

TESTING APPLICATION STANDARD (TAS) No. 104-95
TEST PROCEDURE FOR NAIL-ON UNDERLAYMENT FOR
USE IN DISCONTINUOUS ROOF SYSTEMS

1. Scope

1.1 This Protocol covers procedures for testing mechanically attached, prefabricated, reinforced, polymer modified bituminous, and solid thermoplastic sheet roofing materials intended for use as underlayment in Discontinuous Roof Systems to assist in the waterproofing to function in combination with a Prepared Roof Covering. These products may employ granular surfacing materials on one side in which case the "Granular Adhesion" test, as specified herein, shall also be conducted. The Granular Adhesion test shall be required for all granular surfaced materials used as a bonding surface for mortar or adhesive set tile.

1.2 The test procedures outlined in this Protocol cover the determination of the Thickness; the Dimensional Stability; the Tear Resistance; the Breaking Strength; the Elongation; the Water Absorption; the Low Temperature Flexibility; the Ultraviolet Resistance; the Accelerated Aging Performance; the Cyclic Elongation Performance; the Water Vapor Transmission; the Puncture Resistance; and the Tile Slippage Resistance of an underlayment material; and Granular Adhesion of a mineral surfaced roll roofing material, for use as an underlayment.

1.3 These test methods appear in the following order:

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2. Referenced Documents

2.1 *ASTM Test Standards*

D 1079	Standard Definitions and Terms Relating to Roofing, Waterproofing and Bituminous Materials
D 1938	Tear Propagation Resistance of Plastic Film and Thin Sheeting by a Single-Tear Method
D 2523	Testing Load-Strain Properties of Roofing Membranes
D 570	Water Absorption of Plastics
D 1970	Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection (Low Temperature Flexibility)
E 96	Water Vapor Transmission of Materials
D 5147	Sampling and Testing Modified Bituminous Sheet Materials
E 380	Excerpts from the Standard Practice for Use of the International System of Units (SI) (the Modernized Metric System)

2.2 *International Conference of Building Officials*
 Acceptance Criteria For Roof Underlayment For Use In Severe Climate Areas
 Acceptance Criteria For Concrete Tile Underlayment On Spaced Sheathing

- 2.3 *American Plywood Association*
Performance Standards and Policies for
Structural-Use Panels
- 2.4 *The Florida Building Code, Building.*
- 2.5 *Roof Consultants Institute*
Glossary of Terms

3. Terminology & Units

- 3.1 Definitions - For definitions of terms used in this Protocol, refer to ASTM D 1079; Chapters 2 and 15 (High-Velocity Hurricane Zones) of the *Florida Building Code, Building*; and/or the RCI Glossary of Terms. The definitions from 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 and Use

- 4.1 The test procedures outlined in this Protocol provide a means of determining whether a mechanically attached roofing material, intended for use as an underlayment in a Discontinuous Roof System, for use in the High-Velocity Hurricane Zones, meets the requirements of the *Florida Building Code, Building*.

5. Conditioning

- 5.1 Unless otherwise specified, condition test specimens for a minimum of four hours at $73.4 \pm 3.6^{\circ}\text{F}$ and $50 \pm 5\%$ relative humidity prior to testing. Note separate conditioning requirements for cold bend testing in Section 11.1.

6. Thickness

- 6.1 Materials shall be checked at five points across the roll width. Measurements shall be made at two points, each being 6 ± 0.5 inches from each edge, and at three points equally spaced between these two points.
- 6.2 Compute the average thickness and the standard deviation of the thicknesses, in mils, based on the total number of point measurements from all of the rolls taken.

- 6.3 Report the individual point measurements, average, and standard deviation in mils.

- 6.4 Any modified bitumen and bituminous test specimen which exhibits an average thickness less than sixty (60) mils shall be considered as failing the thickness test. Thickness measurements shall be at the selvage edge, not at a granular surface.

- 6.5 Nonbituminous membranes shall not have a thickness minimum. Performance shall be based on physical property testing.

7. Dimensional Stability

- 7.1 Prepare five (5) 2 foot wide x 6 foot long specimens with a 4 inch overlap seam across the center of the 6 foot length. Prepare the specimens: one from each edge of the roll and three from random places in the roll. The length of each specimen should be in the 'machine direction' of the roll.

- 7.2 The substrate shall be $32/16$ APA span rated sheathing of a $15/32$ in. thickness that has been reinforced on the back side with two angle irons.

