Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover[1]

This standard is issued under the fixed designation E 154; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 These test methods[2] cover the determination of the properties of flexible membranes to be used as vapor retarders in contact with earth under concrete slabs, against walls, or as ground cover in crawl spaces. The test methods are applicable primarily to plastic films, and other flexible sheets. The materials are not intended to be subjected to sustained hydrostatic pressure. The procedures simulate conditions to which vapor retarders may be subjected prior to and during installation, and in service.

1.2 The test methods included are:

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1.3 The values stated in acceptable metric units shall be considered standard. The values in parentheses are for information only.

1.4 *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:*

C 168 Terminology Relating to Thermal Insulating Materials[3]
C 755 Practice for Selection of Vapor Retarders for Thermal Insulation[3]
D 828 Test Method for Tensile Breaking Strength of Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus[4]
D 1709 Test Methods for Impact Resistance of Plastic Film by the Falling Dart Method[5]
D 1985 Practice for Preparing Concrete Blocks for Testing Sealants, for Joints and Cracks[6]
D 2565 Practice for Operating Xenon Arc-Type Light-Exposure Apparatus With and Without Water for Exposure of Plastics[7]
D 4397 Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications[8]
E 84 Test Method for Surface Burning Characteristics of Building Materials[9]
E 96 Test Methods for Water Vapor Transmission of Materials[3]
E 241 Practices for Increasing Durability of Building Constructions Against Water-Induced Damage[10]
E 437 Specification for Industrial Wire Cloth and Screens (Square Opening Series)[11]
E 631 Terminology of Building Constructions[10]

3. Terminology

3.1 *Definitions:* For definitions of terms used in these test methods, see Terminologies C 168 and E 631.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *water–vapor transmission* (WVT), *n*—the steady water vapor flow in unit time through unit area of a flat material or a construction normal to specific parallel surfaces induced

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[2] Some of these test methods were based originally on *Report No. 2040*, U.S. Forest Products Laboratory, and "Vapor Barrier Materials for Use with Slab-On-Ground Construction and as Ground Covers in Crawl Spaces," *Publication 445-1956*, Building Research Advisory Board (currently out-of-print).

[3] *Annual Book of ASTM Standards*, Vol 04.06.
[4] *Annual Book of ASTM Standards*, Vol 15.09.
[5] *Annual Book of ASTM Standards*, Vol 08.01.
[6] *Annual Book of ASTM Standards*, Vol 04.03.
[7] *Annual Book of ASTM Standards*, Vol 08.02.
[8] *Annual Book of ASTM Standards*, Vol 08.03.
[9] *Annual Book of ASTM Standards*, Vol 04.07.
[10] *Annual Book of ASTM Standards*, Vol 04.11.
[11] *Annual Book of ASTM Standards*, Vol 14.02.

by specific temperatures, pressures, and humidities at each surface. Units in SI are kilogram per second, square metre, (kg/s·m^2); in inch-pound grain per hour, square foot, (grain/h·ft^2).

3.2.2 *water–vapor permeance*, *n*—the time rate of water vapor flow through unit area of the known thickness of a flat material or a construction normal to two specific parallel surfaces induced by unit vapor pressure difference between the two surfaces under specific temperature and humidityconditions. While the SI unit is kg/s·m ^{2}·Pa, the practical unit is the perm (see 3.2.3).

3.2.3 *perm*, *n*—the time rate of water vapor migration through a material or a construction of 1 grain/h·ft ^{2}·in. Hg of vapor pressure difference.

3.2.3.1 *Discussion*—There are no SI units that can be combined to give the same mass flow rate as the inch-pound perm without a numerical coefficient. If a specification states that a one perm resistance is required, the same rate of flow will be obtained from the following relationships:

1 perm	= 1 grain/h·ft^2·in. Hg	Inch-pound units
	= 57.2·10^{-12} kg/s·m^2·Pa	SI (fundamental units)
	= 57.2 ng/s·m^2·Pa	SI (frequently used)
	= 0.66 g/24 h·m^2·mm Hg	SI (deprecated, should not be used)

The perm is a specific rate of vapor flow regardless of the units that were used in measuring the flow rate or in converting them into desired units.

