



Member of the FM Global Group

Approval Standard for Profiled Steel Panels for Use as Decking in Class 1 Insulated Roof Construction

Class Number 4451

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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

- 1.1.1 This standard states Approval requirements for profiled steel panels for use as roof decking in Class 1 insulated roof construction.
- 1.1.2 Approval criteria include, but are not limited to, performance requirements, labeling and 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 profiled steel panels intended for use as roof decking in Class 1 insulated roof construction. This standard also applies to the interaction of accessory components with the steel deck. These accessory components include the products used to secure the deck to the structure, the methods of deck side laps securement and the insulation and fasteners located above the roof deck. Each steel roof deck Approval must include an FM Approved above deck roof system qualified in accordance with FM Standards 4454, 4470, 4471, 4475, 4476 or 4477.

1.3 Basis for Requirements

- 1.3.1 The requirements of this standard are based on experience, research and testing. 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 profiled steel panels as roof decking for the purpose of obtaining Approval. Profiled steel panels having characteristics not anticipated by this standard may be FM Approved if performance equal, or superior, to that required by this Standard is demonstrated, or if the intent of the standard is met. Alternatively, profiled steel panels 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 and the manufacturer in the following major areas:

- 1.4.1 Examination and tests on production samples shall be performed to evaluate
- the suitability of the product;
 - the performance of the product 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 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 surveillance 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 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 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.

The effective date of this standard is June 30, 2013 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. 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 the American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)/American Society for Testing Materials (ASTM) SI 10-97, "Standard for Use of the International System of Units (SI): The Modern Metric System."

1.8 Applicable Documents

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

American Iron and Steel Institute (AISI)

- *North American Specification for the Design of Cold-Formed Steel Structural Members, 2007 Edition*, AISI S100-2007, Including Supplement 2 (February 2010), AISI S100-2007

FM Approvals LLC

- *Approval 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, FM Standard 4470*
- *Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures, ANSI/FM Approvals 4474*
- *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.*
- *Test Method for Drivability Evaluation of Fasteners*
- *Test Method for Corrosion Resistance Testing for Steel Roof Deck Coatings*
- *Test Method for Pull Out Tests for Fastener/Roof Deck Combinations and Pull Through Tests for Fastener/Stress Plate or Batten Bar Combinations using Tensile Loading*
- *Test Method for Determining the Pull Out / Pull -Over Resistance of Fasteners for use with Steel Roof Decking*
- *Test Method for Determining the Foot Traffic Resistance and Bearing Capacity of Insulation*
- *Test Method for Determining the Side Lap Crimping and Interlocking Resistance when Used with Steel Roof Decking*

FM Global

- *Wind Design, FM Global Property Loss Prevention Data Sheet 1-28*
- *Roof Deck Securement and Above-Deck Roof Components, FM Global Property Loss Prevention Data Sheet 1-29*

National Fire Protection Association (NFPA)

- *Standard Method of Fire Tests for Determining the Heat Release Rate of Roofing Assemblies with Combustible Above-Deck Roofing Components, NFPA 276*

1.9 Definitions

For purposes of this standard, the following terms apply:

Arc Spot Weld - A type of securement whereby the steel deck is joined to the supporting steel structural member through heat fusion.

Side Lap Crimping and Interlocking – A mechanical securement achieved by crimping adjacent sheets of steel deck panels along the specially designed side laps.

Crack – During wind uplift testing, when an insulation 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 insulation 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 insulation board.

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

Designer - The licensed professional responsible for the content of the drawings and specifications from which the steel deck is to be constructed.

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

Insulation - Insulation is any of a variety of materials designed to reduce the flow of heat, either from or into a building.

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 approximately 3 ft² (0.28 m²); for a 5 x 9 ft (1.5 x 2.7 m) test approximately 0.5 ft² (0.05 m²) or less, whereby two adhered components which are intended to be in contact are not in contact.

Owner's Designated Representative for Construction - The owner or the entity that is responsible to the owner for the overall construction of the project, including its planning, quality and completion; usually the general contractor, the construction manager or similar authority at the job site.

