Item.

B.11 ISO 11925-2, Reaction to Fire Tests - Ignitability of Building Products Subjected to Direct Impingement of Flame - Part 2: Single-Flame Source Test.

B.12 ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B.13 ASTM D1929, Standard Test Method for Determining Ignition Temperature of Plastics.

B.14 ASTM D240, Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter.

B.15 ASTM D4809 Heat Of Combustion Of Liquid Hydrocarbon Fuels By Bomb Calorimeter (Precision Method).

B.16 ASTM D5468 Gross Calorific And Ash Value Of Waste Materials.

B.17 ASTM D5865 Gross Calorific Value Of Coal And Coke.

B.18 ASTM E711 Gross Calorific Value Of Refuse-Derived Fuel By The Bomb Calorimeter.

B.19 ISO 1716, Determination of the Heat of Combustion.

B.20 ISO 1182, Reaction to Fire Tests for Building Products - Non-Combustibility Test.

B.21 ASTM D638 - Standard Test Method for Tensile Properties of Plastics

B.22 ASTM D1781 - Standard Test Method for Climbing Drum Peel for Adhesives

B.23 ASTM D751 - Standard Test Methods for Coated Fabrics

B.24 ASTM D1622 - Standard Method for Apparent Density of Rigid Cellular Plastics