3.2.4 *water–vapor permeability*, *n*— the time rate of water vapor flow through unit area of unit thickness of a flat material induced by unit vapor pressure difference between two parallel specified surfaces under specific temperature and humidity conditions.

3.2.4.1 *Discussion*—Since vapor flow rate does not vary directly with thickness for many materials, comparisons of vapor flow rates for retarders of various thicknesses should be made on test results of permeance rather than on permeability.

4. Significance and Use

4.1 In service, vapor retarders may be exposed to a variety of conditions, so no one test will provide evaluations related to performance for all exposures (refer to Practices E 241 and C 755). Neither will all test methods listed be necessary in all evaluations for specific exposures (see 16.2).

4.2 *Limitations*—Prior to use and in service, vapor retarders may be exposed to a variety of conditions so no one test will provide evaluations related to performance for all exposures (refer to Practices E 241 and C 755). Neither will all tests be necessary in all evaluations for specific exposures. Consequently, the tests and required test results shall be agreed upon by the purchaser and the supplier (see 16.2).

5. Sampling

5.1 Obtain samples for preparation of test specimens from each of three separate rolls or packages of each type of material being tested. Samples shall be representative of the material being tested and shall be of uniform thickness. If the samples are of nonsymmetrical construction, designate the two faces by distinguishing marks and report which side was exposed to a specific condition.

6. Test Specimen

6.1 The number and size of test specimens of each material are specified in each test procedure. Great care is required to protect the test areas of the specimens against damage or contamination.

7. Water-Vapor Transmission of Material as Received

7.1 *Significance and Use*—Since the water-vapor flow rate through a material in service is significant in order for comparisons to be made of performance after specific treatments of the material, the water-vapor flow rate of the material as received is needed as a reference value. The as-received material is presumed to be representative of the material that is to be used on the purchaser's project.

7.2 *Apparatus*—The apparatus and test facilities are described in Test Methods E 96.

7.3 *Procedure*:

7.3.1 Make water-vapor transmission tests on at least three specimens of each material in accordance with Procedure B of Test Methods E 96. If the retarder material is coated or treated on one surface to improve its water-vapor resistance, make the test with this surface toward the water unless otherwise specified.

7.3.2 Where wax seals are used with the wet method, it is good procedure to heat the test dishes uniformly to 45°C (113°F) or slightly warmer before sealing the test sample to the dish to avoid having the wax become too viscous for good sealing.

7.4 *Precision and Bias*—The statements regarding precision and bias in Test Methods E 96 shall also apply to this test method.

8. Water-Vapor Transmission after Wetting and Drying and after Long-Time Soaking

8.1 *Significance and Use*—After water-vapor retarders leave the factory they are exposed to many conditions of wetting and drying, and may be subjected to immersion or partial immersion for various periods. To indicate the potential effect of wetting and drying, and relatively long-time exposure to soaking, the data from these tests will be compared with those of the material as received.

8.2 *Apparatus*:

8.2.1 *Controlled-Temperature Vessels*, of suitable size for soaking specimens, and equipped with a temperature controller actuated by a thermostat. The controller shall be of a type that will maintain temperature in the vessels between 22 and 24°C (72 and 75°F). If space permits, the test chamber used for the water-vapor transmission tests may be used to hold soaking pans in place of the thermostatically controlled vessel.

8.2.2 *Oven or Drying Chamber*, for drying test specimens, thermostatically controlled at a temperature between 60 and 62°C (140 and 144°F).

8.2.3 *Water-Vapor Transmission Apparatus*, as prescribed in Test Methods E 96.

8.2.4 *Mandrel*—A round metal bar or rod 25 mm (1 in.) in diameter and approximately 460 mm (18 in.) long.

8.3 *Procedure*:

8.3.1 Cut three specimens, 305 by 305 mm (12 by 12 in.) of the material to be tested.

8.3.2 Immerse the specimens in potable water kept at a temperature between 22 and 24°C (72 and 75°F) for 16 h (overnight). They dry the specimens in an oven kept between 60 and 62°C (140 and 144°F) for 8 h. Repeat the wetting and drying cycle for a total of 5 cycles (Monday through Friday) to be followed by immersing the specimens in water over the weekend (64 h). Repeat the wetting and drying cycle 5 more days and immerse the specimens in water for a period of 16½ days (weekend plus 2 weeks). Dry the specimens between 60 and 62°C (140 and 144°F) and then condition to a constant weight in the chamber where water-vapor transmission tests are made.

