



Standard Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane¹

This standard is issued under the fixed designation D4068; 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 flexible chlorinated polyethylene (CPE) sheeting which is used without mastic, bedding, or coating for construction of concealed water-containment membranes in applications where there is potential for costly secondary damage from leakage, and where very long-term reliable performance is essential. Examples are fountains, pools, planters, shower and safe pans, tile tubs, and similar installations where the membrane is inaccessible once construction is complete. Included are requirements for composition, strength and toughness, test methods, workmanship criteria, and methods of marking.

1.2 Manufacturers have the option to use recycled materials in this product. Recycled materials must be in accordance with the requirements in Section 4.

1.3 The test methods used to characterize the sheeting are intended to ensure quality and performance and are not necessarily adequate for design purposes. Test methods have been selected to be conducted primarily with liquids that simulate the environments to which the membrane will be subjected during actual installation and use.

1.4 This specification does not cover water-containment membranes exposed in use to ultraviolet light or direct sunlight.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

NOTE 1—There is no known ISO equivalent to this standard.

1.6 The following safety hazards caveat pertains only to the test method portion, Section 14, of this specification: *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
- D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
 - D543 Practices for Evaluating the Resistance of Plastics to Chemical Reagents
 - D618 Practice for Conditioning Plastics for Testing
 - D751 Test Methods for Coated Fabrics
 - D883 Terminology Relating to Plastics
 - 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
 - D1876 Test Method for Peel Resistance of Adhesives (T-Peel Test)
 - D2136 Test Method for Coated Fabrics—Low-Temperature Bend Test
 - D2240 Test Method for Rubber Property—Durometer Hardness
 - D4968 Practice for Annual Review of Test Methods and Specifications for Plastics
 - D5947 Test Methods for Physical Dimensions of Solid Plastics Specimens
 - D6988 Guide for Determination of Thickness of Plastic Film Test Specimens

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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.

*A Summary of Changes section appears at the end of this standard

D7209 Guide for Waste Reduction, Resource Recovery, and Use of Recycled Polymeric Materials and Products (Withdrawn 2015)³

E96/E96M Test Methods for Water Vapor Transmission of Materials

2.2 *ANSI Document:*

Safety Code for Safety Glazing Materials for Glazing Motor Vehicles Operating on Land Highways⁴

3. Terminology

3.1 Definitions:

3.1.1 General—Definitions are in accordance with Terminology **D883** unless otherwise indicated.

3.1.2 The abbreviation for chlorinated polyethylene is CPE.

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3.2 Definitions of Terms Specific to This Standard:

3.2.1 homogeneous sheeting—sheeting that is of homogeneous composition throughout its thickness. (Note that it is not of a sandwich construction with a continuous or semi-continuous layer of one or more materials of different composition enclosed between two or more layers of CPE.)

3.2.2 monolithic sheeting—sheeting manufactured as one piece. (Note that it is not several thicknesses laminated together, nor is it two or more widths lapped and joined with heat or chemicals.)

3.2.3 water containment membrane—a nonporous membrane impervious to water and resistant to permeation by water vapor to an extent that provides a high degree of certainty that secondary damage from leakage shall not occur.

4. Materials and Manufacture

4.1 The sheeting shall be made from a compound that contains more than 50 % chlorinated polyethylene resin by weight of total resin content, and the CPE resin shall: (a) contain 38 to 46 % chlorine; (b) be made from a linear polyethylene having a density of not less than 0.95 g/cm³; (c) be substantially amorphous, having a heat of fusion of less than 0.4 cal/g (1.7 kJ/kg), and (d) have a melt viscosity of 1700 ± 500 Pa·s when measured in a capillary rheometer at a melt temperature of 190 ± 2 °C, and a shear rate of 150 ± 10 s⁻¹.

4.2 When recycled materials, as defined in Guide **D7209**, are used in this product, the material must meet the requirements in Sections 3, 4, 5, 6, 7, and 8.

4.3 The use of water-soluble compounding ingredients shall be prohibited.

4.4 The sheeting shall be homogeneous and monolithic.

5. Physical Requirements

5.1 The sheeting shall have an average Shore-A hardness of 7684 ± 6 points when ten specimens taken equidistantly across the width of the sheet are tested in accordance with Test Method **D2240**, using a Type A durometer and reading durometer hardness after 5 s of presser foot contact with the specimen.

5.1.1 The thickness of the test specimens shall be 0.24 in. (6.0 mm) minimum unless it is known that results equivalent to the 0.24 in. (6.0 mm) values are obtained with a thinner specimen.

