



# Standard Specification for Nonrigid Vinyl Chloride Plastic Film and Sheeting<sup>1</sup>

This standard is issued under the fixed designation D 1593; 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 ( $\epsilon$ ) 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 % may 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 sheet. The film and sheeting shall include the stabilizers and plasticizers necessary to meet the requirements of this specification. The material may be transparent, translucent, or opaque, and may be 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 ISO equivalent for this specification.

## 2. Referenced Documents

### 2.1 ASTM Standards:

- D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing<sup>2</sup>
- D 689 Test Method for Internal Tearing Resistance of Paper<sup>3</sup>
- D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement<sup>2</sup>
- D 882 Test Methods for Tensile Properties of Thin Plastic Sheeting<sup>2</sup>

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.19 on Film and Sheeting.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 08.01.

<sup>3</sup> *Discontinued*—See 1982 *Annual Book of ASTM Standards*, Vol 15.09.

- D 1004 Test Method for Initial Tear Resistance of Plastic Film and Sheeting<sup>2</sup>
  - D 1203 Test Methods for Volatile Loss from Plastics Using Activated Carbon Methods<sup>2</sup>
  - D 1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature<sup>2</sup>
  - D 1239 Test Method for Resistance of Plastic Films to Extraction by Chemicals<sup>2</sup>
  - D 1433 Test Method for Rate of Burning and/or Extent and Time of Burning of Flexible Thin Plastic Sheeting Supported on a 45° Incline<sup>4</sup>
  - D 1505 Test Method for Density of Plastics by the Density-Gradient Technique<sup>2</sup>
  - D 1898 Practice for Sampling of Plastics<sup>2</sup>
  - D 3892 Practice for Packaging/Packing of Plastics<sup>5</sup>
- 2.2 *Military Standard:*
- MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes<sup>6</sup>

## 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 film and sheeting. The tests 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 sheets are available, compounded differently, where special properties are required. Special types of film and

<sup>4</sup> *Discontinued*—See 1987 *Annual Book of ASTM Standards*, Vol 08.01. Replaced by Specification D 4549.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 08.02.

<sup>6</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

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

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 should 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 determined from five uniformly spaced readings taken across the width of the sheet shall be within the following limits:

- 7.1.1 *Type I*— $\pm 10\%$  of the specified thickness.
- 7.1.2 *Type II*— $\pm 15\%$  of the specified thickness.
- 7.1.3 *Type III*— $\pm 10\%$  of the specified thickness.

7.2 *Average Thickness Based on Yield per Roll*—The average thickness based on yield shall be determined in accordance with 10.1.3 and shall be within the following limits:

- 7.2.1 *Type I*— $\pm 5\%$  of the specified thickness.
- 7.2.2 *Type II*— $\pm 10\%$  of the specified thickness.
- 7.2.3 *Type III*— $\pm 5\%$  of the specified thickness.

7.3 *Width*—The film and sheeting shall be held to a tolerance of  $\pm 12$  or  $-0$  mm ( $+1/2$  or  $-0$  in.) for Types I and II, and  $+19$  or  $-0$  mm ( $+3/4$  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. In addition, selected samples of the film or sheeting may be subjected to individual visual inspection.

## 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  $23 \pm 2^\circ\text{C}$  ( $73.4 \pm 3.6^\circ\text{F}$ ) and  $50 \pm 5\%$  relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D 618, for those tests where conditioning is required. In cases of disagreement, the tolerances shall be  $1^\circ\text{C}$  ( $\pm 1.8^\circ\text{F}$ ) and  $\pm 2\%$  relative humidity.

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

10.1.3 *Thickness*—This method for thickness is to be used as a referee method and must be used for embossed sheeting. For routine testing, standard dead weight methods may be used.

**TABLE 1 Detail Requirements for Nonrigid Vinyl Chloride Plastic Film and Sheetting**

Property	Requirement		
	Type I	Type II	Type III
Tensile strength, <sup>A</sup> min, MPa (psi):			
D 882, Method A	15.9 (2300)	20.7 (3000)	20.0 (2900)
D 882, Method B	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
Internal tear resistance, min:			
Over 0.076 mm (0.003 in.) thick, g/ $\mu\text{m}$ (g/mil)	2.36 (60)	3.94 (100) for all thicknesses	5.91 (150) for all thicknesses
0.076 (0.003 in.) or less, g/sheet	180		
Volatile loss, max, %	see Fig. 1		
Water extraction, max, %	1	1	1
Low-temperature impact, max:			
$^\circ\text{C}$	-18 to -20	-18 to -20	-10 to -12
$^\circ\text{F}$	0 to -2	0 to -2	+14 to +12
Burning rate, max, mm/s (in./s)	30.5 (1.2)	not applicable	not applicable
Crocking	no crocking	no crocking	no crocking
Shrinkage at elevated temperature, max, %	7	8	5

<sup>A</sup>If the sheeting meets the requirement by either method, it shall be considered as passed.

