Designation: D1593 – 13

Standard Specification for Nonrigid Vinyl Chloride Plastic Film and Sheeting[1]

This standard is issued under the fixed designation D1593; 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 nonrigid, unsupported vinyl chloride plastic film and sheeting in which the resin portion of the composition contains at least 90 % vinyl chloride. The remaining 10 % can include one or more monomers copolymerized with vinyl chloride, or consist of other resins mechanically blended together with poly(vinyl chloride) or copolymers thereof.

1.2 The vinyl chloride plastic film and sheeting covered herein shall be 0.075 to 0.25 mm (3 to 10 mils) in thickness for film and greater than 0.25 mm in thickness for sheeting. The film and sheeting shall include the stabilizers and plasticizers necessary to meet the requirements of this specification. This specification covers transparent, translucent, or opaque film and sheeting that is plain, printed, embossed, or otherwise surface treated.

1.3 The values stated in SI units are to be regarded as the standard.

1.4 The following safety hazards caveat pertains only to the test methods portion, Section 10, 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.*

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D618 Practice for Conditioning Plastics for Testing

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

D1505 Test Method for Density of Plastics by the Density-Gradient Technique

D1790 Test Method for Brittleness Temperature of Plastic Sheeting by Impact

D1922 Test Method for Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method

D3801 Test Method for Measuring the Comparative Burning Characteristics of Solid Plastics in a Vertical Position

D3892 Practice for Packaging/Packing of Plastics

D4804 Test Method for Determining the Flammability Characteristics of Nonrigid Solid Plastics

D5947 Test Methods for Physical Dimensions of Solid Plastics Specimens

D6988 Guide for Determination of Thickness of Plastic Film Test Specimens

2.2 *Military Standard:*

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *vinyl chloride plastics*—plastics based on polymers of vinyl chloride or copolymers of vinyl chloride with other monomers, the vinyl chloride being in greatest amount by mass.

4. Significance and Use

4.1 This specification designates three general-purpose types of vinyl chloride plastic film and sheeting. The tests

[1] This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.19 on Film, Sheeting, and Molded Products.

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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] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.

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

involved are expected to provide information to identify the type of material and to ensure a minimum of good workmanship and quality. The test data are not necessarily suitable for direct application in design because of differences encountered in the shape of the part, loading, size, environmental conditions, and so forth. The test results can be used for inspection and quality control tests, provided similar test equipment and proper methods are used.

4.2 Films and sheetings are available, compounded differently, where special properties are required. Special types of film and sheeting will be added to the specification as their inclusion becomes generally desirable and the necessary data and methods become available.

5. Classification

5.1 This specification covers three types of nonrigid vinyl chloride plastic film and sheeting, designated in accordance with the method of manufacture as follows:

5.1.1 *Type I*—Calendered film and sheeting,

5.1.2 *Type II*—Extruded film and sheeting, and

5.1.3 *Type III*—Cast film and sheeting.

6. General Requirements

6.1 The material shall be of uniform composition and so compounded as to conform to the requirements of this specification.

6.2 The color, transparency or opacity, and surface finish shall be as specified by the purchaser in the contract or order.

6.3 The material shall be reasonably free from pinholes, particles of foreign matter, undispersed raw materials, and visual defects. Edges are to be smooth and free from cuts. The extent of the above defects permissible shall be as agreed upon between the purchaser and the seller.

7. Dimensional Tolerances

7.1 *Thickness*—The average thickness of the film and sheeting shall be determined in accordance with 10.1.4 and shall be within the following limits:

7.1.1 *Type I*—±10 % of the specified thickness.

7.1.2 *Type II*—±15 % of the specified thickness.

7.1.3 *Type III*—±10 % of the specified thickness.

7.1.4 Average gauge for embossed film and sheeting shall be determined in accordance with 10.1.4.2

7.2 *Average Thickness Based on Yield per Roll*—The average thickness based on yield shall be determined in accordance with 10.1.4 and shall be within the following limits:

7.2.1 *Type I*—±5 % of the specified thickness.

7.2.2 *Type II*—±10 % of the specified thickness.

7.2.3 *Type III*—±5 % of the specified thickness.

7.3 *Width*—The film and sheeting shall be held to a tolerance of ±12 or –0 mm (+½ or –0 in.) for Types I and II, and +19 or –0 mm (+¾ or –0 in.) for Type III, of the width specified by the purchaser on the contract or order. This tolerance shall apply when the material is in roll form on the core.

7.4 *Length*—The length of material for Types I and II, excluding that which has been subjected to embossing, printing, and so forth, shall be continuous in any one roll. Four heat-sealed splices shall be allowed for Type III sheeting. The total length in a roll shall be as specified by the purchaser in the contract or order.