Rated Load - The uplift load resulting from a windstorm that a roof assembly must resist. The rated load is equal to two times the service load. The rated load is equal to the rating requested for FM Approval; e.g. the rated load is 90 psf (4.3 kPa) for a Class 1-90 rating.

Roof Assembly - A roof assembly is 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.

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.

Span – The distance between deck supports measured center to center.

Steel Roof Deck – Profiled steel panel used as a structural component to support a roof system.

Service Wind Load – The uplift load resulting from a windstorm that a roof assembly must resist. The service load is used for bending stress calculations and is equal to one half of the rated load in psf (kPa).

Structure - The structure is the building framework to which the roof deck is fastened.

Wind Uplift - Wind uplift is the force generated by wind on a roof assembly or components in a roof assembly resulting from wind-induced pressure.

2 GENERAL INFORMATION

2.1 Product Information

Steel roof deck is supplied as sheets or panels. Materials employed in the manufacture of steel roof deck shall consist of cold rolled carbon or stainless steel panels with a minimum yield point of 33 ksi (230 MPa) and a minimum tensile strength of 45 ksi (310 MPa). The minimum steel design thickness shall be 0.0276 in. (0.70 mm). The uncoated minimum steel thickness delivered to a job site shall not be less than 95% of the steel design thickness at any location (exception: lesser thickness due to cold forming is permitted at bends).

2.2 Approval Application Requirements

To apply for an Approval examination the manufacturer, or its authorized representative, should submit a request to

Materials Director
FM Approvals
1151 Boston-Providence Turnpike
PO Box 9102
Norwood, MA 02062
U.S.A.

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

- A complete list of all models, types, sizes, and options for the products or services being submitted for Approval consideration; and
- A set of manufacturing drawings for each gauge and profile, sales brochures/literature, installation instructions and maintenance procedures;
- The number and location of manufacturing facilities;
- The wind uplift rating(s) desired, or expected, for example: Class 1-60, 1-75, etc.;

- The type of above deck roof system for use with the deck, for example: fully adhered and/or mechanically fastened roof coverings; and
- All documents shall identify 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.

2.3 Requirements for Samples for Examination

- 2.3.1 Following authorization of an Approval examination, the manufacturer may be required to submit samples for examination and testing based on the Approvals requested. Sample requirements will be determined by FM Approvals following review of the preliminary information.
- 2.3.2 Requirements for samples may vary depending on design features, results of prior or similar testing, and results of any foregoing tests.

The manufacturer shall submit samples representative of production. Any decision to use data generated using prototypes is at the discretion of FM Approvals. It is the manufacturer's responsibility to provide any specialized tools or equipment needed to properly evaluate their product for Approval

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 details shall be reviewed to assess the ease and practicality of installation and use. The Approval investigation shall define the limits of the Approval.

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;
 - trade name or model number.

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

- 3.2.2 The product trade name, model number or model type identification shall correspond with RoofNav, the manufacturer's catalog designation and shall uniquely identify the product as FM Approved. The manufacturer shall not place this trade name or model number identification on any other product unless covered by a separate agreement with FM Approvals.
- 3.2.3 The Approval Mark (see Appendix B) shall be displayed visibly and permanently on the product and/or packaging. The manufacturer shall not use this Mark on any other product unless such product is covered by a separate report.
- 3.2.4 Labels or markings denoting FM Approval shall be applied by the manufacturer only within and on the premises of manufacturing locations that are under the FM Approvals Surveillance Audit Program.
- 3.2.5 All markings shall be legible and durable.

3.3 Manufacturer's Required Submittals

The following documents shall be submitted to the Designer and Owner's Designated Representative for Construction for approval prior to the installation of the steel deck.

- Installation drawings showing deck layout and all accessories, including installation details.
- Catalogue data or independent evaluation reports on deck(s), including profile, thickness, physical properties and finish. Deck profile, thickness, physical properties, and finish may be shown on the installation drawings instead of on submitted catalogue sheets.

The following documents shall be made available in electronic or printed form to the Designer and Owner's Designated Representative for Construction for review prior to the installation of the steel deck.

- Manufacturer's installation instructions and product data sheets, catalogue data, or independent evaluation reports for mechanical fasteners, when mechanical fasteners are being used.
- Mill certification of sheet steel used for deck.

