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

Class Number 4451

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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 profiled steel panels for use as roof decking in Class 1 insulated roof construction.

1.1.2 Certification criteria include 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 certification must include a certified 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 certification.

1.4 Basis for Certification

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 for certification;
- the durability and reliability of the product.

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 the following based upon the certification scheme and requirements of the certification agency:

- production or availability of the product as currently certified;
- the continued use of acceptable quality assurance procedures;
- compliance with the terms stipulated by the certification;
- satisfactory re-examination of production samples for continued conformity to requirements; and
- satisfactory surveillance audits conducted as part of the certification agency’s 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 S100, North American Specification for the Design of Cold-Formed Steel Structural Members, including Supplement 2

ANSI/FM 4474, Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures

FM 4470, 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 4880, Class 1 Fire Ratings of Insulated Wall or Roof/Ceiling Panels, Interior Finish Materials or Coatings and Exterior Wall System

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

1.9 Terms and 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 ft^2 (0.28 m^2); for a 5 x 9 ft (1.5 x 2.7 m) test approximately 0.5 ft^2 (0.05 m^2) 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 certification; 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 Certification Application Requirements

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

- a complete list of all models, types, sizes, and options for the products or services being submitted for certification consideration;
- 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;
- 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; 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 a certification examination, the manufacturer may be required to submit samples for examination and testing based on the following:

- 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.

2.3.4 It is the manufacturer's responsibility to provide any specialized tools or equipment needed to properly evaluate their product 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 details shall be reviewed to assess the ease and practicality of installation and use. The certification examination results may further define 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, size, rating, capacity, etc., as appropriate.

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

3.2.2 The model or type identification shall correspond with the manufacturer's catalog designation and shall uniquely identify the certification agency's mark of conformity.

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 Required Submittals

The following documents shall be submitted to the designer and owner's designated representative for construction for certification 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

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

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 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 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 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. 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 certification. 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 (mm^4 per 305 mm of width)

E = modulus of elasticity (steel = 205 kN/mm^2)

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

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, Standard Method of Fire Tests for Determining the Heat Release Rate of Roofing Assemblies with Combustible Above-Deck Roofing Components (Construction Materials Calorimeter Test) shall not exhibit fuel contribution rates in excess of the values shown in the following table.

Time Interval	*Maximum Fuel Contribution Rate*	
minute	*Btu/ft^2/min*	*(kW/m^2)*
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 Examination Standard FM 4880, Class 1 Fire Ratings of Insulated Wall or Roof/Ceiling Panels, Interior Finish Materials or Coatings and Exterior Wall System, 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)

4.3.1.1.1 Test Requirements

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 ensure that the deck remains in place during the design windstorm.

4.3.1.1.2 Test/Verification

Testing shall be conducted at laboratory conditions of 70°F [+25°F, -30°F] (37°C [+14°C, -17°C]) at a relative humidity of 35% (±25%).

The steel deck is fastened to the structural steel in accordance with manufacturers specifications.

The ends of the deck are folded up over a spacer and attached to the upper jaws of the test machine while the structural steel substrate is clamped to the moveable crosshead below. The force was exerted at a constant rate of 2 in./min (50 mm/min) in a direct line parallel to the shank of the fastener.

4.3.1.1.3 Acceptance Criteria

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 ensure 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, AISI S100, Section E.4.4.2-1 and the following equation:

$P_{nov} = 1.5 t_1 d'_w F_{u1}$

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} = Pnov/Ωf

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 = dh + 2tw + t1 $d'_w \leq 0.625$ in. (16 mm)		For a domed (non-solid) and independent steel washer beneath

The certification rating for the fastener/deck combination is equal to 2.1Pall 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 ensure 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, AISI S100, Section E2.2.2:

$$w_s = 0.8\left(\frac{F_u}{F_y}\right)^2 td_aF_u$$

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

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 certification, 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 = 0.5Ws/ Ωw

= 0.2Ws

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 Fu

td_aF_u ≤ 3,000 lb (13.34 kN)

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

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

The certification rating for the weld/deck combination is equal to 2Wa 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 pull out testing

4.3.1.4.1 Test Requirements

The 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. The top sheet of all steel deck side laps must be fastened to supports.

4.3.1.4.2 Test/Verification

Testing shall be conducted at laboratory conditions of 70°F [+25°F, -30°F] (37°C [+14°C, -17°C]) at a relative humidity of 35% (±25%).

The steel deck is fastened to the structural steel in accordance with manufacturer's specifications.

The ends of the deck are folded up over a spacer and attached to the upper jaws of the test machine while the structural steel substrate is clamped to the moveable crosshead below. The force was exerted at a constant rate of 2 in./min (50 mm/min) in a direct line parallel to the shank of the fastener.

4.3.1.4.3 Acceptance Criteria

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 Side lap crimping and interlocking resistance

4.3.1.5.1 Test Requirements

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.

4.3.1.5.2 Test/Verification

Testing shall be conducted at laboratory conditions of 70°F [+25°F, -30°F] (37°C [+14°C, -17°C]) at a relative humidity of 35% (±25%).

The interlocking side lap section of the steel deck is secured to the moveable crosshead.

The attached to the upper jaws of the test machine while the bottom sheet of steel deck is clamped to the moveable crosshead below. The force is exerted at a constant rate of 2 in. /min (50 mm/min) in a direct line parallel to the shank of the bolt.

4.3.1.5.3 Acceptance Criteria

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.

4.3.1.6 Fastener pull out resistance for above deck components

4.3.1.6.1 Test Requirements

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.

4.3.1.6.2 Test/Verification

Testing shall be conducted at laboratory conditions of 70°F [+25°F, -30°F] (37°C [+14°C, -17°C]) at a relative humidity of 35% (±25%).

