



Designation: D5747/D5747M – 21

Standard Practice for Tests to Evaluate the Chemical Resistance of Geomembranes to Liquids¹

This standard is issued under the fixed designation D5747/D5747M; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope

1.1 This practice covers procedures for the testing of geomembranes for chemical resistance with liquid wastes, prepared chemical solutions, and leachates derived from solid wastes.

1.2 This practice covers procedures for testing semi-crystalline, amorphous, elastomeric, and fabric-reinforced geomembranes.

1.3 This practice is intended to be used in conjunction with Practice D5322 or D5496, or both. The scope of this practice is limited to testing and reporting procedures for unexposed and exposed geomembrane samples.

1.4 Evaluation and interpretation of test data are beyond the scope of this practice.

1.5 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.6 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Specific precautionary statements are given in Section 7.

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

¹ This practice is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.02 on Endurance Properties.

Current edition approved March 1, 2021. Published March 2021. Originally approved in 1995. Last previous edition approved in 2020 as D5747/D5747M – 20. DOI: 10.1520/D5747_D5747M-21.

2. Referenced Documents

2.1 ASTM Standards:²

- C717 Terminology of Building Seals and Sealants
- D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
- D413 Test Methods for Rubber Property—Adhesion to Flexible Substrate
- D624 Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
- D638 Test Method for Tensile Properties of Plastics
- D751 Test Methods for Coated Fabrics
- D882 Test Method for Tensile Properties of Thin Plastic Sheeting
- D883 Terminology Relating to Plastics
- D907 Terminology of Adhesives
- D1004 Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting
- D1505 Test Method for Density of Plastics by the Density-Gradient Technique
- D2124 Test Method for Analysis of Components in Poly(Vinyl Chloride) Compounds Using an Infrared Spectrophotometric Technique (Withdrawn 2020)³
- D2240 Test Method for Rubber Property—Durometer Hardness
- D3417 Test Method for Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry (DSC) (Withdrawn 2004)³
- D3418 Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry
- D3895 Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
- D4437/D4437M Practice for Nondestructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes
- D4439 Terminology for Geosynthetics

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 The last approved version of this historical standard is referenced on www.astm.org.

- D4545 Practice for Determining the Integrity of Factory Seams Used in Joining Manufactured Flexible Sheet Geomembranes (Withdrawn 2008)³
- D4833/D4833M Test Method for Index Puncture Resistance of Geomembranes and Related Products
- D5199 Test Method for Measuring the Nominal Thickness of Geosynthetics
- D5322 Practice for Laboratory Immersion Procedures for Evaluating the Chemical Resistance of Geosynthetics to Liquids
- D5323 Practice for Determination of 2 % Secant Modulus for Polyethylene Geomembranes
- D5397 Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
- D5496 Practice for In-Field Immersion Testing of Geosynthetics
- D5885/D5885M Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
- D8117 Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by Differential Scanning Calorimetry
- E793 Test Method for Enthalpies of Fusion and Crystallization by Differential Scanning Calorimetry
- E794 Test Method for Melting And Crystallization Temperatures By Thermal Analysis
- F1251 Terminology Relating to Polymeric Biomaterials in Medical and Surgical Devices (Withdrawn 2012)³
- 2.2 Government Standard:⁴
- EPA/600/2-88/052 Lining of Waste Containment and Other Impoundment Facilities
- 2.3 NSF Standard:⁵
- NSF Standard 54 Flexible Membrane Liners
- 2.4 FTMS Standard:⁶
- FTMS 101C Method 2031 Test Method for Preservation, Packaging, and Package Materials: Test Procedures

3. Terminology

3.1 For definitions of general terms used in this practice, refer to Terminologies D883 and D4439.

3.2 Definitions:

3.2.1 *elastomer, n*—a macromolecular material that returns rapidly to approximately the initial dimensions and shape after substantial deformation by a weak stress and release of the stress. (D907)

3.2.2 *elastomeric, adj*—having the characteristics of an elastomer. (C717)

3.2.3 *plasticizer, n*—a substance incorporated into a material to increase its workability, flexibility, or distensibility. (D883)

3.2.4 *thermoplastic, n*—a plastic that can be repeatedly softened by heating and hardened by cooling through a

temperature range characteristic of the plastic, and that in the softened state can be shaped by flow into articles by molding or extrusion. (F1251)

3.3 Definitions of Terms Specific to This Standard:

3.3.1 *chemical resistance, n*—for geosynthetics, the extent to which a material or product retains its as-manufactured physical and chemical characteristics when subjected to immersion or contact with a foreign substance.

