

TESTING APPLICATION STANDARD (TAS) No. 104-9520 TEST PROCEDURE FOR NAIL-ON UNDERLAYMENT FOR USE IN DISCONTINUOUS TILE ROOF SYSTEMS

Revise the following sections as follows:

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 Tile~~ Roof Systems to assist in the waterproofing to function in combination with a Prepared Roof Covering. These products may employ fine or 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; the Accelerated Weathering Performance of an underlayment material; the Tensile Adhesion properties of the exposed surface of the underlayment; and Granular Adhesion of a mineral for granular 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 570 Water Absorption of Plastics~~
- 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 4073 Standard Test Method For Tensile Tear Strength of Bituminous Roofing Membranes
- D 1970 Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection (~~Low Temperature Flexibility~~)

- D 2523 Testing Load-Strain Properties of Roofing Membranes
- D 1623 Standard Test Method For Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
- D 5147 Sampling and Testing Modified Bituminous Sheet Materials
- E 96 Water Vapor Transmission of Materials
- E 380 Excerpts from the Standard Practice for Use of the International System of Units (SI) (the Modernized Metric System)

2.2 *The Florida Building Code, Building*

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*. 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 Specimens shall be selected in accordance with ASTM D5147. Unless otherwise specified, condition test specimens for a minimum of four (4) 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~~ low temperature flexibility 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 or~~ bituminous test specimen which exhibits an average thickness less than sixty (60) mils shall be considered as failing the thickness test. For granular surfaced products, ~~Thickness~~ measurements shall be at the selvage edge, not at a granular surface.

6.5 Non-bituminous 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 $3\frac{2}{16}$ APA span rated plywood sheathing of a $1\frac{5}{32}$ 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 ~~40d~~ 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 4073, 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 20 lbf (88.5 N) in either the machine 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 UV Exposure, shall consist of 460 hours of continuous ultraviolet light exposure per Section 12.1.2.2.

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 UV 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 $73.4 \pm 3.6^{\circ}\text{F}$ for all tests.

9.1.3.4 Specimens and testing grips shall be conditioned at $73.4 \pm 3.6^{\circ}\text{F}$ 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 UV exposure as specified in 9.1.2.1 and 9.1.2.2 herein. ~~These grouping test specimens~~ 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	25 lbf/inch of width (35 N/cm of width)
After Heat Aging	25 lbf/inch of width (35 N/cm of width)
After QUV Exposure	25 lbf/inch of width (35 N/cm of width)

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 UV 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. Reserved

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 except as noted below. Membranes shall be test at a maximum of 10°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.

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. No cracking at - 10°F shall be considered as passing the low temperature flexibility test.

TABLE 2 MINIMUM ELONGATION VALUES (%)

SPECIMEN	ORGANIC REINFORCEMENT	FIBERGLASS REINFORCED	POLYESTER OR POLYPROPYLENE REINFORCED	SOLID THERMOPLASTIC SHEATHING SHEETS
As Received	6%	3%	25%	225%
After Heat Aging	5%	2.5%	21%	191%
After QUV Exposure	5%	2.5%	21%	191%

12. Ultraviolet Resistance

12.1 This test covers the determination of the ultraviolet resistance performance of materials specified in Section 1.

12.1.1 Sampling - Two 18 in. x ~~48~~ 48 in. specimens are to be cut.

12.1.2 Conditioning

12.1.2. ~~21~~ **21** Ultraviolet light shall be produced by four ~~300~~ 275 watt UV lamps in an enclosure in accordance with Figure 1. Recommended lamps are: Ultra-Vitalux, ~~300~~ 275 W, 220-230 V, #E27; or Osram ~~300~~ 275 W lamps, or; equivalent bulbs providing UV characteristics of 5.0 W/m²/nm irradiance at a wavelength of 315 to 400 nm at one meter..

12.1.2. ~~32~~ **32** Specimens to be exposed for ~~200~~ 460 (± 2) continuous hours (~~10 hours per day for 20 days~~).

12.1.2. ~~43~~ **43** Specimen temperature to be maintained at 135-140°F throughout the UV exposure portion of the test period. ~~Specimens shall be maintained between 70°F +/- 15°F when not exposed to UV during 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 12.1.3.1 of this Protocol shall be considered as failing the ultraviolet resistance test.

13. Accelerated Aging

13.1 This test covers the determination of the accelerated aging performance of materials specified in Section 1 of this protocol.

13.2 Sampling Specimen Preparation - 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. Specimens shall be marked to indicate machine direction.

