



Designation: D5514/D5514M – 24

Standard Test Methods for Large-Scale Hydrostatic Puncture Testing of Geosynthetics¹

This standard is issued under the fixed designation D5514/D5514M; 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 These test methods evaluate the stress/time properties of geosynthetics by using hydrostatic pressure to compress the geosynthetic over a subgrade.

1.2 These test methods allow the user to determine the relative failure mode or points of failure for geosynthetics, or both.

1.3 Procedures B and C incorporate site-specific soil or other material selected by the user as the test base of the testing apparatus. Procedures B and C are methods for geosynthetic design for a specific site.

NOTE 1—Earlier versions of this test method incorporated a ‘Procedure A’ involving manufactured test pyramids or cones as the base of the testing apparatus. This procedure was withdrawn, but the designations B and C were retained to avoid confusion on historical specifications and technical data sheets.

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 nonconformance 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For a specific warning statement, see Section 6.

1.6 *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 These test methods are under the jurisdiction of ASTM Committee D35 on Geosynthetics and are the direct responsibility of Subcommittee D35.10 on Geomembranes.

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2. Referenced Documents

2.1 ASTM Standards:²

- D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D1505 Test Method for Density of Plastics by the Density-Gradient Technique
- D2488 Practice for Description and Identification of Soils (Visual-Manual Procedures)
- D4439 Terminology for Geosynthetics
- D5199 Test Method for Measuring the Nominal Thickness of Geosynthetics
- D5261 Test Method for Measuring Mass per Unit Area of Geotextiles
- D5994/D5994M Test Method for Measuring Core Thickness of Textured Geomembranes
- E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

3. Terminology

3.1 Definitions:

3.1.1 *atmosphere for testing geomembranes, n*—air maintained at a relative humidity of 50 to 70 % and a temperature of $21 \pm 2^\circ\text{C}$ [$70 \pm 4^\circ\text{F}$].

3.1.2 *failure, n*—in testing geosynthetics, water or air pressure in the test vessel at failure of the geosynthetic.

3.1.3 *hydrostatic pressure, n*—a state of stress in which all the principal stresses are equal (and there is no shear stress), as in a liquid at rest; induced artificially by means of a gaged pressure system; the product of the unit weight of the liquid and the difference in elevation between the given point and the free water elevation.

3.2 For definitions of other terms used in this test method, refer to Terminology D4439.

4. Significance and Use

4.1 *Procedures B and C* are performance tests intended as a design aid used to simulate the *in situ* behavior of geosynthetics under hydrostatic compression. These test methods may

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

assist a design engineer in comparing the ability of several candidate geosynthetic materials to conform to a site-specific subgrade under specified use and conditions. In Procedure B, the pressure is increased until a failure is observed. In Procedure C, a given set of conditions (pressure, temperature, and test duration) are maintained constant and the performance of the system is observed at the end of the test.

5. Apparatus

5.1 For safe operation, the test vessel should have an appropriate ASME pressure rating. The maximum pressure rating of the vessel is dependent on the material being tested and expected pressures to be encountered. Pressure can be achieved from a regulated air system or a hydraulic pump.

5.2 *Subgrade Pan*, several removable pans for configuring various subgrades. Subgrade pans are to be built with a depth of 102 mm [4 in.], and with drain holes in the bottom of the pan to allow the pressurizing medium to flow through. The subgrade pan shall be constructed of suitable material to support a load of 1800 kPa [250 psi].

5.3 *Leak Detection System*, can be designed by using displacement floats, moisture sensor, pressure sensors, a sight glass, or other means that will accurately detect failure.

5.4 *Layout Grid*, for Procedure B, the layout grid is to assist in determining deformation of the tested geosynthetic. The grid is placed flat against the test specimen that has been placed ready for testing. Depth readings will be taken in a prearranged pattern over the entire area of the test specimen. The prearranged area that the geosynthetic displacement depth is checked must remain consistent throughout the complete testing. The depth is taken from the top of the grid to the surface of the test specimen. The layout grid is to be made of 3 mm [0.12 in.] aluminum rod with a grid layout of 50 by 50 mm [2 by 2 in.].