8.3.3 Cut the specimens into halves parallel to the machine direction (the long direction as taken from the roll or package). Bend one of the halves of each specimen with one surface up and the other specimen with the opposite surface up at an angle of 90° over a 25-mm (1-in.) diameter mandrel in a period of 2 s or less at a temperature between 22 and 24°C (72 and 75°F). Record evidence of cracking or delamination.

8.3.4 Cut specimens for the water-vapor transmission test so that the full bent portion is installed in the center of the pan with the surface that was concave at the time of bending facing the water. Determine water-vapor transmission in accordance with Section 7.

8.4 *Precision and Bias*—The statements regarding precision and bias in Test Methods E 96 shall also apply to this test method.

9. Tensile Strength

9.1 *Significance and Use*—The thin sheet materials that are used as vapor retarders are subjected to several kinds of handling stresses. Since it is desirable that the material have a tensile strength that will minimize tearing or permanent elongation in normal use, the tensile data may be used to compare different materials that are being considered for use in specific constructions.

9.2 *Apparatus*:

9.2.1 *Controlled-Temperature Vessels*— See 8.2.1.

9.2.2 *Testing Machine*—A pendulum-type tension testing machine such as described in Test Method D 828, or the equivalent.

9.3 *Procedure*:

9.3.1 Cut ten specimens, 25 m (1 in.) wide and 203 mm (8 in.) long, in each principal direction (crosswise and lengthwise) of the sample.

9.3.2 Immerse in potable water controlled at a temperature between 22 and 24°C (1) (72 and 75°F) for 7 days in such a manner that water has free access to all surfaces and edges of the specimens.

9.3.3 Remove the specimens from the water one at a time, lightly blot the free water from both surfaces, and immediately determine the tensile strength and elongation at maximum load. Test both sets of specimens at a temperature between 22 and 24°C (72 and 75°F) with the tester adjusted so the distance between the jaws is about 13 mm (½ in.). Line the jaws of the clamp with emery cloth or other rough material to prevent slippage of the specimen during test. Materials with high elongation may be tested with a requirement for energy absorbed to maximum load in joules or in inch-pounds. Average the ten readings, crosswise and lengthwise, respectively.

9.4 *Precision and Bias*—The statements on reproducibility in Test Method D 828 shall also apply to this test method.

10. Resistance to Puncture

10.1 *Significance and Use*:

10.1.1 One of the major stresses to which sheet materials used as vapor retarders are subjected is puncture. These data may be used to evaluate the resistance to one type of puncture force on different materials to be considered for a specific construction.

10.1.2 The falling dart test in the paragraph on Impact Resistance of Specification D 4397 may be used to evaluate puncture resistance of the material. (See Test Method D 1709 also.)

10.2 *Apparatus*:

10.2.1 *A Square Mounting Frame*, of wood, metal, or rigid plastic 254 by 254 mm (10 by 10 in.) outside with a 152 by 152 mm (6 by 6 in.) central opening, consisting of two parts that are held together with 8 thumbscrews, on each side. The thickness of wood or plastic shall be 32 mm (1¼ in.); of metal 10 mm (⅜ in.). The contact areas of each part shall be faced with well-adhered Grade No. 80 sandpaper to prevent slippage of the sheet under test (see Fig. 1).

10.2.2 *Steel Cylinder*, solid, 25-mm (1-in.) diameter, with the contact face smooth and at 90° with the axis, and with the edge of the end surface slightly rounded.

10.2.3 *Conventional Straightedges and Rules or Dials*, to indicate deflection of the test membrane at the edge of the steel cylinder.

10.3 *Procedure*:

10.3.1 Conduct the tests at a room temperature between 22 and 24°C (72 and 75°F).

10.3.2 Cut three 254-mm (10-in.) square specimens of the material to be tested. Condition specimens to a constant weight between 22 and 24°C (72 and 75°F) and between 45 and 55 % relative humidity.