3.4 Calibration

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

4 PERFORMANCE REQUIREMENTS

- This standard is intended to evaluate a roof deck for its performance as it relates to allowable live load deflection, combustibility from below the deck, wind uplift resistance, foot traffic resistance of insulation, bearing capacity of insulation and corrosion resistance (optional).
- Tests or evaluations of alternate deck products may be waived if considered less critical than those previously tested or evaluated.
- Confirming tests may be required, at the discretion of FM Approvals, 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 discretion of FM Approvals and with a technical justification of the conditions or reasons for the failure. When a test specimen fails to meet the Approval acceptance criteria for a given classification/rating, two successful test specimens of the same or similar construction must meet the Approval 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 FM Approval.
- Prior to testing, roof assemblies shall be permitted to cure for a maximum period of 28 days.

4.1 Allowable Live Load Deflection

Live load deflection is a function of the span of the deck and the stiffness of the deck which is a function of the moment of inertia (I) of the deck profile. Under a static ultimate load of 200 lb (0.89 kN) the deck shall not deflect more than 1/240 of the span (L) when the 200 lb (0.89 kN) static load is applied at mid-span of a two span arrangement or at the mid-span of a single span arrangement when the deck is designed to be installed in a single span arrangement.

4.1.1 Conditions of Acceptance for Allowable Live Load Deflection

The moment of inertia (I) is determined by the manufacturer in accordance with the current edition of *North American Specification for the Design of Cold-Formed Steel Structural Members*, AISI S100-2007. The manufacturer shall supply calculations used to determine the Moment of Inertia. The moment of inertia shall be used in the following equations to determine the allowable span (L). The steel thickness used to determine the moment of inertia shall be the design thickness requested for FM Approval. For acoustical roof deck, the Moment of Inertia is reduced by 5% when determining the allowable span (L) or the manufacturer may submit calculations showing a reduced Moment of Inertia for the acoustical deck. Substitute the calculated I into the equations below to determine the allowable span. For a single span condition, the load is applied at mid-span. For a multi span condition, the load is applied at the mid-span of one span of the two span condition. At no time shall the allowable span based on deflection exceed the allowable span based on applied stresses (See Section 4.3.1.6).

U.S. Customary Units

	One Span Condition	Two Span Condition
Equation	$D = \frac{PL^3}{48EI}$	$D = 0.015 \left(\frac{PL^3}{EI} \right)$
Reduced Equation	$L = \sqrt{29500(I)}$	$L = \sqrt{40,970(I)}$

where:

D = deflection = L/240, (in.)

P = load = 200 lb concentrated load distributed over a 12 in. wide section of deck

L = span (in.)

I = moment of inertia (in.⁴ per foot of width)

E = modulus of elasticity [steel = 29,500,000 psi]

International System of Units (SI)

	One Span Condition	Two Span Condition
Equation	$D = \frac{PL^3}{48EI}$	$D = 0.015 \left(\frac{PL^3}{EI} \right)$
Reduced Equation	$L = \sqrt{46.1(I)}$	$L = \sqrt{64.0(I)}$

where:

D = deflection = L/240, (mm)

P = load = 890 N concentrated load distributed over a 305 mm wide section of deck

L = span (mm)

I = moment of inertia (mm⁴ per 305 mm of width)

E = modulus of elasticity (steel = 205 kN/mm²)

4.2 Combustibility from Below the Roof Deck

To qualify as Class 1, each insulated steel deck roof assembly shall satisfy the -performance criteria described below to reduce the potential for internal fire spread. Acoustical decks with web or bottom flange perforations and non-acoustical decks with hanger tabs are of special concern. The design of the deck with perforations allow for combustible gasses to migrate to the underside of the deck and enhance on the potential fire spread on the underside of the deck beyond the potential fire spread found on non-acoustical 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 *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.

4.2.1 Conditions of Acceptance for Combustibility from Below the Roof Deck

4.2.1.1 The roof assembly when subjected to the *Standard Method of Fire Tests for Determining the Heat Release Rate of Roofing Assemblies with Combustible Above-Deck Roofing Components* NFPA 276 (Construction Materials Calorimeter Test) shall not exhibit fuel contribution rates in excess of the values shown in the following table.