10.1.3.1 *Apparatus*—The apparatus shall consist of the following:

- (1) *Analytical Balance*, equipped with pan straddle or other stationary support, sensitive to 0.005 g,
- (2) *Class S Weights*,
- (3) *Beaker*, 250-mL,
- (4) *Fine Thread or Wire*, nonabsorbent,
- (5) *Thermometer*, 0 to 100°C, graduated in 1°C divisions,
- (6) *Die or Template*, for cutting test specimens, 10 by 10 cm, with dimensional tolerance of ±0.01 cm/side, and
- (7) *Sharp Knife or Razor*.

10.1.3.2 *Test Specimens*—Test five 10 by 10-cm specimens taken uniformly across the width of the sheet.

10.1.3.3 *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 D 792, or Test Method D 1505, and record as *D*. Use of a wetting agent is recommended.

10.1.3.4 *Calculation*—Calculate the average thickness of each test specimen, using the following formula, and average the five values:

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

where:

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

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

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

10.1.5 *Tensile Strength and Elongation at Rupture*—Either Test Method A or Test Method B of Test Methods D 882 may be used. In either case, test specimens shall be 25.4 mm (1 in.) wide. The test method used shall be stated in the report.

10.1.6 *Tear Resistance*—Test Method D 1004, using pendulum or constant elongation type of machine.

10.1.7 *Internal Tear Resistance*—Test Method D 689, except that readings obtained where the tear deviates more than 10 mm (3/8 in.) from the line of the initial slit shall not be rejected when obtained with embossed sheeting. Determine the average from measuring five samples taken each direction across the width of the film or sheet and two samples of each direction taken directly adjacent to the longitudinal edges of the film or sheet, the remaining three being equally spaced between these two. Report the tear tests for each machine. Report the cross-directional averages of these five tests in each direction.

10.1.8 *Volatile Loss*—Measure volatile loss by Procedure A of Test Methods D 1203. (See also Fig. 1 of this specification.)

10.1.9 *Water Extraction*—Test Method D 1239, except that the specimens shall be preconditioned for 3 h at 50 ± 3°C (122

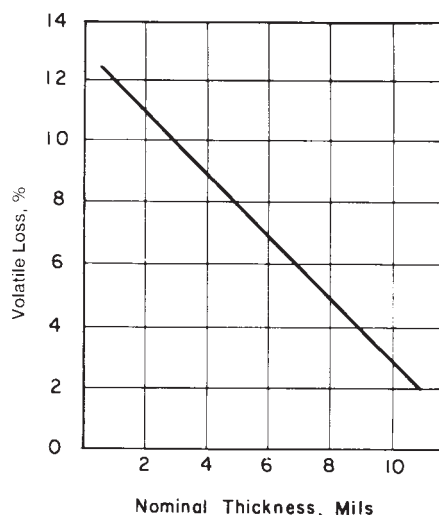


FIG. 1 Maximum Percentage of Volatile Loss versus Thickness (All Types)

± 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 the following paragraphs:

10.1.10.1 *Apparatus*:

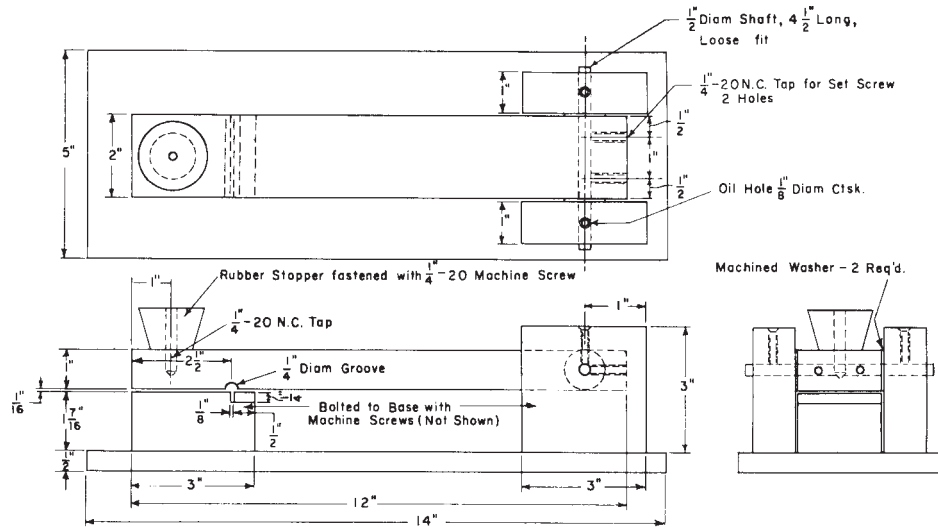
(1) *Cold Chambers*, at least 450 by 450 mm (18 by 18 in.) that open from the top are preferable. Dry-ice cabinets, cooled by circulated air and solid carbon dioxide, that are equipped with heater units perform well for this test method.

(2) *Impact Machine*, as shown in Figs. 2 and 3, constructed of cold-rolled steel, except for the bolts, screws, and rubber stopper. All structural parts (that is, base, anvil, arm, arm supports, and shaft) may be chromium-plated. The arm including rubber stopper and bolt shall weigh 3.09 ± 0.3 kg (6 lb 13 oz ± 1 oz).