10.3.3 Place a single sheet between the upper and lower parts of the mounting frame and tighten the thumbscrews.

10.3.4 Make the tests at a room temperature between 22 and 24°C (72 and 75°F). Support the test frame containing the mounted specimen on all sides on a rigid base high enough to enable the specimen to deflect to its maximum. A circular or a square support may be used. Bring the end surface of the solid steel cylinder into contact with the sheet being tested. Lower the cylinder at a rate of 6 mm (¼ in.)/min, and measure the membrane deflection within 6 mm (¼ in.) of the edge of the cylinder. Record the membrane deflection and the load periodically. Continue the test until the maximum load is reached.

10.3.5 Report the maximum load, the membrane deflection at maximum load, and the type of failure of the sheet.

10.3.6 Average the values for the three tests.

10.4 *Precision and Bias*—At this time, insufficient data are available to make a statement on precision and bias. However, when the necessary data have been accumulated, the appropriate statement will be added to this test method.

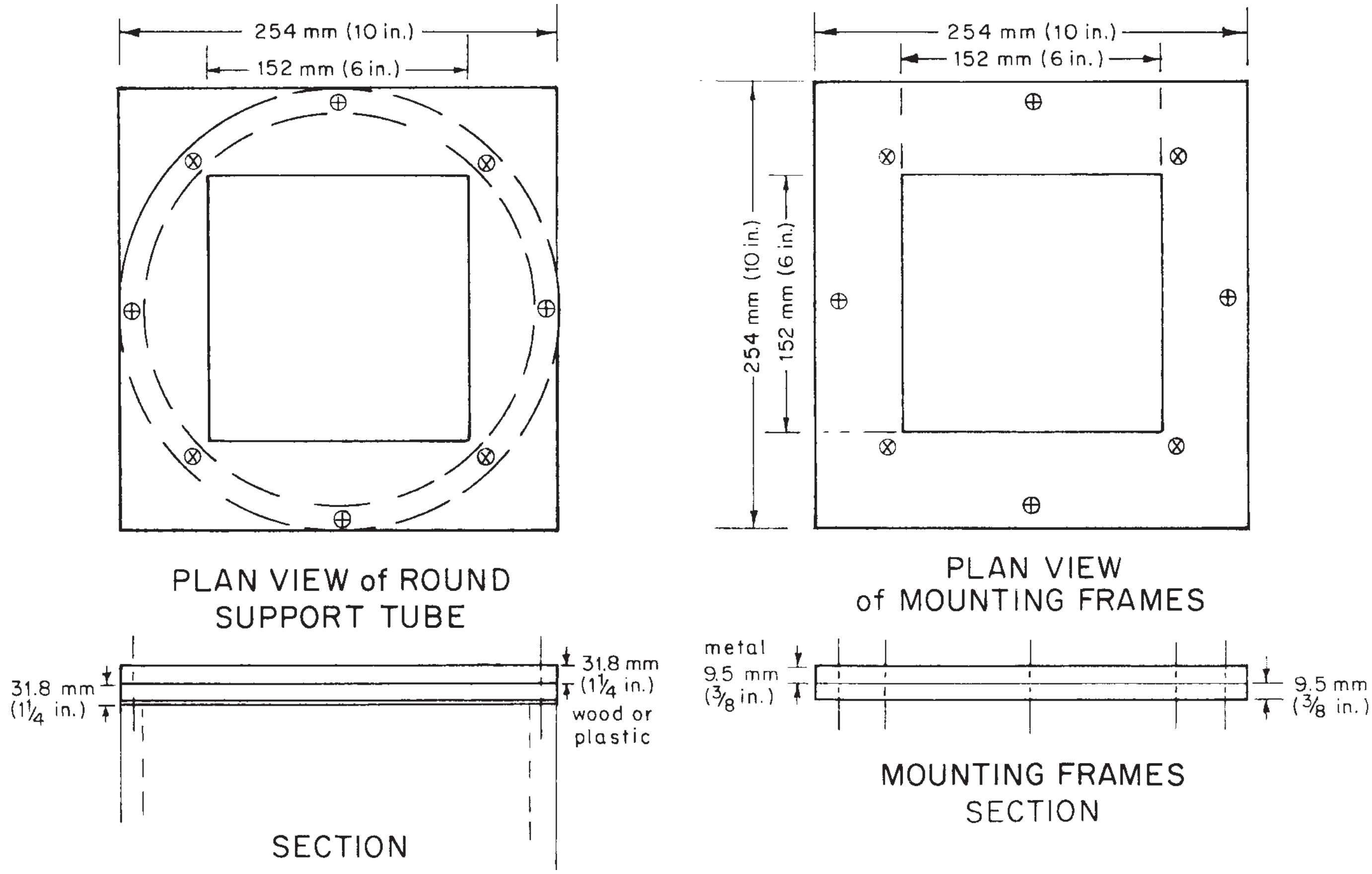

FIG. 1 Typical Mounting Frames and Round Support Tube for Resistance to Puncture Test

11. Resistance to Plastic Flow and Elevated Temperature

11.1 *Significance and Use*—When some materials remain under stress for a long time, they become thinner by plastic flow. A similar dimensional change may occur when the material is exposed to elevated temperatures. These data may be used to indicate potential change in water-vapor resistance under such exposures when compared with material asreceived.

11.2 *Apparatus*:

11.2.1 *Crushed Rock*, 19-mm (¾-in.) size to a depth of at least 51 (2 in.) in suitable containers not less than 178 mm (7 in.) square and 95 mm (3¾ in.) deep. The crushed rock shall be relatively uniform in size, passing through a 19-mm (¾-in.) sieve and retained on a 12-mm (½-in.) sieve.

11.2.2 *Conditioning Chamber*, thermostatically controlled between 60 and 62°C (140 and 144°F) and maintained with a relative humidity between 28 and 32 %.

11.3 *Procedure*:

