Designation: D7176 – 06 (Reapproved 2011)

Standard Specification for Non-Reinforced Polyvinyl Chloride (PVC) Geomembranes Used in Buried Applications[1]

This standard is issued under the fixed designation D7176; 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 covers polyvinyl chloride (PVC) flexible sheeting which is used for construction of concealed containment-membranes. Examples are ponds and lakes, canals, reservoirs, landfill liners, covers and closures or similar installations where the membrane is inaccessible once the construction is complete. Included are requirements for materials and sheeting, test methods, workmanship criteria and methods of marking. This Specification covers un-reinforced flexible sheet made from polyvinyl chloride (PVC) resin as the primary polymer intended for use in geomembranes. This specification covers PVC sheet 0.25 mm through 1.5 mm thickness (0.010 in. through 0.060 in.)—typically used for geomembrane linings.

1.2 Reworked materials may be used in this product in accordance with the requirements in Section 5.

1.3 The tests are intended to ensure quality and performance and are not intended for design purposes. Tests have been selected to be conducted primarily with liquids that simulate the environment to which the membrane will be subjected during actual use. The test and property limits used to characterize the sheet are values intended to ensure minimum quality for the intended purpose. In place design criteria such as material compatibility, chemical resistance, among others, are factors that shall be considered but are beyond the scope of this specification.

1.4 The values stated in metric units are to be regarded as the standard. The values stated in parentheses (English) are for information only.

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]

D751 Test Methods for Coated Fabrics

D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

D882 Test Method for Tensile Properties of Thin Plastic Sheeting

D1004 Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting

D1203 Test Methods for Volatile Loss From Plastics Using Activated Carbon Methods

D1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature

D1239 Test Method for Resistance of Plastic Films to Extraction by Chemicals

D1243 Test Method for Dilute Solution Viscosity of Vinyl Chloride Polymers

D1790 Test Method for Brittleness Temperature of Plastic Sheeting by Impact

D2124 Test Method for Analysis of Components in Poly(Vinyl Chloride) Compounds Using an Infrared Spectrophotometric Technique

D4439 Terminology for Geosynthetics

D5033 Guide for Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics (Withdrawn 2007)[3]

D5199 Test Method for Measuring the Nominal Thickness of Geosynthetics

D5747 Practice for Tests to Evaluate the Chemical Resistance of Geomembranes to Liquids

[1] This specification is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.10 on Geomembranes.

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

G160 Practice for Evaluating Microbial Susceptibility of Nonmetallic Materials By Laboratory Soil Burial

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology D4439 unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *fabricator, n*—a company that converts geomembrane rolls into panels.

3.2.2 *homogeneous sheeting, n*—sheeting that is of uniform composition throughout its thickness.

3.2.3 *manufacture, n*—a company that processes raw materials into geomembrane rolls.

3.2.4 *panel, n*—a series of geomembrane sheets fabricated together to make a larger unit, as supplied by a fabricator usually folded onto a pallet or folded then rolled on a core.

3.2.5 *roll, n*—a quantity of geomembrane rolled up to form a single package as supplied from the manufacturer.

3.2.6 *roll width, n*—the width of a roll as supplied from the manufacture, (typically 1.5 to 2.5 m) (60 to 96 in.).

3.2.7 *sheet, n*—a part of the manufactured geomembrane material cut from the roll.

4. Classification

4.1 The sheeting will be subdivided by grades based on thickness:

4.1.1 *PVC10*—0.254 mm (0.010 in.).
4.1.2 *PVC20*—0.508 mm (0.020 in.).
4.1.3 *PVC30*—0.762 mm (0.030 in.).
4.1.4 *PVC40*—1.016 mm (0.040 in.).
4.1.5 *PVC50*—1.270 mm (0.050 in.).
4.1.6 *PVC60*—1.524 mm (0.060 in.).