3.3.2 *coupon, n*—a portion of a material or laboratory sample from which multiple specimens can be taken for testing.

3.3.2.1 *Discussion*—See Fig. 1 for the relationship between sample, coupon, and specimen.

3.3.3 *fabric-reinforced, adj*—structurally reinforced material made by incorporating geotextile.

3.3.4 *flood coating, n*—the process of placing a layer(s) of adhesive or polymer on the edges of cut, fabric-reinforced geomembranes in order to prevent exposure of the fabric to an environment.

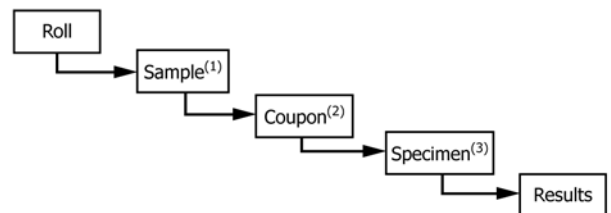
3.3.5 *plasticized, adj*—having had a plasticizer added.

3.3.6 *semi-crystalline, n*—a solid that contains a mixture of both crystalline and amorphous regions.

3.3.7 *tensile set, n*—represents residual deformation which is partly permanent and partly recoverable after stretching and retraction.

4. Summary of Practice

4.1 This practice defines test methods and procedures for evaluating the resistance of geomembranes to liquid exposure by monitoring physical and chemical properties of geomembrane coupons immersed in a test liquid. The physical condition of the geomembrane is monitored as a function of cumulative exposure time by means of dimensional measurements, and physical and chemical property tests.



- (1) sent to lab from manufacturer (for laboratory immersion) or taken directly in field (for field immersion)
- (2) cut from sample and immersed in container (for laboratory) or sump (for field)
- (3) cut from the immersed coupon on a periodic basis for testing

FIG. 1 Chemical Resistance of Geomembranes

⁴ Available from National Technical Information Service (NTIS), 5301 Shawnee Rd., Alexandria, VA 22312, <http://www.ntis.gov>, PB-89-129670.

⁵ Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140, <http://www.nsf.org>.

⁶ Available from IHS, 15 Inverness Way East, Englewood, CO 80112, <http://www.global.ihs.com>.

5. Significance and Use

5.1 This practice is intended to provide a list of standard procedures for test programs investigating the chemical resistance of a geomembrane with a liquid waste, leachate, or chemical. This practice should be used in the absence of other specifications required for the particular situation being addressed.

5.2 Chemical resistance, as used in this practice, is not a quantifiable term. This practice is intended to provide a basis of standardization for those wishing to compare or investigate the chemical resistance of a geomembrane. It should be recognized that chemical resistance is a user judgment evaluation and that this practice does not offer procedures for interpreting the results obtained from test procedures contained in this practice. As a practice, this does not produce a test result.

NOTE 1—This practice is for the chemical resistance assessment of geomembranes and is written in parallel to similar standard practices for geotextiles, geonets, geogrids, geopipes, and geosynthetic clay liners. Each standard is to be considered individually for the geosynthetic under investigation and collectively for all geosynthetics exposed to the potentially harsh chemical environment under consideration.

6. Apparatus

6.1 *Analytical Balance*, capable of weighing to an accuracy of 0.001 g.

6.2 *Dead Weight Micrometer(s)*, meeting the requirements of Test Method D638, D751, or D5199, or combination thereof, capable of measuring thicknesses to an accuracy of 0.0025 mm [0.0001 in.].

6.3 *Air Circulating Oven*, capable of maintaining a temperature of 105 ± 2 °C.

6.4 All other required equipment is specified in the referenced test method standards. Refer to the appropriate standards for a description of the apparatus necessary to perform those tests.