5.1.2 The test specimen shall be of solid construction

5.1.2.1 A specimen composed of plied sheets is permitted if it has been shown the results are equivalent to a solid specimen.

NOTE 2—Plied specimens may not agree with those made on solid specimens, as the surfaces of the plied specimens may not be in complete contact.

5.1.3 The lateral dimensions of the specimen shall be sufficient to permit measurements at least 0.48 in. (12.0 mm) from any edge.

5.1.3.1 Measurements are permitted at a lesser distance from an edge if identical results are obtained as 5.1.3.

6. Mechanical Properties

6.1 The sheeting shall conform to the mechanical property requirements in **Table 1**.

7. Performance Requirements

7.1 The sheeting shall conform to the performance requirements in **Table 2**.

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

TABLE 1 Mechanical Properties

| Property | Unit | Specification | |
|--|----------------|---------------------------------|--------------------------------|
| | | Grade 1 | Grade 2 |
| Thickness | in. (mm) | 0.040 (1.02), min | 0.030 (0.0765), min |
| Tensile strength, transverse direction | psi (MPa) | 1200 (8.28), min | 800 (5.5), min |
| <u>Tensile strength</u> | psi (MPa) | <u>1200 (8.28), min</u> | <u>800 (5.5), min</u> |
| Tensile stress at 100% elongation (modulus), transverse direction | psi (MPa) | 400 (2.76), min | 300 (2.07), min |
| <u>Tensile stress at 100% elongation (modulus)</u> | psi (MPa) | <u>400 (2.76), min</u> | <u>300 (2.07), min</u> |
| Elongation, at break, transverse direction | % | 350, min | 300, min |
| <u>Elongation, at break</u> | % | <u>350, min</u> | <u>300, min</u> |
| Tear resistance, transverse direction | lbf/in. (kN/m) | 175 (30.6), min | 120 (20.9), min |
| <u>Tear resistance</u> | lbf/in. (kN/m) | <u>175 (30.6), min</u> | <u>120 (20.9), min</u> |

TABLE 2 Performance Requirements

| Property | Unit | Specification | |
|---------------------------------------|--------------|---------------|-----------|
| | | Grade 1 | Grade 2 |
| <i>Volatile Loss at 158°F (70°C):</i> | | | |
| Weight change | percent loss | ±1.5, max | ±1.5, max |
| <i>Microorganism Resistance:</i> | | | |
| Weight change | percent | ±5, max | ±5, max |
| <i>Chemical Resistance:</i> | | | |
| <i>Sodium Hydroxide:</i> | | | |
| Weight change | percent | ±5, max | ±5, max |
| <i>Soapy Water, 1% solution:</i> | | | |
| Weight change | percent | ±3, max | ±3, max |
| <i>Distilled Water:</i> | | | |
| Weight change | percent | ±2, max | ±2, max |

8. Other Requirements

8.1 The sheeting shall be capable of being bonded to itself in a manner suitable for making seams and repairs in the field. The manufacturer shall recommend or furnish methods, materials, or equipment necessary and suitable for this purpose.

8.2 Bonds between sheets of material used in fabrication of a water-containment membrane shall conform to the requirements in **Table 3** and shall not reduce the overall resistance of the membrane to permeation or leakage.

9. Dimensions and Permissible Variations

9.1 The actual width and length of the sheeting shall be as agreed upon between the purchaser and the seller.

9.1.1 Sheeting width tolerance shall be +0.5, -0 in. (+12.7, -0 mm).

TABLE 3 Bonded Seam Requirements

| Property | Unit | Specification | |
|---|---------------------------------|--------------------|--------------------|
| | | Grade 1 | Grade 2 |
| Bonded seam shear strength, transverse direction | percent of tensile | 75, min | 75, min |
| <u>Bonded seam shear strength</u> | percent of tensile | <u>75, min</u> | <u>75, min</u> |
| Bonded seam peel strength (T-peel) | lbf/in. (kN/m) of seam width | 10 (2.75) min | 6 (1.65) min |

9.1.2 The length of the sheeting after unrolling and relaxing for 10 min at $73.4 \pm 3.6^{\circ}\text{F}$ ($23 \pm 2.0^{\circ}\text{C}$) shall be no less than that specified in the purchase order or contract.

9.2 The sheeting shall be divided by grade based on thickness, as follows:

9.2.1 *Grade 1*—40 mil (1.02 mm) shall be a minimum of 0.040 in. (1.02 mm) in thickness.

9.2.2 *Grade 2*—30 mil (0.765 mm) shall be a minimum of 0.030 in. (0.765 mm) in thickness.