5. Materials and Manufacture

5.1 This specification covers polyvinyl chloride (PVC) containment membrane formulated from PVC materials meeting the following requirements:

5.2 The geomembrane sheet shall consist of polyvinyl chloride (PVC) resin in amounts greater than 50 % of the total weight suitably compounded with plasticizers, stabilizers, additives, and pigments, to satisfy the physical property requirements.

5.3 A PVC resin with an inherent viscosity (logarithmic viscosity number) of not less than 0.92 as determined by Test Method D1243.

5.4 Reworked materials, as defined in Guide D5033, may be used in this product if all the requirements in Sections 3, 5, and 6 are met by the reworked material. A maximum of up to 10 % reworked material shall be permitted.

6. Physical Properties and Requirements

6.1 The sheeting shall conform to the physical requirements prescribed in Tables 1 and 2.

6.2 Sheeting shall be compounded so that bonds between sheets used in fabrication of large geomembrane panels can be accomplished in the factory or field without reducing the overall resistance of the membrane to permeation or leakage or significantly reducing the sheeting's physical strength. The manufacturer shall specify recommended bonding procedures in its product literature.

6.3 The sheeting shall be colored as agreed upon between the purchaser and the seller as part of the purchase contract.

6.4 The sheeting shall be monolithic and homogeneous.

6.5 Metric values are converted from U.S. values and are rounded to the available significant digits.

6.6 *Manufacturing Certified Properties*—Certified properties are tested based on a quantity of material produced. Certified properties are tested once per lot, or once every 18 000 kg of material (40 000 lb), whichever is more frequent. The certification properties include thickness, tensile break strength, elongation at break, modulus at 100 % strain, tear resistance, dimensional stability, and low temperature impact. Thickness is to be tested once per roll unless automatic

TABLE 1 Certified Properties

Certified Properties	ASTM	PVC 10	PVC 20	PVC 30	PVC 40	PVC 50	PVC 60
Thickness ±	D5199	0.254 ± 0.013 mm (0.010 ± 0.0005 in.)	0.508 ± 0.030 mm (0.020 ± 0.0010 in.)	0.762 ± 0.040 mm (0.030 ± 0.0015 in.)	1.016 ± 0.050 mm (0.040 ± 0.0020 in.)	1.270 ± 0.060 mm (0.050 ± 0.0025 in.)	1.524 ± 0.080 mm (0.060 ± 0.0030 in.)
Tensile Properties	D882						
Strength at Break	Min	4.2 kN/m (24 lb/in.)	8.4 kN/m (48 lb/in.)	12.8 kN/m (73 lb/in.)	17.0 kN/m (97 lb/in.)	20.3 kN/m (116 lb/in.)	24.0 kN/m (137 lb/in.)
Elongation	Min	250 %	360 %	380 %	430 %	430 %	450 %
Modulus at 100 %	Min	1.8 kN/m (10 lb/in.)	3.6 kN/m (20 lb/in.)	5.4 kN/m (30 lb/in.)	7.2 kN/m (40 lb/in.)	9.0 kN/m (50 lb/in.)	10.8 kN/m (60 lb/in.)
Tear Strength	D1004 Min	11 N (2.5 lb)	27 N (6 lb)	35 N (8 lb)	44 N (10 lb)	58 N (13 lb)	67 N (15 lb)
Dimensional Stability	D1204 Max Change	4 %	4 %	3 %	3 %	3 %	3 %
Low Temperature Impact	D1790 Pass	-23°C (-10°F)	-26°C (-15°F)	-29°C (-20°F)	-29°C (-20°F)	-29°C (-20°F)	-29°C (-20°F)