11.3.1 Cut three 152-mm (6-in.) square specimens of the material to be tested and condition to a constant mass at a temperature between 22 and 24°C (72 and 75°F) and at a relative humidity between 48 and 52 %. Place the specimens treated or coated side down, over carefully leveled crushed rock in containers, conforming to 11.2.1, and cover each specimen with a 152 by 152-mm (6 by 6-in.) platen made of 19-mm (¾-in.) plywood. Load the platen with a weight of 11 kg (25 lb). Condition the assembly for 28 days at a temperature between 60 and 62°C (140 and 144°F) and a relative humidity between 28 and 32 %.

11.3.2 Make a water-vapor transmission test of each specimen, with the unabraded surface toward the water, in accordance with Test Methods E 96.

11.4 *Precision and Bias*—The statement regarding precision and bias in Test Methods E 96 shall also apply to this test method.

12. Effect of Low Temperature on Bending

12.1 *Significance and Use*—In some exposures, the material will be subjected to low temperatures that reduce flexibility. With reduced flexibility, some materials will crack or tear in handling. These data will enable different materials to be compared in performance under a specific condition.

12.2 *Apparatus*:

12.2.1 *Controlled-Temperature Chamber*, maintained at a temperature between −6.5 and −5.5°C (20 and 22°F).

12.2.2 *Mandrel*—See 8.2.4.

12.3 *Procedure*:

12.3.1 Cut three 305-mm (12-in.) square specimens of the material to be tested.

12.3.2 Cut the specimens into halves, parallel to the machine direction (the long dimension as taken from the roll or package). Place the specimens and the 25-mm (1-in.) mandrel in a chamber maintained between −6.5 and −5.5°C (20 and 22°F) for at least 24 h.

12.3.3 Bend one of the halves of each specimen with one surface up and the other half with the opposite surface up at an angle of 90° over the mandrel in a period of 2 s or less. The specimens and the mandrel shall be in the chamber when bends are made. Record evidence of cracking or delamination.

12.3.4 Cut specimens for the water-vapor transmission test to include the bent portion and install them in pans with the surface that was concave at time of bending facing the water. Determine water vapor transmission in accordance with the Significance and Use Section of Test Methods E 96.