- 7.3 Place the underlayment specimen on the substrate and install a $1\frac{1}{2}$ in. x $1\frac{1}{2}$ in. x 2' wood termination batten to one "free" end of the underlayment using three (3) equally spaced #12 wood screws to secure the batten through the underlayment and the sheathing. Mechanically attach the other "free" end of the underlayment using three (3) equally spaced 10d roofing nails, located two (2) inches from the "free" end, with one nail at one inch from each edge, penetrating the sheathing a minimum of $\frac{1}{2}$ inch.

- 7.4 Condition each specimen in an oven or under heat lamps maintained at $180 \pm 5^{\circ}\text{F}$ for a minimum of six (6) hours.

- 7.5 Report any tears or "tear drop" conditions which arise at fastener penetrations during and/or after conditioning is complete. Report any shrinking or wrinkling which appears to have compromised the lapped area of underlayment.

- 7.6 Any test specimen which exhibits conditions noted in Section 7.5 of this Protocol shall be considered as failing the dimensional stability test.
- 7.7 Provide before and after photographs of each specimen in the final test report.

8. Tear Resistance

- 8.1 This test covers the determination of the tear propagation resistance of materials specified in Section 1 of this Protocol in accordance with ASTM Test Method D 1938, except as noted below.
- 8.1.1 The prescribed Test Method shall be run in both the machine and the cross-machine direction of the roll material.
- 8.1.2 The final test report shall include average tear propagation force values and standard deviations of these value for both the machine and the cross-machine direction of the material.
- 8.1.3 Any test specimen which exhibits a tear propagation value less than 3.5 lbf (15.5 N) in either the machine direction or cross-machine directions shall be considered as failing the tear strength test.

9. Breaking Strength and Elongation

- 9.1 This test covers the determination of the breaking strength and elongation of materials specified in Section 1 of this Protocol in accordance with ASTM Test Method D 2523, except as noted below.
- 9.1.1 Sampling
- 9.1.1.1 Ten specimens; five in the machine direction and five in the cross-machine direction of the roll, shall be cut to dimensions of 1 in. x 6 in.
- 9.1.2 Conditioning

- 9.1.2.1 Heat Aging, shall consist of seven (7) days in an air circulating oven at a controlled temperature of $149 \pm 5^{\circ}\text{F}$.
- 9.1.2.2 QUV Exposure, shall consist of 460 hours of continuous ultraviolet light exposure.

9.1.3 Procedure

- 9.1.3.1 Each set of samples, as specified in 9.1.1.1 herein, shall be tested "as received," after heat aging, and after QUV exposure, as specified in 9.1.2.1 and 9.1.2.2 herein.
- 9.1.3.2 Grip separation rate shall be 20 ± 0.2 inches per minute for all tests conducted.
- 9.1.3.3 Testing shall be performed at 77°F for all tests.
- 9.1.3.4 Specimens and testing grips shall be conditioned at 77°F for a minimum of one (1) hour prior to testing.

9.1.4 Report

- 9.1.4.1 Report the grip separation rate used.
- 9.1.4.2 Breaking strength shall be reported, in lbf/inch of width, for all test specimens and shall be itemized in grouping of "as received," after heat conditioning, and after QUV exposure. These grouping shall be itemized in subgroups of machine direction and cross-machine direction. Any test specimen which exhibits a breaking strength value less than those listed in

Table 1 shall be considered as failing the breaking strength test.

TABLE 1
MINIMUM BREAKING STRENGTH VALUES (%)

SPECIMEN	BREAKING STRENGTH (Machine Direction or Cross-Machine Direction)
As Received	20 lbf/inch of width (35 N/cm of width)
After Heat Aging	85% of "as received"
After QUV Exposure	85% of "as received"

9.1.4.3 Elongation shall be reported, in (%), for all test specimens and shall be itemized in grouping of "as received," after heat conditioning, and after QUV exposure. These grouping shall be itemized in subgroups of machine direction and cross-machine direction. Any test specimen which exhibits elongation values less than those listed in Table 2 shall be considered as failing the elongation test.

10. Water Absorption

10.1 This test covers the determination of the water absorption of materials specified in Section 1 of this Protocol in accordance with ASTM Test Method D 570, except as noted below.

10.1.1 Specimen Preparation

10.1.1.1 Edges of membranes which include internal reinforcement as a component shall be sealed with wax to prevent water absorption through these edges. Wax shall cover

not more than 0.25 in. at each edge.

10.1.2 Conditioning

10.1.2.1 Conditioning shall consist of 72 continuous hours of exposure to temperatures and relative humidity specified in Section 5 of this Protocol.

10.1.3 Report

10.1.3.1 Any test specimen which exhibits water absorption values greater than 3% shall be considered as failing the water absorption test.

