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Standard Specification for Vapor Permeable Flexible Sheet Water-Resistive Barriers Intended for Mechanical Attachment[1]

This standard is issued under the fixed designation E2556/E2556M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification is limited to vapor permeable flexible sheet materials which are intended to be mechanically attached and are generally installed behind the cladding system in exterior walls.

1.2 This specification is limited to the evaluation of materials and does not address installed performance. Although the fastening practices (type of fastener, fastening schedule, etc.) may affect the installed function of these materials, they are not included in this specification.

1.3 This specification does not address integration of the water-resistive barrier with other wall elements. The topic is addressed in more detail in Practice E2112 and Guide E2266.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D226 Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
D779 Test Method for Water Resistance of Paper, Paperboard, and Other Sheet Materials by the Dry Indicator Method
D828 Test Method for Tensile Properties of Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus
D882 Test Method for Tensile Properties of Thin Plastic Sheeting
D4869 Specification for Asphalt-Saturated Organic Felt Underlayment Used in Steep Slope Roofing
D5034 Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)
E96/E96M Test Methods for Water Vapor Transmission of Materials
E631 Terminology of Building Constructions
E1677 Specification for an Air Barrier (AB) Material or System for Low-Rise Framed Building Walls
E2112 Practice for Installation of Exterior Windows, Doors and Skylights
E2128 Guide for Evaluating Water Leakage of Building Walls
E2136 Guide for Specifying and Evaluating Performance of Single Family Attached and Detached DwellingsDurability
E2266 Guide for Design and Construction of Low-Rise Frame Building Wall Systems to Resist Water Intrusion
G154 Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

2.2 *Other Standards:*

AATCC Test Method 127 Water Resistance: Hydrostatic Pressure Test[3]
CGSB CAN2-51.32.M77 Sheathing Membrane, Breather Type[4]

[1] This specification is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.55 on Exterior Building Wall Systems.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Association of Textile Chemists and Colorists (AATCC), P.O. Box 12215, Research Triangle Park, NC 27709, http://www.aatcc.org.

[4] Available from Canadian General Standards Board (CGSB), Gatineau, Quebec K1A 1G6, Canada, http://www.tpsgc-pwgsc.gc.ca/cgsb.

Federal Specification UU-B-790a Federal Specification Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water ~~Repellant~~Repellent and Fire Resistant)[5]
TAPPI T-410 Test Method for Grammage of Paper and Paperboard (Weight Per Unit Area)[6]
UBC Standard 14-1 Kraft Waterproof Building Paper[7]
UBC Standard 32-1 Asphalt Saturated Rag Felt[7]
ICC-ES Acceptance Criteria AC38 for Water-Resistive Barriers[8]

3. Terminology

3.1 *Definitions*—For definitions of general terms related to building construction used in this specification, refer to Terminology E631.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 ~~*felt-based barrier*~~felt-based barrier, *n*—asphalt-saturated organic felts that comply with Specification D226 and are intended for use as water-resistive barriers.

3.2.2 ~~*paper-based barrier*~~paper-based barrier, *n*—building papers composed predominantly of sulfate pulp fibers that comply with Federal Specification UU-B-790a and that are intended for use as water-resistive barriers.

3.2.3 ~~*polymer-based barrier*~~polymer-based barrier, *n*—plastic sheet materials for use as water-resistive barriers. These materials are generally referred to as a housewrap or building wrap. These materials can be perforated with small holes or may be non-perforated, composed of films or non-woven materials.

3.2.4 ~~*Type I WRB*~~Type I WRB, *n*—water-resistive barrier with base-level water resistance (see Table 1).

3.2.5 ~~*Type II WRB*~~Type II WRB, *n*—water-resistive barrier with enhanced water resistance (see Table 1).

3.2.6 ~~*Water-Resistive Barrier (WRB)*~~Water-Resistive Barrier (WRB), *n*—a material that is intended to resist liquid water that has penetrated the cladding system.

NOTE 1—Wall assemblies often include two lines of defense against rain water ingress. The cladding serves as the first line of defense and the water-resistive barrier as the second line of defense

NOTE 2—Water-resistive barriers are sometimes referred to as weather resistant barriers or sheathing membranes.

4. Classification

4.1 This specification covers vapor permeable flexible sheet materials that are classified as Type I and Type II, which are determined by the degree of water resistance. The water-resistive barrier material composition shall determine the specific test method used to measure physical and mechanical properties (see Table 1). Appendix X1 provides explanatory information on the physical and mechanical property test methods.