12.4 *Precision and Bias*—Since the effects are indicated in Test Methods E 96, the respective statements on precision and bias shall also apply to this test method.

13. Resistance to Deterioration from Organisms and Substances in Contacting Soil

13.1 *Significance and Use*—After materials have been in contact with soil, some may be attacked by organisms or substances in the soil so that their resistance to water-vapor flow is reduced. While many different organisms and substances in soil are found, it is impracticable to test those at a specific location and presume that data may apply to others. These test exposures have been found to be sufficiently general that they may be used to obtain data that is applicable to most cases if agreed upon by the purchaser and the supplier.

13.2 *Apparatus and Materials*:

13.2.1 *Incubation Chamber or Room*, maintained at a temperature between 27 and 29°C (81 and 84°F) and a relative humidity between 67 and 73 %.

13.2.2 *Soil Containers*, consisting of nonporous dishes or pans, four for each biological test of each material being tested; a container that will accept a specimen as large as 159 mm (6¼ in.) in diameter and deep enough to hold 76 mm (3 in.) of soil. (The soil may be mounded if necessary to obtain the 76-mm depth.) The dishes or pans should have covers of some nonporous material such as glass, metal foil, or 0.15-mm (6-mil) polyethylene. Covers are intended to retard evaporation, but should not be so tight that they prevent access of air into the container. Disposable type aluminum baking pans and pie-plate covers can be obtained in suitable size.

13.2.3 *Sieves*, 3.35 mm (No. 6) and 2.00 mm (No. 10). See Specification E 437.

13.2.4 *Spatula*—A conventional laboratory spatula.

13.2.5 *Soil and Soil Preparation*—Soil, of high microbial activity, such as greenhouse specialists call potting soil, rich in cellulose-destroying organisms, and meeting the following additional requirements:

13.2.5.1 Potting soil containing approximately equal parts by volume of well-rotted barnyard manure, loam top soil, and coarse sand generally should be adequate. Since the soil is depended on for microbiological activity, it is very important that it should not be sterilized if purchased; therefore, unsterilized soil should be carefully specified. Moreover, the soil should have the following characteristics:

(*1*) A particle size obtained by sifting through a 3.35-mm (No. 6) sieve. To facilitate sifting, the soil should be in good working condition, that is, neither particularly wet nor dry.

(*2*) A pH in the range from 5.5 to 7.0. (pH is a measurement of hydrogen-ion concentration).

(*3*) A moisture content as great as can be tolerated without the soil forming into large lumps, so that it stays in a condition for scooping into uniform amounts for transfer to the soil pans. With many potting soils, the proper amount of moisture can be determined on small batches by adding small increments of water as the soil is stirred. The moisture content probably will be between 30 and 35 % of the oven-dry weight of the soil. Water to be added should be distilled or so low in alkalinity that it will not take the soils out of the specified pH range. The added water should be thoroughly mixed into the soil, which will serve to provide a uniform distribution of both moisture and the solid soil constituents. Adequate mixing of all the soil to be used in connection with vapor-barrier materials being compared at one time is essential so that the materials will all be exposed to soil of essentially the same microbiological activity.

13.2.6 *Veneer Sample Cards*, 76 by 76 by 1.6 mm (3 by 3 by ¹⁄₁₆in.) of sweetgum sapwood veneer, for determining the duration of test according to the microbiological activity of the soil.

13.3 *Test Specimens*—The test membranes shall be circular and of the same diameter as the test specimens required for the water-vapor transmission test in Test Methods E 96. Test four samples of each membrane.

13.4 *Hazards*—Take precautions at all times to avoid damage to the surfaces in handling that might significantly affect subsequent permeability testing of the membrane.

13.5 *Procedure*:

13.5.1 *Burial and Incubation of Specimens*— Bury the specimens, without folding or wrinkling, using the following steps:

13.5.1.1 Put soil carrying the required amount of water (see 13.2.5.1) in the soil pan to a depth of approximately 38 mm (1½ in.) and level the surface under light compression that will eliminate any surface lumps.

