TESTING APPLICATION STANDARD (TAS) No. 114-95

TEST PROCEDURES FOR ROOF SYSTEM ASSEMBLIES IN THE HIGH-VELOCITY HURRICANE ZONE JURISDICTION

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1. Scope:

1.1 This protocol covers the requirements for approval of membrane roof system assemblies in the high-velocity hurricane zone jurisdiction. An approved membrane roof cover is one that meets the criteria of this protocol for accelerated weathering, corrosion of metal parts, F.I.T. [Fatigue, Indentation (dynamic and static puncture) & Temperature], fire, foot traffic, hail, leakage, and wind.

1.2 This protocol applies to any membrane roof cover intended to protect the roof assembly and building contents from the weather.

1.3 The performance of a membrane roof cover depends partially on the substrate materials over which it is applied. It is therefore necessary to evaluate the roof system assembly as a whole, including the cover and auxiliary items necessary to build up a roof system assembly. These components are included within the subject test criteria.

1.4 This Protocol is intended to evaluate only those hazards investigated, and is not intended to determine suitability for the end use of product.

1.5 This protocol evaluates roof system assemblies for their performance regarding accelerated weathering characteristics, corrosion resistance of metal parts, [(Fatigue, Indentation (dynamic and static puncture) & Temperature)], external fire (fire or burning debris from above), foot traffic resistance, susceptibility from hail storm damage, leakage, and simulated wind uplift.

1.6 Approval is based on satisfactory evaluation of the product(s) and manufacturer in the following major areas:

1.6.1 Examination and tests to evaluate: 1) the performance of the product as required by the authority having jurisdiction, and, as far as practical, 2) the marking procedures which shall be used to identify the product as set forth in Section 1517 of the *Florida Building Code, Building*.

1.7 Continued approval is based upon:

1.7.1 production or availability of the product as currently approved;

1.7.2 the continued use of acceptable quality control procedures;

1.7.3 satisfactory field experience; and,

1.7.4 compliance with the terms and conditions of the Product Approval.

1.8 All testing and calculations shall be conducted by an approved testing agency and all test reports, including calculations, shall be signed and sealed by a professional engineer.

2. Referenced Documents:

2.1 *Florida Building Code, Building:* Chapters 15 and 16 (High-Velocity Hurricane Zones)

2.2 *Application Standards:*

TAS 105	Field Withdrawal Resistance Test Procedure
TAS 105	Field Withdrawal Resistance
Appendix A	Test Results Report

2.3 *Application Standards:*

RAS 111	Standard Requirements for Attachment of Perimeter Flashing and Woodblocking

RAS 117 Standard Requirements for Bonding or Mechanical Attachment of Insulation Panels and Mechanical Attachment of Anchor or Base Sheets to Various Substrates

RAS 137 Standard Requirements for Mechanical Attachment of Single-Ply Membrane Roof Coverings to Various Substrates

2.4 *Factory Mutual Engineering Corporation:*
Loss Prevention Data Sheet 1-7, April, 1983
Loss Prevention Data Sheet 1-28, September, 1991
Loss Prevention Data Sheet 1-28(S), November, 1991
Loss Prevention Data Sheet 1-30, May, 1990
Loss Prevention Data Sheet 1-48, June, 1991

2.5 *Factory Mutual Research Corporation Approval Standards:*

4450 Class I Insulated Steel Deck Roofs

4470 Class I Roof Covers Annual Approval Guide, 1994

2.6 *The American Society of Civil Engineers (ASCE):*
ASCE 7; Minimum Design Loads for Buildings and Other Structures

2.7 *ASTM Standards:*

A 90 Standard Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles

A 641 Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire

B 117 Standard Test Method for Salt Spray (Fog) Testing

D 638 Standard Test Method for Tensile Properties of Plastics

D 751

D 1781 Standard Test Method for Climbing Drum Peel for Adhesives

E 70 Standard Test Method for pH of Aqueous Solutions With the Glass Electrode

E 108 Standard Test Methods for Fire Tests of Roof Coverings

E 380 Excerpts from the Standard Practice for Use of the International System of Units (SI) (the Modernized Metric System)

G 23 Standard Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials

G 26 Standard Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials

G 53 Standard Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials

G 85 Standard Practice for Modified Salt Spray (Fog) Testing

2.8 *DIN Standards:*

50018 Testing in a Saturated Atmosphere in the Presence of Sulfur Dioxide

2.9 *Norwegian Building Research Institute:*
Roof Coverings: Dynamic Wind-Load Resistance

2.10 *Roof Consultants Institute:*
Glossary of Terms

2.11 *Centre Scientifique et Technique du Batiment*
Classification for Roofing Systems

3. Terminology & Units:

3.1 Definitions—For definitions of terms used in this Protocol, refer to Chapter 2 and Section 1513 of the *Florida Building Code, Building*; and/or Section 6.2, herein; and/or the RCI Glossary of Terms. The definitions of the *Florida Building Code, Building* shall take precedence.

3.2 Units—For conversion of U.S. customary units to SI units, refer to ASTM E 380.

4. Significance of Use:

4.1 The requirements of this protocol are based on experience, research and testing or the standards of other national and international organizations. The advice of manufacturers, users, and trade associations is also considered.

4.2 Meeting these requirements will qualify a product as a Product Approved roof system assembly. An approved roof system assembly of itself is not a significant fire hazard when reviewed from the aspect of external fire, and can withstand expected wind uplift forces, hail stones, etc., when installed in accordance with all Product Approval requirements. Approval requirements prohibit substitution of components in the roof system assembly without a revision to the manufacturer's Product Approval. Please note that some Approvals include modified use of terminology relating to performance in hail. The High-Velocity Hurricane Zone jurisdiction is considered a moderate hail zone, as noted on the National Hailstorm Map published by the National Oceanic and Atmospheric Administration (NOAA).

4.3 Products that do not conform to these requirements may be Approved if they meet the intent of this Protocol. Conversely, those that do conform may not be Approved if other conditions prevail.

4.4 Effective date of revision:

4.4.1 The effective date of a protocol mandates that all products tested for Approval after the effective date must satisfy the requirements of that protocol. Products Approved under a previous Protocol must comply with the new version by the effective date or such date established by the chief code compliance officer or else forfeit Product Approval. The effective date may apply to the entire protocol, or, where so indicated, only to specific paragraphs of the protocol.

4.4.2 The effective date of this protocol is January 31, 1995, for full compliance with performance requirements.

5. General Information:

5.1 Roof covers:

5.1.1 Roof covers are supplied in either roll, sheet or liquid form. They may be fabricated in multi-plies (layers) or as a single ply. The single ply sheets are usually manufactured from thermoplastic materials (e.g., PVC - polyvinyl chloride); thermostat materials (e.g) EPDM - ethylene propylene diene monomers); uncured elastomer materials (e.g., PIB - polyisobutylene); or modified bitumen materials (e.g. rubberized asphalt or asphalt saturated or coated materials). The liquid covers may be supplied as silicone, polyurethane, chlorosulfonated polyethylene, acrylic, etc. Multiply systems may be various bituminous or coal tar pitch systems utilizing organic, fiberglass or polyester reinforced base, anchor or interply reinforcement.

5.2 Application of this standard:

5.2.1 To qualify as an approved roof system assembly, each assembly shall satisfy all of the following performance criteria, and be installed as tested over specific insulations and/or decks. Insulated and uninsulated deck types are listed in Product Approvals as follows:

- Wood;
- Steel;
- Concrete;
- Lightweight concrete;
- Cementitious wood fiber; and,
- Poured gypsum concrete.

5.2.2 The Approval examination includes 1) accelerated weathering;

2) corrosion resistance of metal parts; 3) F.I.T. testing which includes fatigue, dynamic and static puncture and temperature testing (F.I.T. testing is specified for modified bitumen roof membranes only; however, static and dynamic puncture testing is required for all membrane types); 4) external fire; 5) foot traffic, 6) simulated hail resistance; 7) water leakage resistance; 8) simulated wind uplift, and other tests as noted. A complete review of construction and application specifications and details shall be conducted to insure, as far as possible, a practical and reliable installation.

5.2.3 As noted in Section 4.2, approved components within a roof system assembly may not be substituted with components not listed in Product Approvals. However existing data in Product Approvals may be extrapolated, in compliance with methods set forth in RAS 117 (for insulation or base sheet attachment) or RAS 137 (for single-ply membrane attachment), to determine acceptable fastener spacings in elevated pressure zones.

6. Applicable Documents and Glossary:

6.1 Applicable documents:

6.1.1 The following standards, test methods and practices are referenced in this protocol and are summarized in the appendices herein.

- Fire tests of roof coverings - ASTM E 108, American Society for Testing and Materials
- Roof coverings: dynamic wind-load resistance, Norwegian Building Research Institute
- Uplift pressure test standard for Class I roof covers, Factory Mutual Research Corporation
- Uplift pull test standard for Adhered Class I Roof Covers, Factory Mutual Research Corporation
- Modified Salt Spay (Fog) Testing–ASTM G 85, American Society for Testing and Materials
- Testing in a Saturated Atmosphere with the Presence of Sulfur Dioxide–DIN 50018
- Susceptibility to Hail Damage Test Standard for Adhered Class I Roof Covers, Factory Mutual Research Corporation
- Susceptibility to Leakage Test for Class I Roof Covers, Factory Mutual Research Corporation
- Small Scale QC and Physical Properties Tests for Class I Roof Covers, Factory Mutual Research Corporation
- 12 foot by 24 foot Uplift Test Procedure, Factory Mutual Research Corporation
- F.I.T. Classification for Roofing Systems–Centre Scientifique et Technique du Batiment

6.2 Glossary–The following definitions shall relate to this protocol only.

Adhere: To cause two surfaces to be held together by adhesion. Single-ply membranes are often “partially-” or “totally-adhered” to a substrate with the use of contact cements, such as air-cured phenolic-neoprene mixtures, or other similar adhesives.

Ballast: An anchoring material, such as rounded river rock, gravel, or precast concrete pavers, which is used to hold single-ply roofing membranes in place and to stabilize the roof system from wind uplift forces. Although ballasting materials differ greatly in size, composition, and weight, they are typically applied at a minimum rate between 10 and 15 pounds per square foot of roof area. Thus, ballast should be applied only to those roof structures able to support this added weight.

Also, ballast materials should be large and heavy enough to resist being blown off the roof, yet light and smooth enough to avoid damaging the membrane. (Systems utilizing these applications are not generally approved in the high-velocity hurricane zone jurisdiction.)

Batten: A narrow metal band or plate, usually of galvanized steel or aluminum, which is used to fasten or hold in place a single-ply membrane, to prevent its displacement.

Delamination: Separation of the plies in a roof membrane or system in any laminated roofing material or component, e.g., laminated layers of rigid insulation or the felt plies in a built-up roof.

Disc Fasteners: A wide variety of devices of mechanical assemblies used to attach single-ply membranes, insulation boards and/or base sheets to a substrate or deck. Disc attachments generally consist of a square- or circular-shaped plate with a hole in the center, through which a screw or nail-like clip may be inserted. They are generally set in place with a drill-like device.

EPDM: Designated nomenclature for a tripolymer of ethylene, propylene, and diene.

Field Seam: A splice made in the field which joins two sheets together using an adhesive splicing tape, or heat- or solvent-welding.

Heat Welding: A process or method of melting and sealing or fusing the overlapping edges of separate sections of thermoplastic or uncured elastomeric roofing membranes by the application of heat and pressure. Small, portable "hot air" or "heat welding" devices are available which can, without the use of chemicals or adhesives, heat seal or fuse together overlapping edges to form waterproof seams.

Loosely Laid: Membranes which are not attached to the substrate except at the perimeter of the roof and at projections. Loosely laid membranes are held in place with appropriate and adequate ballast, such as round river washed stone, gravel, pavers, etc. This assembly may be used only on roof structures able to support the added weight of the ballast, which is generally applied at a minimum rate of 10 pounds per square foot of roof area. (These systems are not generally approved in the high-velocity hurricane zone jurisdiction.)

Mechanically Fastened Membrane: Generally used to describe single-ply membranes which have been positively attached at intervals to the substrate, usually with various fasteners and other mechanical devices such as battens. Mechanical fastening permits the membrane to float free between the fasteners, and allows greater movement between the membrane and the substrate than in fully adhered systems.

Modified Bitumen: A material consisting of bitumen which has been modified through the inclusion of one or more polymers and may contain stabilizers and other additives. Modified bitumen roofing membranes may also contain a reinforcing material.

Partially Adhered: A roofing assembly in which the membrane has been "spot affixed" to a substrate, usually with an adhesive, such as contact cement, or a mechanical device.

Polyisobutylene (PIB): A synthetic uncured elastomer produced by the copolymerization of isobutylene and isoprene. PIB roofing membranes are composed of polyisobutylene, and various other reinforcing fillers and stabilizers.

Polyvinylchloride (PVC): A thermoplastic polymer, synthesized from vinyl chloride monomer. Membranes containing polyvinyl chloride are used in single-ply roofing membranes.

Self-Adhesive Membranes: Single-ply membranes which can adhere to a substrate and to itself at overlaps without the use of an adhesive. The undersurface of a self-adhesive membrane is protected by a "release paper" that prevents the membrane from bonding to itself during shipping and handling. Later, as the membrane is unrolled, the release paper is peeled away, and the self-adhering undersurface is applied to the substrate. Successful application of a self-adhesive membrane requires a clean and dry substrate and the application of firm, uniform pressure.

Single-Ply Membranes:
Roofing membranes that are field applied using just one layer of membrane material (either homogenous or composite) rather than multiple layers. However, the manufacture of the single-ply sheeting may involve lamination or several layers of the same or different materials.

Thermoplastic: Polymers that soften when heated and harden when cooled. This process is repetitive provided the material is not heated above the point at which decomposition occurs.

Thermoset: A material that solidifies or "sets" irreversibly when heated. This property is usually associated with crosslinking of the molecules induced by heat or radiation.

TPO: Designated nomenclature for thermoplastic olefin elastomer based single-ply sheets made from blends of polypropylene and ethylene-polypylenene rubber.

Wind Uplift: The force generated by wind on a roof system or components in a roof system resulting from wind-induced pressures. Wind that is deflected around and across the surfaces of a building causes a drop in air pressure immediately above the roof surface. As a result, the air in the building will flow beneath the membrane and roof deck and tend to lift the roof upward. Wind uplift may also be caused by the introduction of wind underneath the membrane and roof edges, where it can cause the membrane to balloon and pull away from the substrate. Roof loss by wind can be avoided or prevented by proper installation and adequate adhesion, attachment, or ballasting.

