



Designation: D 2103 – 9703

## Standard Specification for Polyethylene Film and Sheeting <sup>1</sup>

This standard is issued under the fixed designation D 2103; 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.

*This standard has been approved for use by agencies of the Department of Defense.*

### 1. Scope\*

1.1 This specification covers the classification of polyethylene film and sheeting up to 0.3 mm (~~0.012 in.~~) in thickness, inclusive. The film or sheeting may contain additives for the improvement of the surface properties, pigments, or stabilizers, or ~~all three combinations thereof.~~

1.2 The values stated in SI units are to be regarded as ~~the~~ standard. The values given in ~~parentheses~~ brackets are for information only.

1.3 The following precautionary caveat pertains only to the test method portion, Section 8, 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.*

1.4 This specification allows for the use of recycled polyethylene film or resin as feedstock, in whole or in part, as long as all the requirements as governed by the producer and end user are also met (see Note 1).

NOTE 1—Guide D 5033 describes terminology and definitions related to recycled plastics.

NOTE 2—There is no known ISO equivalent to this specification.

### 2. Referenced Documents

2.1 *ASTM Standards:*

D 374 Test Methods for Thickness of Solid Electrical Insulation<sup>2</sup>

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.19~~4~~ on ~~Government/Industry Standardization—Film and Sheeting~~.

Current edition approved ~~Nov. 10, 1996~~, August 10, 1996; 2003. Published ~~January 1997~~, October 2003. Originally published as D 1999–94; approved in 1991. Last previous edition D 1999–96.

A title change was the subject of this revision; approved in 1997 as D 1999–97.

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

- D 618 Practice for Conditioning Plastics ~~and Electrical Insulating Materials~~ for Testing<sup>3</sup>
  - D 882 Test Methods for Tensile Properties of Thin Plastic Sheeting<sup>3</sup>
  - D ~~883 Terminology Relating to Plastics~~<sup>3</sup>
  - D ~~1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics~~<sup>3</sup>
  - D 1434 Test Method for Determining Gas Permeability Characteristics of Plastic Film and Sheeting ~~to Gases~~<sup>4</sup>
  - D 1505 Test Method for Density of Plastics by the Density-Gradient Technique<sup>3</sup>
  - D 1709 Test Methods for Impact Resistance of ~~Polyethylene Plastic~~ Film by the Free-Falling Dart Method<sup>3</sup>
  - D 1746 Test Method for Transparency of Plastic Sheeting<sup>3</sup>
  - D 1893 Test Method for Blocking of Plastic Film<sup>5</sup>
  - D 1894 Test Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting<sup>3</sup>
  - D 1898 Practice for Sampling of Plastics<sup>6</sup>
  - D 1922 Test Method for Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method<sup>3</sup>
  - D 1938 Test Method for Tear-Propagation Resistance (Trouser Tear) of Plastic Film and Thin Sheeting by a Single-Tear Method<sup>3</sup>
  - D 2457 Test Method for Specular Gloss of Plastic Films and Solid Plastics<sup>7</sup>
  - D 2578 Test Method for Wetting Tension of Polyethylene and Polypropylene Films<sup>7</sup>
  - D 2839 Practice for the Use of a Melt Index Strand for Determining Density of Polyethylene<sup>8</sup>
  - D 3892 Practice for Packaging/Packing of Plastics<sup>7</sup>
  - D 4321 Test Method for Package Yield of Plastic Film<sup>7</sup>
  - D ~~4976 Specification~~ 4703 Practice for Polyethylene Plastics Compression Molding and Extrusion Thermoplastic Materials into Test Specimens, Plaques, or Sheets<sup>9</sup>
  - D ~~5033 Guide~~ 4976 Specification for Polyethylene Plastics Molding and Extrusion Materials<sup>8</sup>
  - D 5033 Guide for Development of ASTM Standards Relating to the Proper Recycling and Use of Recycled Plastics<sup>8</sup>
  - E 96 Test Methods for Water Vapor Transmission of Materials ~~in Sheet Form~~<sup>7</sup>
- ~~2.2 NIST Standard:~~

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 10.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 08.01.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 09.01.

<sup>5</sup> Discontinued; see *1990 Annual Book of ASTM Standards*, Vol 08.021.

<sup>6</sup> Discontinued; see *1997 Annual Book of ASTM Standards*, Vol ~~10.02~~ 08.01.

National Institute of Standards and Technology Circular 585 Measurement of Thickness<sup>8</sup>

~~2.3 Military Standard:~~

~~MIL-STD-105 Sampling Procedures and Tables<sup>9</sup>~~

~~F 1249 Test Method for Inspection by Attributes<sup>10</sup> Water Vapor Transmission Rate through Plastic Film and Sheeting Using a Modulated Infrared Sensor<sup>11</sup>~~

**3. Terminology**

3.1 Definitions:

3.1.1 Unless otherwise specified, the definitions of plastics used in this specification are in accordance with Terminology D 883.