11. Low Temperature Flexibility

11.1 This test covers the determination of the low temperature flexibility of materials specified in Section 1 of this Protocol in accordance with ASTM Test Method D 1970 (7.7), except as noted below. Membranes shall be test at 5°F.

11.1.1 Procedure

11.1.1.1 Each set of specimens shall be tested "as received" and after conditioning, as specified in ASTM D 1970 (7.7.2).

11.1.2 Report

11.1.2.1 Low temperature flexibility results shall be reported on a pass/fail basis, for all test specimens and shall be itemized in grouping of "as received" and after conditioning.

TABLE 2
MINIMUM ELONGATION VALUES (%)

SPECIMEN	ORGANIC REINFORCEMENT	FIBERGLASS REINFORCED	POLYESTER OR POLYPROPYLENE REINFORCED	SOLID THERMOPLASTIC SHEATHING
As Received	MD 6% XMD 6%	MD 3% XMD 3%	MD 25% XMD 25%	MD 225% XMD 225%
After Heat Aging	85% of "as received"	85% of "as received"	85% of "as received"	85% of "as received"
After QUV Exposure	85% of "as received"	85% of "as received"	85% of "as received"	85% of "as received"

12. Ultraviolet Resistance

12.1 This test covers the determination of the ultraviolet resistance performance of materials specified in Section 1 of this Protocol in accordance with the ICBO Acceptance Criteria For Roof Underlayment For Use In Severe Climate Areas (Section IV-H), except as noted below.

12.1.1 Sampling - Two 18 in. x 18 in. specimens are to be cut.

12.1.2 Conditioning

12.1.2.1 Conditioning shall be in accordance with ICBO Acceptance Criteria For Roof Underlayment For Use In Severe Climate Areas (Section IV-H), except as noted below.

12.1.2.2 Ultraviolet light shall be produced by four 300 watt UV lamps. Recommended lamps are Ultra-Vitalux, 300 W, 220-230 V, #E27, or osram 300 W lamps.

12.1.2.3 Specimens to be exposed for 200 hours (10 hours per day for 20 days).

12.1.2.4 Specimen temperature to be maintained at 135-140°F throughout the test period.

12.1.3 Report & Conditions of Acceptance

12.1.3.1 Report any visible peeling, chipping, cracking, flaking, pitting or other damage, under 5x magnification, which resulted from the ultraviolet conditioning. Report the type and location of the damage (if any).

12.1.3.2 Report the type of UV lamps used to condition the samples.

12.1.3.3 Any test specimen which exhibits damage as defined in Section 12.1.2.1 of this Protocol shall be considered as failing the ultraviolet resistance test.

12.1.3.4 Do not subject the ultraviolet exposed specimens to “tensile strength and peel-adhesion test” as noted in the ICBO Acceptance Criteria Document. The “breaking strength” shall be addressed as specified in Section 9 of this Protocol and “peel-adhesion” will not be a requirement of this Protocol.

13. Accelerated Aging

13.1 This test covers the determination of the accelerated aging performance of materials specified in Section 1 of this Protocol in accordance with the ICBO Acceptance Criteria For Roof Underlayment For Use In Severe Climate Areas (Section IV-G), except as noted below.

13.1.1 Sampling

13.1.1.1 The six (6) 12 in. x 12 in. specimens shall be prepared with three (3) in the machine direction and three (3) in the cross-machine direction of the roll.

13.1.2 Conditions of Acceptance

13.1.2.1 Do not subject the aged specimens to “tests in accordance with Section III A, D and E.” Water ponding tests (“Section III D”) and peel-adhesion tests (“Section III E”) are not requirements of this Protocol. The noted “Section III A” shall be addressed in Section 13.1.3 of this Protocol.

13.1.3 Breaking strength and elongation tests of aged specimens shall be conducted in accordance with

Section 9 of this Protocol, except as noted below.

13.1.3.1 Sampling - After the six (6) 12 in. x 12 in. aged specimens have been examined for visible damage, prepare ten (10) 1 in. x 6 in. specimens from the aged material; five in the machine direction and five in the cross-machine direction of the roll. In addition to these ten aged specimens, prepare ten “as received” specimens of the same dimensions; five in the machine direction and five in the cross-machine direction of the roll.

13.1.3.2 Conditioning - No further conditioning is to be incurred on the aged specimens.

13.1.3.3 Procedure - Each set of samples, as specified in 13.1.3.1 herein, shall be tested “as received” and after accelerated aging.

13.1.3.4 Report

13.1.3.4.1 Breaking strength shall be reported, in lbf/inch of width, for all test specimens and shall be itemized in grouping of “as received” and after accelerated aging. These grouping shall be itemized in subgroups of machine direction and cross-machine direction. Any aged specimen which exhibits a breaking strength less than 85% of the “as received” value shall be considered as failing

the accelerated aging test.