5. Materials and Manufacture

5.1 Description of the material composition and structure shall be made available upon request.

5.1.1 Descriptions of the materials shall include roll weight and dimensions.

5.1.2 Descriptions of the material composition shall include linear density (basis weight). Basis weight shall be measured using TAPPI T-410.

6. Performance Requirements

6.1 All products seeking compliance with this specification shall conform to the minimum performance requirements listed in Table 1. Sampling and specimen size shall be in accordance with the referenced test methods. If not otherwise specified in the referenced test method, a minimum of five specimens shall be tested and all specimens shall meet the minimum performance requirements.

NOTE 3—The laboratory accelerated-ultraviolet (UV)/condensation exposure procedure specified in A1.2 is not intended to represent a specific service exposure. It is a method of comparing the stability of materials under consistent laboratory exposure conditions.

7. Other Requirements

7.1 The material shall not adhere to itself to an extent that will cause tearing or other damage on unrolling.

8. Sampling

8.1 The product to be tested for conformance to this specification shall be taken directly from a randomly selected roll which is representative of commercial product.

[5] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://dodssp.daps.dla.mil.
[6] Available from Technical Association of the Pulp and Paper Industry (TAPPI), 15 Technology Parkway South, Norcross, GA 30092, http://www.tappi.org.
[7] Uniform Building Code (UBC) information is available from International Code Council (ICC), 500 New Jersey Ave., NW, 6th Floor, Washington, DC 20001-2070, http://www.iccsafe.org.
[8] Available from the ICC Evaluation Service (ICC-ES), 5360 Workman Mill Road, Whittier, CA 90601, http://www.icc-es.org.

TABLE 1 Requirements for Water Resistive Barriers

Test Requirement	Specimen Type	Test Method	Minimum Performance Requirements	
			Type I	Type II
Dry tensile strength or dry breaking force (choose 1)	(1) as manufactured and (2) aged in accordance with A1.2	Test Method D828 for paper and felt materials, or	3500 N/m (20 lb/in.) minimum (machine and cross direction)	
		Test Methods D882 for polymeric materials, or	3500 N/m (20 lb/in.) minimum (machine and cross direction)	
		Test Method D5034 (Grab Method)	178 N (40 lbf) minimum (machine direction) 156 N (35 lbf) minimum (cross direction)	
Water resistance test (choose 1)	(1) as manufactured and (2) aged in accordance with A1.2	Test Method D779, or	10 min minimum	60 min minimum
		~~Water Resistance Ponding Test (A1.1), or~~	~~No water shalltransmit through the membrane in 120 min~~	~~not applicable~~
		Water Resistance Ponding Test (A1.1), or	No water shall penetrate through the membrane in 120 min	not applicable
~~AATCC Test Method 127 except that the specimens shall be held at a hydrostatic head of 55 cm (21.6 in.)~~	~~not applicable~~	~~No leakage is permitted to the underside of any specimen in 300 min~~		
AATCC Test Method 127 except that the specimens shall be held at a hydrostatic head of 55 cm (21.6 in.)	not applicable	No leakage is permitted to the underside of any specimen in 5 h		
Water vapor transmission test	as received	Test Method E96/E96M (Dessicant Method)	290 ng/(Pa · s · m^2) (5 perms) minimum	
Pliability test	as received	see A1.3	The material shall not crack when bent over a 1.6 mm (1/16-in.) diameter mandrel at a temperature of 0°C (32°F)	

8.2 The specimens shall be cut from the interior of the sample roll so that no specimen edge is nearer than 75 mm (3 in.) to the original sample edge.

8.3 Unless otherwise stated, all specimens to be tested shall be conditioned for a minimum period of 40 h at 23 ± 2°C (73.4 ± 4°F) and 50 ± 5 % relative humidity (RH).

9. Marking and Labeling

9.1 The finished product shall be marked or labeled with product identification.

9.2 Installation instructions shall be provided and shall include as a minimum the maximum weather exposure time allowed before cladding shall be installed, type of mechanical fastener and minimum fastener spacing to attach the WRB to the underlying structure, and lapping and taping requirements. This information shall be recorded and reported in any applicable test report or product rating.

10. Keywords

10.1 building felt; building paper; building wrap; housewrap; sheathing membrane; water-resistive barrier; weather-resistive barrier

ANNEX

(Mandatory Information)

A1. TEST METHODS AND PRACTICES

A1.1 Water Resistance Ponding Test

A1.1.1 *Scope*—This is a test method intended for evaluating the water resistance of a Type I water-resistive barrier.