7. Hazards

7.1 **Warning**—The solutions used in this practice may contain hazardous chemicals. Appropriate precautions must be taken when handling hazardous waste, chemicals, and the immersion solutions. Protective equipment suitable for the chemicals being used must be worn by all personnel handling or exposed to the chemicals. Particular care should be taken when opening storage vessels at elevated temperatures due to the increased volatility of organics and the increased activity of acids and bases. Care must also be taken to prevent the spilling of hazardous materials and provisions must be made to clean up any accidental spills which do occur.

8. Sampling

8.1 Determine the number and dimensions of the test specimens according to the requirements of the dimensional measurements and physical/chemical property tests to be performed, the duration of the immersion, and the number of test intervals.

8.2 Sample in accordance with the respective test methods selected.

8.3 Cut the geomembrane coupons so that they are representative of the geomembrane being evaluated. Discard coupons that contain scratches or other imperfections that might affect the test results.

NOTE 2—Since rate of leachate absorption is a function of thickness and can have an impact on the test results, the geomembrane coupons should be as close in thickness as possible.

8.4 Mix the selected coupons in a random fashion and then re-select coupons for the immersion and baseline testing.

8.5 Cut individual test specimens for thickness, weight, and volatile loss measurements. Specimens may be of any size for which accurate and repeatable measurements can be made. Cut specimens from sheet stock using a die to ensure consistency of dimensions.

NOTE 3—Circular specimens 7.98 cm^2 [3.14 in.^2] have been found to be satisfactory for thickness, weight, and volatile loss measurements. The same individual specimen may be used for thickness, weight, and volatile loss measurements if desired.

9. Conditioning

9.1 *Conditioning*—Condition samples at 21 ± 2 °C [70 ± 4 °F] and a relative humidity between 50 and 70 % for not less than 40 h prior to weighing or baseline testing and immersion, or combination thereof.

10. Procedure

10.1 Immerse the geomembrane in the test solution as specified in Practice D5322 or D5496, or both.

10.2 Immerse a sufficient number of coupons to perform the required testing for each of the immersion periods.

10.3 Immerse additional pieces of geomembrane for weight changes, thickness changes, and volatile loss for each immersion period. Record the weight of the specimens to an accuracy of at least 0.1 % of the specimen's weight. Record the thickness of the specimens to an accuracy of 0.0025 mm [0.0001 in.].

10.4 Remove a sufficient number of coupons at the prescribed test period for the required testing. Rinse each coupon with deionized water and blot dry with water-absorbent, lint-free paper towels to remove any visible liquid or solid residue on the coupon surface. Allow elevated temperature coupons to cool to room temperature in a sample of immersion fluid. Store coupons in an airtight container or bag with as little air as possible when not being used or tested in order to minimize moisture or volatile loss, or both. Keep cut specimens in an airtight container between tests.

10.5 The tests to be performed on the geomembrane are listed in Sections 11 – 20 for each of the four types of geomembranes addressed by this practice. The tests consist of required testing to be done on the geomembrane and recommended testing to be performed at the discretion of the user. Conduct recommended tests whenever possible, as this data will aid in the interpretation of the final test results. All the tests should be completed on the unexposed geomembrane as well as on the exposed material after each test period. Test twice as many specimens as listed below on the unexposed material in order to increase precision of baseline data.

10.6 Testing (except the extractables test) of the material exposed to the leachate must be done within 24 h of removal from the test solution.

11. Required Testing, All Geomembranes

11.1 *Weight Change*—After each period, remove three pre-weighed pieces of geomembrane from the liquid, quickly blot dry with water-absorbent, lint-free paper towels any visible liquid or solid residue on the specimen surface, and weigh to the nearest 0.001 g. Calculate the percent weight change to the nearest 0.1 %.

NOTE 4—Extra care should be taken to completely dry textured surfaces to avoid an apparent increase in weight caused by residual surface moisture.

11.2 *Dimension Changes*—Measure thickness as directed in Test Method **D751**, **D638**, or **D5199** to the nearest 0.0025 mm [0.0001 in.] at three locations near the center of the pieces of geomembrane used for weight changes before and after immersion. Measure length and width (machine and transverse directions) at two locations on the sheets of geomembrane used for the physical testing before and after immersion. Calculate percent changes to the nearest 0.1 %.