8. Requirements

8.1 Test specimens shall conform to the requirements prescribed in Table 1.

9. Sampling

9.1 A sample shall be selected at random from each lot of material sufficient to determine the conformance of the material to this specification. Individual visual inspection of selected film or sheeting samples is permissible.

10. Test Methods

10.1 Determine the properties enumerated in this specification in accordance with the following methods:

10.1.1 *Conditioning*—Condition the test specimens as 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 10 % relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D618, for those tests where conditioning is required. In cases of disagreement, the tolerances shall be 1°C (±1.8°F) and ±2 % relative humidity.

10.1.2 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 10 % relative humidity, unless otherwise specified in the test methods or in this specification. In cases of disagreements, the tolerances shall be ±1°C (±1.8°F) and ±5 % relative humidity.

TABLE 1 Detail Requirements for Nonrigid Vinyl Chloride Plastic Film and Sheeting

Property	Requirement		
	Type I	Type II	Type III
Tensile strength, min, MPa (psi):			
D882	14.5 (2100)	17.2 (2500)	17.9 (2600)
Elongation at rupture, min, %	150	125	150
Tear resistance, min, N/mm (lbf/in.)	35 (200)	not applicable	not applicable
Volatile loss, max, %	see Fig. 1		
Water extraction, max, %	1	1	1
Low-temperature impact, max:			
°C	–18 to –20	–18 to –20	–10 to– 12
°F	0 to –4	0 to –4	+14 to +12
Burning rate, max, mm/s (in./s)	30.5 (1.2)	not applicable	not applicable
Shrinkage at elevated temperature, max, %	7	8	5

10.1.3 *Specific Gravity*—Determine specific gravity in accordance with Method A or Method B of Test Method D792, or Test Method D1505

10.1.4 *Thickness:*

10.1.4.1 *Non-Embossed Film or Sheeting*—For routine testing, standard dead weight methods may be used. Measure thickness by D5947 or D6988, as appropriate.

10.1.4.2 *Embossed Film or Sheeting*—This method for thickness is to be used as a referee method and must be used for embossed film and sheeting

(1) Apparatus—The apparatus shall consist of the following:

(a) Analytical Balance, equipped with pan straddle or other stationary support, sensitive to 0.005 g,

(b) Class S Weights,

(c) Beaker, 250-mL,

(d) Fine Thread or Wire, nonabsorbent,

(e) Thermometer, 0 to 100°C, graduated in 1°C divisions,

(f) Die or Template, for cutting test specimens, 10 by 10 cm, with dimensional tolerance of ±0.01 cm/side, and

(g) Sharp Knife or Razor.

(2) Test Specimens—Test five 10 by 10-cm specimens taken uniformly across the width of the sheet.

(3) Procedure—By means of the die or template and the sharp knife or razor, cut five specimens from the sample of material. Weigh each specimen to the nearest 0.5 mg on the analytical balance. Record the weight as *W*. Determine the specific gravity of each specimen in accordance with Method A of Test Methods D792, or Test Method D1505, and record as *D*. Use of a wetting agent is recommended.

(4) Calculation—Calculate the average thickness of each test specimen, using the following formula, and average the five values:

$$T = 394W \;/\; 100D = 3.94W/D \qquad (1)$$

where:

T = average thickness of test specimen, mils,
W = weight of test specimen, g,
D = density of test specimen, g/cm^3,
394 = conversion factor, cm to mils, and
100 = area of specimen, cm^2.

10.1.5 *Average Thickness Based on Yield per Roll*—Calculate the average thickness based on yield per roll as follows:

$$\text{average thickness, mils} = \frac{768.9 \times \text{net weight (lb)}}{\text{specific gravity} \times \text{length (yd)} \times \text{width (in.)}} \qquad (2)$$

10.1.6 *Tensile Strength and Elongation at Rupture*—Test Method D882 shall be used. Test specimens shall be 25.4 mm (1 in.) wide. The test method used shall be stated in the report.

10.1.7 *Tear Resistance*—Test Method D1004 or D1922 shall be applied.

10.1.7.1 The test method performed must be agreed upon between the purchaser and the seller of the product(s) since the two test methods are not equivalent

10.1.8 *Volatile Loss*—Measure volatile loss by Procedure A of Test Methods D1203. (See also Fig. 1 of this specification.)

