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## Standard Specification for Polyethylene Plastics Molding and Extrusion Materials<sup>1</sup>

This standard is issued under the fixed designation D4976; 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.*

### INTRODUCTION

This specification is not intended for the selection of materials, but only as a means to call out plastic materials to be used for the manufacture of parts. The selection of these materials is to be made by personnel with expertise in the plastics field where the environment, inherent properties of the materials, performance of the parts, part design, manufacturing process, and economics are considered. This specification does not specify the source of the resin to be used for the fabrication of any given article.

### 1. Scope\*

1.1 This specification provides for the identification of polyethylene plastics molding and extrusion materials in such a manner that the supplier and the user can agree on the acceptability of different commercial lots or shipments. The tests involved in this specification are intended to provide information for identifying materials in accordance with the groups, classes, and grades covered. It is not the function of this specification to provide specific engineering data for design purposes.

1.2 Other requirements may be necessary to identify particular characteristics important to specialized applications. These shall be agreed upon between the user and the supplier, by using the suffixes given in Section 1.3.

1.3 Ethylene plastic materials, being thermoplastic, are reprocessible and recyclable (see Note 1). This specification allows for the use of those ethylene plastic materials, provided that any specific requirements as governed by the producer and the end user are met.

NOTE 1—See Guide D5033 for information and definitions related to recycled plastics.

1.4 The values stated in SI units are regarded as standard.

1.5 The following precautionary caveat pertains to the test method portion only, Section 12, 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.*

1.6 For information regarding plastic pipe materials see Specification D3350. For information regarding wire and cable materials, see Specification D1248. For information on polyethylenes with densities below 0.910 g/cm<sup>3</sup>, see Classification D5593.

NOTE 2—There is no similar or equivalent ISO standard.

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

D257 Test Methods for DC Resistance or Conductance of Insulating Materials

D568- Method of Test for Rate of Burning and/or Extent and Time of Burning of Flexible Plastics in a Vertical Position

D618 Practice for Conditioning Plastics for Testing

D635 Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position

D638 Test Method for Tensile Properties of Plastics

D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

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

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials. Current edition approved Nov. 15, 2006. Published November 2006. Originally approved in 1995. Last previous edition approved in 2004 as D4976-04. DOI: 10.1520/D4976-06.

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<sup>2</sup> 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.

- D883 Terminology Relating to Plastics
- D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
- D1248 Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
- D1505 Test Method for Density of Plastics by the Density-Gradient Technique
- D1531 Test Methods for Relative Permittivity (Dielectric Constant) and Dissipation Factor by Fluid Displacement Procedures
- D1600 Terminology for Abbreviated Terms Relating to Plastics
- D1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics
- D1898 Practice for Sampling of Plastics
- D2565 Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications ~~D2839~~
- D2839 Practice for Use of a Melt Index Strand for Determining Density of Polyethylene
- D2951 Test Method for Resistance of Types III and IV Polyethylene Plastics to Thermal Stress-Cracking
- D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials
- D3892 Practice for Packaging/Packing of Plastics
- D4000 Classification System for Specifying Plastic Materials
- D4703 Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets
- D4883 Test Method for Density of Polyethylene by the Ultrasound Technique
- D5033 Guide for Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics
- D5593 Classification for Thermoplastic Elastomers Olefinic (TEO)
- E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- F1473 Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins
- G23 Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials (Discontinued 2001)
- G53 Practice for Operating Light-and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials (Discontinued 2001)

## 2.2 Military Standard:

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes<sup>3</sup>

## 2.3 DOT Standard:

Federal Motor Vehicle Safety Standard 302, Flammability of Interior Materials<sup>4</sup>

### 3. Terminology

3.1 *Definitions*—For definitions of technical terms pertaining to plastics used in this specification, see Terminology D883 and Terminology D1600.

3.2 Historical usage and user group conventions have resulted in inconsistent terminology used to categorize and describe polyethylene resins and compounds. The following terminology is in use in ASTM specifications pertaining to polyethylene:

3.2.1 *Specification* D1248: <https://standards.iteh.ai/catalog/standards/sist/fa3782e8-fa68-4476-a6c5-462dfad20de0/astm-d4976-12>

3.2.1.1 Type (I, II, III, IV) = density ranges (same, respectively, as Classes 1, 2, 3, and 4 in Specification D4976).

3.2.1.2 Class (A, B, C, D) = composition and use.

3.2.1.3 Category (1, 2, 3, 4, 5) = melt index ranges (same as Grade in Specification D4976).

3.2.1.4 Grade (E, J, D, or W followed by one or two digits) = specific requirements from tables.

3.2.2 *Specification* D3350:

3.2.2.1 Type (I, II, III) = density ranges (same as Types I, II, and III in Specification D1248 and Classes 1, 2, and 3 in Specification D4976).

3.2.2.2 Class = a line callout system consisting of “PE” followed by six cell numbers from Table 1 plus a letter (A, B, C, D, E) denoting color and UV stabilizer.

3.2.2.3 Grade = simplified line callout system using “PE” followed by density and slow crack growth cell numbers from Table 1.