<i>Time Interval</i>	<i>Maximum Fuel Contribution Rate</i>	
	<i>Btu/ft²/min</i>	<i>(kW/m²)</i>
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 top 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

Steel roof deck may be subject to wind damage if not properly secured. Portions of the roof deck where damage is possible are the securement of the deck to the structure, the securement of deck side laps, the securement of above deck components to deck and overstressing the deck. These areas of concern are addressed though the following testing and evaluation.

4.3.1 Wind Uplift Ratings of Maximum Class 1-90

4.3.1.1 Combination pull out / pull over resistance of fasteners (testing)

Combination pull out / pull over resistance testing of the fasteners used to secure the steel deck to the building structure is conducted to verify the capacity of the fastener to resist pull out from the substrate and the capacity of the fastener head to resist rupture. The securement of the deck to the structure must insure that the deck remains in place during the design windstorm. Testing for pull out / pull over resistance shall be in accordance with *Test Method for Determining the Pull Out / Pull Over Resistance of Fasteners for use with Steel Roof Decking*, FM Approvals, LLC.

4.3.1.1.1 Conditions of acceptance for combination pull out / pull over resistance

The required pull out / pull over resistance of fasteners shall not be less than the calculated rated load that the fastener/deck must resist for the desired wind uplift rating nor shall the required pull over resistance of the fastener exceed the calculated pull over resistance per 4.3.1.2 below.

4.3.1.2 Pull over resistance of fasteners (calculation)

Pull over resistance calculation of the fasteners used to secure the steel deck to the building structure is conducted to verify the capacity of the deck to resist rupture over the fastener head. The securement of the deck to the structure must insure that the deck remains in place during the design windstorm. The pull over resistance of fasteners evaluation shall be in accordance with *North American Specification for the Design of Cold-Formed Steel Structural Members, 2007 Edition*, AISI S100-2007, Section E.4.4.2-1 and the following equation:

$$P_{nov} = 1.5t_1d'_wF_{u1}$$

Where

P_{nov} = nominal pull-over strength (resistance) of the fastener

t_1 = thickness of member in contact with fastener head or washer

F_{u1} = Tensile strength of member in contact with fastener head or washer

d'_w = Effective pull-over diameter

Ω_f = Resistance factor
= 3.0

$$P_{all} = P_{nov}/\Omega_f$$

$d'_w =$	Where	Condition
$d'_w = d_h + 2t_w + t_1 < d_w$	d_h = fastener or integral washer head diameter t_w = steel washer thickness d_w = washer diameter	For a round, hex or hex washer head fastener and independent solid steel washer beneath
$d'_w = d_h$ $d'_w \leq 0.5$ in. (13 mm)		For a round, hex or hex washer head fastener without an independent washer
$d'_w = d_h + 2t_w + t_1$ $d'_w \leq 0.625$ in. (16 mm)		For a domed (non-solid) and independent steel washer beneath

The FM Approvals rating for the fastener/deck combination is equal to $2.1P_{all}$ divided by the contributory area it is designed to carry rounded down to the nearest 15 psf (0.7 kPa).

4.3.1.2.1 Conditions of acceptance for pull over resistance

The calculated pull over resistance of fasteners shall not be less than the calculated rated load that the fastener/deck must carry for the desired wind uplift rating nor shall the calculated pull over resistance of the fastener exceed the tested pull over resistance per 4.3.1.1 above.

4.3.1.3 Combination pull off / pull over resistance of arc spot welds

Combination pull off / pull over evaluation of arc spot welds is conducted to verify that the securement of the deck to the structure is sufficient to insure that the deck remains in place during the design windstorm. Welding of steel roof deck is acceptable for a maximum Class 1-90 wind rating. Arc spot weld evaluation shall be in accordance with the following equations from the *North American Specification for the Design of Cold-Formed Steel Structural Members, 2007 Edition*, AISI S100-2007, Section E2.2.2:

$$W_s = 0.8 \left(\frac{F_u}{F_y} \right)^2 t d_a F_u$$

$$W_s = \left(\frac{\pi d_e^2}{4} \right) F_{xx}$$

Where:

W_s = uplift nominal tensile strength for each concentrically loaded arc spot weld and is the smaller of the above two equations. For eccentrically loaded arc spot welds subject to uplift tensile load the nominal tensile strength is 50% of the above value. For FM Approval, the deck and the above deck components may be installed in configurations that do not concentrically load welds. As such the nominal tensile strength shall be 50% of the above value.