10. Workmanship, Finish, and Appearance

10.1 The sheeting shall be free of pin holes, particles of foreign matter, undispersed raw materials, or other manufacturing defects that might affect serviceability.

10.2 The sheeting shall be free of blisters, craters, pimples, pits, crazing, and thin spots. Sheet edges shall be straight, parallel, and free of trim material.

10.3 Printing and markings on the sheet shall be legible and not easily removed from the sheet during normal handling, transportation, and installation.

10.4 The sheeting shall be colored as agreed upon between the purchaser and the seller.

11. Sampling

11.1 *Sampling for Evaluating Conformance to Physical, Mechanical, and Performance Requirements:*

11.1.1 One roll, or other equivalent packaged unit, with a minimum continuous sheet of 100 ft² (9.3 m²) shall be sufficient for completing all tests and evaluations in this specification.

11.1.2 Select randomly each roll or unit submitted for evaluation from an inventory of regular production stock not older than one year. Selecting more than one roll or unit or selecting from multiple inventory stocks or locations will increase the likelihood of obtaining a representative sample of contemporary production. The age of stocks from which selections are made is required to be documented.

11.1.3 Divide all submitted sheet into smaller samples of sufficient size to provide a set of specimens for any one of the tests in this specification. In no case shall a sample be less than 16 ft² (1.49 m²), nor shall either width or length be less than 3 ft (0.91 m).

11.1.4 Sample using a statistically acceptable procedure.

11.1.5 From this population, select samples randomly to provide specimens for each test.

11.2 *Sampling for In-Plant Quality Control Evaluation:*

11.2.1 Samples for quality control evaluation shall be a minimum of 25 ft² (2.5 m²), and completely span the width of the finished sheet.

11.2.2 Select randomly one or more samples from each 10 000 ft² (1 000 m²) for the quality assurance tests specified in Section 18 and Table 4.

12. Number of Tests and Retests

12.1 One set of test units is sufficient to determine conformance. The average result of all samples tested shall conform to the requirements of this specification.

12.2 Retesting to determine conformance shall be required after any significant change in compound or method of manufacture.

12.2.1 Significant changes in compound include addition, elimination, or substitution of any ingredient, changes in ratios between ingredients, change in type or grade of CPE resin, change in supplier or manufacturer, or both, of CPE resin, and change in manufacturer or supplier, or both, of CPE compound or sheet.

12.2.2 Changes in compound that are not significant include substitution of one material for another (except CPE resin) where the two are essentially identical and changes in material which do not remain a part of the sheet after manufacture.

NOTE 3—Material substitutions include changes in supplier, grade or type.

12.2.3 Significant changes in manufacture include blending process (dry blend, wet blend, Banbury mix, or separate compounding line) or method of fabricating sheet (calender, extrusion, or casting).

TABLE 4 Quality Assurance Requirements

| Property | Unit | Specification | |
|------------------|----------|---------------|---------------|
| | | Grade 1 | Grade 2 |
| Thickness | in. (mm) | 0.040 (1.02) | 0.030 (0.765) |
| Pinholes | . . . | none | none |
| Shrinkage | percent | 5, max | 5, max |
| Width tolerance | in. (mm) | +0.5 (−0.0) | +0.5 (−0.0) |
| Length tolerance | in. (mm) | −0.0 | −0.0 |

12.2.4 Changes in manufacture that are not significant include changes in brands of processing equipment, age of equipment, location of manufacture, personnel, take-off equipment and processes, packaging, and ambient or atmospheric conditions.

12.3 Retesting to determine conformance shall occur at least every five years whether or not significant changes have occurred.

NOTE 4—This requirement is included to monitor cumulative effects of relatively insignificant changes in compound or manufacture over time.

12.4 If the results of any test do not conform to the requirements of this specification, retesting to determine conformity is performed only after the purchaser and supplier agree to the retesting. However, this provision shall not be used to lower a minimum requirement, omit, substitute, or modify a test or requirement, or alter specification limits.

13. Specimen Preparation

13.1 Conditioning:

13.1.1 Condition all physical, mechanical, and performance test specimens at $73.4 \pm 3.6^{\circ}\text{F}$ ($23.0 \pm 2.0^{\circ}\text{C}$) and $50 \pm 10\%$ relative humidity for not less than 40 h in accordance with Procedure A of Methods **D618** prior to testing or starting environmental and chemical exposures.

13.1.2 Recondition all environmental and chemical exposure samples at $73.4 \pm 3.6^{\circ}\text{F}$ ($23.0 \pm 2.0^{\circ}\text{C}$) and $50 \pm 10\%$ relative humidity for not less than 40 h in accordance with Procedure A of Methods **D618** following removal from exposure and prior to physical or mechanical property testing.