A1.1.2 *Significance and Use*—This method is for use with water-resistive barriers.

A1.1.3 *Procedure:*

A1.1.3.1 Five specimens will be chosen at random from the material supplied.

A1.1.3.2 A ring shall be constructed with a sample of the membrane fastened between two 200-mm (8-in.) diameter aluminum rings using a rubber-type gasket. The membrane shall be placed between the rings and cupped to permit a depth of 25 mm (1 in.) of water to be exposed to 16 000 mm^2 (25 $in.^2$) of its surface.

A1.1.3.3 Distilled water shall be poured into the cylinder to a depth of 25 mm (1 in.).

A1.1.3.4 The ring shall be raised by 250 mm (9.8 in.) above a sheet of plain kraft paper placed underneath the membrane to aid in monitoring any passage of water.

A1.1.3.5 The membrane shall be maintained at constant conditions of temperature (23 ± 2°C (73.4 ± 4°F)) and RH (50 ± 5 %) and be inspected at frequent intervals over a period of 2 h for water passage through the barrier material.

A1.1.4 *Report:*

A1.1.4.1 The report shall include the following:

(1) The material and the side tested.

(2) The material sampling procedure used.

(3) Pass/fail test results for each specimen tested.

(4) Any modification to the method.

A1.1.5 *Precision and Bias*—No information is presented about either the precision or bias of this test method for evaluating water resistance since the test result is nonquantitative.

A1.2 Accelerated Aging (UV Exposure and Cyclic Drying/Wetting)

A1.2.1 *Scope*—This practice is used to condition samples of water-resistive barriers to evaluate degradation of performance due to accelerated aging (UV exposure and dry/wet cycling).

A1.2.2 *Significance and Use*—This practice is not intended to represent a service exposure. It is a method of comparing the stability of materials under consistent laboratory exposure conditions.

A1.2.3 *Procedure*:

A1.2.3.1 Three samples shall be conditioned at 23 ± 2°C (73 ± 4°F) and 50 ± 5 % RH for a minimum of 40 h. One sample shall be used for preparing unexposed specimens as a control. Two samples shall be exposed to UV radiation, followed by exposure to drying and wetting cycles in accordance with A1.2.3.2 of this specification.

A1.2.3.2 Two samples shall be exposed to fluorescent UVA-340 lamps in a fluorescent UV condensation apparatus operated in accordance with Practice G154, Cycle 1. The samples shall be exposed for a duration of 2 weeks (336 h). UV radiation exposure shall be directed on the sample surfaces that will be exposed to sunlight in normal applications.

A1.2.3.3 Three specimens shall be cut from each of the samples ~~That~~that have been exposed to UV radiation and subjected to further accelerated aging consisting of 25 cycles of drying and soaking as follows:

(1) Oven drying at 49°C (120°F) for 3 h, with all surfaces exposed.

(2) Immersion in room-temperature (23 ± 2°C (73 ± 4°F)) water for 3 h, with all surfaces submerged.

(3) After removal from the water, specimens shall be blotted dry, then air-dried for 18 h at a 23.8 ± 2.8°C (75 ± 5°F) room temperature, with all surfaces exposed.

A1.3 Pliability

A1.3.1 *Scope*—This is the test method intended for evaluating the pliability of a water-resistive barrier

A1.3.2 *Significance and Use*—This method is for use with water-resistive barriers

A1.3.3 *Procedure*:

A1.3.3.1 Five specimens will be chosen at random from the material supplied.

A1.3.3.2 Each specimen is bent 180 ± 5° over a 1.6 mm (1⁄16 in.) mandrel in 2 ± 1 s.

A1.3.3.3 The specimen and mandrel shall be maintained at constant conditions of temperature (0 ± 2°C (32 ± 4°F) during the test procedure.

A1.3.4 *Report*:

A1.3.4.1 The report shall include the following:

(1) The material tested.

(2) The material sampling procedure used.

(3) Observations of any visual cracking.

(4) Any modification to the method.

A1.3.5 *Precision and Bias*—No information is presented about either the precision or bias of this test method for evaluating pliability since the test result is non-quantitative.