Ω_w = resistance factor
= 2.5

W_a = $0.5W_s / \Omega_w$
= $0.2W_s$

t = total combined design base steel thickness of all deck sheets

d = visible diameter of the outer surface of the arc spot weld

d_a = Average diameter of the arc spot weld at mid-thickness of t
= $d - t$

d_e = effective diameter of the fused area and equal to $0.7d - 1.5t$ and less than or equal to $0.55d$

F_u = tensile strength of the deck and less than or equal to 82 ksi (565 MPa)

F_y = design yield stress of the deck

F_{xx} = tensile strength of the electrode classification and must be greater than or equal to ≥ 60 ksi (410 MPa) and greater than F_u

$t d_a F_u \leq 3,000$ lb (13.34 kN)

d_r = visible diameter of the outer surface of the arc spot weld required for FM Approval

$$d_r = \frac{6.25W_a F_y^2}{t F_u^3} + t$$

The FM Approvals rating for the weld/deck combination is equal to $2W_a$ divided by the contributory area it is designed to carry rounded down to the nearest 15 psf (0.7 kPa).

4.3.1.3.1 Conditions of acceptance for pull off / pull over resistance of arc spot welds

The required pull off / pull over resistance of arc spot welds shall not be less than the calculated rated load that the weld must carry for the wind uplift rating desired.

4.3.1.4 Side lap fastener and side lap crimping and interlocking resistance

Side lap fastener pull out testing is conducted to verify that individual sheets remain securely fastened at their side laps under moving loads during roof construction. Testing for side lap fastener pull out shall be in accordance with *Pull Out Tests for Fastener/Roof Deck Combinations and Pull Through Tests for Fastener/Stress Plate or Batten Bar Combinations using Tensile Loading*, FM Approvals, LLC. The top sheet of all steel deck side laps must be fastened to supports.

Side lap crimping and interlocking resistance testing is conducted to verify that individual sheets remain secured at their side laps under moving loads during roof construction. Testing for side lap crimping and interlocking resistance shall be in accordance with *Test Method for Determining the Side Lap Crimping and Interlocking Resistance when used with Steel Roof Decking*, FM Approvals, LLC.

4.3.1.4.1 Conditions of acceptance for side lap fastener and side lap crimping and interlocking resistance

Side lap securements are spaced at maximum 36 in. (914 mm) on center and the pull out resistance of the side lap fasteners and the resistance of the crimping and interlocking shall be greater than or equal to 300 lb (1335 N). If the resistance of the securement is found to be less than 300 lb (1335 N), then additional securements shall be provided by reducing the spacing to achieve the same 8.33 lb/in. (1.46 N/mm) strength along the length of the lap.

4.3.1.5 Fastener pull out resistance for above deck components

Fastener pull out testing for above deck components is conducted on decks having a stiffening rib on the top flange to verify that the above deck fasteners will remain securely anchored when penetrating the deck at the stiffening rib. Testing for fastener pull out shall be in accordance with *Pull Out Tests for Fastener/Roof Deck Combinations and Pull Through Tests for Fastener/Stress Plate or Batten Bar Combinations using Tensile Loading*, FM Approvals, LLC.

4.3.1.5.1 Conditions of acceptance for fastener pull out resistance

The pull out resistance of the fasteners driven through the stiffening rib shall be equal to or greater than the pull out resistance of the fastener driven through the flat top flange.