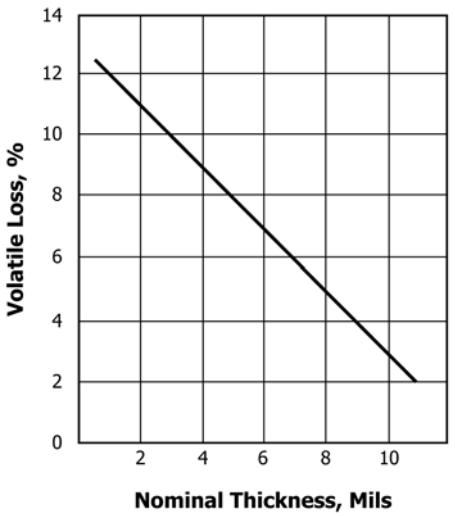

FIG. 1 Maximum Percentage of Volatile Loss versus Thickness (All Types)

10.1.9 *Water Extraction*—Test Method D1239, except that the specimens shall be preconditioned for 3 h at 50 ± 3°C (122 ± 5°F), removed from the oven, placed in the desiccator, and allowed to cool to room temperature before weighing. Also, the immersion test shall be made for 24 h at 50 ± 3°C (122 ± 5°F) in distilled water only.

10.1.10 *Low-Temperature Impact*—Determine the low-temperature impact in accordance with the procedure described in D1790.

10.1.11 *Burning Rate*—Test Method D3801.

10.1.11.1 Due to specimen thinness and nonrigidity, distortion or shrinkage can occur when testing per this test method.

10.1.11.2 Use Test Method D4804 if distortion or shrinkage occurs.

10.1.12 *Shrinkage at Elevated Temperatures*—Test Method D1204, using a temperature of 100°C for 30 min.

11. Number of Tests

11.1 One set of test specimens as prescribed in Section 10 shall be considered sufficient for testing each lot. The average result for the specimens tested shall conform to the requirements prescribed in this specification. All of the tests in Section 10 shall be used to establish conformity of a material to this specification. It is recommended that routine inspection be limited to those tests required to identify the material to the satisfaction of the purchaser. The purchaser shall state in the contract or order the tests that the seller shall be required to make on each shipment for identification of the material.

12. Retest and Rejection

12.1 If any failure occurs, the materials shall be permitted to be retested to establish conformity in accordance with agreement between the purchaser and the seller.

13. Packaging and Package Marking

13.1 *Packaging*—The material shall be packaged in standard commercial containers, so constructed as to ensure acceptance by common or other carriers for safe transportation

at the lowest rate to the point of delivery, unless otherwise specified in the contract or order.

13.2 *Marking*—Shipping containers shall be marked with the name, stock number, and surface finish of the material; the size and quantity therein, as defined by the contract or order under which shipment is made; the name of the manufacturer; and the number of the contract or order.

13.3 All packing, packaging, and marking provisions of Practice D3892 shall apply to this specification.

14. Keywords

14.1 nonrigid; plastic film; plastic sheet; poly vinyl chloride

SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue (D1593 – 09) that may impact the use of this standard. (October 1, 2013)

(1) Rewrote Note 1 ISO statement in accordance with Guide D4968.
(2) Removed non-mandatory language from 1.1, 1.2, 6.3, 9.1, and 12.1.
(3) Replaced sheet with sheeting in 1.2 and throughout section.
(4) Deleted D689, D1433, and D1898 from 2.1.
(5) Added D1790, D1922, D3801, D4804, D5947, and D6988 to 2.1.
(6) Reworded 4, 7.1, and 10.1.6.
(7) Added 7.1.4 concerning average gauge for embossed film and sheeting
(8) Revised 10.1.1, Conditioning—Increased humidity deviation to ±10 % from 5 %, and changed referee humidity to 5 % from 2 %.
(9) Revised 10.1.2, Test Conditions—Increased humidity deviation to ±10 % from 5 %, and changed referee humidity to 5 % from 2 %
(10) Added 10.1.3, Specific Gravity—Added references to D792 or F1505 to determine specific gravity.
(11) Rewrote 10.1.4, Thickness–Added D5947 and D6988 references to determine thickness
(12) Deleted old 10.1.7 Internal Tear Resistance—D 689 has been discontinued
(13) Revised 10.1.7 to add D1922.
(14) Added 10.1.7.1.
(15) Added D1790 reference to 10.1.10.
(16) Deleted 10.1.10.1 – 10.1.10.2: This test is covered in D 1790.
(17) Revised 10.1.11: Delete D 1433 reference, document is discontinued, add D 3801 and D 4804 reference
(18) Add 10.1.11.1and 10.1.11.2.
(19) Deleted 10.1.13 on Crocking, as well as related subsections: 10.1.13.1 – 10.1.13.7.
(20) Added Keywords section: nonrigid, poly vinyl chloride (PVC), plastic film, plastic sheet.
(21) Revised Table 1: a.) Removed methods A and B from D882; b.) Removed Internal Tear Resistance reference; c.) Corrected low-temperature Impact °F temperatures; and d.) Removed Crocking reference.
(22) Removed Fig. 2: Low-temperature Impact Testing Machine and Fig. 3: Impact Testing Machine
(23) Removed old Notes 2 and 3.
(24) Removed old footnotes 3, 4, 6, 7
(25) Added 'Summary of Changes.'