11.3 *Volatile Loss*—Dry the pieces of geomembrane from the weight changes at 105 ± 2 °C for 24 h and then weigh to the nearest 0.001 g. Calculate the percent volatiles to the nearest 0.1 %.

11.4 *Visual Observations*—Describe the samples before and after immersion. Visual appearance can help in the interpretation of the data and may explain anomalous test results. Appearance items to be considered may include change from original color, including any mottling; change in surface gloss; change in surface roughness; curling, swelling, or other change at the edges of the specimen; scratch, scoring, fracture initiation, or splitting of specimen into separate parts; and gross specimen changes such as wrinkling, ovalization, or noticeable curling.

12. Required Testing, Group 1 Geomembranes (Nonreinforced)

12.1 Group 1 geomembranes include but are not necessarily limited to polyolefins.

12.2 *Tensile Properties*—Use Test Method **D638**, Type IV specimens and a rate of grip separation of 50 mm [2 in.]/min. Highly extendable geomembranes such as VLDPE should use a rate of grip separation of 500 mm [20 in.]/min. Test five specimens in each of the machine and transverse directions. Determine strain at yield, strain at break, stress at yield, and stress at break. For materials without a pronounced yield point, determine stress at 100 % elongation and stress at 200 % elongation.

NOTE 5—Stress and strain at break are subject to more variables than the other tensile properties due to the catastrophic nature of the failure. Since the standard deviations are higher for the break values, changes in those values should be considered with less importance than the other tensile values.

12.3 *Tear Resistance*—Use Test Method **D1004**, a rate of grip separation of 50 mm [2 in.]/min, and test five specimens

in each direction. Report tear resistance in N/mm thickness (or pounds per inch thickness).

12.4 *Puncture Resistance*—Use Test Method **D4833/D4833M** to test ten specimens. Report puncture resistance in N/mm thickness (or pounds per inch thickness).

12.5 *2 % Secant Modulus*—Use Practice **D5323** to test five specimens in each direction.

NOTE 6—Secant modulus is subject to more variables than the other properties due to operator interpretation of the linear portion of the stress/strain curve. Since variability is high, changes in secant modulus should be considered with less importance than the other tensile properties.

12.6 *Hardness*—Use Test Method **D2240**, Type D Durometer, and test five specimens.

12.7 *Extractables Content*—Use the procedure in Appendix E of EPA/600/2-88/052.

12.8 *Density*—Use Test Method **D1505** and test three specimens.

12.9 *Oxidative Induction Time*—Use Test Method **D3895** or **D8117**; for high-pressure oxidative induction time, use Test Method **D5885/D5885M**.

NOTE 7—The choice of OIT or HP-OIT depends on the formulation of the material and is therefore selected by the manufacturer, as details of the formulation are only known by the manufacturer. Should the formulation be unknown or undisclosed, both tests should be conducted.

12.10 *Notched Constant Tensile Load*—Use Test Method **D5397** (single point at 30 % of room temperature stress at yield) and test five transverse direction specimens.

NOTE 8—NCTL is only for HDPE geomembranes.

13. Recommended Testing, Group 1 Geomembranes (Nonreinforced)

13.1 *Seam Peel Adhesion*—Use Practice **D4437/D4437M** or **D4545** and test five specimens.

13.2 *Bonded Seam Strength*—Use Practice **D4437/D4437M** or **D4545** and test five specimens.

13.3 *Melting Point*—Use Test Method **D3418** or **E794** to obtain melting point.

13.4 *Percent Crystallinity*—Use Test Method **D3417** or **E793** to derive the percent crystallinity.

13.5 *Hydrostatic Resistance*—Use Method A, Procedure 1 of Test Method **D751** and test five specimens.

14. Required Testing, Group 2 Geomembranes (Nonreinforced)

14.1 Group 2 geomembranes include but are not necessarily limited to polyvinyl chloride (PVC).

NOTE 9—This group includes PVC geomembranes plasticized with solid plasticizer such a ketone ethylene ester. However, understand the reaction of this particular type of plasticizer may require tests which are not listed in this document.

14.2 *Tensile Properties*—Use Test Method **D882** and a rate of grip separation of 500 mm [20 in.]/min. Test five specimens