7. General Requirements:

7.1 During the initial investigation and before physical testing, the manufacturer's specifications and details shall be reviewed to assess the ease and practicality of installation and use. Confirmation of specifications and details are assessed through an inspection of a field application or through viewing of a video of an application which includes all pertinent areas of the application. The product shall be capable of being used within the limits of the Approval investigation.

7.2 Markings:

7.2.1 Packaging material and/or containers shall bear the manufacturer's name and product identification in compliance with provisions set forth Section 1517 of the *Florida Building Code, Building*.

7.2.2 Product shall be marked by embossing, painting or cutting in compliance with *Florida Building Code, Building* requirements.

7.3 Instructions:

7.3.1 Printed, published installation instructions shall be provided by the manufacturer to demonstrate proper installation procedures to be followed by installers. As part of the approval examination, at least one inspection of a field installation, during and/or after its completion, shall be required. In some cases, a continued program of inspections shall be necessary to assess the application procedures or changes within the application techniques.

7.3.2 Review of a Factory Mutual Approval Report and/or the listing of the roof system assembly in the current edition of the Factory Mutual Approval Guide may be, at the discretion of the chief compliance officer, sufficient evidence of compliance with any portion of this protocol.

8. Performance Requirements and Tests:

8.1 General

8.1.1 This protocol is intended to evaluate a roof system assembly for its performance as it relates to accelerated weathering, corrosion of metal parts, F.I.T. performance (Fatigue, Indentation and Temperature), fire, foot traffic, hail, leakage, and wind. The applicant may submit up to five roof system assemblies in its Application for Product Approval. The chief code compliance officer shall respond, in writing, stating which tests shall be required for sufficient evidence of compliance.

8.2 Combustibility:

Note: Roof adhesives effect the potential fire spread properties of a roof system assembly. In addition, combustible adhesives are susceptible to ignition during roof construction and cure periods. Therefore, fire testing shall be done after a minimum 28 day cure period.

8.2.1 External fire testing shall be in strict compliance with ASTM E 108, as noted in Appendix A herein.

8.2.2 Testing shall include:

- spread of flame;
- intermittent flame;
- burning brand; and
- flying brand

tests as applicable.

8.2.3 Tests of alternate constructions may be waived by the chief code compliance officer if considered less hazardous than those previously tested.

8.2.4 During these tests, there shall be no flaming or burning particles blown off the test assembly and reaching the floor.

8.3 Wind resistance:

Note: Perimeter flashing, including metal components, shall be in fabricated and installed in compliance with RAS 111 for all approved roof system assemblies.

8.3.1 Totally or partially adhered roof system assembly:

8.3.1.1 Requirements:

- The adhesive(s) used to bond insulation and/or roofing plys or membrane shall penetrate or adhere to the substrates sufficiently to establish an adequate bond without degradation of the insulation. It shall be sufficiently fluid for effective application in accordance with the manufacturer's directions. In addition, the application shall not be adversely affected by temperature extremes. Applications within the *Florida Building Code, Building* jurisdiction generally take place at temperatures above 70°F (21°C).
- The adhesives shall achieve substantial adhesion with the insulation and at the laps within a minimum specified time such that winds will not lift the covering and/or insulation before the adhesive bond has fully developed. The solids within the adhesive shall generally remain in suspension. Any settlement must be redispersed after 5 minutes of agitation. Adhesives shall be designed and formulated to facilitate reliable field application according to the manufacturer's specifications. All adhesives shall be labeled

with maximum 'open' time in a high temperature, high humidity climate to reduce the chance of application spoiled adhesive.

8.3.1.2 Simulated uplift testing

- After a 4 day laboratory cure time at ambient conditions, the totally or partially adhered roof system assembly shall be initially tested for uplift resistance in compliance with the test procedures outlined in Appendix C, D, H or J, herein. The roof system assembly shall attain a passing load not less than 30 psf (1.5 kPa). Thereafter, the roof system assembly test specimen shall be allowed to cure for the remaining cure time. Failure to meet this initial four (4) day cure time uplift criteria shall result in failure of the roof system assembly and no further testing shall be conducted.
- After the remaining laboratory cure time, the totally or partially adhered roof system assembly shall be tested for uplift resistance in compliance with the test procedures outlined in Appendix C, D or J, herein.

8.3.2 Mechanically attached roof system assembly:

8.3.2.1 Mechanically attached roof covers are held in place by "single-type" or "batten type" fastener assemblies.

- "Single-type" fastener assemblies include a fastener accompanied by a stress distribution plate which is installed in a specific pattern to secure roofing components within a roof system assembly. Stress plates are available in a variety of shapes and sizes, each of which may provide differing uplift resistance results when installed with the same fastener in an identical pattern. They may be: 1) installed under the roof cover with adhesive applied to the top surface of the plate; 2) installed through the roof cover and sealed; 3) installed within the lap as the covering is being installed; or, 4) installed under the roof cover with an integral fastener above (non-piercing types).
- "Batten-type" fastener assemblies have a long bar or batten strip through which the fasteners are driven. They are usually installed: 1) through the roof cover with a patch or sealant applied over the batten; 2) as the cover is being installed within the lap; or, 3) under the roof cover with an integral fastener applied over the cover (non-piercing type).

8.3.2.2 Requirements:

- Fasteners and stress plates shall be tested in compliance with the requirements set forth in TAS 117, Appendices A, B and C.

- All fasteners, other than base ply fasteners, shall record a withdrawal resistance value under static load greater than or equal to 275 lbf (1220 N) and a withdrawal resistance value under pulsating load greater than or equal to 175 lbf (778 N) when tested in compliance with Appendix A of TAS 117.
- Fasteners shall be of proper length to penetrate the roof deck, if applicable. For steel deck application, fasteners must penetrate the top flange. Fasteners shall hold securely in the structural deck and prevent the covering from being lifted off. The fastening system shall secure the insulation in place under the roof cover. (Preliminary fasteners shall be used to maintain the insulation in place under the cover. See RAS 117.) If fasteners are installed within the lap, they shall be installed so as not to weaken the field seam. Any separation or delamination at the field seam that would require remedial measures shall be considered a failure. Materials and design shall be adequate to prevent fastener failure. The design must insure permanent securement to the deck, resisting horizontal and vertical deck movement due to temperature changes, live loads on the roof, and to vibration.
- The fastener shall be capable of proper installation with the recommended equipment without damage to the roof cover. The fastener application density or spacing shall be initially verified through simulated uplift pressure testing, as noted in Section 8.3.2.3, herein. Data extrapolation for fastener density or spacing shall be conducted in strict compliance with RAS 117 (for insulation or base sheet attachment) or RAS 137 (for single-ply membrane attachment). Data extrapolation is limited by the test method utilized for simulated uplift testing. (See Section 8.3.2.3, herein.)
- A minimum of two approved insulation fastener assemblies are required for preliminary attachment of insulation panels having dimensions less than or equal to 4 feet by 4 feet (1.2 m by 1.2 m). A minimum of four approved insulation fastener assemblies are required for preliminary attachment of insulation panels having dimensions greater than to 4 feet by 4 feet (1.2 m by 1.2 m).

8.3.2.3 Simulated uplift testing:

- Mechanically attached Roof System Assemblies shall be tested using one or more of the test procedures outlined in Appendices B, C, and/or J.

- The test procedure outlined in Appendix B is a dynamic uplift test utilizing a dynamic wind chamber for testing of all mechanically attached roof system assemblies having a maximum fastener row spacing of 72 inches. Appendix B simulated uplift testing generates a fastener assembly design value and a maximum allowable fastener density or spacing. This maximum allowable fastener density or spacing may be altered through data extrapolation, in compliance with RAS 137 (for single-ply membrane attachment), to meet design pressures for a specific building.
- The test procedure outlined in Appendix 'C' is a static uplift test utilizing a 5 foot by 9 foot (1.5 m by 2.7 m) pressure vessel for testing of mechanically attached roof systems assemblies with a row spacing less than or equal to 48 inches (1.2 m) o.c. or a fastener grid spacing less than or equal to 12 inches by 24 inches (0.6 m by 1.2 m); (8 square feet per attachment point). The roof system assembly shall attain a passing load not less than 90 psf (4.2 kPa). Data generated from Appendix C simulated uplift testing may not be used for extrapolation.
- The test procedure outlined in Appendix J is a static uplift test utilizing a 12 feet by 24 feet (3.6 m by 7.6 m) pressure vessel for testing of mechanically attached roof systems assemblies with a row spacing greater than 48 inches (1.2 m) o.c. or a fastener grid spacing greater than 12 inches by 24 inches (0.6 m by 1.2 m); (8 square feet per attachment point). The roof system assembly shall attain a passing load not less than 90 psf (4.2 kPa). Data generated from Appendix J simulated uplift testing may be used for extrapolation, in compliance with RAS 137 (for single-ply membrane attachment), to meet design pressures for a specific building. Extrapolation of data from Appendix J simulated uplift testing is limited to 1.75 times the maximum uplift pressure noted in the Product Approval.
- The chief code compliance officer may, at his/her option, accept and publish in Product Approvals roof system assemblies that do not meet the minimum 90 psf (4.2 kPa) uplift criteria providing the manufacturer has one or more assemblies that meet the minimum uplift criteria.

8.4 Corrosion Resistance:

8.4.1 Nails and carbon steel fasteners:

8.4.1.1 All nails and carbon steel fasteners shall be tested for corrosion resistance in compliance with ASTM Standard Practice G 85 [(Modified Salt Spray (Fog) Testing)], Annex A5 (Dolute Electrolyte Cyclic Fog/Dry Testing) as modified for the high-velocity hurricane zone and noted in Section 2 of Appendix E, herein.

8.4.2 Batten bars, stress distribution plates and fasteners (other than nails):

8.4.2.1 All batten bars, stress distribution plates, and metal fasteners (other than nails) shall be tested for corrosion resistance in compliance with DIN 50018 as noted in Section 3 of Appendix E, herein.

8.4.2.2 Each specimen shall be exposed to air saturated with water vapor (104°F, 40°C) containing a mild concentration of sulfur dioxide for 8 hours, followed by a drying period of 16 hours at room temperature. After each drying cycle, the specimen shall be inspected and signs of corrosion or rust shall be recorded.

8.4.2.3 The 24-hour cycle shall be repeated 15 times and the corrosion percentage shall be recorded.

8.4.2.4 To evaluate the corrosion increase after Cycle 1 through Cycle 15, the specimen shall be mounted to blue painted sheet backdrop.

8.5 Hail resistance:

Note: The high-velocity hurricane zone jurisdiction is a 'moderate hail' area, as designated by the National Oceanic and Atmospheric Administration (NOAA).

8.5.1 The roof system assembly shall be tested for hail damage resistance in compliance with either of the Simulated Hail Damage Test procedures noted in Appendix F, herein. A minimum of ten drops from the impactor is required, five of which shall be conducted in a field-fabricated seam or flashing detail where appropriate.

8.5.2 The roof cover and the field seam shall not show signs of cracking, splitting, internal separation, delamination, or rupture. Under adhered conditions, minor separation of the roof cover from the substrate (directly under the impact area) is acceptable performance for monolithic decks only (e.g. lightweight concrete, structural concrete, and gypsum, etc.). Severe degradation, such as cracking, crushing, etc., of the deck itself is reason for failure. The cover thickness shall be checked at the points of impact.

8.6 Water leakage:

8.6.1 The roof cover shall be tested for water leakage resistance in compliance with the Water Leakage Test procedures noted in Appendix G, herein. A sample 18 inches (45 cm) in diameter shall be prepared and, where appropriate, a field seam and/or penetration detail shall be included. The sample shall be conditioned (weathered) for 1000 hours in a fluorescent ultraviolet condensation type weathering apparatus before being cut into a size 10 inches (25 cm) in diameter and placed in the leakage test apparatus. The sample shall be maintained at ambient conditions.

8.6.2 The roof cover and field seam and/or penetration detail shall not show signs of a leakage during or at the end of the 7 day period.

8.7 Accelerated weathering:

8.7.1 Accelerated weathering testing shall be in strict compliance with ASTM G 23 or G 26.

8.8 F.I.T. Testing (F = Fatigue, I = Indentation, T = Temperature):

Note: Complete F.I.T. testing is required for modified bitumen roof membranes only; however, static and dynamic puncture resistance testing, which forms a part of F.I.T., is required for all membrane types.

8.8.1 Fatigue:

8.8.1.1 Fatigue testing of modified bitumen roofing membranes shall be in compliance with the test procedures outlined in Appendix K, herein.

8.8.2 Static and dynamic puncture:

8.8.2.1 Static and dynamic puncture resistance testing shall be in strict compliance with the test procedures outlined in Appendix I, herein.

8.8.3 Temperature:

8.8.3.1 Temperature testing of modified bitumen roofing membranes shall be in compliance with the test procedures outlined in Appendix K, herein.

8.9 Resistance to foot traffic:

8.9.1 Resistance to foot traffic testing shall be in strict compliance with the test procedures outlined in this section.

8.9.2 Test:

8.9.2.1 A 3 inch (76 mm) square steel plate with rounded corners shall be centered on the centerline of a 12 inch (305 mm) square horizontal panel and positioned along the butt edge and side joint of the insulation boards.

8.9.2.2 A 200 lbf (889 N) 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, with penetration and residual readings taken each time without removing the plate. The specimen shall be inspected after the test and the condition of the cover noted at the steel plate interface.

8.9.2.3 Tearing or cracking of the protective coating causing exposure of the plastic, glass fibers, foam or other compressible core material shall be unacceptable.

9. Manufacturing and Field Installation Requirements:

9.1 Demonstrated QC Program:

9.1.1 A Quality Control Program is required to insure that subsequent roof covers produced by the manufacturer shall present the same quality and reliability as the specific roof cover samples 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 covered in the Product Approval. Conformance to design is verified by quality control in the following areas:

- Existence of corporate quality control guidelines;
- Incoming inspection and testing;
- In-process inspection and testing;

- Final inspection and testing;
- Equipment calibration;
- Drawing and change control; and,
- Packaging and shipping

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

9.1.3 The manufacturer shall establish a system of product configuration control to prevent unauthorized changes, including the following, as appropriate:

- Engineering drawings;
- Engineering change requests;
- Engineering orders; and/or,
- Change notices

These shall be implemented through policy and detailed procedures to implement engineering change requests, orders or change notices; and records of all revisions to all approved products shall be kept.

9.2 Inspection procedures:

9.2.1 At manufacturing plant:

9.2.1.1 An inspection of the product manufacturing facility may be part of the approval application. Its purpose shall be to determine that equipment, procedures, and the manufacturer's quality controls are properly maintained to produce a product of the same quality as initially tested.

9.2.1.2 Periodic, unannounced follow-up inspections may be conducted to insure continued quality control and product uniformity.

9.2.1.3 The chief code compliance officer may rely on continued listing of approved systems in the annual Factory Mutual Approval Guide and quarterly supplements as confirmation of requirements under this section.