5.5 *Temperature Probe*, used to measure the test chamber temperature as well as the liquid temperature (if applicable). The accuracy of the temperature probe shall be $\pm 1^\circ\text{C}$.

5.6 *Support Bridge*, used to support the center of the subgrade pan to keep the pan from deflecting under load.

5.7 *Pressure Measurement Gages*, should be in a series such that each lower pressure can be closed off as its maximum safe operation pressure is reached. The series of gages should be 0 to 210 kPa [0 to 30 psi], 0 to 690 kPa [0 to 100 psi], and 0 to 1400 kPa [0 to 200 psi]. The accuracy shall be ± 7.0 kPa [1 psi].

6. Hazards

6.1 **Warning**—In addition to other precautions, the test apparatus is under pressure and adequate safety measures should be taken. When drain valves are opened, safety glasses should be worn by the operator. Pressure relief valves are highly recommended to prevent unsafe pressures.

7. Test Specimen

7.1 Cut the geosynthetic test specimen to fit a minimum of 10 mm beyond the clamping area (test vessel flange area) of the designed pressure vessel.

NOTE 2—The conceptual drawing of a pressure vessel as diagrammed in Fig. 1 is acceptable, however, other types of vessels can be used as long as the size does not bias results for a particular material.

NOTE 3—If it is difficult to determine a material's machine direction after testing, first mark on the specimen before testing a line parallel to the machine direction.

7.2 Measure the geosynthetic specimen thickness accurately by one of the industry standard test methods referenced in Section 2.

NOTE 4—If testing a permeable geosynthetic without the support of a geomembrane, a non-permeable sheet on the liquid medium side may be used, provided adjustments are made for the strength of the non-permeable sheet (that is, 0.4 mm latex).

7.3 The test specimen should be free of any scratches, folds, or other abnormalities, unless the abnormality is the item of interest.

7.4 Examine a total of three replicate test specimens.

8. Conditioning

8.1 Expose the specimens to the standard atmosphere for testing geomembranes for a period long enough to allow the geomembranes to reach equilibrium with the standard atmosphere. Consider the specimen to be at moisture equilibrium when the change in mass of the specimen in successive weighings made at intervals of not less than 2 h does not exceed 0.1 % of the mass of the specimen. Consider the specimen to be at temperature equilibrium after 1 h of exposure to the standard atmosphere for testing.

8.2 If the test is to simulate actual application, the test specimen should be conditioned for at least 40 h in that environment. If there is not a specific environment, then the conditioning should be in accordance with ASTM standard conditioning for the material being tested. If no such standard exists, state the conditioning procedure used.

9. Procedure B

9.1 The site-specific fill material will be classified by the testing laboratory by the use of sieves (conforming to Specification E11), and the aggregate measured by calipers.

9.2 Place the specimen over the prearranged subgrade and secure the top of the test apparatus to the bottom.

9.3 After the specimen is placed in position for testing, place the layout grid over the specimen. Mark on the specimen

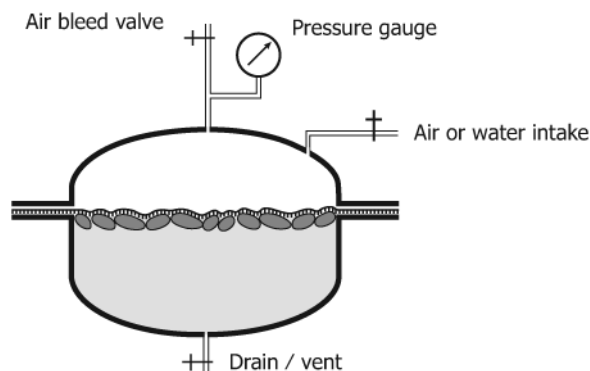


FIG. 1 Experimental Test Apparatus