4.3.1.6 Steel deck bending stresses under service wind loads

The steel deck bending stress under service wind loads is evaluated to verify the ability of the steel deck to withstand wind uplift service loads without damage or overstressing the steel deck. 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 latest edition of the *North American Specification for the Design of Cold-Formed Steel Structural Members*,

AISI S100-2007. The manufacturer shall supply calculations used to determine the stresses. The load conditions for determining the bending stress are:

- The applied service load shall be considered to act uniformly distributed across the surface of the roof for all fully adhered or partially adhered roof covers.
- The applied service load shall be considered to act as a concentrated load for all mechanically attached single and multi-ply roof cover assemblies when the in-row fastener spacing is greater than one-half of the deck span.
- The applied service load shall be considered to act uniformly distributed across the surface of the roof for all mechanically attached single and multi-ply roof cover assemblies when the in-row fastener spacing is less than or equal to one-half of the deck span.
- The dead load used in the calculations may include the weight of the deck only.
- A single span condition shall be used to evaluate decks designed for use only in a single span condition.
- A two span condition shall be used to evaluate decks designed for use with two spans.
- A three span condition shall be used to evaluate decks designed for use with three or more spans.
- Rows of roof cover fasteners shall be installed perpendicular to the deck ribs.

4.3.1.6.1 Conditions of acceptance for steel deck bending stresses under wind uplift service loads

The steel deck bending stress under wind uplift service loads shall not exceed the allowable stress of the steel when calculated in accordance with the current edition of the *North American Specification for the Design of Cold-Formed Steel Structural Members*, AISI S100-200.

4.3.2 Wind Uplift Ratings Greater Than Class 1-90 and All Assemblies That Utilize Steel Deck with a Design Thickness Less Than 0.0295 In. (0.75 Mm)

In addition to meeting all of the requirements outlined in Section 4.3.1 for wind uplift ratings with maximum Class 1-90 ratings, 12 x 24 ft (3.7 x 7.3 m) simulated wind uplift pressure testing is required to qualify steel deck roof assemblies with greater than Class 1-90 wind uplift ratings and all assemblies that utilize steel deck with a design thickness less than 0.0295 in. (0.75 mm).

4.3.2.1 12 x 24 ft (3.7 x 7.3 m) simulated wind uplift pressure test

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 testing shall utilize the 12 x 24 ft (3.7 x 7.3 m) simulated wind uplift pressure test. The minimum rating required for FM Approval is Class 1-60. Ratings above 1-60 are available in increments of 15 psf (0.7 kPa). The rating assigned to the assembly shall be the maximum simulated uplift resistance pressure which the assembly maintains for one (1) minute without failure.

- Multiple cracks or creases in the same insulation or cover board, which would impair performance is indicative of catastrophic 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.
- In addition, the assembly must maintain the service wind load for one minute without visible cracking or visible creasing of the insulation or cover board.

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 that cannot be fully evaluated using the methods shown in Section 4.3.1 above.
- 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 securement of insulation and roof covers to steel roof deck is not permitted.
- 3) Steel deck roof assemblies with greater than Class 1-90 wind uplift ratings.
- 4) Assemblies with a steel deck design thickness less than 0.0295 in. (0.75 mm).

4.3.2.1.1 Conditions of acceptance for 12 x 24 simulated wind uplift pressure test

1. All roof decks and their securements shall: a) maintain their structural integrity during the entire classification period; b) not fracture, split, crack or allow for fastener withdrawal.
2. All above deck components shall meet the requirements outlined in the appropriate FM Standard 4454, 4470, 4471, 4475, 4476 or 4477.

4.4 Foot Traffic Resistance of Insulation

Foot traffic resistance testing for insulation is conducted to verify the ability of the roof insulation to resist simulated foot traffic without damage when the top rib opening of the deck exceeds 2.5 in. (64 mm). Foot traffic resistance tests for insulation shall be in accordance with *Test Method for Determining the Foot Traffic Resistance and Bearing Capacity of Insulation*, FM Approvals, LLC.

4.4.1 Conditions of Acceptance for Foot Traffic Resistance of Insulation

The top surface of the roof insulation shall resist puncture. Under this same loading the roof insulation shall not fracture over rib openings. There shall be no visible damage to the insulation facer or compressible core material.

4.5 Bearing Capacity of Insulation

Bearing capacity of insulation testing is conducted to verify the ability of the roof insulation to resist simulated foot traffic without damage when top flange width is less than 2 in. (50 mm). Foot traffic resistance tests for insulation shall be in accordance with *Test Method for Determining the Foot Traffic Resistance and Bearing Capacity of Insulation*, FM Approvals, LLC.