9.2.2 At site of installation:

9.2.2.1 Field inspections may be conducted to review roof system assembly installations. The inspections shall be conducted to assess ease of application, workability, and conformance to written specifications and details. When more than one application technique is used, one or all may be inspected.

9.2.2.2 The chief code compliance officer shall review established procedures from recognized testing and listing agencies to confirm compliance with the requests set forth herein.

TESTING APPLICATION STANDARD (TAS) 114-95
APPENDIX A

TEST PROCEDURE FOR ABOVE DECK COMBUSTIBILITY
ASTM E 108

1. Scope:

1.1 Flame propagation over the exterior surface of a roof system assembly is dependent on the rate at which the fuel is liberated from the test sample. The extent of spread and speed of propagation is influenced not only by the roof cover, but also by the substrate insulation and slope. Therefore, it is necessary to select constructions for evaluation that will demonstrate the performance of the roof cover when applied to a variety of roof insulation materials.

1.2 The applicant shall submit in the initial application all roof system assemblies requested over combustible and noncombustible decks. From this submission, the chief code compliance officer may list a limited number of roof system assemblies which will require external fire testing to represent all proposed assemblies.

1.3 Alternatively, the applicant may submit copies of its listing(s) from Underwriters Laboratories' Annual *Roofing Materials and Systems Guide*, Warnock Hersey's Annual *Certification Listing Guide*, and/or Factory Mutual Research Corporation's Annual *Approval Guide* or Quarterly *Supplement Approval Guide* to confirm those assemblies tested in compliance with ASTM E 108 (or UL 790). Copies of test reports from these organizations, or any other approved testing agency, are also acceptable.

2. Test Procedure:

2.1 The above deck combustibility tests shall be conducted in strict compliance with ASTM E 108 test procedure.

2.2 Testing in compliance with ASTM E 108 yields the following external fire ratings:

- Class 'A' external fire tests are applicable to roof coverings that are effective against severe exposure to external fire, afford a high degree of fire protection to the roof deck, do not slip from position, and do not present a flying brand hazard.
- Class 'B' external fire tests are applicable to roof coverings that are effective against moderate exposure to external fire, afford a moderate degree of fire protection to the roof deck, do not slip from position, and do not present a flying brand hazard.

2.3 A rating of Class 'A' or 'B' shall be obtained. Use of a Class 'C' external fire rated roof system assembly is extremely limited in the high-velocity hurricane zone jurisdiction.

2.4 Refer to Section 1516 of the *Florida Building Code, Building* for fire resistance roof covering requirements.

3. Evaluation of Results:

3.1 A minimum external fire rating of Class 'B' is required for approval of any roof system assembly.

TESTING APPLICATION STANDARD (TAS) 114-95
APPENDIX B

TEST PROCEDURE FOR SIMULATED DYNAMIC UPLIFT PRESSURE RESISTANCE OF MECHANICALLY ATTACHED ROOF SYSTEM ASSEMBLIES

1. Scope:

1.1 Loads incurred on roof systems assemblies generated from external wind, in combination with internal pressure, are dynamic in nature.

1.2 Damage incurred by the effects of wind over and internal pressure under a mechanically attached roof system assembly generally results in failure of the fastener/substrate combination, the fastener/insulation combination or the fastener/roof cover combination.

1.3 Thus, the dynamic nature of external wind and internal pressure loading on mechanically attached roof system assemblies, in combination with incurred damage to these assemblies, suggests that an instrument designed to measure the stability of roof system assemblies be equipped to evaluate fastener withdrawal from the substrate, roof cover blow-off from the substrate, the influence of the airtightness of the substructure on load transfer to the fasteners, and the effects of fastener fatigue when subjected to dynamic loading. The Dynamic Uplift Pressure Test Procedure has been designed for this purpose.

1.4 Testing under this test method is limited to mechanically attached roof system assemblies having a fastener row spacing not greater than 72 inches.

2. Terminology–the following definitions apply to the test procedure outlined herein.

2.1 P = the static positive pressure applied as a uniform load on the roof system assembly underside while dynamic loading is being applied from below.

2.2 Pd = the dynamic negative pressure ap plied as gusts of suction to the storage tank; the suction is noted as the instantaneous pressure measured at the air intake slit above the roofing membrane (see Figure B1, herein).

2.3 Failure = roof system assembly failure under this test standard could be one or more of the following:

- withdrawal or breakage of fasteners;
- tearing, splitting or other breakage of the roof cover at the point(s) of attachment;
- impairment of the waterproofing function of the roof systems assembly; or,
- permanent deformation of the roof cover or fastener assembly, including stress plate, which may reduce the waterproofing function of the roof system assembly over time.

3. Apparatus:

3.1 The test apparatus for determining dynamic wind-load resistance is shown in Figure B1, herein.

4. Test Limitations and Precautions:

4.1 Testing under this test method is limited to mechanically attached roof system assemblies having a fastener row spacing not greater than 72 inches.

4.2 During the test, all testing agency representatives and other test observers shall wear ear and eye protection and hard hats to prevent injury.

4.3 This test procedure may involve hazardous materials, operations and equipment. This protocol does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

5. Test Specimens:

5.1 The test specimen(s) shall be constructed in compliance with the manufacturer's current, published installation specifications and details for the roof system assembly under consideration for approval. If the fastener density or spacing for the roof system assembly varies, those having the lowest number of attachment points shall be tested.

5.2 Roof system assemblies whose wind-load resistance performance may be affected by bad weather conditions during installation shall be constructed in a manner which simulates actual working conditions.

6. Test Procedure:

6.1 Principal:

6.1.1 The roof system assembly test specimen is mounted between two air-tight boxes. A pressure difference is applied across the test specimen. Subsequent increasing pressure differences are applied until failure occurs.

6.2 A constant, positive static pressure (P) of 15 psf (718 Pa) shall be applied to the underside of the test specimen during all dynamic pressure intervals. This constant, positive static pressure shall be applied from the lower box of the test apparatus. See Figure B1, herein.

6.3 The dynamic pressure (Pd) is applied as gusts of suction in a $1^1/_8$ inches (30 mm) slit positioned above the roof cover and between fastener rows where insulation has been removed, resulting in initial upward deflection of the roof cover and non-axial loading at attachment points.

6.4 The dynamic pressure (Pd) gusts, as measured at the air intake slit above the roof cover, are applied in 60 minute time intervals with each interval having increasing pressure gusts as noted in Table B1, below.

6.5 Subsequent to each dynamic pressure interval, the apparatus shall be turned off and the test specimen shall be inspected for signs of failure.

6.6 The passing load interval shall be that which the roof system assembly resisted dynamic pressure (Pd) and static pressure (P) without failure for the 60 minute duration. The maximum allowable fastener density or spacing shall be that which was utilized in test specimen construction.

7. Calculations:

7.1 Determine the maximum uplift pressure (Pm):

7.1.1 The maximum uplift pressure shall be the passing dynamic pressure (Pd) interval, recorded subsequent to testing, plus the static pressure (P) applied to the underside.

$Pm = Pd + P$ where,

Pm = maximum uplift pressure (psf);

Pd = passing dynamic pressure (psf); and,

P = static pressure = 15 psf.

TABLE B1
DYNAMIC PRESSURE GUST INTERVALS

Load Interval[1]	Dynamic Pressure (Pd)	Load Interval[1]	Dynamic Pressure (Pd)
1	15 psf (718 Pa)	6	90 psf (4309 Pa)
2	30 psf (1436 Pa)	7	105 psf (5027 Pa)
3	45 psf (2154 Pa)	8	120 psf (5745 Pa)
4	60 psf (2872 Pa)	9	135 psf (6437 Pa)
5	75 psf (3590 Pa)	etc.	etc.

[1] Each load interval is 60 minutes long consisting of dynamic pressure gust loading every 15 seconds.

7.2 Determine the fastener assembly design value (dv) using the maximum uplift pressure (Pm), achieved during testing, and the maximum allowable fastener density or spacing utilized for test specimen construction.

$$dv = \frac{Pm \times l \times w}{n}$$ where,

dv = fastener assembly design value (lbf);

Pm = maximum uplift pressure (psf);

l = length of test specimen (ft);

w = width of test specimen (ft); and,

n = number of fasteners.

8. Interpretation of Results:

8.1 The maximum allowable fastener density or spacing utilized for test specimen construction relates directly to the maximum uplift pressure (Pm), determined in Section 7.1.

8.2 A 2:1 margin of safety shall be applied to the maximum uplift pressure (Pm) determined in Section 7.1.

8.3 The fastener assembly design value (dv) determined from dynamic uplift testing may be used to alter the maximum allowable fastener density or spacing through data extrapolation, in compliance with RAS 137 (for single-ply membrane attachment), to meet design pressures for a specific building. Only 'upward' extrapolation is acceptable (i.e. fastener density may not be decreased and fastener spacing may not be increased for lesser design pressures).

9. Report:

9.1 The final test report shall include the following:

9.1.1 A description of the roof system assembly test specimen, including the manufacturer of all components, a description of all components and the method of test specimen construction (including the fastener density or spacing).

9.1.2 A copy of the published application instructions provided by the roof system assembly manufacturer.

9.1.3 A description of the test apparatus.

9.1.4 A record of all observations noted during inspections subsequent to each dynamic pressure interval, including the final mode of failure.

9.1.5 The dynamic pressure interval, and time within the interval, at which the test specimen failed. If failure was not observed until the end of the dynamic pressure interval, record only the 'failure interval.'

9.1.6 A copy of the calculations from Section 7 and the results thereof.

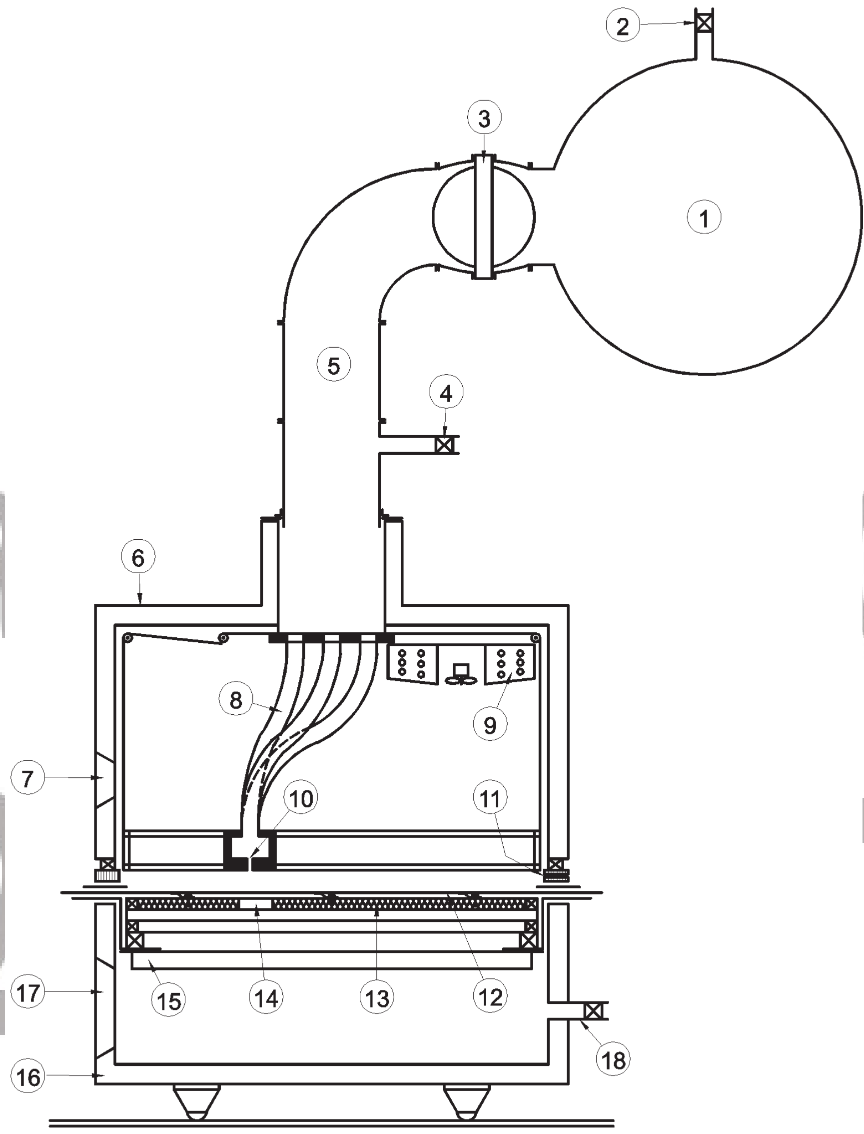


FIGURE B1
DYNAMIC UPLIFT TEST APPARATUS

1. Storage tank (388 cubic feet) for air at low pressure
2. Connection to fan for air evacuation
3. Valve to operate dynamic suction
4. Connection to fan operating pulsating suction for standard wind load testing
5. Main air duct
6. Upper box
7. Inspection window
8. Flexible air tubes (7 with 6-inch diameter)
9. Air cooler
10. $1^1/_8$ inch: air intake slot
11. Holes to equalize pressure after gust
12. Roof cover with fasteners
13. Roof deck with insulation
14. Section without insulation
15. Steel frame
16. Lower box
17. Inspection manhole
18. Connection to fan operating static pressure for standard wind load testing.

TESTING APPLICATION STANDARD (TAS) 114-95
APPENDIX C

TEST PROCEDURE FOR SIMULATED UPLIFT PRESSURE RESISTANCE OF ROOF SYSTEM ASSEMBLIES

1. Scope:

1.1 Damage incurred by the effects of wind over and internal pressure under a totally adhered, partially adhered or mechanically attached roof system assembly generally results in one or more of the following:

- Uplift of the cover (when totally adhered);
- Delamination within the roof insulation cover (when totally or partially adhered);
- Failure of adhesive between the insulation and the deck or between the insulation and the vapor retarder and/or between the vapor retarder and the deck; and,
- Failure of the fastener/substrate, fastener/insulation or fastener/roof cover combination.

1.2 Thus the nature of the damage incurred would suggest that an instrument designed to measure the stability of roof assemblies be equipped to evaluate bond strength indicated in the items above. The Uplift Pressure Test has been designed for this purpose.

1.3 This procedure is not applicable to mechanically attached roof system assemblies having a batten or fastener row spacing greater than 48 inch (1.2 m) o.c. or a spot/grid attachment density greater than 8 square feet (0.7432 m^2) per fastener.

2. Terminology–the following definitions apply to the test procedure outlined herein.

2.1 Failure: Roof system assembly failure under this test standard could be one or more of the following:

- withdrawal or breakage of fasteners;
- tearing, splitting or other breakage of the roof cover at the point(s) of attachment;
- impairment of the waterproofing function of the roof systems assembly (i.e. cracking of components within the assembly);
- permanent deformation of the roof cover or fastener assembly, including stress plate, which may reduce the waterproofing function of the roof system assembly over time; and,
- delamination or separation of adhered areas.