13.1.3 Condition in-plant quality assurance specimens at $73.4 \pm 3.6^{\circ}\text{F}$ ($23.0 \pm 2.0^{\circ}\text{C}$) for 2 h in air prior to testing.

13.2 Bonded Seam Samples:

13.2.1 Bonded seam samples from which specimens are to be taken for testing shall be prepared using sheet samples supplied by the manufacturer. The manufacturer shall include detailed instructions as well as recommend or supply all materials needed to fabricate the bonded seam samples. The manufacturer has the option to entirely prepare the bonded seam samples used for the test specimens.

13.2.2 Finished bonded seam samples from which test specimens are to be cut shall be conditioned at $73.4 \pm 3.6^{\circ}\text{F}$ ($23.0 \pm 2.0^{\circ}\text{C}$) and $50 \pm 10\%$ relative humidity for no less than 40 h after being made and prior to cutting test specimens.

13.2.3 After cutting, prepared specimens shall be conditioned at $73.4 \pm 3.6^{\circ}\text{F}$ ($23.0 \pm 2.0^{\circ}\text{C}$) and $50 \pm 10\%$ relative humidity for not less than 168 h, in accordance with Procedure A of Methods **D618** prior to testing or starting environmental exposures.

14. Test Methods

14.1 *Stress-Strain Properties*—Tensile strength, tensile stress at 100 % elongation (modulus), and ultimate elongation shall be determined in accordance with Method A of Test Methods **D412** using dumbbell cut specimens (Die C). Report the average of six specimens in transverse direction.

14.2 *Tear Resistance*—Determine average value from ten acceptable specimens in transverse direction tested in accordance with Test Methods **D1004**.

14.3 *Volatile Loss*—Determine volatile loss in accordance with Test Methods **D1203**, Method A, at 158°F (70°C) with Grade AC ($\frac{1}{4}$ mesh) activated carbon. Test specimens shall be nominal thickness sheeting.

14.4 *Microorganism Resistance*—Test in accordance with the method described in **Annex A1**.

14.5 *Low-Temperature Flexibility*—Test three specimens in accordance with Test Method **D2136** at a temperature of -22°F (-30°C) or less. Report temperature used in test and whether material passed or failed at that temperature. Failure of one specimen (as defined in Method **D2136**) constitutes rejection of the sample.

NOTE 5—This test procedure may require testing an additional set of three specimens. For greater efficiency, six specimens may be prepared, conditioned, cooled, and tested at one time. If done in this manner the three specimens comprising each testing group must be identified prior to the start of the test.

NOTE 6—Requirement for Water-Vapor Transmission of Materials in Sheet Form (Procedure E of Test Methods **E96/E96M** has been deleted until the test method is improved to the extent that it can be reproducibly run by commercial laboratories).

14.6 *Chemical Resistance*—Determine weight changes in accordance with Procedures I and II of Test Method **D543**.

14.6.1 Reagents:

14.6.1.1 *Sodium Hydroxide* (10 % solution)—Immerse specimens for 72 h at 120°F (49°C).

14.6.1.2 *Soap Solution* (1 %)—Immerse specimens for 24 h at 120°F (49°C). Rinse specimens in clean water after removal and dry in forced-air oven at 125°F (52°C) for 24 h prior to weight measurement and testing.

14.6.1.3 *Distilled Water*—Immerse specimens for 24 h at 120°F (49°C). Dry specimens in forced-air oven at 125°F (52°C) for 24 h prior to weight measurement and testing.

14.6.2 *Testing*—Immerse adequate specimens in each reagent to test for all properties specified.

14.6.3 *Weight Change*—For each reagent, test a minimum of three weight-change specimens. Weigh each specimen after conditioning prior to immersion and record the average weight ($W1$). Weigh each specimen again after conditioning following immersion, recording the average weight ($W2$). Calculate weight change as:

$$\text{Weight Change, \%} = (W2 - W1) / W1 \times 100\%$$

Report this value as the average weight change.

14.7 *Hydrostatic Pressure Resistance*—Test three specimens in accordance with Annex A2. Rejection (failure) of one specimen shall constitute failure of the entire sample. Report results as pass or fail.

14.8 *Puncture Resistance*—Test six specimens in accordance with Annex A3. Report results as pass or fail.

14.9 *Bonded Seam Strength*—Sufficient samples for specimen selection shall be prepared or provided as directed in 13.2 for each seaming method as specified by the manufacturer. Possible seaming methods include solvent bonding, bodied cements, adhesives, and thermal, dielectric, or RF welding techniques. Other methods or techniques are also acceptable.