13.2.1 Accelerated Aging – The specimens prepared per Section 14.1 are aged by the following cyclic process. Twenty-five cycles are required, with each cycle consisting of the following:

1. Oven dry at 120°F (48.9°C) for three hours with all surfaces exposed.
2. Immerse in water maintained at room temperature for three hours, with all surfaces exposed.
3. Remove from water and blot dry, then air dry for 18 hours at room temperature for eighteen hours with all surfaces exposed.

Samples shall be in the air dry period over weekends and holidays, which shall be confirmed in the test log. The room temperature shall be maintained at $73.4 \pm 53.6^\circ\text{F}$ ($23.2 \pm 2.8^\circ\text{C}$).

13.2.3.1 Conditions of Acceptance – No visible damage to the specimens, such as chipping, cracking, or delamination.

13.2.3.2 Breaking strength and elongation tests of aged specimens shall be conducted in accordance with Section 9 of this Protocol, except as noted below.

13.2.3.2.1 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.

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

13.2.3.3 Procedure - Each set of samples, as specified in 13.2.3.1 herein, shall be tested “as received” and after accelerated aging.

13.2.3.4 Report

13.2.3.4.1 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 specimens shall be itemized in subgroups of machine direction and cross-machine direction. Any aged specimen which exhibits a breaking strength less than the value listed in Table 2 shall be considered as failing the accelerated aging test.

13.2.3.4.2 Elongation shall be reported, in (%), for all test specimens and shall be itemized in grouping of ‘as received’ and after accelerated aging. These grouping specimens shall be itemized in subgroups of machine direction and cross-machine direction. Any aged specimen which exhibits an elongation value less than the applicable value listed in Table 2 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.

14.1.1 Three specimens are prepared with $15/32$ -inch-thick (12.7 mm), 3-inch-by-6-inch (76 mm by 152 mm) APA Rated A-C plywood. Each specimen includes two plywood pieces aligned so that the 6-inch (152 mm) edges are parallel and separated by 1/8 inch (3.2 mm). One piece of underlayment, 5-1/2 inches by 5-1/2 inches, is attached to the plywood pieces across the joint using four (4) 40d roofing nails, one at each outside corner of the underlayment. See Figure 2. The specimens are then conditioned at $73 \pm 4^\circ\text{F}$ ($22.8 \pm 2.2^\circ\text{C}$) for seven days. After conditioning, specimens are placed in a cold box, which is maintained at -20°F (-28.9°C) for ~~48~~ 24 hours ± 1 hour. Specimens are then cycled between a 1/8-inch (3.2 mm) and 1/4-inch (6.4 mm) plywood edge separation for 100 cycles while maintaining the temperature at -20°F (-28.9°C). The rate of movement shall be 1/8 inch (3.2 mm) per hour.

14.1.2 Conditions of Acceptance - 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, Procedure B.

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 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 13 and 14 of this Protocol, respectively.

16.1.2 The puncture point shall be affixed to any shaft and have a right angle triangular pyramid shape that is 1 inch in height with rounded leading edges of $0.062 \pm .002$ inch radius. The point should be honed to a 0.062 inch radius and the base edges left sharp. The weight of the puncture point and shaft shall be $1.0\text{lb} \pm 0.1\text{lb}$.

16.1.2.1 Attach each specimen to a frame consisting of nominal wood members spaced 24 inches on center.

16.1.2.2 The test specimens shall have a maximum sag of 1 inch measured from the top of the framing member.

16.1.2.3 Drop the puncture point from a height of 30 inches above the top of the framing in five different locations.

16.1.3~~2~~ Any test specimen which exhibits any sign of puncture shall be considered as failing the puncture test..

17. Tile Slippage Resistance

17.1 Prepare three (3) 4 foot wide x 8 foot long test frames using min. 2 inch by 4 inch nominal lumber spaced at 24 inches on center. ~~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~~ Install 32/16 ¹⁵/₃₂ in. APA 32/16 span rated sheathing on the test frames 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, with a side lap per the manufacturer’s installation instructions. The side lap width shall be included in the final test report.

17.4 Condition each test deck in ~~an oven or under heat lamps~~ conditioning cell or room maintained at $165 \pm 5^\circ\text{F}$ for a minimum of four (4) hours. Thereafter, the deck shall be cooled for minimum 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 profiled clay tiles manufactured equipped with “lugs” on the underside of each tile 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~~ minimum 36 hours while maintaining a controlled surface temperature of $165^\circ \pm 5^\circ\text{F}$. Temperature to be maintained by a surface-mounted thermocouple mounted on the surface of the underlayment.