3. Apparatus:

3.1 The uplift pressure apparatus is a steel pressure vessel arranged to supply air pressure at pre-established standard rates to the underside of the roof system assembly test specimen which forms the top of the test apparatus.

3.2 The pressure vessel measures 9 feet long by 5 feet wide by 2 inches deep (2.7 m by 1.5 m by 51 mm) (See Figures C1 and C2, herein).

3.3 A $^3/_4$ inch (19 mm) opening is supplied in one 9 foot (2.7 m) side for an air supply inlet. A $^1/_4$ inch (6 mm) opening in the opposite 9 foot (2.7 m) side serves as a manometer connection. A rubber gasket that lies between the top angle of the pressure vessel and the test assembly minimizes air leakage when the sample is clamped on.

3.4 Air pressure is supplied through the use of an air compressor (5 horse power electric motor, 1200 rpm) in conjunction with a 21 foot (6.4 m) section of 12 inch (305 mm) pipe which serves as a reservoir. Pressure readings are obtained from a water-filled, or other type of, manometer, calibrated to read directly in pounds per square foot (kg/m^2).

4. Test Limitations and Precautions:

4.1 During the test, all testing agency representatives and other test observers shall wear ear and eye protection and hard hats to prevent injury.

4.2 This test procedure may involve hazardous materials, operations and equipment. This protocol does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

5. Test Specimens:

5.1 The components for a proposed test panel are assembled to the desired specifications and details (gauge of steel, application method and rate for the adhesives or fasteners, size and thickness of insulation, type of cover) and then left to "cure" for a specified time period.

5.1.1 Test specimens assembled in hot asphalt shall be allowed to cure for not less than 24 hours prior to testing.

5.1.2 Test specimens assembled in cold adhesive shall be allowed to cure for not less than 28 days prior to testing, with the exception of the preliminary four day testing noted in Section 8.3.1.2 of TAS 114.

5.1.3 Test specimens assembled over lightweight concrete deck substrates shall be constructed seven days after the deck is poured and shall be tested on the 28th day.

5.2 If the test specimen is a totally or partially adhered roof system assembly, the test specimen shall be tested to 30 psf (1.4 kPa) after a 4 day laboratory cure time at ambient conditions. If the test specimen fails to resist this initial test pressure, the test shall be discontinued. Upon passing this initial testing, the test specimen shall be allowed to cure for the remaining cure time.

5.3 When ready for testing, the panel is placed on top of the uplift pressure apparatus. A $^{7}/_{8}$ inch (22 mm) thick, 2 inch (51 mm) wide board is placed around the perimeter of the sample followed by 2 inch by 3 inch (51 mm by 76 mm) metal angles (smaller dimension horizontal). Five C-clamps are securely attached on each 9 feet (2.7 m) edge three along each 5 foot (1.4 m) edge. The appropriate hose connections are then made to the air supply and manometer.

5.4 Not less than three test specimens shall be constructed for each roof system assembly being tested.

5.5 Roof system assemblies whose wind-load resistance performance may be affected by bad weather conditions during installation shall be constructed in a manner which simulates actual working conditions.

6. Test Procedure:

6.1 Principal:

6.1.1 The roof system assembly test specimen is mounted on the test apparatus. A pressure difference is applied across the test specimen. Subsequent increasing pressure differences are applied until failure occurs. Three roof system assembly test specimens shall be tested and the average passing load reported.

6.2 After the test specimen is mounted on the test apparatus, compressed air is introduced beneath the sample in accordance with Table C1, below:

TABLE C1
UPLIFT PRESSURE INTERVALS

Time (Minutes)	Static Uplift Pressure	
	psf	kPa
0:01 to 1:00	30.00	1.40
1:01 to 2:00	45.00	2.20
2:01 to 3:00	60.00	2.90
3:01 to 4:00	75.00	3.60
4:01 to 5:00	90.00	4.20
5:01 to 6:00	105.00	4.90
6:01 to 7:00	120.00	5.70
7:01 to 8:00	135.00	6.50
8:01 to 9:00	150.00	7.20

[1] Add 15 psf (0.7 kPa) for each successive one minute interval.

6.3 Prior to and during the attainment of the uplift pressures noted above, the test specimen is examined for failure. Upon failure, the test specimen is dismantled and examined to determine the exact mode of failure.

6.4 Record the mode, time and pressure interval of failure.

6.5 Repeat Sections 6.2 through 6.4 for each of three test specimens.

7. Interpretation of Results:

7.1 The passing uplift pressure shall be the average of the three pressures which the test specimens resisted for one minute without failure. If one or more of the three tests yields a passing uplift pressure greater or less than 15 percent of other recorded values, an additional test shall be conducted.

7.2 The minimum passing uplift pressure for an approved roof system assembly shall be 90 psf (4.2 kPa).

7.3 A 2:1 margin of safety shall be applied to the passing uplift pressure prior to inclusion in the system manufacturer's Product Approval.

7.4 Average wind velocities can vary considerably from area to area. The *Florida Building Code, Building* utilizes a windspeed as noted in Section 1620.2. These wind velocities in miles per hour are related to the design pressure, in pounds per square feet (kg/m^2), for a particular building. Refer to Chapter 16 (High-Velocity Hurricane Zones) of the *Florida Building Code, Building* and ASCE 7.

7.5 No extrapolation of resulting data will be accepted.

8. Report:

8.1 The final test report shall include the following:

8.1.1 A description of the roof system assembly test specimen, including the manufacturer of all components, a description of all components and the method of test specimen construction (including the fastener density or spacing and/or asphalt or adhesive application rate).

8.1.2 A copy of the published application instructions provided by the roof system assembly manufacturer.

8.1.3 A description of the test apparatus.

8.1.4 A record of all observations noted during each test during each pressure interval, including the final mode(s) of failure.

8.1.5 The pressure interval, and time within the interval, at which each test specimen failed.

8.1.6 The passing uplift pressure for each test specimen and the calculated average passing uplift pressure from the three tests. If additional tests are conducted to maintain the +15 percent criteria, record results from all additional testing.

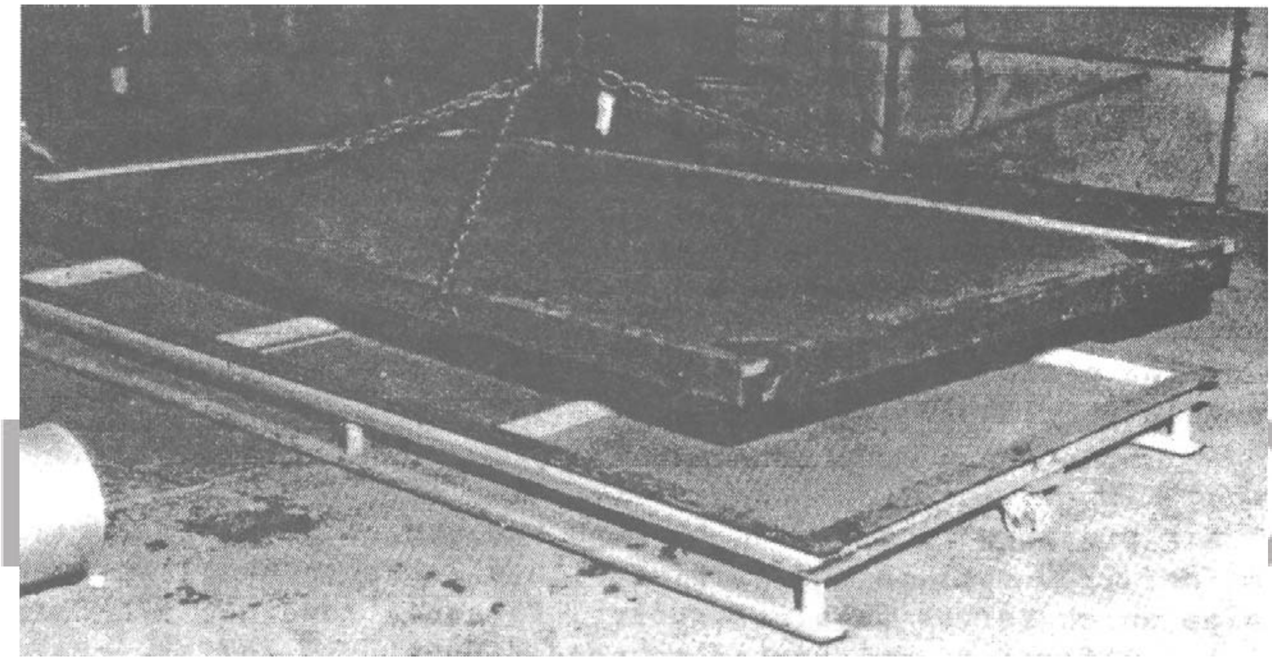


FIGURE C1
UPLIFT PRESSURE TEST APPARATUS

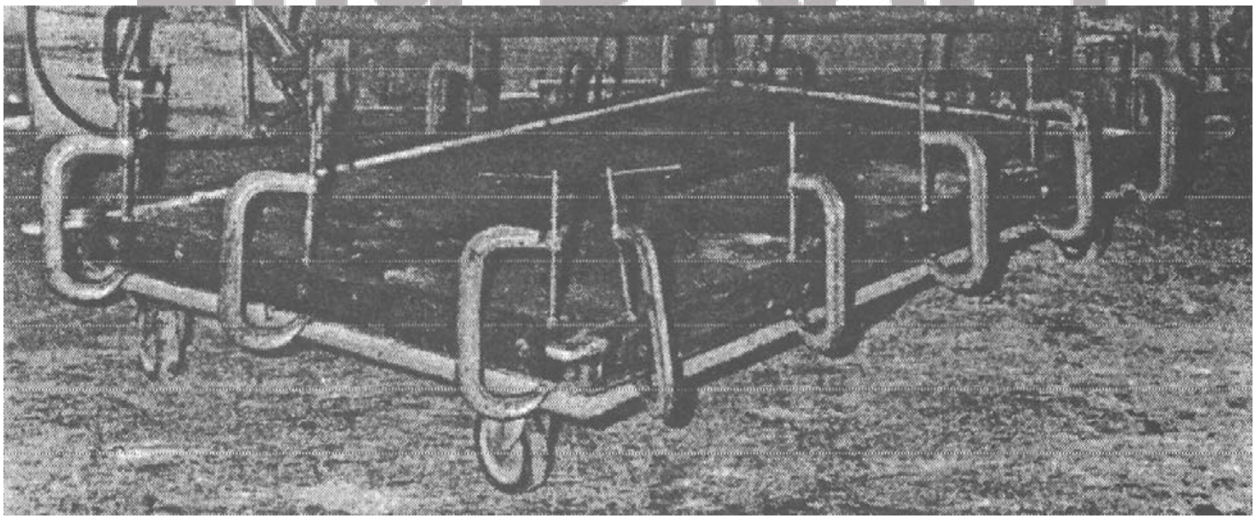


FIGURE C2
UPLIFT PRESSURE TEST SPECIMEN MOUNTED IN TEST

TESTING APPLICATION STANDARD (TAS) 114-95
APPENDIX D

TEST PROCEDURE FOR SIMULATED UPLIFT PRESSURE RESISTANCE OF ADHERED ROOF SYSTEM ASSEMBLIES

1. Scope:

1.1 In situations where the uplift pressure test procedure described in Appendix B, C or J is not applicable, especially for liquid/spray applied roof constructions, the following test procedure may be used as an alternate method for evaluation of uplift resistance of the roof construction.

2. Terminology–the following definitions apply to the test procedure outlined herein.

2.1 Failure = roof system assembly failure under this test standard could be one or more of the following:

- tearing, splitting or other breakage of the roof cover;
- impairment of the waterproofing function of the roof systems assembly (i.e. cracking of components within the assembly);
- permanent deformation of the roof cover, which may reduce the waterproofing function of the roof system assembly over time; and,
- delamination or separation of adhered areas.

3. Apparatus:

3.1 The uplift pressure apparatus is a 2 foot by 2 foot by $1^1/_2$ inch (0.6 m by 0.6 m by 39 mm) plywood square containing a centrally located eyebolt secured to the top of the test panel. The plywood square is bonded to the top surface of the roof system assembly test specimen.

3.2 A load cell, or other force sensing device, is positioned in line and connected to the eyebolt. The opposite end of the load cell is attached to a chain-hoist assembly. Prior to testing, the load cell shall be calibrated such that the downward force incurred by the test apparatus mass is eliminated from recorded load values.

3.2 A minimum 2 inch (51 mm) wide strip is cut around and adjacent to the perimeter of the plywood down through the insulation to the deck.

4. Test Limitations and Precautions:

4.1 During the test, all testing agency representatives and other test observers shall wear ear and eye protection and hard hats to prevent injury.

4.2 This test procedure may involve hazardous materials, operations and equipment. This protocol does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

5. Test Specimens:

5.1 The components for a proposed test panel are assembled to the desired specifications and details (gauge of steel, application method and rate for the adhesives, size and thickness of insulation, type of cover) and then left to "cure" for a specified time period.

5.2 The test specimen shall be tested to 30 psf (1.4 kPa) after a 4 day laboratory cure time at ambient conditions. If the test specimen fails to resist this initial test pressure, the test shall be discontinued. On passing this initial testing, the test specimen shall be allowed to cure for the remaining cure time.

5.3 If insulation panels for part of the test specimen, a panels shall be installed such that a three way joint is located in the center of the test specimen. If more than one layer of insulation forms part of the test specimen, the top layer shall employ the three way joint.

5.4 Roof system assemblies whose wind-load resistance performance may be affected by bad weather conditions during installation shall be constructed in a manner which simulates actual working conditions.

6. Test Procedure:

6.1 Principal

6.1.1 The test apparatus is secured to the roof system assembly test specimen which is cut around the perimeter of the test apparatus. Thereafter, an uplift load is applied to the test apparatus which distributes the load over its area. The distributed load is transferred to the test specimen. Subsequent increasing uplift loads are applied until failure occurs.

6.2 Once the test specimen has cured and the test apparatus is secured, uplift loads are applied through the test apparatus in accordance with Table D1, below:

6.3 Prior to and during the attainment of the uplift pressures noted above, the test specimen is examined for failure. On failure, the test specimen is dismantled and examined to determine the exact mode of failure.

6.4 Record the mode, time, and pressure interval of failure.

7. Interpretation of Results:

7.1 The passing uplift pressure shall be the pressure which the test specimen resisted for one minute without failure.

7.2 The minimum passing uplift pressure for an approved roof system assembly shall be 90 psf (4.2 kPa).

7.3 A 2:1 margin of safety shall be applied to the passing uplift pressure prior to inclusion in the system manufacturer's Product Approval.