APPENDIXES

(Nonmandatory Information)

X1. EXPLANATORY INFORMATION ON MECHANICAL AND PHYSICAL TEST METHODS

INTRODUCTION

X1.1 There are a number of attributes of WRBs that should be considered in their selection. These include water resistance, water vapor permeance, air resistance, durability[9] compatibility with other materials, cost, installation challenges, and more. There are three different base materials that make up Type I and II water-resistive barriers. These base materials are felt, paper, and polymeric materials. Within North America, each base material has been historically evaluated using test methods that each respective base material industry recognized as most applicable or appropriate for material characterization. These test methods, while providing distinction with a given base material, are not always transferable between base material types. Because the goal of a single set of test methods that can be used to accurately evaluate the comparable critical performance properties of all WRBs is not attainable at this time, this specification is envisioned as a first step towards that goal. Appendix X1 describes additional information about the test methods prescribed in this specification and their specificity to material composition.

TENSILE STRENGTH

X1.2 Although tensile strength does not directly measure field performance of a WRB, it may indicate durability of materials that are subjected to repetitive straining and stressing. The test methods used to test different materials differ primarily in the initial grip separation and the rate of strain of the test. Test Method D828, the test method used for paper and felt-based materials, prescribes an initial grip separation of 180 mm (7 in.), and a separation (strain) rate of 25 mm/min (1 in./min). Test Methods D882, used for polymeric materials, prescribes an initial grip separation, and rate of strain which are dependent on the percent elongation at break of the material.

RESISTANCE TO LIQUID WATER

X1.3 The most fundamental property of a WRB is its resistance to the passage of liquid water, typically originating as precipitation. Test methods commonly used for water resistance were developed by the paper and textile industries for applications in such things as packaging and tarpaulins and bear limited resemblance to the function that WRBs play in building-wall assemblies.

X1.3.1 Test methods and code requirements.

X1.3.1.1 Water resistance of WRBs is commonly measured in the United States by three test methods that are referenced, directly or indirectly, in building codes. The three methods are AATCC Test Method 127 (“hydrostatic pressure test”), some variation of Test Method D779 – Water Resistance of Paper, Paperboard, and Other Sheet Materials by the Dry Indicator Method (“boat test”), or the water resistance ponding test developed by the Canadian Construction Materials Center (CCMC). WRBs evaluated by the CCMC water resistance ponding test are subjected to water for 2 h at a depth of 25 mm (1 in.).[10]

X1.3.1.2 Codes used in the United States typically allow #15 asphalt saturated felt, conforming to Specification D226, prescriptively or Grade D asphalt treated kraft paper (10 min water resistance) under some variation of Test Method D779. Specification D226 covers felts both with and without perforations, but only the non-perforated type is referenced in the IBC for use as a WRB. Other materials, including polymeric housewraps, are qualified by testing and reporting under ICC-ES Acceptance Criteria AC38.

X1.3.1.3 Felt and paper-based materials are tested for water resistance within this specification by Test Method D779 “the boat test.” This test is performed by measuring the amount of time it takes for water to diffuse through the material and affect an indicator dye when the opposite side is in full contact with water. The 1997 UBC Standard 14-1, Kraft Waterproof Building Paper, is based on Federal Specification UU-B-790a (February 5, 1968). UBC Standard 14-1 does not describe the test protocol but simply states in a footnote “approved test methods shall be used.” The “boat test” from UU-B-790a was incorporated into Test Method D779 and is referenced in ICC-ES Acceptance Criteria AC38 as one of the alternate tests applicable to polymer-based water-resistive barriers. This test method is sensitive for both vapor and liquid-transfer through the sample. As stated in Section 4.1 of Test Method D779, “The dry indicator used in this test method is so strongly hygroscopic it will change color in a moderate- to high-humidity atmosphere without contacting liquid water. It will also change in contact with liquid water. This test method, therefore, measures the combined effect of vapor and liquid transmission. For test times up to approximately 30 s, liquid transudation rate is dominant and this test method can be considered to measure this property. As test times exceed 30 s, the influence of vapor-transmission rate increases and this test method cannot be regarded as a valid measure of liquid.”

[9] For more information see Guide E2136.

[10] The CGSB offers a Certification Program for Breather Type Sheathing Membrane based on standard CGSB CAN2-51.32.M77—Sheathing, Membrane, Breather Type. For information, contact the Conformity Assessment Officer at CGSB’s Certification Services - Products and Services.

X1.3.1.4 Polymer-based materials are tested for water resistance within this specification by three different tests; AATCC Test Method 127 the "hydrostatic pressure test, the "water resistance ponding test" and Test Method D779.