13.1.3.4.2 Elongation shall be reported, in (%), for all test specimens and shall be itemized in grouping of “as received” and after accelerated aging. These grouping shall be itemized in subgroups of machine direction and cross-machine direction. Any aged specimen which exhibits an elongation value less than 85% of the “as received” value shall be considered as failing the accelerated aging test.

14. Cyclic Elongation

14.1 This test covers the determination of the cyclic elongation performance of materials specified in Section 1 of this Protocol in accordance with the ICBO Acceptance Criteria For Roof Underlayment For Use In Severe Climate Areas (Section IV F), except as noted below.

14.1.1 Specimens shall be nailed, using four (4) 10d roofing nails, with one nail in each exterior corner of the two pieces of plywood sheathing.

14.1.2 The three specimens shall be prepared with $32/16$ $15/32$ in. x 3 in. x 6 in. APA span rated sheathing.

14.1.3 Any test specimen which exhibits cracking of material shall be considered as failing the cyclic elongation test.

15. Water Vapor Transmission

- 15.1 This test covers the determination of the water vapor transmission of materials specified in Section 1 of this Protocol in accordance with ASTM Test Method E 96.
- 15.2 The water vapor transmission of the membrane shall not be greater than 1.0 g/m² in 24 hours.

16. Puncture Resistance

- 16.1 This test covers the determination of the puncture resistance of materials specified in Section 1 of this Protocol in accordance with the ICBO Acceptance Criteria For Concrete Tile Underlayment On Spaced Sheathing (Section 5.0, d,2), except as noted below.
- 16.1.1 Two 12 in. x 25 in. specimens shall be prepared; one ultraviolet light conditioned and one accelerated aging conditioned, as specified in Sections 12 and 13 of this Protocol, respectively.
- 16.1.2 Any test specimen which exhibits any sign of puncture shall be considered as failing the puncture test.

17. Slippage Resistance

- 17.1 Prepare three (3) 4 foot wide x 8 foot long specimens with a 4 inch overlap seam across the center of the 8 foot length. Prepare the specimens: one from one edge of the roll and one from the center of the roll. The length of each specimen should be in the "machine direction" of the roll.
- 17.2 The substrate shall be $32/16$ $15/32$ in. x 4' x 8' APA span rated sheathing that has been reinforced on the back side with two angle irons.
- 17.3 Nail the underlayment to the substrate through "tin caps," not less than $1\frac{5}{8}$ in. and not more than 2 in. in diameter and of not less than 32 gage (0.010 in.) sheet metal, using 10d roofing nails, in a grid pattern of 12 in. with 6 in. spacing at the lap, penetrating the sheathing a minimum of $\frac{1}{2}$ inch.

- 17.4 Condition each test deck in an oven maintained at $165 \pm 5^\circ\text{F}$ for a minimum of four (4) hours. Thereafter, the deck shall be cooled for three hours at $75^\circ \pm 5^\circ\text{F}$.
- 17.5 After conditioning, position one test deck at a slope of 4 in:12 in.; one at 5 in:12 in. and the third at a slope of 6 in:12 in.. A 5 in:12 in. test deck may be omitted if requested by the client.
- 17.6 Onto each sloped test deck, place one (1) stack of 10 flat concrete tiles and one (1) stack of 10 clay tiles equipped with "lugs," at the center of each underlayment piece, equidistant from the edge and the seam, to simulate actual loading conditions. Allow the tile stacks to sit on the underlayment surface for 72 hours while maintaining a controlled ambient temperature of $165^\circ \pm 5^\circ\text{F}$.
- 17.7 Report any tears, slippage or "tear drop" conditions which arise at fastener penetrations during the test. Report any tile sliding which has damaged any portion of the top surface of the underlayment.
- 17.8 Any test specimen which exhibits conditions noted in Section 17.7 of this Protocol shall be considered as failing the tile slippage resistance test.
- 17.9 Provide before and after photographs of each specimen in the final test report.

**FOR MINERAL SURFACED ROLL MATERIALS
TO BE
USED AS A MORTAR OR ADHESIVE SET TILE
UNDERLAYMENT**

18. Granule Adhesion

- 18.1 This test covers the determination of granule loss of materials specified in Section 1 of this Protocol, which employ a granular surfacing on one side, in accordance with ASTM Test Method D 5147, Section 14, except as noted below.
- 18.1.1 Any test specimen which exhibits an average granule loss greater than 0.75 grams shall be considered as failing the granule adhesion test.