7.4 Average wind velocities can vary considerably from area to area. The *Florida Building Code, Building* utilizes a windspeed as noted in section 1620.2. These wind velocities in miles per hour are related to the design pressure, in pounds per square feet (kg/m^2), for a particular building. Refer to Chapter 16 (High-Velocity Hurricane Zones) of the *Florida Building Code, Building* and ASCE 7.

7.5 No extrapolation of resulting data will be accepted.

8. Report:

8.1 The final test report shall include the following:

8.1.1 A description of the roof system assembly test specimen, including the manufacturer of all components, a description of all components and the method of test specimen construction.

8.1.2 A copy of the published application instructions provided by the roof system assembly manufacturer.

8.1.3 A description of the test apparatus.

APPARATUS TABLE D1
UPLIFT LOAD INTERVALS AND CORRESPONDING PRESSURES

Time (Minute)	Load		Pressure	
	lbf	N	psf	kPa
0:01 to 1:00	120	534	30	1.4
1:01 to 2:00	180	801	45	2.2
2:01 to 3:00	240	1067	60	2.9
3:01 to 4:00	300	1334	75	3.6
4:01 to 5:00	360	1601	90	4.2
5:01 to 6:00	420	1868	105	4.9
6:01 to 7:00	480	2135	120	5.7
7:01 to 8:00	540	2402	135	6.5
8:01 to 9:00	600	2670	150	7.2

1 Add 60 lbf (N) from each successive one minute interval.

8.1.4 A record of all observations noted during each pressure interval, including the final mode of failure.

8.1.5 The pressure interval, and time within the interval, at which the test specimen failed.

TESTING APPLICATION STANDARD (TAS) 114-95
APPENDIX E

TEST PROCEDURE FOR CORROSION RESISTANCE OF FASTENERS, BATTEN BARS AND STRESS DISTRIBUTION PLATES

1. Scope:

1.1 The corrosion test procedure is designed to assess the potential damage to nails, metal fasteners, batten bars and stress distribution plates used for mechanically attached roof covers and/or attachment of insulation. There is no single test procedure that approximates all climactic conditions experienced by roofing components; however, tests are available that provide an indication of potential resistance to corrosion.

1.2 All nails and carbon steel fasteners shall be tested for corrosion resistance in compliance with ASTM Standard Practice G 85 [(Modified Salt Spray (Fog) Testing)], Annex A5 (Dolute Electrolyte Cyclic Fog/Dry Testing) as modified for the *Florida Building Code, Building* and noted in Section 2, herein.

1.3 All batten bars, stress distribution plates, and other metal fastener types shall be tested for corrosion resistance in compliance with DIN 50018 as noted in Section 3, herein.

2. ASTM G 85–All nails and carbon steel fasteners shall be tested for corrosion resistance in compliance with ASTM Standard Practice G 85 except as noted below.

2.1 Salt solution:

2.1.1 The salt solution shall consist of an electrolyte solution of 0.05 percent sodium chloride and 0.35 percent ammonium sulfate by mass.

2.1.2 The water and sodium chloride shall meet the purity requirements of Section 6 of ASTM G 85. The ammonium sulfate shall contain not more than 0.3 percent total impurities.

2.2 Conditions in the salt fog chamber:

2.2.1 One cycle shall consist of 1 hour fog followed by 1 hour dry-off.

2.2.2 During the fog period, the chamber shall be at ambient room conditions [(i.e. 75 + 6°F (24 + 3°C)].

2.2.3 During the dry-off period, the temperature throughout the exposure zone shall reach and remain at 95 + 3°F (35 + 1.5°F) within 3/4 hour of switching from the fog period to the dry period.

2.2.3.1 The dry-off shall be achieved by purging the chamber with fresh air, such that within 3/4 hour all visible moisture is dried off the specimens.

2.2.3 The pH of the collected solution shall range between 5.0 and 5.4, as measured in compliance with ASTM E 70.

2.3 Saturation Tower:

2.3.1 This test does not use humidified air; therefore, one of the following methods shall be utilized to avoid humidifying the air.

- Empty the saturation tower and ensure that the tower heaters are tuned off; or,
- Arrange the spray plumbing so that the atomizing air does not go through the saturation tower, but goes directly to the spray nozzle.

2.4 Atomization and quantity of fog:

2.4.1 Collect the fog in a special continuous spray run of at least 16 hours, performed between test runs. The regular spray periods of 1 hour are not long enough for collecting sufficient fog to make accurate determinations of deposition rate. See Section 4.3.2 of ASTM G 85 for instructions on fog collection.

2.5 Cabinet modification:

2.5.1 In order to achieve the temperature changes for this test, modifications or additions to the ASTM Test Standard B 117 apparatus may be required. These may include modifications to:

- exposure chamber;
- temperature controls;
- air flow apparatus;
- insulation; and,
- means for conditioning the heated air in the chamber or water in the jacket.

2.5.2 Two manufacturers of cabinets which meet the needs of this test are:

- Arotech—Cleveland, Ohio
- Q Panel—Cleveland, Ohio

2.5.3 Consult the cabinet manufacturer for any additional information or suggestions for cabinet modification to meet the needs of this test.

2.6 Period of time:

2.6.1 The acetic acid-salt spray (fog) test shall be conducted for 140 cycles for nails and 180 cycles for carbon steel fasteners, where one cycle consists of 1 hour fog and 1 hour dry-off. Continuous operation implies that the chamber be closed except for the short daily interruptions necessary to inspect, rearrange, or remove test specimens, and to check and replenish the solution in the reservoir. Schedule operations so that these interruptions are held to a minimum.

2.6.1.1 Any test specimen which exhibits corrosion on an area in excess of 5 percent of its total surface area shall be considered as failing the corrosion resistance test. It shall be the responsibility of the testing agency representative to conduct an objective visual examination of the test specimen regarding its percentage of corroded or rusted area.

2.6.2 As an alternate, the test specimen may be tested along side a 'control' specimen consisting of 'wire,' of similar type and diameter as the test specimen, which is zinc-coated (galvanized), in compliance with ASTM A 641, to a zinc-coating weight of not less than 0.28 ounces per square feet (0.00073 kg/m^2), as measured in compliance with ASTM A 90.

2.6.2.1 The test specimen and control specimen (noted in Section 2.4.2) shall be tested concurrently until:

- The test specimen exhibits visually notable signs of corrosion while the control specimen does not;
- The control specimen exhibits visually notable signs of corrosion while the test specimen does not; or,
- If the test and control specimens exhibit equivalent signs of corrosion during the test, the test shall continue for 140 continuous cycles.

2.6.2.2 Any test specimen which exhibits visually notable signs of corrosion prior to the control specimen shall be considered as failing the corrosion resistance test. It shall be the responsibility of the testing agency representative to conduct an objective visual examination of the test and control specimens regarding corrosion or rusting.

2.6.2.3 If it becomes necessary to test for the full 140 cycles, the criteria shall be as noted in Section 2.6.1.1.

2.6.3 The cabinet manufacturer Q Panel (Cleveland, Ohio), noted above, also provides metal wire samples of various diameters which are coated and measured in compliance with Section 2.6.2 and can be used as control specimens.

3. **DIN 50018**–All batten bars, stress distribution plates, and other fastener types shall be tested for corrosion resistance in compliance with DIN 50018.

3.1 Duplicate tests are conducted in accordance with the DIN 50018 Standard Kesternick Test (2.01) on samples prepared first with fasteners (other than nails) installed in: 1) minimum 22 gage steel deck; 2) minimum 3000 pounds per square inch (20 685 kPa) concrete; or, 3) minimum $^3/_4$ inch thick plywood (where applicable).

3.2 For concrete and plywood samples, the fasteners are removed from the substrate before testing. Each sample is subjected to 15 cycles of exposure. Batten bars and plates shall also meet these requirements.

3.3 Evaluation of DIN 50018 results:

3.3.1 The fastener, stress distribution plate and/or batten bar shall not show more than 15 percent of the surface area rusted. Coatings covering these components shall not blister, peel or crack. It shall be the responsibility of the testing agency representative to conduct an objective visual examination of the test specimen regarding its percentage of corroded or rusted area and/or the degradation of any coatings.

TESTING APPLICATION STANDARD (TAS) 114-95
APPENDIX F

TEST PROCEDURE FOR SUSCEPTIBILITY TO HAIL DAMAGE FOR ROOF SYSTEM ASSEMBLIES

1. Scope:

1.1 Simulated hail damage test procedures are designed to assess the potential for damage to roof system assemblies when adhered directly to insulation, lightweight concrete roof decks, structural concrete roof decks, gypsum decks or fire-treated wood roof decks. The procedures were developed to determine the potential for puncture of the roof cover resulting from hail storms when the roof cover is applied over its tested substrate within an approved assembly.

1.2 Due to the variable severity of potential damage resulting from hail storms in different geographic areas, two separate hail damage tests are used. The tests yield ratings identified as Class 'SH' (Severe Hail Damage Resistant) and Class 'MH' (Moderate Hail Damage Resistant).

2. Description of Test Apparatus:

2.1 *Class 'SH'*—The test apparatus consists of a plastic tube 2 inches (51 mm) inside diameter, supported above the sample. A steel ball $1^3/_4$ inch (45 mm) in diameter, weighing 0.79 pounds (3.5 N) is dropped from a height of 17 feet $9^1/_2$ inches (5.4 m) onto the sample. This procedure is repeated 10 times on various sections of the sample. This procedure generates an impact energy of approximately 14 pounds per feet (19 J) over the impact area of a $1^3/_4$ inch (45 mm) diameter ball.

2.2 *Class 'MH'*-The test apparatus consists of a steel tube $2^1/_4$ inches (57 mm) inside diameter supported vertically above the sample by a tripod. Holes are drilled in the steel tube to allow the release mechanism to be adjusted for the proper drop height. A steel ball 2 inches (51 mm) in diameter, weighing 1.625 pounds (737 g) is dropped from a height of 5 feet (1.5 m) through the tube onto the sample. This procedure is repeated 10 times on various sections of the sample. This procedure generates an energy of approximately 8 pounds per feet (10.8 J) over the impact area of a 2 inch (51 mm) diameter ball.

3. Test Procedure:

3.1 Two identical roof cover samples, 2 feet by 4 feet (0.6 m by 1.2 m) are selected from the material to be tested. The first sample is prepared with the roof cover applied to the selected insulation substrate(s) or adhered directly to the appropriate roof deck in accordance with the manufacturer's specifications. After preparation, the sample is conditioned for up to 28 days (laboratory cure). For materials supplied as sheets or rolls, the sample shall incorporate a field seam within the assembly, in the center and running parallel to the 4 foot (1.2 m) side. The second sample is loose laid over the matching substrate or roof deck. Both samples are subjected to initial testing. The $1^3/_4$ inch (45 mm) diameter steel ball is dropped onto the sample from a height of 17 feet $9^1/_2$ inches (5.4 m) for a Class 'SH' rating, or the 2 inch (51 mm) diameter ball is dropped onto the sample from a height of 5 feet (1.5 m) for a Class 'MH' rating. A minimum of ten drops of the impactor is required, five of which shall be on the field-fabricated seam, if appropriate. The samples are then removed and inspected for damage.

3.2 A piece of loose laid sample 12 inch by 24 inch (305 mm by 610 mm) is cut from the original sample, and then further conditioned (weathered) for 1000 hours in a fluorescent ultraviolet condensation-type weathering apparatus using the ASTM G 53 Test Method. After weathering, the impact test procedure is repeated. The sample is then removed and inspected for damage.

4. Evaluation of Results:

4.1 The roof cover shall not show any signs of cracking or splitting. The field seam shall not show any signs of cracking, splitting, or separation or rupture when examined closely under a 10x magnification. The cover thickness shall be checked at the points of impact.

TESTING APPLICATION STANDARD (TAS) 114-95
APPENDIX G

TEST PROCEDURE FOR SUSCEPTIBILITY TO LEAKAGE FOR ROOF SYSTEM ASSEMBLIES

1. Scope:

1.1 The Susceptibility to Leakage Test Procedure is designed to assess the potential for water migration when the cover is fabricated with a typical lap seam or perimeter detail.

2. Description of Test Apparatus

2.1 The test apparatus consists of top and bottom sections that are bolted together with the specimen being evaluated placed as a diaphragm between the sections. The top section consists of a $9^{1}/_{4}$ inch (203 mm) diameter cap which has two $^{1}/_{2}$ inch (13 mm) diameter threaded inlet holes. This top cap is cemented to a $5^{3}/_{4}$ inch (146 mm) length of $7^{3}/_{4}$ inch (1197 mm) diameter clear acrylic pipe which is cemented to an $11^{5}/_{8}$ inch (295 mm) diameter pipe flange. The bottom section consists of a $9^{1}/_{4}$ inch (235 mm) cap which has two $^{1}/_{2}$ inch (13 mm) diameter threaded inlet holes. The bottom cap is cemented to a $5^{7}/_{8}$ inch (149 mm) length of $7^{3}/_{4}$ inch (197 mm) diameter clear acrylic pipe which is cemented to an $11^{5}/_{8}$ inch (295 mm) diameter pipe flange.

2.2 Both top and bottom sections are bolted together at the flanges with the cover being evaluated between them. The top and bottom caps are fabricated to allow a standing head of water above and additional air pressure above and below. Each section is fabricated with two $^{1}/_{2}$ inch (13 mm) diameter pipe outlets to allow connection of an air pressure inlet and pressure gauge.

3. Test Procedure:

3.1 An 18 inch (457 mm) diameter sample is prepared with the roof cover. This specimen is prepared with a field seam and/or penetration detail included and running along the diameter of the sample. The completed sample is conditioned (weathered) for 288 hours (minimum) in an Ultraviolet Weatherometer before being cut to a 10 inch (254 mm) diameter size.

3.2 The 10 inch (254 mm) diameter specimen is then bolted in place between the flanges of the test apparatus. Water is then placed over the sample to a depth of 6 inches (152 mm) and maintained for a period of 7 days. At the end of the 7 day period, air is introduced below the water to a 1 pound per square inch (6.8 kPa) level and cycled 25 times from 1 pounds per square inch (6.8 kPa) level and cycled 25 times from 1 pounds per square inch (6.8 kPa) to ambient.

4. Evaluation of Results:

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

TESTING APPLICATION STANDARD (TAS) 114-95
APPENDIX H

TEST PROCEDURES FOR SMALL SCALE QC AND PHYSICAL PROPERTIES OF APPROVED ROOF SYSTEM ASSEMBLIES

1. Scope:

1.1 The following series of small scale tests are designed to allow monitoring of quality controls exercised in the manufacture of single-ply roof covers and/or to characterize individual materials. In addition, they may be used to assess certain physical characteristics necessary for the continued performance of a cover assembly when installed within a construction. It may not be appropriate to require all tests for each construction. A preliminary decision shall be made as to which tests will be required. The decision will be based on several factors: e.g., (a) from what basic material or polymer is the roof membrane fabricated; (b) how is the roof membrane applied; (c) how is the roof membrane secured; (d) to what substrates is the roof membrane applied, etc.