3.2 Definitions of Terms Specific to This Standard:

3.1.1 ~~ethylene plastics~~—plastics based on polymers made with ethylene as the sole monomer.

3.1.2 ~~polyethylene plastics~~—plastics based on polymers of ethylene or copolymers of ethylene and other monomers, the ethylene being the greatest amount by mass.

3.1.3—

3.2.1 ~~treated~~—modification of the surface—surface characteristics of the sheet or film have been modified by flame, corona discharge, or other means to promote the adhesion of inks, etc.

3.2.2 ~~yield~~—the area provided by a given weight of film or sheeting of specified thickness.

**4. Classification**

4.1 The film and sheeting covered in this specification shall be designated by a type number, composed by listing the desired cell limit for each of the five properties, in the order shown in Table 1.

NOTE 3—Examples of this classification system are as follows:

<sup>7</sup> Annual Book of ASTM Standards, Vol 08.032.

<sup>8</sup> Annual Book of ASTM Standards, Vol 11.03, 10.02.

<sup>9</sup> Annual Book of ASTM Standards, Vol 04.06.

<sup>10</sup> International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) standards are available from ANSI, 11 West 42nd St., 13th Floor, New York, NY 10036.

<sup>10</sup> Annual Book of ASTM Standards, Vol 08.03.

<sup>11</sup> This guide is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.19 on Film and Sheeting. Current edition approved August 10, 2003. Published October 2003. Originally approved in 1991. Last previous edition approved in 1997 as D 1999 – 97.

**TABLE 1 Type Numbers**

Property Order Number	Property	0	1	2	3	4	5	Units
1	Density <sup>A</sup>	unspecified	0.910–<0.926	0.926–<0.941	0.941–0.965	<0.910	...	g/cm <sup>3</sup>
2	Impact strength <sup>B</sup>	unspecified	<40	40–70	71–150	151–300	>300	g
3	Coefficient of friction	unspecified	<0.20	0.20–0.40	0.41–0.70	>0.70	...	...
4	Haze	unspecified	<5.0	5.0–9.0	>9.0	...	...	...
5	Nominal thickness	unspecified	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>	<i>G</i>	mm (in.)
5	Nominal thickness	unspecified	—	—	—	—	—	mm [in.]

<sup>A</sup> Annealed density of molded plaques or Melt Index extrudates.

<sup>B</sup> F50 (Results of a recent round robin have shown the equivalency of these two procedures.)

<sup>C</sup> <0.0254 (<0.0010).

<sup>D</sup> 0.0254–<0.0508 (0.0010–<0.0020)

<sup>E</sup> 0.0508–<0.1016 (0.0020–<0.0040)

<sup>F</sup> 0.1016–<0.1778 (0.0040–<0.0070)

<sup>G</sup> 0.1778–≤0.3048 (0.0070–≤0.0120)

(1) A high-clarity packaging film might be described as follows:

Type Number	2	1	1	1	2
Density (0.926 to 0.940)	_____				
Impact strength (<40)	_____				
Coefficient of friction (<0.20)	_____				
Haze (<5.0)	_____				
Nominal Thickness 0.0254-<0.0508 mm (0.0010-<0.0020 in.)	_____				

(2) A thin garment bag film might be described as follows:

Type Number	2	1	1	2	2
Density (0.926 to 0.940)	_____				
Impact strength (<40)	_____				
Coefficient of friction (<0.20)	_____				
Haze (5.0 to 9.0)	_____				
Nominal Thickness 0.0254-<0.0508 mm (0.0010-<0.0020 in.)	_____				

(3) A tough, thick, pigmented industrial film might be described as follows:

Type Number	1	4	3	3	5
Density (0.910 to 0.925)	_____				
Impact strength (151-300)	_____				
Coefficient of friction (0.41 to 0.70)	_____				
Haze (>9.0)	_____				
Nominal Thickness 0.1778-≤0.3048 mm (0.0070-≤0.0120 in.)	_____				

With this type of classification it is possible to assemble on paper a combination of properties that is impossible to obtain with the present state of technology. A purchaser wishing to use this specification for the first time will probably find it necessary to contact material suppliers to learn what materials are commercially available. After establishing which available material meets his requirements, the purchaser may, from then on, specify the material by the appropriate type number available.

4.2 In cases where surface treatment is specified by the purchaser, the test method must be agreed upon between the purchaser and the seller. The recommended test to measure the degree of surface treatment is Test Method D 2578.