The steel deck is fastened to the structural steel in accordance with manufacturer's specifications.

The ends of the deck are folded up over a spacer and attached to the upper jaws of the test machine while the structural steel substrate is clamped to the moveable crosshead below. The force was exerted at a constant rate of 2 in./min (50 mm/min) in a direct line parallel to the shank of the fastener.

4.3.1.6.3 Acceptance Criteria

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.

4.3.1.7 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. 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.

4.3.1.7.1 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 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 certification 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

4.4.1 Test Requirements

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).

4.4.2 Test/Verification

- Testing shall be conducted at laboratory conditions of 70°F [+25°F, -30°F] (37°C [+14°C, -17°C]) at a relative humidity of 35% (±25%).
- The steel deck is fastened it a minimum 0.5 in. (13 mm) thick piece of plywood to stabilize it. The steel deck shall have the wide rib opening centered on the plywood.
- The insulation is placed on the steel deck and the test sample is placed under the movable crosshead of the Tinius Olsen machine.
- A 3 in. (76 mm) square steel plate with rounded corners shall be centered on the centerline over the wide rib opening of the deck.
- The 12 in. (305 mm) long tube steel is centered on the steel plate and the crosshead is moved into position to apply a compressive load through the tube steel and square plate onto the test sample.
- A 200 lb load shall be imposed on the plate. The superimposed load shall be reduced to zero and the sample cover reloaded a minimum of four additional times.
- The top of the insulation specimen shall be inspected after the test and the condition of the cover noted at the steel plate interface.

4.4.3 Acceptance Criteria

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

4.5.1 Test Requirements

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).

4.5.2 Test/Verification

- Testing shall be conducted at laboratory conditions of 70°F [+25°F, -30°F] (37°C [+14°C, -17°C]) at a relative humidity of 35% (±25%).
- The steel deck is fastened it a minimum 0.5 in. (13 mm) thick piece of plywood to stabilize it. The steel deck shall have the wide rib opening centered on the plywood.
- Two pieces of minimum 6 x 12 in. (150 x 305 mm) insulation are cut and placed on the steel deck with a minimum 12 in. (305 mm) long joint placed over the narrow top flange. The test sample is then placed under the movable crosshead of the Tinius Olsen machine.
- A 3 in. (76 mm) square steel plate with rounded corners shall be centered on the centerline over the wide rib opening of the deck.
- The 12 in. (305 mm) long tube steel is centered on the steel plate and the crosshead is moved into position to apply a compressive load through the tube steel and square plate onto the test sample.
- A 200 lb load shall be imposed on the plate. The superimposed load shall be reduced to zero and the sample cover reloaded a minimum of four additional times.
- The top of the insulation specimen shall be inspected after the test and the condition of the cover noted at the steel plate interface.

4.5.3 Acceptance Criteria

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.

4.6 Corrosion Resistance Test (Optional Test)

4.6.1 Test Requirements

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.

4.6.2 Test/Verification

- Nylon line and/or glass rods can be used to arrange the specimens in the cabinet. Arrange the specimens in cabinet in a such a way that no part of any specimen is within ¾ in. of another, 4 in. of the walls or lid, or 7-7/8 in. of the surface of water in the base of the chamber. Also, arrange the specimens so that the moisture which may condense on them or their supports will not fall on other specimens placed at lower levels.
- Document the appropriate steps on the corrosion test form.
- Close the lid and ensure that the water trough is filled to an adequate level to provide a seal.
- Switch the chamber main power control switch to the “ON” position and the selector switch on the SO2 control enclosure to the “ON” position and press the “Start Cycle” pushbutton.
- The cycle timer will start and the SO2 solenoid will open for 60 seconds to introduce the preset 1.94 liters of SO2 gas into the chamber. The chamber will also begin heating to a temperature of 104°F. This temperature will be reached in approximately 1-1/2 hours.
- The cycle will automatically run for 8 hours. The chamber is automatically purged at the end of each cycle.
- Immediately after the 8 hours, wash the specimens by gently swishing the mounted specimens in a tank of distilled water heated to 100°F +/- 5°F.
- Arrange the specimens back in the cabinet to air dry overnight with the lid open.
- Repeat section 4.6.2 for a total of 15 cycles.

4.6.3 Acceptance Criteria

- The analysis is run by an engineer.
- Analysis is performed upon the completion of the 15 cycles.
- Document the analysis on the corrosion analysis form.
- Consult a total of 5 engineers. Through visual inspection, determine the amount of red rust and average the results. 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. Each consulted engineer must also pass or fail the specimen based on the preceding criteria.

4.7 Drivability Evaluation of Fasteners

4.7.1 Test Requirements

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.

4.7.2 Test/Verification

- Testing shall be conducted at laboratory conditions of 70°F [+25°F, -30°F] (37°C [+14°C, -17°C]).
- The steel deck is fastened to the structural steel in accordance with manufacturer's specifications.

4.7.3 Acceptance Criteria

Three fasteners are driven and all fasteners must penetrate through all layers of decking and substrate and seat properly in accordance with manufacturer's specifications.

5 MANUFACTURER'S REQUIREMENTS

5.1 Demonstrated Quality Control Program

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

- Design quality is determined during the examination and tests and may be 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 re-examination 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

5.2.1 An audit of the manufacturing facility may be part of the certification agencies surveillance requirements 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

5.3.1 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 the certification agency.

5.4 Manufacturer's Responsibilities

5.4.1 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.

6 BIBLIOGRAPHY

ISO/IEC 17025, *General Requirements for the Competence of Testing and Calibration Laboratories*.

FM Global Property Loss Prevention Data Sheet 1-28, Wind Desing

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