2. Delamination Test:

2.1 The roof membrane is applied to the top surface of an insulation sample in accordance with the manufacturer's specifications and allowed to cure for the specified period of time, maximum 28 days. This assembly is then cut into 6 inch by 6 inch (152 mm by 152 mm) pieces prior to assembly of the test specimen. Plywood, 6 inch by 6 inch by $^3/_4$ inch (152 mm by 152 mm by 19 mmm), is adhered to the top and bottom surface of the prefabricated specimen with a compatible adhesive. A steel plate, 6 inch by 6 inch by $^1/_2$ inch thick (152 mm by 152 mm by 13 mm), is fastened to the plywood facers with four #12, $1^1/_4$ inch diameter by 6 inch (152 mm) long bolts on each plate. Force is exerted in a direct line parallel to the shank of the bolt at a constant machine speed of 2 inch (51 mm) per minute. A minimum of three tests must be conducted on each selected substrate. The ultimate average load of failure is then determined.

3. Peel Test (ASTM D 1781):

3.1 The roof membrane is applied to the top surface of an insulation sample in accordance with the manufacturer's specifications such that a minimum 1 inch (25 mm) extends beyond the edge of the rigid insulation after cutting and trimming. The top 3 inches (76 mm) of the cover is not adhered to the insulation substrate. The sample is allowed to cure for the specified time, maximum 28 days. The assembly is cut into 3 inch (76 mm) by 12 inch (305 mm) pieces with the 1 inch (25 mm) excess cover at each 3 inch (76 mm) end. The top edge is held with a suitable clamp and the bottom edge is clamped to the peel drum tester.

3.2 The specimen and test apparatus are then suspended from the top head of the testing machine. A peel of at least 6 inches (152 mm) of the cover is then made with the machine speed set at 1 inch (25 mm) per minute. A minimum of 3 tests shall be conducted on each selected substrate. The average peeling load required to peel the facing is then calculated in pound per inch of peel torque.

4. Tensile Test (ASTM D 1781):

4.1 ASTM D 638 — The roof cover is cut according to ASTM D 638 Type IV. The specimen is clamped into the upper and lower jaws of the tensile testing machine, with the machine speed set at 20 inches per minute (8.5 mm/s). Determination of stress is conducted at 100 percent, 200 percent, and 300 percent elongation as well as ultimate failure (if possible). A minimum of 3 tests shall be conducted.

4.2 ASTM D 751 — The roof cover is fabricated with a field seam according to the manufacturer's specifications before being cut according to ASTM D 751 seam strength determination instructions. The specimen is clamped into the upper and lower jaws of the tensile testing machine, with the machine speed set at 12 inch per minute (5 mm/s). Determination of stress is conducted at 100 percent, 200 percent, and 300 percent elongation, as well as at ultimate failure (if possible). A minimum of 3 tests shall be conducted.

TESTING APPLICATION STANDARD (TAS) 114-95
APPENDIX I

TEST PROCEDURE FOR STATIC AND DYNAMIC PUNCTURE RESISTANCE OF ROOF SYSTEM ASSEMBLIES

1. Scope:

1.1 The test procedures outlined herein cover the maximum static and dynamic puncture loads which roofing membrane samples can withstand without allowing the passage of water due to puncture. Membrane samples are subjected to both static and dynamic puncture loads from a rigid object having a sharp edge to determine their puncture resistance performance.

1.2 This laboratory test is conducted at any desired temperature using sheet membrane samples manufactured in a factory or prepared in a laboratory.

1.3 Roof membrane samples to which the method is applicable include bituminous built-up, polymer-modified bitumen, vulcanized rubber, non-vulcanized polymeric, and thermoplastic materials. The method is not applicable to aggregate-surfaced membrane samples.

2. Terminology:

2.1 *Definitions*—For definitions of terms, refer to ASTM D 1079 or Chapter 2 and Section 1513 of the *Florida Building Code, Building*. The definitions from the *Florida Building Code, Building* shall take precedence.

3. Significance and Use:

3.1 An important factor affecting the performance of membrane roof system assembly is their ability to resist static and/or dynamic puncture loads. The test procedures outlined herein provide a means to assess static and dynamic puncture resistance.

3.2 The methods can be used to compare the puncture resistance of a single type of membrane sample as a function of a variety of insulation substrates or, conversely, to compare the resistance of a number of membrane samples set on a single type of insulation.

3.3 The effect of temperature on puncture resistance can be studied by conducting the test under controlled conditions using such equipment as an environmental chamber, oven, or freezer.

3.4 The methods can be useful in developing puncture resistance performance criteria and/or classifications for membrane roof system assemblies.

4. Apparatus:

4.1 Static puncture test

4.1.1 The static puncture test apparatus shall consist primarily of a movable rod to which a $^3/_8$ inch (10 mm) diameter ball bearing is attached at one end and a means for loading the specimen is attached to the other. The static puncture test apparatus is shown in Figure I1, herein.

4.1.2 One means for static puncture loading is to attach to the movable rod a platform on which deadweights are placed. Alternatively, pneumatic loading may be used whereby the ball bearing is attached to the movable rod and the load is measured by an air pressure gauge which has been calibrated against a load cell.

4.1.3 The length of the rod above the specimen shall be not less than 3.9 inch (100 mm). A framework, having a minimum width of 9.8 inches (250 mm), supports the rod perpendicular to the surface of the test specimen. Free vertical movement of the rod shall not be hindered by the framework. The rod and framework shall be capable of supporting loads up to 56 lbf (250 N).

4.2 Dynamic puncture test:

4.2.1 The dynamic puncture test apparatus shall consist primarily of a heavy base, a falling arm and a puncture head. The dynamic puncture test apparatus is shown in Figure I2, herein.

4.2.2 The falling arm shall be attached to the base such that it can rotate freely (e.g. using ball bearings) from a vertical to a horizontal position. The length of the arm shall be 1.7 feet (0.51 m).

4.2.3 The shape and dimensions of the puncture head are shown in Figure I3, herein Several heads of differing mass may be needed. Alternatively, a means of adding mass to a given puncture head may be utilized. The puncture head and additional masses shall constitute a continuous series of mass from 2.2 to 22.0 pounds (1 to 10 kg) in 1.1 pounds (0.5 kg) increments. The mass of the puncture head for any given test shall be within + 5 percent of that selected.

4.2.4 When mounted on the rotating arm, the face of the puncture head shall be parallel to the arm's axis of rotation. When the puncture head contacts the membrane surface, the rotating arm shall be horizontal.

4.2.5 The apparatus shall incorporate a mechanism which allows the puncture head to remain stationary when in an upright position, forming an angle with the vertical of not greater than 5 degrees. The mechanism shall allow for release of the arm such that is falls freely from gravitational forces only. A vacuum release mechanism has been found suitable for this purpose.

4.2.6 The apparatus base, on which the rotating arm and puncture head are mounted, shall be placed on a horizontal surface such that no movement occurs when the test is conducted at maximum impact energy.

4.2.7 The membrane test specimen shall be held in place over the substrate with a square frame having minimum exterior and interior dimensions of 9.8 inches (250 mm) and 7.9 inches (200 mm), respectively.

5. Test Limitations and Precautions:

5.1 This test procedure may involve hazardous materials, operations and equipment. This Protocol does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

6. Test Specimens:

6.1 Sampling–single-ply specimens:

6.1.1 Test specimens shall be cut directly from the sheet membrane and insulation materials provided for the test using a metal template having dimensions of 7.9 inches by 7.9 inches (200 mm by 200 mm), ± 5 percent.

6.2 Sampling–multi-ply specimens:

6.2.1 Test samples, having dimensions not less than 3 feet by 4 feet (0.9 m by 1.2 m), shall be prepared in compliance with the roof system assembly manufacturer's published installation instructions and details. The quantity of materials in each layer shall be within + 10 percent of that specified in the published installation instructions.

6.2.2 All roofing components to be used in the roof system assembly test specimen shall be conditioned at 77°F + 3°F (25°C + 2°C) and 50 percent + 5 percent relative humidity for a 24 hour period prior to test sample construction.

6.2.3 Test specimens shall be cut directly from the constructed 3 feet by 4 feet (0.9 m x 1.2 m) test sample as noted in Section 6.1.1, herein.

6.3 A minimum of 4 test specimens shall be constructed and tested.

6.4 Unless otherwise specified, the membrane substrate shall be expanded polystyrene board having a density within the range of 1.7 to 2.0 lbm/ft^3 (27 to 32 kg/m^3) and a thickness of 1.5 inch (38 mm), + 15 percent.

7. Conditioning:

7.1 The test apparatus and test specimen shall be conditioned at the desired temperature for a minimum of 8 hours prior to testing. The selected temperature shall be maintained at + 3°F (+ 2°C) for the duration conditioning.

8. Test Principal:

8.1 Static puncture:

8.1.1 The roof system assembly test specimen is subjected to a predetermined static puncture load using a ball bearing for a period of 24 hours. The puncture loads are increased in 2.2 lbf (10 N) increments until puncture of the test specimen occurs or until the maximum load of 56 lbf (250 N) is reached. Puncture of the test specimen is assessed by visual examination and verified by conducting a watertightness pressure test.

8.2 Dynamic puncture:

8.2.1 The Roof System Assembly test specimen is subjected to a predetermined dynamic puncture load created by a rigid puncture head falling through a 90 degree trajectory from a vertical position to a horizontal position under gravitational acceleration. The impact energy is increased from 119 foot-pdl (5 J) in 59.4 foot-pdl (2.5 J) increments until puncture of the test specimen occurs or until the maximum impact energy of 1190 foot-pdl (50 J) is reached. Puncture of the test specimen is assessed by visual examination and verified by conducting a watertightness pressure test.

8.2.2 The impact energy is equated to the potential energy of the raised puncture head, as noted below.

$E = m \times g \times h$ where,

E = impact energy (ft-pdl or J);

m = puncture head mass (lbm or kg);

g = gravitational acceleration (32.2 ft/s^2 or 9.8 m/s^2):

h = the puncture head fall distance (1.7 ft or 0.51 m).

9. Test Procedures:

9.1 Static puncture:

9.1.1 Place a test specimen on an insulation substrate and position the assembly within the framework of the test apparatus such that the ball bearing is set on the center of the surface of the specimen. Assure that the movable rod is aligned perpendicular to the specimen surface.

9.1.2 Select a static puncture load, in an increment of 2.2 lbf (10 N), somewhat below that at which the specimen may be expected to fail.

Notes:

1. Pretesting specimens under various loads is useful to estimate the initial load to be applied.
2. If a platform and deadweights are used as the means to provide loading of the specimen, then the mass of the ball bearing, rod, and platform assembly must be included in the load applied to the specimen.

9.1.3 Apply the initial static puncture load to the test specimen for 24 hours. Then remove the specimen from the test apparatus and visually examine it to determine whether puncture has occurred.

9.1.4 If test specimen puncture cannot be determined through visual examination, a suitable watertightness test, using a water pressure of 0.73 lbf/in^2 (5000 Pa) applied to the surface of the membrane, shall be conducted for 15 minutes.

Note: One type of watertightness test that has been used to examine whether membrane specimens have been punctured incorporates a water column sealed to the top of the membrane specimen. A water height of 20 inches (500 mm) provides a pressure of 0.73 lbf/in^2 (5000 Pa). Alternatively, a chamber in which the membrane specimen is sealed and into which water is forced at the specified pressure may be utilized.

9.1.5 If the test specimen punctures or is not watertight due to the initial static puncture load, repeat Sections 9.1.1 through 9.1.4 on another test specimen using a lesser initial load. If no puncture is seen or if the test specimen is determined to be watertight after the initial loading, continue the test as noted in Section 9.1.6.

9.1.6 Increase the applied static load by 2.2 lbf (10 N) on the same specimen and maintain this for 24 hours. Determine whether membrane puncture has occurred, either through visual examination or through watertightness testing. Continue increasing the applied static load on the same specimen in increments of 2.2 lbf (10 N), maintaining each load for 24 hours, until puncture occurs or until the maximum load of 56 lbf (250 N) is reached. Record the load at which puncture occurs or a maximum load of 56 lbf (250 N) if no puncture occurs.

9.1.7 Conduct the test on three additional test specimens according to Section 9.1.6 using a initial load that is 2.2 lbf (10 N) less than that which caused puncture in the first set of tests or using an initial load of 56 lbf (250 N) if the first set of tests yielded no puncture. Consider the results as follows:

9.1.7.1 If none of the three specimens are punctured at this selected load, report that load as the puncture resistance of the test specimen. A watertightness test shall be conducted on all three test specimens to verify that puncture did not occur.

9.1.7.2 If puncture occurs on any of the three test specimens, repeat Section 9.1.6 using an initial load that is 2.2 lbf (10 N) less than that which caused puncture. Repeat until no puncture is observed in all three test specimens as noted in Section 9.1.7.1.

9.2 Dynamic puncture:

9.2.1 Place a test specimen on an insulation substrate and position the assembly within the horizontal framework of the test apparatus such that the puncture head will strike the center of the test specimen.

9.2.2 Select an initial mass of the puncture head, in an increment of 1.1 pounds (0.5 kg), somewhat below that at which the specimen may be expected to fail.

Notes: 1. Pretesting specimens under various loads is useful to estimate the initial puncture head mass to be used.

9.2.3 Position the rotation arm, with the selected puncture head, in the vertical position and allow the arm to drop under gravitational acceleration. Then remove the specimen from the test apparatus and visually examine it to determine whether puncture has occurred.

9.2.4 If test specimen puncture cannot be determined through visual examination, a suitable watertightness test, using a water pressure of 0.73 lbf/in^2 (5000 Pa) applied to the surface of the membrane, shall be conducted for 15 minutes.

Note: One type of watertightness test that has been used to examine whether membrane specimens have been punctured incorporates a water column sealed to the top of the membrane specimen. A water height of 20 inches (500 mm) provides a pressure of 0.73 lbf/in^2 (5000 Pa). Alternatively, a chamber in which the membrane specimen is sealed and into which water is forced at the specified pressure may be utilized.

9.2.5 If the test specimen punctures or is not watertight due to the initial dynamic puncture load, repeat Sections 9.2.1 through 9.2.4 on another test specimen using a lesser initial load. If no puncture is seen or if the test specimen is determined to be watertight after the initial loading, continue the test as noted in Section 9.2.6.