4.5.1 Conditions of Acceptance for Bearing Capacity of Insulation

There shall be no visible damage to the insulation facer or compressible core material.

4.6 Corrosion Resistance Test (Optional Test)

Steel roof deck paint or other protective coatings may be tested for corrosion resistance in accordance with *Corrosion Resistance Testing for Steel Roof Deck Coatings*, FM Approvals, LLC.

4.6.1 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.

4.7 Drivability Evaluation of Fasteners

Drivability evaluation of fasteners used to secure steel deck to the structure is conducted to confirm that the fasteners will perform as specified by the manufacturer. Drivability evaluation for fasteners shall be in accordance with *Test Method for Drivability Evaluation of Fasteners*, FM Approvals, LLC.

4.7.1 Conditions of Acceptance for Drivability of Fasteners

Fasteners must penetrate through all layers of decking and substrate and seat properly in accordance with manufacturer's specifications.

5 OPERATIONS REQUIREMENTS

A quality assurance program is required to assure that subsequent steel deck produced by the manufacturer shall present the same quality and reliability as the steel deck 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 Approval Report.

Continued conformance to this Standard is verified by the Surveillance Audit.

Quality of performance is determined by field performance and by periodic re-examination and testing.

5.1 Demonstrated Quality Control Program

5.1.1 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.

5.1.2 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.

5.1.3 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.

5.1.4 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 Approval Report, must be reported to, and authorized by, FM Approvals prior to implementation for production.
- The manufacturer shall assign an appropriate person or group to be responsible for, and require that, proposed changes to FM Approved or Listed products be reported to FM Approvals before

implementation. The manufacturer shall notify FM Approvals of changes in the product or of persons responsible for keeping FM Approvals advised by means of FM Approvals' Form 797, FM Approved Product/Specification-Tested Revision Report or Address/Main Contact Change Report.

- Records of all revisions to all FM Approved products shall be maintained.

5.2 Surveillance Audit

- 5.2.1 An audit of the manufacturing facility is part of the Approval 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 insure a uniform product consistent with that which was tested and FM Approved.
- 5.2.2 These audits shall be conducted periodically but at least annually by FM Approvals or its representatives.
- 5.2.3 FM Approved products or services shall be produced or provided at or from the location(s) audited by FM Approvals and as specified in the Approval Report. Manufacture of products bearing the Approval Mark is not permitted at any other location without prior written authorization by FM Approvals.

5.3 Installation Inspections

Field inspections may be conducted to review an installation. The inspections are conducted to assess ease 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 FM Approvals.

5.4 Manufacturer's Responsibilities

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

APPENDIX A: UNITS OF MEASUREMENT

LENGTH:	in. - "inches"; (mm - "millimeters") mm = in. x 25.4
HEAT:	Btu - "British thermal units"; (J - "joules") J = Btu x 1.0551 x 10 ³
HEAT RELEASE RATE:	Btu/min - "British thermal units per minute"; (kW - "kilowatts") kW = Btu/min x 0.0176
TEMPERATURE:	°F - "degrees Fahrenheit"; (°C - "degrees Celsius") °C = (°F - 32) x 0.556
MASS:	lb - "pound"; (kg - "kilogram") kg = lb x 0.4535924
MODULUS OF ELASTICITY:	psi - "pound per square inch"; (kN/mm ² - "kilonewton per millimeter square") kN/mm ² = psi x 6.895 x 10 ⁻³
MOMENT OR INERTIA:	in. ⁴ - "inches to the fourth power"; (mm ⁴ - "millimeter to the fourth power") mm ⁴ = in. ⁴ x 416.2 x 10 ³
FUEL CONTRIBUTION RATE:	Btu/ft ² /min - "British thermal unit per square foot per minute"; (kW/m ² /min - "kilowatt per square meter per minute") kW/m ² /min = Btu/ft ² /min x 0.1891489
FORCE:	lbf - "pound force"; (N - "Newton or kN - kilo Newton") N = lbf x 4.448; kN = lbf x 4.448 x 10 ⁻³
STRESS:	psi - "pound per square inch", kips per square inch; (MPa - "mega Pascal") 1 ksi = 1000 psi MPa = psi x 6.895 x 10 ⁻³ , ksi x 6.895

APPENDIX B: FM APPROVALS CERTIFICATION MARKS

FM Approvals certifications marks are to be used only in conjunction with products or services that have been Approved by FM Approvals and in adherence with usage guidelines.