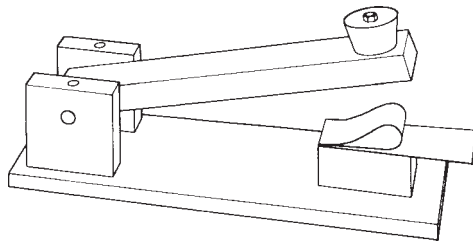
NOTE 2—Lubricants are not usually necessary. However, if lubrication is necessary, use suitable low-temperature lubricants.

(3) *Miscellaneous Equipment*, consisting of a 50.8 by 146-mm (2 by 5¾-in.) die; a good desk-type stapler with metal base, and a stop mounted on a base exactly 12.7 mm (½ in.) back of the center of the groove that turns the staple; 50.8 by 127-mm (2 by 5-in.) cards of regular 127 by 203-mm (5 by 8-in.) index-file card stock.

10.1.10.2 *Procedure*—Keep the impact machine in the cold chamber at the specified temperature (see Table 1) at all times. Measure the temperature in close proximity to the test specimen. Cut ten specimens with a die with the long dimension parallel with the transverse direction of the sheet. Cut each 50.8 by 146-mm (2 by 5¾-in.) specimen and fold lengthwise with a normal loop at room temperature. Match the two ends of the folded specimen and one end of the 50.8 by 127-mm (2 by 5-in.) card exactly, with the loop lying on the card. Crimp two staples, 12.7 mm (½ in.) from and parallel to the 50.8-mm (2-in.) end of the stack. Place the mounted specimens with loops up in the cold chamber at the desired testing temperature



NOTE 1—Developed by the Society of the Plastics Industry.  
**FIG. 2 Low-Temperature Impact Testing Machine**



**FIG. 3 Impact Testing Machine**

for a conditioning period of 1 h. Place the card with the specimen (after conditioning) on the anvil with the crimped ends of the staples on the back of the card fitted into the groove in the anvil (see Fig. 3). Handle the card, not the sample. Allow the arm to fall free from a position within 5° off perpendicular to the base. In order to facilitate this, employ a mechanical release device. Raise the arm, remove the sample on the card from the anvil, and position and strike the next specimen. Continue in this manner. Examine the removed specimen for failure, which shall consist of breaking it into two or more pieces. Not more than two specimens out of ten shall fail when tested at the upper specified temperature, nor more than five out of ten shall fail at the lower endpoint temperature shown in Table 1.

10.1.11 *Burning Rate*—Test Method D 1433.

10.1.12 *Shrinkage at Elevated Temperatures*—Test Method D 1204, using a temperature of 100°C for 30 min.

10.1.13 *Crocking*:

10.1.13.1 *Scope*—Color fastness to rubbing (crocking) is understood to be resistance to physical transfer of color from the material tested to a piece of white cotton under the conditions of the test.

10.1.13.2 *Apparatus-AATCC Crockmeter and Cloth*, 50.8 by 50.8-mm (2 by 2-in.) test squares.<sup>7</sup>

10.1.13.3 *Materials*—White bleached cotton cloth, starch-free, cut into 50.8-mm (2-in.) test squares. Lawns, percales, or print cloths are suitable.

10.1.13.4 *Test Specimens*—Two 50.8 by 127-mm (2 by 5-in.) specimens of sheeting shall be used, one for the dry test and one for the wet test.

10.1.13.5 *Procedure for Dry Rubbing*—Precondition the test specimen in accordance with Procedure A of Practice D 618, and place the test specimen on the base of the crockmeter so as to rest flat on the abrasive cloth with its long dimension in the direction of the rubbing. Mount the square of white testing cloth over the end of the finger that projects downward from the slide, with the weave oblique to the direction of rubbing, which is held in place by the spiral clip. Place the covered finger of the slide on the test specimen and slide back and forth for 20 rubbings, that is, for 10 steady turns of the crank at the rate of 1 turn/s.

10.1.13.6 *Procedure for Wet Rubbing*—For wet rubbing (crocking) test, wet out the white testing square thoroughly in distilled water, squeeze, and then pass it through a wringer between two sheets of filter paper just before use. Otherwise the procedure for wet rubbing is the same as for dry rubbing.

10.1.13.7 Repair the accidental damage to the rubbing finger, spiral clip, or abrasive cloth when noticeable as follows: neatly renew the abrasive cloth; bend the clip further open or shut over an inserted rod of the correct diameter, as required; and resurface the finger by movement on an extra piece of fine emery cloth in a manner simulating regular use.

## 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

<sup>7</sup> The crockmeter and cloth may be obtained from the secretary of the American Association of Textile Chemists and Colorists, Box 836, Durham NC.

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 may 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 D 3892 shall apply to this specification.

## SUMMARY OF CHANGES

This section identifies the location of selected changes to this specification. For the convenience of the user, Committee D-20 has highlighted those changes that may impact the use of this specification. This section may also include descriptions of the changes or reasons for the changes, or both.

*D 1593 – 99:*

(I) This specification was updated to reflect both film and

sheeting.

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