9.2.6 Increase the mass of the puncture head by 1.1 pounds (0.5 kg) and conduct the test on the same specimen. Determine whether membrane puncture has occurred, either through visual examination or through watertightness testing. Continue increasing the mass of the puncture head in increments of 1.1 pounds (0.5 kg) and conduct the test on the same specimen until puncture occurs or until the maximum puncture head mass of 22 pounds (10 kg) has been used. Record the puncture head mass at which puncture occurs or a maximum puncture head mass of 22 pounds (10 kg) if no puncture occurs.

9.2.7 Conduct the test on three additional test specimens according to Section 9.2.6 using an initial puncture head mass that is 1.1 pounds (0.5 kg) less than that which caused puncture in the first set of tests or using an initial puncture head mass of 22 pounds (10 kg) if the first set of tests yielded no puncture. Consider the results as follows:

9.2.7.1 If none of the three specimens are punctured at this puncture head mass, calculate the energy in compliance with Section 8.2.2 and report that energy as the dynamic puncture resistance. A watertightness test shall be conducted on all three test specimens to verify that puncture did not occur.

9.2.7.2 If two of the three specimens are not punctured, test one additional specimen using the same puncture head mass as used in Section 9.2.7. If this additional test specimen is not punctured, calculate the energy in compliance with Section 8.2.2 and report that energy as the dynamic puncture resistance. If the additional test specimen is punctured, repeat Section 9.2.7 using three new test specimens and a puncture head mass which is 1.1 pounds (0.5 kg) less than that which caused puncture in the additional specimen.

9.2.7.3 If two of the three specimens are punctured, repeat Section 9.2.7 using three new test specimens and a puncture head mass which is 1.1 pounds (0.5 kg) less than that which caused puncture in two of the three specimens. Consider the results as noted in Sections 9.2.7.1 through 9.2.7.3.

10. Report:

10.1 The report of test shall include the following:

10.1.1 Complete identification of the test specimen including types, sources, manufacturers, dimensions, etc. of all components in the specimen and the method of preparation.

10.1.2 The temperature of the test.

10.1.3 A description of the watertightness test used.

10.1.4 The static puncture resistance of the specimen as the load which three specimens can support for 24 hours without puncture and without loss of watertightness.

10.1.5 The dynamic puncture resistance of the membrane material as the maximum impact energy which three specimens sustained without puncture and without loss of watertightness. The direct of the specimen shall be included.

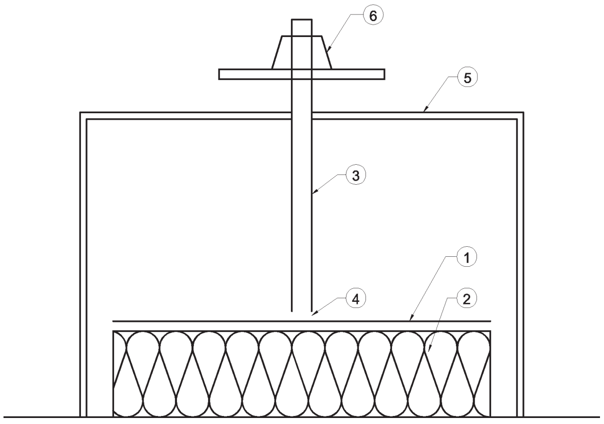
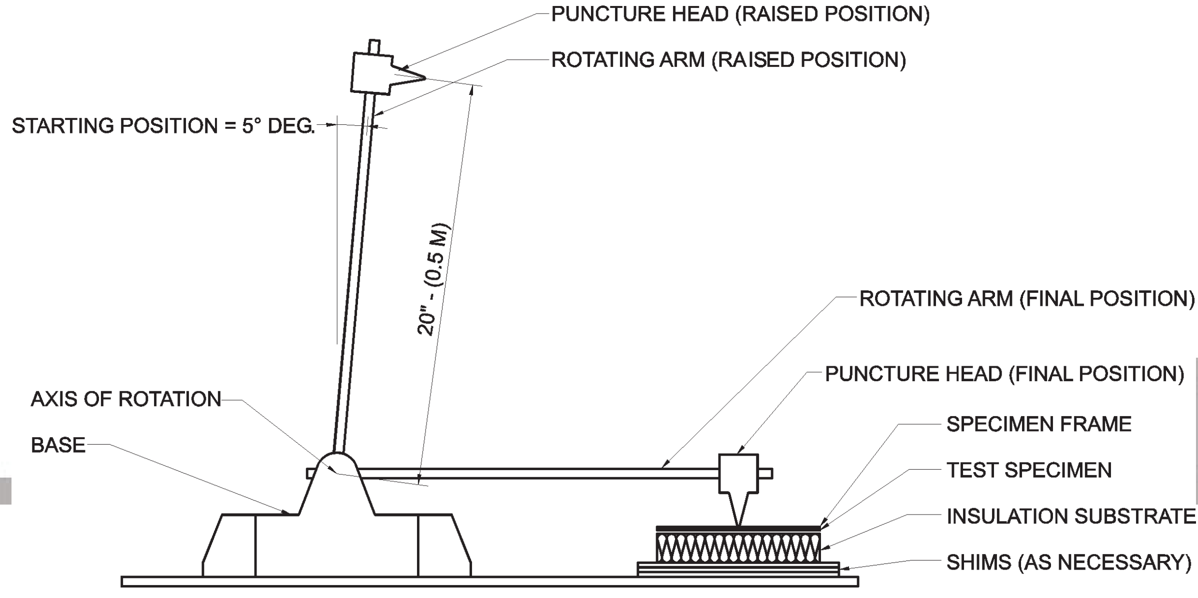


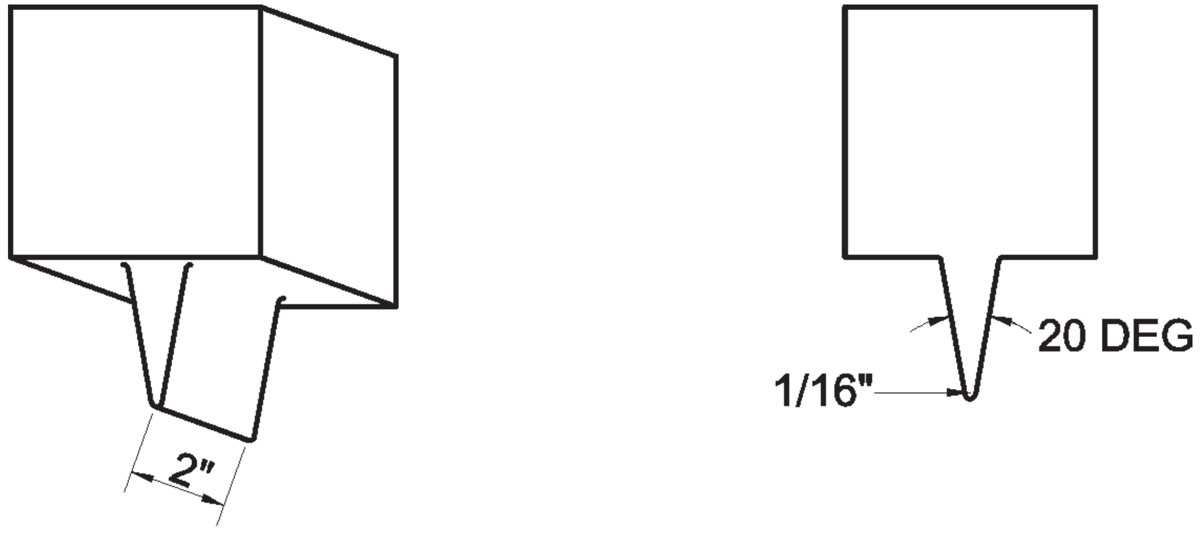
FIGURE I1
STATIC PUNCTURE TEST APPARATUS

1. **Membrane test specimen**
2. **Insulation substrate**
3. **Movable rod**
4. **Ball bearing**
5. **Framework supporting movable rod and load**
6. **Applied load**



For SI: 1 inch = 25.4 mm.

FIGURE I2
DYNAMIC PUNCTURE TEST APPARATUS



For SI: 1 inch = 25.4 mm.

FIGURE I3
TYPICAL DYNAMIC PUNCTURE HEAD

TESTING APPLICATION STANDARD (TAS) 114-95
APPENDIX J

TEST PROCEDURE FOR 12 FOOT BY 24 FOOT SIMULATED UPLIFT PRESSURE RESISTANCE OF ROOF SYSTEM ASSEMBLIES

1. Scope:

1.1 Damage incurred by the effects of wind over and internal pressure under a totally adhered, partially adhered or mechanically attached Roof System Assembly generally results in one or more of the following:

- Uplift of the cover (when totally adhered);
- Delamination within the roof insulation cover (when totally or partially adhered);
- Failure of adhesive between the insulation and the deck or between the insulation and the vapor retarder and/or between the vapor retarder and the deck; and,
- Failure of the fastener/substrate, fastener/insulation or fastener/roof cover combination.

1.2 Thus the nature of the damage incurred would suggest that an instrument designed to measure the stability of roof assemblies be equipped to evaluate bond strength indicated in the items above. The 12 foot by 24 foot simulated uplift pressure test has been designed for this purpose.

1.3 The object of the test is to provide a realistic method of evaluating the uplift resistance of a completed roof construction and its individual components when applied within a completed assembly. The test procedure must contain the ability to realistically evaluate the actual size of the roof components which comprise a completed roof system assembly.

1.4 The test method is applicable to any roof system assembly incorporating the deck, air/vapor retarders, insulation, roof cover, adhesives, sealants, mechanical fasteners, batten bars and proprietary fastening systems.

1.5 The test method is designed to measure the stability of the Roof System Assembly on its supports and to evaluate the ultimate strength of the individual components in the completed Roof System Assembly under static conditions which are intended to simulate the uplift loads imposed by wind forces on the roof system. The roof specimen is sufficiently large so that the means of securing the perimeter of the sample to the pressure vessel have virtually no effect on the ultimate behavior of the assembly during testing.

1.6 The test procedure described in Appendix C does not adequately evaluate the performance of some newer roof constructions. With the increased use of extended fastener spacings in mechanically attached single-ply cover construction and air/vapor retarders, the perimeter edge effect of small or intermediate scale tests produces unreliable results. Therefore, a larger sample size is needed to properly evaluate resistance to wind uplift forces.

2. Terminology–the following definitions apply to the test procedure outlined herein.

2.1 Failure–Roof system assembly failure under this test standard could be one or more of the following:

- withdrawal or breakage of fasteners;
- tearing, splitting or other breakage of the roof cover at the point(s) of attachment;
- impairment of the waterproofing function of the roof systems assembly (i.e. cracking of components within the assembly);
- permanent deformation of the roof cover or fastener assembly, including stress plate, which may reduce the waterproofing function of the roof system assembly over time; and,
- delamination or separation of adhered areas.

3. Apparatus:

3.1 The 12 foot by 24 foot uplift pressure apparatus is a steel pressure vessel arranged to supply air pressure at pre-established pressure levels to the underside of the roof system assembly. This roof system assembly, when secured in place, forms and seals the top of the pressure vessel.

3.2 The pressure vessel measures 24 feet-7 inch long by 12 feet-7 inch wide by 2 inch deep (7.5 m by 3.8 m by 51 mm). It is fabricated from 8 inch (203 mm) deep steel channel sections as the perimeter structure with 6 inch (152 mm) deep steel beams spaced 2 feet (0.6 m) o.c. running parallel to the width. The bottom of the pressure vessel is sheathed with a 7 gauge (4.8 mm) thick steel plate spot welded to the top of the steel beams and continuously welded to the inside perimeter channels.

3.3 The air supply into the sealed vessel is provided by an inlet manifold constructed with 4 inch (102 mm) diameter PVC pipe. Four openings, equally spaced, penetrate the steel plate and serve as the air inlet on the bottom of the pressure vessel. A $^1/_4$ inch (6.4 mm) opening on the bottom of the vessel serves as the manometer connection. A foam gasket that lies between the top channel of the pressure vessel and the sample construction frame minimizes air leakage when the sample is clamped into place.

3.4 Pressurized air is supplied to the inlet manifold by a turbo pressure blower having the capability of generating 600 cubic feet per minute (17 m^3/min). The air flow is regulated by a manually operated 4 inch (102 mm) diameter PVC butterfly valve. Pressure readings are obtained from a water filled manometer calibrated to read directly in pounds per square feet.

4. Test Limitations and Precautions:

4.1 During the test, all testing agency representatives and other test observers shall wear ear and eye protection and hard hats to prevent injury.

4.2 This test procedure may involve hazardous materials, operations and equipment. This protocol does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

5. Test Specimens:

5.1 The components for a proposed test panel are assembled to the desired specifications and details (type and thickness of the deck, application method and rate for the adhesive or fasteners, size and thickness of insulation and type of cover) and then left to "cure" for the manufacturer's specified time period (maximum of 28 days).

5.2 When steel decking is used, it is secured to a 24 feet-7 inch by 12 feet-7 inch by $^1/_4$ inch (7.5 m by 3.8 m by 6.4 mm) angle iron frame. This test specimen frame typically includes a structural steel support located along the centerline and parallel to the length. In addition, three intermediate structural steel supports are located parallel to the width, 6 feet (1.8 m) o.c.. The steel deck is then applied parallel to the length. It is welded to the perimeter angle iron with $^1/_2$ inch (13 mm) diameter puddle welds 12 inch (305 mm) o.c. along the entire perimeter. In addition, it is fastened at all supports [6 feet (1.8 m) spans for 22 gage (0.75 mm) steel] 12 inch (305 mm) o.c. with approved fasteners. All deck side laps are fastened with approved fasteners spaced at a maximum of 30 inch (762 mm) o.c. Other structural roof decks may be used if requested by the program sponsor. Their application is according to the manufacturer's specifications and approval requirements.

Note: The method of securing the steel deck to the test frame may vary when a specific test, as requested by an applicant, dictates.

5.3 When ready for testing, the test specimen frame, containing the test specimen, is placed on the pressure vessel and clamped into place using C-clamps and 2 inch by 3 inch by $^1/_4$ inch (51 mm by 76 mm by 6.4 mm) steel angles placed around the perimeter of the sample [smaller dimension horizontal and the 3 inch (76 mm) leg facing down]. See Figures K1 and K2, herein. In addition, the test specimen frame is secured to the pressure vessel at the three intermediate support clips located near the centerline of the pressure vessel. The appropriate hose connections are then made to the air supply and the manometer.

5.4 Roof system assemblies whose wind-load resistance performance may be affected by bad weather conditions during installation shall be constructed in a manner which simulates actual working conditions.