FM APPROVED mark:

Authorized by FM Approvals as a certification mark for any product that has been FM Approved. There is no minimum size requirement for the mark, but it must be large enough to be readily identifiable. The mark should be produced in black on a light background, or in reverse on a dark background.



Cast-On FM Approvals marks:

Where reproduction of the FM Approved mark described above is impossible because of production restrictions, use these modified versions of the FM Approved mark. There is no minimum size requirement for the mark, but it must be large enough to be readily identifiable.



FM Approved Mark with “C” only:

Authorized by FM Approvals as a certification mark for any product that has been evaluated by FM Approvals in accordance with Canadian codes and standards. There is no minimum size requirement for the mark, but it must be large enough to be readily identifiable. The mark should be produced in black on a light background, or in reverse on a dark background.



FM Approved mark with “C” and “US”:

Authorized by FM Approvals as a certification mark for any product that has been evaluated by FM Approvals in accordance with US and Canadian codes and standards. There is no minimum size requirement for the mark, but it must be large enough to be readily identifiable. The mark should be produced in black on a light background, or in reverse on a dark background.

FM Approvals Certification Marks

USAGE GUIDELINES

All FM Approvals certification marks are the sole property of FM Approvals LLC (“FM Approvals”) and are registered or the subject of applications for registration in the United States and many other countries. They are for use only according to these guidelines.

FM Approvals certification marks may be used only on FM Approved products and related product packaging, in advertising material, catalogs and news releases. Use of FM Approvals certification marks on such material is not a substitute for use of the complete FM Approvals certification mark on FM Approved products and/or product packaging.

No FM Approvals certification mark or aspect thereof may be incorporated as part of a business name, Internet domain name, or brand name/trademark for products/product lines. This includes both design aspects (the FM Approvals “diamond,” etc.) and word aspects (“FM,” “Approved,” etc.). The use of any FM Approvals certification mark as a trademark is strictly prohibited.

The Approval Standard number or class number may not be incorporated as part of a business name, Internet domain name, or brand name/trademark for products/product lines. For example, a company may not say “ABC Company’s 4100 Fire Door is FM Approved”; the proper terminology is, “ABC Company’s Fire Door is FM Approved per Approval Standard 4100.”

FM Approvals certification marks, except for the FM Approvals Quality System Registration mark, may not be used on business stationery/cards/signage because this could mischaracterize the relationship with FM Approvals. Additionally, these items should not reference any FM Approvals certification mark.

Products or services may not be marketed under any mark or name similar to “FM Global,” “FM Approvals” or any of the FM Approvals certification marks. Further, products or services may not be marketed to imply a relationship beyond the scope of any Approval made by FM Approvals.

When an FM Approvals certification mark is used in advertising material or on product packaging, all material must reflect the specific circumstances under which the product was FM Approved. The material must clearly differentiate between products that are FM Approved and those that are not, and may not, in any way, imply a more substantial relationship with FM Approvals.

A company may not reference the intent to submit a product for Approval or the expectation that a company will have a certain product FM Approved in the future. For example, a company may not state, “Approval by FM Approvals pending” or “Approval by FM Approvals applied for.”

FM Approvals certification marks should not be preceded or followed by a qualifier that indicates a degree of certification or acceptability. For example, “exceeds,” “first” or “only” may not be used to qualify any FM Approvals certification mark.

Only original artwork issued by FM Approvals should be used. The FM Approvals certification marks should not be altered in any way other than to resize the artwork proportionately. Unacceptable uses of the marks include, but are not limited to, adding/deleting wording or artwork, reducing the artwork to an illegible size, animation or distortion.

The text of the FM Approvals certification marks may not be translated into any language other than English.

FM Approvals certification marks must appear in a size and location that is readily identifiable, but less prominent than the name of the owner of the certification or the manufacturer/seller/distributor of the certified products.