(1) The "hydrostatic pressure test," "water column test," or, technically, AATCC Test Method 127, is listed in ICC-ES Acceptance Criteria AC38 as an alternate test for polymer-based materials. This test measures the hydrostatic pressure head at which three drops of water can be forced through a material specimen. Manufacturers of these types of membranes use a water column test. This involves sealing a sample of membrane to the base of a hollow column. Water is then poured into the column and the height of water over time is measured until water is observed on the dry side of the membrane. The pressure at penetration is recorded. Alternatively, the test can be run by maintaining a specific pressure of water above a sample and measuring the time for three drops of water to penetrate. ICC-ES Acceptance Criteria AC38 recognizes polymer-based WRBs that withstand a hydrostatic pressure of 55 cm (22 in.) for 5 h as equivalent to having a 60 min rating by Test Method D779. Non-perforated polymeric membranes generally perform better than building papers in this test because of the small pores in the membrane and the better water-saturated strength of the membrane. Other housewrap products, such as perforated polyolefin membranes, usually fall somewhere between sheathing papers and non-perforated polymeric membranes in terms of vapor permeability and resistance to liquid water **(1)**.[11] The properties of these products will vary with the size and number of holes that are perforated though the base sheet. Resistance to liquid water of perforated products will usually decrease as the vapor permeance increases.

(2) The water resistance ponding test is described in CCMC Technical Guide for Sheathing, Membrane, Breather-Type, Masterformat Section 07102 (Technical Update July 7, 1993), Section 6.4.5, in which a cylindrical bowl of the sample material is filled with 25 mm (1 in.) of water and observed for 2 h. To pass the test, no seepage can be observed below the sample. The Guide states that it is applicable to Breather-Type Sheathing Membranes, which are "polyethylene-based or polypropylene-based, woven or non-woven."

(3) The Test Method D779 water resistance test is also used to evaluate polymeric water resistive barriers as described in X1.3.1.3."

X1.3.2 *Typical Test Results*—Unexposed material: In a type of test where pressure is not a factor, asphalt-saturated felt typically and significantly outperforms asphalt-saturated kraft paper. With high pressures, asphalt-saturated kraft paper typically slightly outperforms asphalt-saturated felt. This may be because kraft paper has a tighter matrix than felt, thus performing better under pressure. Felt, however, has more asphalt, thus resisting migration of water longer under low pressure. It is well accepted that unperforated polymer WRBs perform well under higher pressure compared to cellulose-based WRBs. However, the pressure at which even the least water-resistant WRB failed a hydrostatic test 6000 Pa (0.87 lbf/in.^{2}) is equivalent to the force of a 320 kph (200 mph) wind **(2)**. Most low-rise residential windows are designed to withstand a water-penetration pressure equivalent to a wind speed of 50–80 kph (30–50 mph). An 80 kph (50 mph) wind speed is equivalent to approximately 300 Pa (0.04 lbf/in.^{2}). Relatively high performance of polymeric WRBs under high hydrostatic pressures may be impressive but not necessarily indicative of a property required to fulfill their intended function.

X1.3.3 *Resistance to Liquid Water: Aged Material*—There is no test information in the literature about comparative water resistance of WRBs after prolonged exposure to water, UV light or to wet/dry cycling. Under ICC-ES Acceptance Criteria AC38, weathering by UV light exposure and wet/dry cycling is required of polymeric WRBs if they are tested for water resistance using AATCC Test Method 127, Section 6.4.5 of CCMC 07102 or Test Method D779. Current codes do not require paper or felt based products to be evaluated after UV exposure or accelerated aging. Polymeric WRB manufacturers typically limit exposure of their products prior to cladding.

WATER VAPOR PERMEANCE

X1.4 Conventional wisdom has been that it is important for a WRB to be water-vapor permeable so as to allow drying of water from the wall cavity. Water can exist in a wall cavity from any number of sources including initial construction moisture, seasonal condensation of water vapor within a wall assembly, condensation of vapor from air leakage or incidental water leakage as defined in Guide E2128. The optimum level of vapor permeance will, however, be dependent on the wall system, the climate in which it is built, and the interior conditions of the building structure. The appropriate level of permeability for specific climates and wall designs is the subject of current building science research. The vapor permeability requirement in this specification is consistent with Grade D water-resistive barriers and vapor permeable membrane definition in the International Building Code and International Residential Code.[12]

X1.4.1 *Test Methods and Code Requirements*:

X1.4.1.1 In North America, the typical tests for the measurement of permeance and water vapor transmission rate (WVT) are

[11] This specification is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.55 on Exterior Building Wall Systems.

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[12] The International Building Code and the International Residential Code are available from International Code Council (ICC), 500 New Jersey Ave., NW, 6th Floor, Washington, DC 20001-2070, http://www.iccsafe.org.