TABLE 2 Index Properties

Index Properties	ASTM	PVC 10	PVC 20	PVC 30	PVC 40	PVC 50	PVC 60
Specific Gravity	D792 Min	1.2	1.2	1.2	1.2	1.2	1.2
Water Extraction	D1239 Max Loss	0.15 7%	0.15 %	0.15 %	0.20 %	0.20 %	0.20 %
Volatile Loss	D1203 Max Loss	1.5 %	0.90 %	0.70 %	0.50 %	0.50 %	0.50 %
Soil Burial	G160 Max Change						
Break Strength		5 %	5 %	5 %	5 %	5 %	5 %
Elongation		20 %	20 %	20 %	20 %	20 %	20 %
Modulus at 100 %		20 %	20 %	20 %	20 %	20 %	20 %
Hydrostatic Resistance	D751 Min	290 kPa (42 psi)	470 kPa (68 psi)	690 kPa (100 psi)	830 kPa (120 psi)	1030 kPa (150 psi)	1240 kPa (180 psi)
Minimum Average Molecular Weight	D2124	400	400	400	400	400	400

thickness measuring equipment is installed on the production equipment. Certified test reports (Material Certification) for the certified properties are to be provided by the manufacturer with every order.

6.7 *Manufacture's Index Properties*—Index tests are performed when preparing and approving a geomembrane formulation. The tests are performed on the final production formulation of a geomembrane. The index properties include specific gravity, water extraction, volatile loss, hydrostatic resistance, and soil burial resistance. A certified statement of the test results for the formulation is to be provided with each order by the manufacturer.

6.8 Any modification of this compound shall require that the sheeting be retested for conformance to the index properties of this specification. In addition, retesting shall be done every 5 years whether the compound has been modified or not to assess cumulative effects of switching suppliers, grades of raw materials, or processing changes.

7. Endurance Properties

7.1 Other properties may be specified and agreed upon between the purchaser and supplier.

7.2 *Chemical Resistance, ASTM D5747*—Test to evaluate chemical resistance to liquids.

8. Dimensions

8.1 The width and length of the roll or fabricated panel shall be as agreed upon between the purchaser and the seller.

8.2 Sheeting width tolerance shall be +0.5 in., −0.0 in. (+12.7 mm, −0.0 mm).

8.3 The length of the sheeting after unrolling and relaxing for 10 min at 21 ± 2°C (70 ± 4°F) shall be no less than that specified in the purchase order.

9. Workmanship, Finish, and Appearance

9.1 The sheet and any factory seams shall be watertight. It shall be visually free of pinholes, particles of foreign matter, un-dispersed raw material, or other manufacturing defects that might affect serviceability as agreed on by the supplier and end user.

9.2 Typical pigment colors are gray or black. PVC geomembrane shall be any color as agreed on by the supplier and end user.

9.3 Surface texture shall be smooth or embossed finish as agreed on by the supplier and end user.

10. Sampling

10.1 *All Properties*—All samples will be removed from the actual PVC sheet used for the panel or from PVC geomembrane trial seams from the sheet used for the panel. Samples shall be removed randomly and not removed from the same location repeatedly.

10.2 *Tensile Properties (Strength at Break, Elongation, Modulus)*—Test five (5) specimens in the machine direction and five (5) specimens in cross machine direction. The sample size is typically 12 inches in the machine direction by the width of the roll. Specimens shall be removed in equal increments across a roll width sample. The specimen size is typically 25.4 by 203.2 mm (1 by 8 in.). One specimen in both the machine and cross machine directions shall be cut from the edge of the roll. A certified statement (Material Certification) of the test results for the tensile properties is to be provided with every order. The testing frequencies for this test shall be a minimum of once per 40 000 lb (once per truckload or shipment).

11. Conditioning and Curing

11.1 Standard laboratory acclamation for samples are to be conditioned for a minimum of 40 hours at standard atmosphere for testing geosynthetics, a relative humidity between 50 to 70 % and a temperature of 21 ± 2°C (70 ± 4°F).

12. Inspection and Special Testing

12.1 The manufacturer shall inspect and test material production to ensure compliance of the product with this specification.