17.7 Report any of the following: tears, slippage, or “tear drop” condition which arise at fastener penetrations during the test. Report any tile sliding which has damaged any portion of the top surface of the underlayment.

- Any tile slippage on any portion of the underlayment
- Any tears in the underlayment
- Any tears in the underlayment surfacing
- Any delamination of the underlayment facing from the adhesive layer
- Any “tear drop” conditions at fastener penetrations

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.

17.10 Alternate ~~slippage resistance testing and~~ stacking configurations shall be permitted to be approved as part of a Product Approval. Details of such stacking configurations shall be included 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 fine or granular surfacing on one side, in accordance with ASTM Test Method D 5147, 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.

FOR UNDERLAYMENTS TO BE USED WITH ADHESIVE SET TILE SYSTEMS

19. Tensile Adhesion of Tile Adhesives

19.1 This test covers the determination of the tensile adhesion bond between a tile adhesive and the underlayment surface.

19.2 This test is required to be performed on all adhesives for which approval is sought.

19.3 Sample Preparation and Testing

19.3.1 Prepare 20 (5 each) specimens for testing at 0 days (control), 14 days, 60 days, and 120 days:

19.3.1.1 Bond a 2 inch wide by 24 inch long piece of underlayment to a 2 inch wide by 24 inch long piece of 23/32" B-C APA rated plywood. Take care that the method of bonding does not interfere with or otherwise alter the surface of the underlayment to which the tile adhesive is to be applied. Prepare (6) underlayment/plywood strips in this fashion.

19.3.1.2 Place 2 prepared specimens with the long edge horizontal in a jig such that there is a max. 3/4 inches between specimens and the specimens are braced to prevent expansion. The exposed surface of the specimens should be facing each other.

19.3.1.3 Apply foam adhesive in void between the specimens in the manner specified by the adhesive manufacturer's instructions.

19.3.1.4 Allow the adhesive to cure for min. two hours.

19.3.1.5 Remove the adhered specimens from the jig and trim excess adhesive from all edges.

19.3.1.6 Cut each adhered specimen into 2 inch by 2 inch squares.

19.3.2 Condition the 2 inch by 2 inch specimens as follows:

19.3.2.1 Control specimens shall be conditioned at 77 ± 2.5°F and 50% relative humidity for 4 hours.

19.3.2.2 All remaining specimens shall be conditioned at 180 ± 2°F and 65% relative humidity. Six specimens each shall be conditioned for 14, 60, and 120 days.

19.3.3 Test samples in accordance with ASTM D1623. Testing shall be performed after a stabilization at 77 ± 2.5°F and 50% relative humidity.

19.4 The average tensile adhesion of (5) specimens after 0, 14, 60, and 120 days shall be min. 15 psi. Any set of specimens with an average tensile adhesion below 15 psi will be considered as having failed this test.

20. Accelerated Weathering

20.1 Underlayments for which an outdoor exposure greater than 30 days is desired must comply with the requirements of this section.

20.2 Underlayments shall be exposed to accelerated weathering in accordance with ASTM D4798, Cycle A-1.

20.2.1 Exposure Limitations shall be established per Table 20.1.

20.2.2 At the conclusion of the required accelerated weathering, the weathered underlayment shall be tested per Table 20.2. Any product not achieving the values therein will be considered as having failed the test.