13.5.1.2 Place the test specimen on the soil, centering it approximately.

13.5.1.3 After pressing the test specimen firmly into the soil, add 1½ in. (40 mm) of concrete as specified in 5.1 of Practice D 1985 and level with wood screed. Using a suitable concrete mold, completely cover the specimens with concrete. The soil shall contact the entire lower surface area of the test specimen, and the concrete shall contact the entire upper surface of the test specimen, hence the need for some compression prior to placement of the concrete.

13.5.1.4 Cover the pans containing the soil beds and specimens thus prepared and hold them for a period, as determined by the microbiological activity of the soil (see 13.5), in a darkened chamber or room having a temperature of 27 ± 2°C (80 ± 3°F) and a relative humidity of 70 ± 3 %.

13.6 *Standardization of Test Duration According to Microbiological Activity of Soil*—Using the same batch of soil described in 13.2.5 place under test, at the same time and in the same way as hereafter described for the membranes to be tested, cards of 1.6 mm (¹⁄₁₆ in.) thick sweetgum sapwood veneer that have been conditioned to a constant weight, and weighed, at the same temperature and relative humidity as maintained in the chamber where vapor-transmission tests are made in accordance with 11.3.2. Conditioning should take approximately 24 h and the cards should have a moisture content of about 9 %. Remove individual cards from the test at intervals to establish a weight-loss trend. Gently wash the cards free of soil and condition again before weighing. When the trend of veneer-card weight losses indicates a weight loss not less than 35 % of the initial card weight, the test may be characterized as standard for appraising permeance stability and may be terminated. Control in this respect can be guided by using a small surplus of veneer cards and removing one from test at suitable intervals, beginning at about the fourth week. If appraisal of the long-term persistance of membrane strength as well as permeance is important, it is advisable to carry out the test on a second set of membranes and to continue the test until the veneer cards have incurred a weight loss of about 65 %.

13.7 *Dismantling of Test*—At the end of the incubation period (13.5.1.4), carefully remove the concrete from the specimen and remove the specimen from the soil. Use particular care when removing the concrete so as not to damage the specimen. Wipe and wash the specimen free of soil and dust.

13.8 *Measurement of Results*—Weigh test specimens before and after the soil-burial test. Condition the test material to a constant moisture content as required for the water-vapor transmission test before each weighing. Determine water-vapor transmission rate on the test specimens in accordance with the Significance and Use Section of Test Methods E 96. Judge loss of membrane strength to be proportional to the reduction in weight of the specimen.

13.9 *Precision and Bias*—The statements in Test Methods E 96 apply insofar as practicable until an accumulation of test data will enable a statement on precision and bias to be added to this test method.

14. Resistance to Deterioration from Petroleum Vehicle for Soil Poisons

14.1 *Significance and Use*—The vehicle used in soil poisons intended for termite control may cause deterioration to some vapor-retarded membranes. Ordinarily, the chemicals are used in a diluted form and are unlikely to occur in sufficient concentration to cause damage. The vehicle used with most poisons is water when temperatures at time of use will not cause freezing problems, but when temperatures are too long to permit the use of water, petroleum products such as fuel oil, kerosene or naptha may be substituted. Some proprietary poisons can be used only with petroleum-product vehicles. Petroleum oils may cause more or less damage to membranes containing asphalt that are in contact with or even exposed to vapor from the oils. Other membranes may also be affected by long exposure to petroleum vehicles.

14.2 *Apparatus and Materials*:

14.2.1 *Containers and Covers*, consisting of glass, graniteware, or earthenware crocks at least 228-mm (9-in.) square and 76-mm (3-in.) deep and aluminum-foil covers.

14.2.2 *Constant-Temperature Room or Incubator*, in which temperatures can be maintained between 27 and 32°C (80 and 90°F).

14.2.3 *Testing Machine*—See 9.2.2.

14.2.4 *Soil*—A supply of potting soil that has been sterilized by steaming or autoclaving for 30 min at atmospheric pressure.

14.3 *Procedure*:

14.3.1 Cut and prepare four specimens, each not less than 203 by 203 mm (8 by 8 in.). Condition specimens to a constant weight under the conditions required for the water-vapor transmission test in accordance with 7.3.1 and record this weight.