6. Test Procedure:

6.1 Principal:

6.6.1 The framed roof system assembly test specimen is mounted on the test apparatus and sealed by a foam polyurethane gasket located between the top of the pressure vessel and the bottom of the test specimen frame. Air is supplied to the vessel in increasing amounts to maintain a certain pressure for a given length of time on the underside of the test specimen and to offset minor pressure loss due to leaks. The sustained air pressure delivered to the underside of the test specimen represents the combined positive and negative pressures incurred on an actual roof system assembly from above and below. Pressure is increased until failure occurs.

6.2 After the test specimen is mounted on the test apparatus, air is introduced beneath the sample in accordance with Table J1, below.

TABLE J1
12 FOOT BY 24 FOOT UPLIFT PRESSURE INTERVALS

Time (Minutes)	Static Uplift Pressure[1]	
	psf	kPa
0:01 to 1:00	30	1.4
1:01 to 2:00	45	2.2
2:01 to 3:00	60	2.9
3:01 to 4:00	75	3.6
4:01 to 5:00	90	4.2
5:01 to 6:00	105	4.9
6:01 to 7:00	120	5.7
7:01 to 8:00	135	6.5
8:01 to 9:00	150	7.2

1 Add 15 psf (0.7 kPa) for each successive one minute interval.

6.3 Prior to and during the attainment of uplift pressures noted above, the test specimen is examined for failure. Upon failure, the test specimen is dismantled and examined to determine the exact mode of failure.

6.4 Record the mode, time and pressure interval of failure.

7. Interpretation of Results:

7.1 The passing uplift pressure shall be the pressure which the test specimen resisted for one minute without failure.

7.2 The minimum passing uplift pressure for an Approved roof system assembly shall be 90 psf (4.2 kPa).

7.3 A 2:1 margin of safety shall be applied to the passing uplift pressure prior to inclusion in the system manufacturer's Product Approval.

7.4 Average wind velocities can vary considerably from area to area. The *Florida Building Code, Building* utilizes a windspeed of 110 mph at a height of 33 feet above ground. These wind velocities in miles per hour are related to the design pressure, in pounds per square feet, for a particular building. Refer to Chapter 16 (High-Velocity Hurricane Zones) of the *Florida Building Code, Building* and ASCE 7.

7.5 Data generated from Appendix J simulated uplift testing may be used for extrapolation, in compliance with RAS 137 (for single-ply membrane attachment), to meet design pressures for a specific building. Extrapolation of data from Appendix J simulated uplift testing is limited to 1.75 times the maximum uplift pressure noted in the Product Approval. Only 'upward' extrapolation is acceptable (i.e., fastener density may not be decreased and fastener spacing may not be increased for lesser design pressures).

TESTING APPLICATION STANDARD (TAS) 114-95
APPENDIX K

TEST PROCEDURES FOR F.I.T. CLASSIFICATION OF MODIFIED BITUMEN ROOF SYSTEM ASSEMBLIES

1. Scope:

1.1 F.I.T. is a performance-based classification for modified bitumen roof membranes. F.I.T. classifications are intended to provide performance capacities required of a particular roof system assembly when different levels of operating conditions are assumed.

1.2 The F.I.T. classification of modified bitumen roof membranes determines their suitability (fitness) for use with respect to the following parameters:

F → Fatigue

I → Indentation (i.e. puncture)

T → Temperature

The classification defines, in terms of these parameters, both the roof system assembly requirements and the membrane performance capabilities to satisfy these requirements.

1.3 Each letter (F, I and T) is assigned a numerical index, thereby providing a brief, yet precise indication of the following parameters:

- the requirements to be satisfied by the roof system assembly; or,
- the performance capabilities of the modified bitumen roof membrane.

The index increases with the severity of the requirements and with the level of performance provided by the roof membrane.

1.4 For each parameter (F, I and T) of the classification, the modified bitumen roof membrane must provide a performance index (number) better than or equal to the requirement of the roof system assembly in question.

2. F.I.T. Classification:

2.1 Classification F—Substrate Movement (Fatigue) Test:

2.1.1 The F classification index is based on results of fatigue testing noted herein. Testing conducted on bonded modified bitumen roof membranes characterizes the membrane resistance to cyclic substrate movement at a given amplitude consisting of 500 cycles for new roof membranes and 200 cycles for aged roof membranes.

2.1.2 Table K1, below, indicates the conditions under which performance indices 1 to 5 are determined.

TABLE K1
CLASSIFICATION F (FATIGUE) PERFORMANCE INDICES

Class	Initial Joint Width (mm)	Amplitude of Joint Movement (mm)	Test Temperature °F(°C)
F_1	1	-0.5 to +0.5	+68 (+20)
F_2	1	-0.5 to +0.5	32 (0)
F_3	2	-1 to +1	32 (0)
F_4	2	-1 to +1	+14 (-10)
F_5	2	-1 to +1	-4 (-20)

2.1.3 Apparatus:

2.1.3.1 The test apparatus shall consist of the following:

- two plates with clamping screws to attached two concrete slabs so that the edges form a butt joint;
- a device to open and close the

joint at a rate of $^5/_8$ inch per hour (16 mm/hr) and at a controlled amplitude;

- a climactic chamber so the test specimen can be kept at a controlled temperature.

2.1.4 Test specimens:

2.2.4.1 Test specimen shall consist of 12 inch by 2 inch (300 mm by 50 mm) strips of membrane placed on the concrete slabs with the center of the 12 inch dimension centered at the butt joint, which is set at the joint width for the various F classifications noted in Table K1.

2.2.4.2 A total of six test specimen strips shall be tested; three unaged and three which have been conditioned at 176°F (80°C) for 28 days.

2.2.4.3 Specimens shall be fully adhered to the concrete slabs using the method noted in the membrane manufacturer's published literature.

2.1.5 Procedure:

2.1.5.1 From the initial position, the joint is opened and closed alternately under the following conditions:

- the amplitude of movement is + 0.5 mm or + 1 mm, depending on the performance index being tested (see Table K1);
- the test temperature is +68°F, +32°F, +14°F or -4°F depending on the performance index being tested; and,
- the number of cycles is 500 for unaged and 200 for aged specimens.

2.1.6 Observations:

2.1.6.1 The test is terminated at the end of 200 cycles for aged and 500 cycles for unaged specimens at which time:

- the samples are checked for watertightness under a 5 centimeters high water column or by equivalent method; and,
- any loss of bond is observed and reported.

2.1.6.2 Failure criteria shall be complete loss of adhesion or delamination of the specimens.

2.2 Classification I–Static and Dynamic Puncture Test:

2.2.1 The I classification index is based on results of static and dynamic puncture resistance testing noted in Appendix I of TAS 114. Testing conducted on bonded roof membranes characterizes the membrane resistance to static and dynamic impact loading.

2.2.2 Tables K2 through K4, below, indicate the conditions under which performance indices 1 to 5 are determined.

TABLE K2
SUBCLASSIFICATION L (STATIC PUNCTURE)
PERFORMANCE INDICES

Subclass	Static Load lb (kg)
L_1 L_2 L_3 L_4	<15 (7) >15 (7) >33 (15) >55 (25)

TABLE K3
SUBCLASSIFICATION D (DYNAMIC PUNCTURE)
PERFORMANCE INDICES

Subclass	Impact Energy ft-pdl (J)
D_1 D_2 D_3	<240 (10) >240 (10) <480 (20) >480 (20)

TABLE K4
CLASSIFICATION I (INDENTATION)
PERFORMANCE INDICES

Class	Subclass L	Subclass D
I_1	L_1	D_2
I_2	L_2	D_2
I_3	L_3	D_2
I_4	L_4	D_2
I_5	L_5	D_3

2.2.3 Apparatus, Procedure and Observations shall be in compliance with Appendix I of TAS 114.

2.3 Classification T–Temperature Stability:

2.3.1 The T classification index is based on results of slippage resistance testing under the effects of temperature noted herein. Testing conducted on bonded modified bitumen roof membranes characterizes the membrane resistance to slippage under the effects of temperature.

2.3.2 Table K5, below, indicates the conditions under which performance indices 1 to 4 are determined.

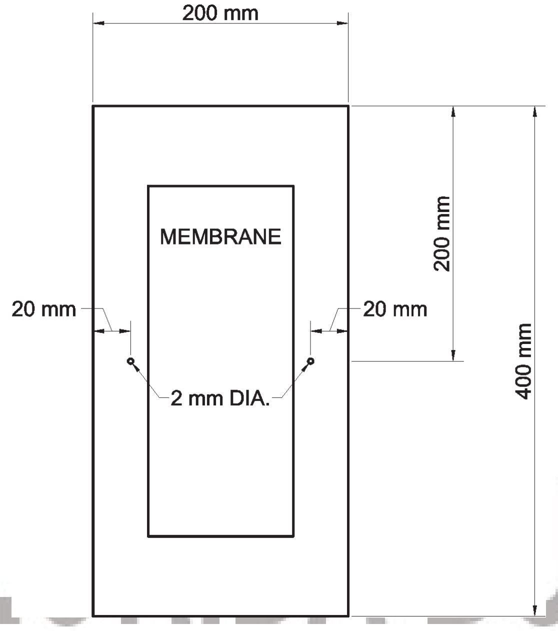
TABLE K5
CLASSIFICATION T (TEMPERATURE STABILITY)
PERFORMANCE INDICES

Class	Slippage Amplitude (mm)	Test Temperature °F (°C)
T_1	> 2	140 (60)
T_2	< 2	140 (60)
T_3	< 2	176 (80)
T_4	< 2	194 (90)

2.3.3 Apparatus

2.3.3.1 The test apparatus shall consist of the following:

- A heat chamber controlled to within +5°F, with an operating range from +120°F to not less than +250°F;
- A frame to which the test specimen described below is attached in a sloping position of 45 degrees. The frame must allow the test specimen to be kept in a horizontal position during the time necessary for the selected test temperature to stabilize;
- A series of clean degreased steel plates, 0.08 inch thick by 7$^3/_4$ inch by 15$^3/_4$ inch (2 mm thick by 200 mm by 400 mm), prepared according to Figure K1, below. Each plate has 2 screws and nuts of appropriate diameter for the holes drilled in the edges of the plate.
- A metal rule not less than 7$^3/_4$ inches (200 mm) long.
- A device to measure length to within 0.1 mm.
- Thin aluminum plates 2 inch by 6 inch (50 mm by 150 mm) and a 2-component adhesive.



For SI: 1.02 mm = 0.040 inch

FIGURE K1
SCHEMATIC OF STEEL PLATE FOR TEMPERATURE STABILITY TEST

2.3.4 Test Specimens:

2.3.4.1 Test specimen shall consist of 12 inch by 6 inch (300 mm by 150 mm) membrane samples adhered or torched to the steel plate (do not use primer) in compliance with the membrane manufacturer's published instructions.

2.3.4.2 Put the screws and nuts in place.

2.3.4.3 Glue the aluminum plate to the membrane surface such that it is possible, before and after exposure to heat, to draw a line on the plate with a scribe using a metal rule which is placed against the screws.

2.3.4.4 Three test specimens shall be constructed.

2.3.5 Procedure:

2.3.5.1 Condition the test specimens at ambient conditions in the horizontal position for 24 hours.

2.3.5.2 Draw a line to show the initial position.

2.3.5.3 Set the heat chamber to the required test temperature.

2.3.5.4 Place the test specimen in horizontal position in the heat chamber, and allow it to remain there for one hour.

2.3.5.5 Put the test specimen in the test position, sloping at an angle of 45 degrees, in less than 5 seconds. Keep it in this position at the test temperature for 2 hours.

2.3.5.6 Remove the test specimen from the chamber and allow it to cool at ambient conditions in the horizontal position.

2.3.5.7 Draw a line to indicate the final position.

2.3.6 Observations:

2.3.6.1 Measure the difference between the two lines along each edge.

2.3.6.2 Slippage of the membrane is expressed as the average of the three test specimens.

3. Classification of Membrane Use:

3.1 The ascending order of the indices assigned to each of the F.I.T. letters corresponds to increasingly severe conditions of use.

3.2 Table K6, below, summarizes the classification of the roof system assembly with respect to the three parameters F.I.T. It provides the total classification of the required modified bitumen membrane roof system assembly.

3.2.1 Based on the premise of increasing performance capacity, a modified bitumen membrane classification greater than that required of the roof system assembly would be a wise precaution.

TABLE K6

Membrane Substrate	Slope	Roof Use and Type of Protection					
			Functional Access Roof				Equipment Maintenance Walkway
		Non-Functional	Pedestrian	Vehicles	Pedestrian	Gardens	
		Factory Applied Surfacing	Slabs - Pavers		Protection Slabs on Spacers	Direct Drainage Layer	Factory Applied Surfacing
Thermal Insulation	0	$F_4I_2T_2^{(1)\,(2)}$			$F_5I_4T_3$	$F_3I_5T_1$	$F_4I_4T_2$
	Low (<4":12")	$F_4I_2T_2^{(1)\,(2)}$	$F_4I_4T_2$	$F_4I_4T_2$	$F_5I_4T_3$	$F_3I_5T_2$	$F_4I_4T_2$
	Pitched (4":12")	$F_4I_2T_2^{(3)}$					$F_4I_2T_2^{(3)}$
Concrete	0	$F_4I_2T_2$			$F_5I_4T_3$	$F_3I_5T_1$	$F_4I_4T_2$
	Low (<4":12")	$F_4I_2T_2$	$F_4I_4T_2$	$F_4I_4T_2$	$F_5I_4T_3$	$F_3I_5T_2$	$F_4I_4T_2$
	Pitched (4":12")	$F_4I_2T_2$					$F_4I_4T_2$
Concrete & Protected Membrane	0				$F_3I_3T_2$	$F_3I_5T_1$	
	Low (<4":12")		$F_3I_3T_2$		$F_3I_3T_2$	$F_3I_5T_2$	
Cellular Concrete	Low (<4":12")	$F_4I_2T_2$					$F_4I_4T_2$
	Pitched (4":12")	$F_4I_2T_2$					$F_4I_4T_2$
Wood and Derived Panels	Low (<4":12")	$F_4I_2T_2$					$F_4I_4T_2^{(3)}$
	Pitched (4":12")	$F_4I_2T_2^{(3)}$					$F_4I_4T_2^{(3)}$
Existing Membrane	0	$F_4I_2T_2$			$F_5I_4T_3$	$F_3I_5T_1$	$F_4I_4T_2$
	Low (<4":12")	$F_4I_2T_2$	$F_4I_4T_2$	$F_4I_4T_2$	$F_5I_4T_3$	$F_3I_5T_2$	$F_4I_4T_2$
	Pitched (4":12")	$F_4I_2T_2^{(3)}$					$F_4I_4T_2^{(3)}$

1 Index I becomes I_3 for mineral wool over concrete and cellular concrete.
2 Index I becomes I_3 on $R > 2m^2$ °C/W mineral wool.
3 Index T becomes T_3 if $R > 2m^2$ °C/W.