**5. General Requirements**

5.1 *Appearance*—The material shall have appearance qualities conforming with those produced by good commercial practice. It shall be as free as commercially possible of gels, streaks, pinholes, particles of foreign matter, and undispersed raw material. There shall be no other visible defects such as holes, tears, or blisters. The edges shall be free of nicks and cuts visible to the unaided eye. There shall be no visible evidence of damage from shipping.

5.2 *Thickness Tolerances*—The point-to-point thickness tolerances of the film or sheeting covered in this specification shall be nominal ±20 %.

5.3 *Yield Tolerances*—The actual yield of film or sheeting covered in this specification shall be within the tolerance limits of the nominal yield as prescribed in Table 2. In cases where each roll, blanket, or unit of production is packaged and marked by the producer as the ultimate consumer sales unit with stated dimensions, the single-roll tolerances for yield shall apply.

5.4 *Width Tolerances*—The tolerance for width shall be ±3.2 mm (±0.13 in.)/ft of nominal width except that the tolerance shall be not less than ±3.2 mm (±0.13 in.).

5.5 *Length*—For unit consumption the length of film or sheeting per roll shall be within +4, -0 % within +4, -0 % of the length as marked, or as agreed upon between the purchaser and the seller. Each roll shall be in one piece, except that it is permissible for no more than 20 % of the rolls in any one shipment may consist to contain a maximum of not more than three pieces. Such rolls shall be clearly marked, labeled.

**6. Detail Requirements**

- 6.1 The film or sheeting shall conform to the requirements of Table 1 as indicated by the type designation.
- 6.2 The film and sheeting shall not be blocked excessively as agreed upon between the purchaser and the seller.

**7. Sampling**

7.1 Samples of film or sheeting sufficient to determine conformance to this specification shall be taken at random.

**8. Test Methods**

8.1 *Conditioning*—Condition the test specimens at 23 ± 2°C (±73.4 ± 3.6°F) and 50 ± 5 % relative humidity for not less than

**TABLE 2 Yield Tolerances**

Number of Rolls	Tolerance, %
Single rolls and lots up to and including 25 rolls	±10
Lots over 25 rolls and up to and including 100 rolls	±5
Lots over 100 rolls	±3

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  $\pm 1^{\circ}\text{C}$  ( $\pm 1.8^{\circ}\text{F}$ ) and  $\pm 2\%$  relative humidity.

8.2 *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 disagreement, the tolerances shall be  $\pm 1^{\circ}\text{C}$  ( $\pm 1.8^{\circ}\text{F}$ ) and  $\pm 2\%$  relative humidity.

8.3 *Density*—Determine the annealed density of the molded plaques or melt index extrudate as specified in accordance with 4.2.1.2 of Specification D 4976. Plaques shall be compression molded in accordance with Practice D 4703, Annex A1, Procedure C. If melt index extrudate is used, it shall be prepared in accordance with Practice D 2839.

8.4 *Impact Strength*—Test the film or sheeting ~~covered in this specification~~ for impact strength ~~according to~~ in accordance with Test Methods D 1709, Test Method A, reporting the results in grams at nominal thickness, except report the results in grams per mil. This test method is not applicable to impact strengths greater than 300 g. Run impact strengths of greater than 300 g in accordance with Test Method B of Test Methods D 1709.

NOTE 4—The impact resistance of polyethylene film, while partly dependent on thickness, has no simple correlation with sample thickness. Hence, impact values expressed in grams cannot be normalized over a range of thicknesses without producing misleading data as to the actual impact resistance of the material. Data from these methods are comparable only for comparing specimens that vary in thickness by no more than  $\pm 25\%$  from the nominal or average thickness of the specimens tested.

8.5 *Coefficient of Friction, Kinetic*—Determine the kinetic coefficient of friction in accordance with Test Method D 1894.

8.6 *Haze*—Determine the haze of the film or sheeting in accordance with Test Method D 1003.

8.7 *Treatment*—Designate the film or sheeting simply as untreated or treated in accordance with ~~3.1.3-3.2.1.~~

8.8 *Thickness*—The thickness of the film and sheeting ~~covered in this specification~~ shall meet the requirements in 5.2 when measured in accordance with ~~9.2 of~~ Test Method D 374 using Method A, B, C, or D, as appropriate for the specimen thickness, using appropriate apparatus as described and calibrated in accordance with the applicable sections of Test Methods D 374, unless otherwise specified.

8.8.1 *Test Specimens*—Five specimens, at least 5 by 5 cm (~~2 [2 by 2 in.]~~) in area, taken randomly across the width of the roll shall be tested. At least one set of specimens shall be measured from each roll being tested.

8.9 *Yield*—Yield is Calculate the amount of area provided by a given weight of film or sheeting of specified thickness.