14.3.2 To dried soil conforming to 14.2.4, add small quantities of No. 1 fuel oil, or other solvents as agreed upon by the purchaser and supplier, mixing it thoroughly until the oil content is as high as can be tolerated without making the soil sticky or muddy. Prepare an exposure bed with such soil in containers conforming to 14.2.1. The first layer of soil shall be 25-mm (1-in.) deep and carefully smoothed or leveled. Place a specimen over the soil and add another 25-mm (1-in.) layer of soil. If the depth of the dish is adequate, additional specimens may be added, provided each specimen is covered with 25 mm (1 in.) of the soil mixture.

14.3.3 Cover the dishes with aluminum foil covers and store them in a room having a temperature of 27 to 32°C (80 to 90°F) for 10 days.

14.3.4 After the exposure period, remove the specimens from the dishes, brush off dirt, and condition them to a constant weight. Weigh the specimens and record the mass. Cut a section from each specimen and determine the water vapor transmission in accordance with the Significance and Use Section of Test Methods E 96. Also, put two pieces 25 mm (1 in.) wide and 152 mm (6 in.) long from each test specimen in each principal direction (crosswise and lengthwise) of the specimen and test for tensile strength and unit elongation at maximum load as directed in 9.3.3.

14.4 *Precision and Bias*—Since the data will be obtained from Test Methods E 96, the respective statements in that method shall apply insofar as practicable until an accumulation of data will enable a statement or precision and bias to be added to this test method.

15. Resistance to Deterioration from Exposure to Ultraviolet Light

15.1 *Significance and Use*:

15.1.1 After a vapor retarder has left the factory it may be subjected to ultraviolet light during storage or handling before it is covered. These data may be used to indicate change in water-vapor flow through as-received material after exposure to ultraviolet light from xenon lamps.

15.1.2 Xenon arcs have been shown to have a spectral energy distribution, when properly filtered, which closely simulates the spectral distribution of sunlight at the surface of the earth. In comparison to sunlight exposure, this test method is not necessarily an accelerated test.

15.1.3 Since the emitted energy from the xenon lamps decays with time and since the other parameters of temperature and water do not represent a specific known climatic condition, the results of laboratory exposure are not necessarily intended to correlate with data obtained by outdoor weathering. There may be no positive correlation of exposure results between the xenon arc and other laboratory weathering devices.

15.2 *Procedures*:

15.2.1 Follow the procedures for exposures described in Practice D 2565.

15.2.2 For determining the effect of exposure to xenon lamps on water-vapor flow, test before and after exposure in accordance with Test Methods E 96.

15.3 *Precision and Bias*—For the exposures, the precision and bias statements of Practice D 2565 shall apply. As regards the water vapor flow before and after exposure, the statements of Test Methods E 96 shall also apply to this test method.

16. Resistance to Flame Spread

16.1 *Significance and Use*—Since vapor retarders may be used in locations wherein a surface may be exposed to flame, the vapor retarder shall have a flame spread rating that meets the requirements of the appropriate building codes.

16.2 *Procedures*—Follow the procedures outlined in Test Method E 84 for materials that need special supports if they sag when heated.

16.3 *Precision and Bias*—Since the evaluations shall be made in accordance with Test Method E 84 for the materials that need special support, the respective statements in that test method on precision and bias shall apply to this test method.

17. Report

17.1 Report the following information:

17.1.1 A complete description of the material tested, so that a purchaser can verify that the material received is the same as that reported,

17.1.2 Water-vapor transmission of the material as received (Section 7), expressed as permeance, and

17.1.3 Data from all tests that were agreed upon by the purchaser and supplier of the materials.

17.2 Since there may be agreement between a purchaser and a supplier that some of the tests in this standard need not be conducted for a specific transaction, the report should designate the omitted tests rather than merely omitting them. Otherwise, a supplier cannot properly claim that the material reported was tested according to Test Methods E 154.

18. Keywords

18.1 earth covers; flame-spread resistance; low-temperature flexibility; puncture-resistance testing; plastic-flow resistance; soil contact testing; tensile testing; ultraviolet light resistance; water-vapor retarder; water-vapor transmission testing