NOTE 7—There is no requirement as to which type of seaming must be tested, or that more than one type needs evaluation. It is only required that at least one type be available and tested.

14.9.1 *Shear Bond:*

14.9.1.1 Sample pieces shall be made from minimum 8-in. (203-mm) square pieces of sheet, with a seam overlap of $1 \pm \frac{1}{8}$ in. (25.4 ± 3.2 mm). When making the seam, align sheets so that orientation is transverse. After conditioning (see 13.2), cut the sample into 1-in. (25-mm) strips and discard the two outside edge pieces. Cut one specimen from each strip using the dumbbell-shaped Die C for Test Methods D412, taking care to place the bonded seam portion in the center of the specimen.

14.9.1.2 Test a minimum of six specimens in accordance with Method A of Test Methods D412, measuring tensile strength as shear bond. Report the average of the shear values in transverse direction as a percentage of the average tensile strength.

14.9.2 *Peel Test (T-Peel):*

14.9.2.1 For each sample piece, cut two 8 by 12-in. (203 by 305-mm) pieces of sheeting, and bond these two pieces completely together except for 3 in. (76 mm) of the 8-in. (203-mm) dimension (see Fig. 1). After allowing the sample to cure, cut the sample into 2 by 8-in. (50 by 203-mm) strips. Discard the outside strips.

14.9.2.2 Test a minimum of six specimens in accordance with Method E of Test Method D1876. Peel strength is the average load per unit width of bond line required to produce progressive separation of the samples when pulled apart at a rate of 10 in./min (254 mm/min). Report the average peel strength of all samples tested.

14.10 *Thickness*—Measure a minimum of five specimens obtained from locations equidistant across the width of the sheet in accordance with Test Methods D5947 or Guide D6988. Report thickness as an average of all specimens measured.

14.11 *Pinholes*—The test specimen shall be a section of sheeting 16 in. (406 mm) or more in length by the full sheeting width. Examine 12 in. (304 mm) of this specimen across the width by viewing the surface of the sheeting while held under slight hand tension. Position a bright light source behind the sheet so as to clearly illuminate the surface without producing glare. A pinhole is defined as any opening observed under the conditions specified. One or more pinholes will be considered as failure of the sheeting. Report the number and locations of any pinholes, and any other observed deformations of the sheet. Separately report any other observed deformations of the sheet.

14.12 *Shrinkage*—Test one specimen for 1 h at 158°F (70 °C) in accordance with Test Method D1204. Percent shrinkage is the average change in both lineal dimensions.

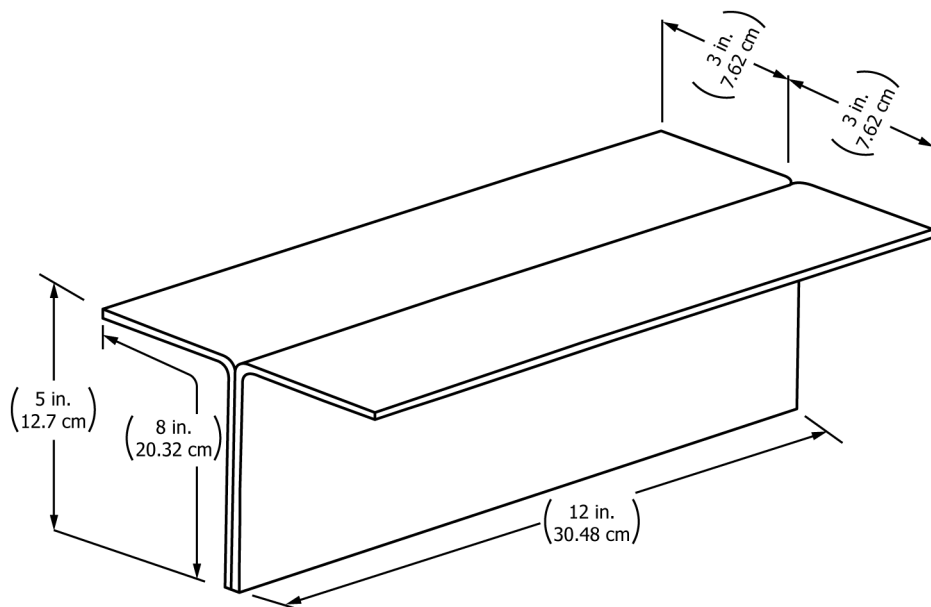


FIG. 1 Bonded-Seam T-Peel Sample After Bonding and Prior to Specimen Cutting and Selection