12.2 The fabricator shall inspect and test seam fabrication to ensure compliance of the product with this specification.

13. Test Methods

13.1 *ASTM D5199, Measuring the Nominal Thickness of Geosynthetics*—U.S. units of thousandths of an inch (0.001 in. = 1 mil). Metric unit of millimeters (mm).

13.1.1 Thickness is to be tested once per roll unless automatic thickness measuring equipment is installed on the production equipment.

13.1.2 *Thickness*—Test (5 specimens or 1 specimen per width foot whichever is greater) obtained from locations equidistant across the width of the sheet. Report the average nominal thickness.

13.2 *ASTM D882, Tensile Properties of Thin Plastic Sheeting*—Use Method A.

13.2.1 Test Method D882 will be used for PVC geomembrane sheet up to 60 mil (1.5 mm) thick. Units are in pounds of force per inch of width (lb/in.). Metric units are in kiloNewtons per meter of width (kN/m), or Newton's per millimeter of width (N/mm) which are equivalent units.

13.2.2 *Stress-Strain Properties*—Determine tensile stress at 100 % elongation (modulus), tensile strength, and ultimate elongation in accordance with Method A of Test Method D882. Report physical properties as the average value from testing of 5 specimens.

13.3 *ASTM D1004, Initial Tear Resistance of Plastic Film and Sheeting*—Units are in pounds of force to initiate tear in the specially die-cut specimen (lb) or in Newton's of force (N). This test shall be tested in both machine and cross machine directions.

13.4 *ASTM D751, Test Methods for Coated Fabrics*—Determine the ability of the PVC geomembrane material to withstand water pressure without leaking in accordance with Test Methods D751 Hydrostatic Burst using Section 33, Procedure A, "Pressure Application by Mullen Type Hydrostatic Tester." Measure pressure in kilopascals (kPa) or pounds per square inch (psi).

13.5 *ASTM D1203, Volatile Loss from Plastics Using Activated Carbon Methods*—Determine volatile loss in accordance with Test Method D1203, Method A.

13.6 *ASTM D1204, Linear Dimensional Changes of Thermoplastic Film at Elevated Temperature*—Test specimens at 100°C for 15 minutes. Measure percent change in two lineal dimensions (length and width).

13.7 *ASTM D1239, Resistance of Plastic Films to Extraction by Chemicals*—Test specimens in 50°C (122°F) water for twenty-four hours. Measure percent change in weight.

13.8 *ASTM D1790, Brittleness Temperature of Plastic Sheeting by Impact*—50 % of specimens must pass at specified temperature.

13.9 *ASTM G160, Evaluating Microbial Susceptibility of Nonmetallic Materials by Soil Burial*—Bury sample in prepared soil for 30 days. Perform test on actual liner sheet samples. Measure maximum change in properties as shown in specification.

14. Certification and Reports

14.1 Test reports for the certified and index properties are to be provided with every order. These are typically referred to as material certifications.

15. Product and Package Marking

15.1 Each roll or panel shall be marked or labeled with the following:

15.1.1 Suppliers name and address.

15.1.2 Material or product description.

15.1.3 Size (length and width).

15.1.4 An individual alpha numeric designation to specifically identify this item from any other similar item (that is, serial number).

15.1.5 Total Weight.

15.2 *Rolled Material*—The material shall be rolled on a substantial core and packaged in a standard commercial container constructed as to ensure acceptance by common or other carriers for safe transportation to the point of delivery, unless otherwise specified in the contract or order.

15.3 *Folded Material*—The material shall be accordion folded onto a pallet and protected for shipment by common or other carriers for safe transportation to the point of delivery, unless otherwise specified in the contract or order.

15.4 Shipping containers shall be also be marked with the same information as rolls or panels whenever the tagged information on the rolls are covered by the packaging.

16. Keywords

16.1 canal; flexible sheeting; geomembrane; geosynthetic; landfill; poly(vinyl chloride); polyvinyl chloride resin; pond liner; PVC; reservoir; water containment membrane; water leakage resistance