~~8.9.1 Calculate the actual yield using Test Method D 4321.~~

8.9.2<sup>1</sup> Calculate the nominal yield using Test Method D 4232<sup>1</sup> and the unannealed film density. Determine the unannealed film density in accordance with Test Method D 1505, using three specimens after conditioning in accordance with Procedure A of Practice D 618.

8.9.3<sup>2</sup> Calculate the deviation of the actual yield from the nominal yield as follows:

$$D = [(Y_a - Y_n)/Y_n] \times 100 \quad (1)$$

where:

$D$  = deviation from the nominal yield, %,

$Y_a$  = measured yield,  $\text{m}^2/\text{kg}$  ( $[\text{in.}^2/\text{lb}]$ ), and

$Y_n$  = nominal yield,  $\text{m}^2/\text{kg}$  ( $[\text{in.}^2/\text{lb}]$ ).

8.10 *Block*—When required, test the block of the film or sheeting in accordance with Test Method D 1893.

## 9. Packaging and Package Marking

9.1 *Packaging*—The material shall be packaged in standard commercial containers, so constructed as to ensure acceptance by common or other carriers for transportation at the lowest rate to the point of delivery, unless otherwise specified in the contract or order.

9.2 *Marking*—Shipping containers shall be marked with the name, ASTM type in accordance with this specification, thickness, width, and weight of the film or sheeting contained therein, as defined by the contract or order under which the shipment is made, the name of the manufacturer, and the contract order number.

9.3 All packing, packaging, and marking provisions of Practice D 3892 shall apply to this specification.

## 10. Keywords

10.1 ethylene plastics; polyethylene film; polyethylene plastics; polyethylene sheeting; recycling

**APPENDIX****(Nonmandatory Information)****X1. OTHER PROPERTIES (OPTIONAL)**

X1.1 Other properties that may be used to characterize polyethylene film and sheeting are as follows:

X1.1.1 *Tensile Strength and Elongation*—When tensile strength and elongation are to be measured, test in accordance with Test Methods D 882. It is important that these properties be measured in both the transverse and longitudinal directions.

X1.1.2 *Tear Strength*— When required, determine the tear strength in accordance with Test Method D 1938 or Test Method D 1922, as agreed upon between the purchaser and the seller.

X1.1.3 *Water Vapor Transmission*—Determine the water vapor transmission of polyethylene film and sheeting, when necessary, in accordance with Test Methods E 96, Procedure E-~~of~~ or Test Methods E F 12496, as agreed upon between the purchaser and the seller.

X1.1.4 *Gas Transmission*—Determine the gas transmission through polyethylene film and sheeting, when necessary, in accordance with Test Method D 1434 or specific methods for the gases of interest, as agreed upon between the purchaser and seller.

X1.1.5 *Odor*—When required, rate the film and sheeting odor as satisfactory or unsatisfactory when compared to an odor standard. The odor standard and test method shall be agreed upon between the purchaser and the seller.

X1.1.6 *Gloss*—Determine the gloss of polyethylene film and sheeting, when necessary, in accordance with Test Method D 2457. Sample preparation and test method shall be agreed upon between the purchaser and the seller.

X1.1.7 *Transparency*— Determine the transparency, when required, in accordance with Test Method D 1746. These specular transmittance data correlate with “see-through” clarity.

X1.1.8 *Flatness*—When required, rate the film or sheeting for degree of flatness. The test method and the degree of flatness shall be agreed upon between the purchaser and the seller.

**SUMMARY OF CHANGES**

Committee D-20 has identified

This section identifies the location of selected changes to this specification since guide. For the last issue convenience of the user, Committee D20 has highlighted those changes that may impact the use of this specification guide. This section may also include descriptions of the changes or reasons for the changes, or both.

**D 2103 – 03:**

(1) Five year review conducted. (December 2002)

(2) Revised second sentence in 1.1.

(2) Corrected jurisdiction statement.

(3) Updated Referenced Documents section.

(4) Reworded definition of “treated” in Terminology Section.

(5) Moved definition of “yield” from Test Methods section to Terminology section.

(6) Corrected errors in Classification examples.

(7) Revised Test Method references in 8.3 and 8.8.

(8) Added references to additional test methods in X1.1.3 and X1.1.4.

(9) Eliminated permissive language in 1.1, 5.5, and the statement following the classification examples in Section 4.

(10) Deleted definitions 3.1.1 and 3.1.2 from the Terminology section and added statement referencing definitions in Terminology D 883.

**D 2103 – 97:**

(1) Eliminated luminous transmittance as a callout property.

(2) Revised impact strength and density in Table 1.

(3) Eliminated measurement procedure and added reference to Test Methods D 374 for apparatus and procedure.

(4) Deleted Table 2 on thickness tolerances.

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