20.3 Report the results of testing per Table 20.2 and the duration of Accelerated Weathering exposure.

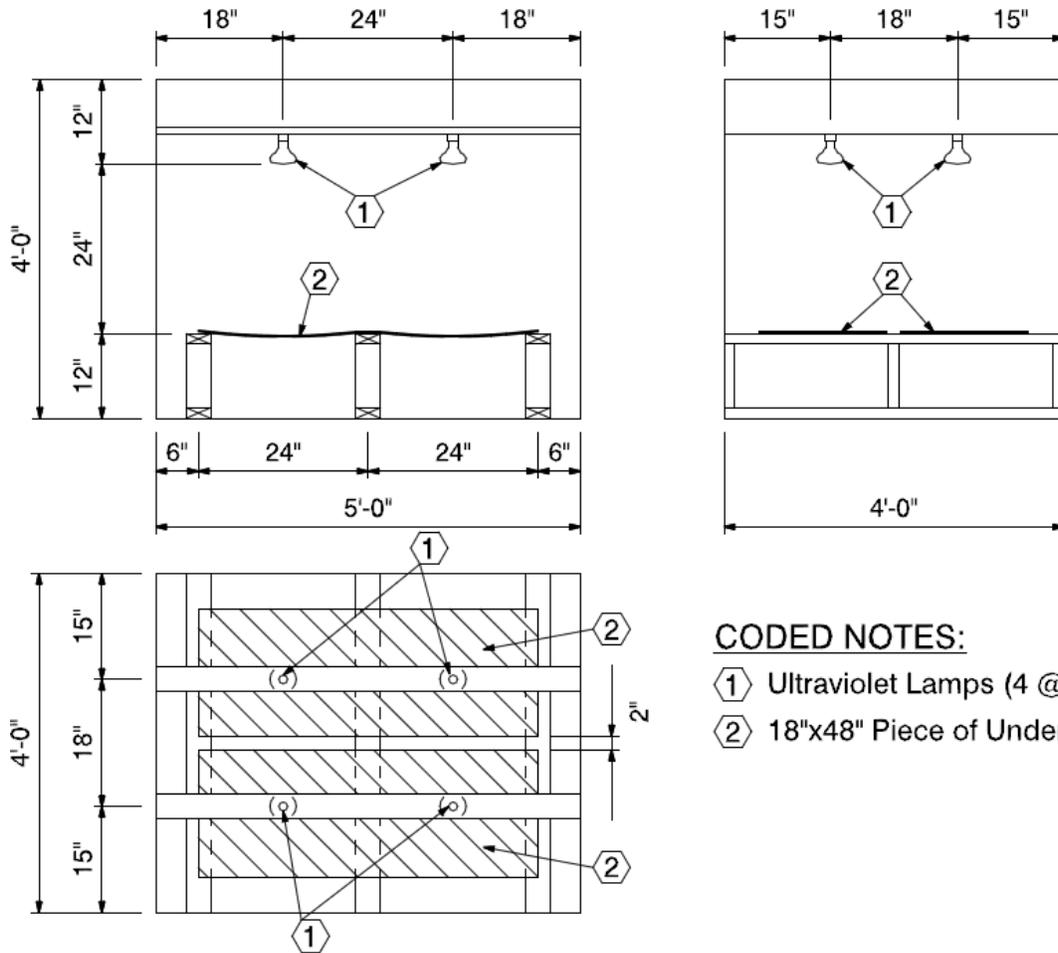
TABLE 20.1

<u>Days of Allowable Outdoor Exposure</u>	<u>Accelerated Weathering Duration (Hours)</u>
<u>45</u>	<u>250</u>
<u>60</u>	<u>333</u>
<u>90</u>	<u>500</u>
<u>120</u>	<u>666</u>
<u>150</u>	<u>833</u>
<u>180</u>	<u>1,000</u>

TABLE 20.2

<u>Property Tested</u>	<u>Section Number</u>	<u>Minimum Requirement (MD & CD)</u>			
<u>Breaking Strength</u>	<u>10</u>	<u>25 lbf/in</u>			
<u>Elongation</u>	<u>10</u>	<u>Organic Reinforcement</u>	<u>Fiberglass Reinforcement</u>	<u>Polyester or Polypropylene Reinforced</u>	<u>Solid Thermoplastic Sheeting</u>

		6%	3%	25%	225%
<u>Low Temperature Flexibility</u>	12	<u>No Cracking</u>			



CODED NOTES:

- ① Ultraviolet Lamps (4 @ 275W Each)
- ② 18"x48" Piece of Underlayment

FIGURE 1

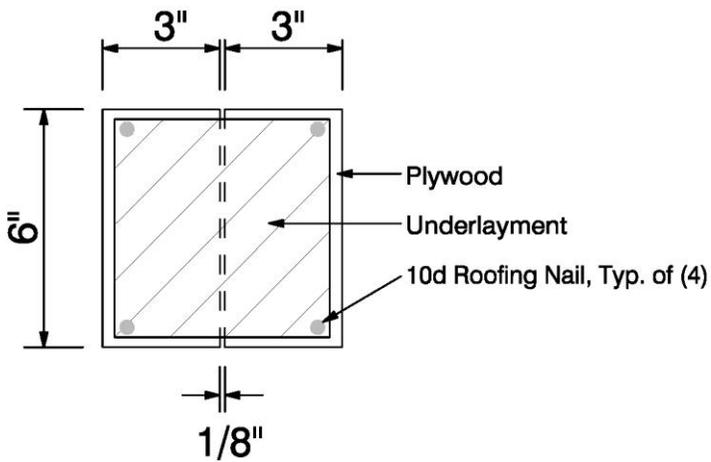


FIGURE 2

(R8283)