3.2.3 *Specification* D4976:

3.2.3.1 Group (1, 2) = branched or linear polyethylene.

3.2.3.2 Class (1, 2, 3, 4) = density ranges (same, respectively, as Types I, II, III, and IV in Specification D1248).

3.2.3.3 Grade (1, 2, 3, 4, 5) = melt index ranges (same as Category in Specification D1248).

### 4. Classification

4.1 Unreinforced polyethylene plastic materials are classified into groups in accordance with molecular structure. These groups are subdivided into classes and grades as shown in Table PE (Basic Property Table).

<sup>3</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

<sup>4</sup> Available from United States Department of Transportation, National Highway Traffic Safety Administration, Office of Public Affairs and Consumer Participation, 400 7th St., SW, Washington, DC 20590.

**TABLE PE Basic Requirement of Polyethylene Plastics**

Group	Description	Class	Description	Grade	Flow Rate, D1238, g/10 min	Tensile Stress at Yield, D638, min, MPa	Nominal Strain at Break, D638, min, %	Flexural Modulus at 2 % Strain, D790, min, MPa	
1	Branched	1	low density	1	>25	8	70	100	
			...	2	>10 to 25	8	90	125	
			0.910–0.925	3	>1 to 10	8.5	100	125	
			...	4	>0.4 to 1 to 0.4	9.5	300	125	
		...	5	to 0.4	9.5	400	150		
		...	0	...	...	...	...		
		...	0	...	...	...	...		
		...	0	...	...	...	...		
	...	2	medium density	1	>25	8	40	200	
	...	2	...	2	>10 to 25	11	50	200	
	...	2	>0.925–0.940	3	>1 to 10	11	70	200	
	...	2	...	4	>0.4 to 1 to 0.4	11	200	250	
	...	2	...	5	to 0.4	12	400	300	
	...	2	...	0	...	...	...	...	
	2	Linear	1	low density	1	>25	10	300	300
				...	2	>10 to 25	10	300	325
0.910–0.925				3	>1 to 10	10	300	350	
...				4	>0.4 to 1 to 0.4	10	400	350	
...				5	to 0.4	12	500	400	
...				0	...	...	...	...	
...				0	...	...	...	...	
...				0	...	...	...	...	
...			2	medium density	1	>25	14	90	500
...			2	...	2	>10 to 25	14	100	500
...			2	>0.925–0.940	3	>1 to 10	14	100	550
...			2	...	4	>0.4 to 1 to 0.4	15	200	600
...			2	...	5	to 0.4	19	400	600
...			2	...	0	...	...	...	...
...			2	...	0	...	...	...	...
...			3	high density	1	>25	17	10	400
...			3	...	2	>10 to 25	17	50	400
...			3	>0.940–0.960	3	>1 to 10	18	200	450
...			3	...	4	>0.4 to 1 to 0.4	19	400	500
...			3	...	5	to 0.4	20	600	600
...			3	...	0	...	...	...	...
...			3	...	0	...	...	...	...
...			4	high density	1	>25	24	10	500
...			4	...	2	>10 to 25	24	10	600
...			4	>0.960	3	>1 to 10	25	30	800
...			4	...	4	>0.4 to 1 to 0.4	28	300	900
...			4	...	5	to 0.4	28	400	1000
...			4	...	0	...	...	...	...
...	4	...	0	...	...	...	...		
0		0	...	0	...	...	...		

**Cell Table A Detail Requirements for Polyethylene Plastics**

Designation Order Number	Property	Cell Limits									
		0	1	2	3	4	5	6	7	8	9
1	Tensile Stress at Yield, Test Method D638, MPa, min	unspecified	4	8	12	16	21	30	35	...	specify value
2	Nominal Strain at Break, Test Method D638, %, min	unspecified	25	50	200	400	600	800	1000	...	specify value
3	Secant Flexural Modulus at 2 % Strain, D790, MPa, min	unspecified	50	100	200	400	600	800	1000	...	specify value
4	Thermal stress-crack resistance, D2951, hours without cracking, min	unspecified	24	48	96	168	...	...	...	...	specify value
5	Environmental stress-crack resistance, D1693, min F <sub>50</sub> , h	unspecified	24	48	96	168	336	672	1008	...	specify value

**Cell Table B Detail Requirements for Polyethylene Plastics**

Designation Order Number	Property	Cell Limits									
		0	1	2	3	4	5	6	7	8	9
1	Tensile Stress at Yield, D638, MPa, min	unspecified	4	8	12	16	21	30	35	...	specify value
2	Nominal Strain at Break, D638, %, min	unspecified	25	50	200	400	600	800	1000	...	specify value
3	Secant Flexural Modulus at 2 % Strain, D790, MPa, min	unspecified	50	100	200	400	600	800	1000	...	specify value
4	Thermal stress-crack resistance, D2951, hours without cracking, min	unspecified	24	48	96	168	...	...	...	...	specify value
5	Slow Crack Growth Resistance, PENT-Test Method F1473, h, min	unspecified	0.3	1	3	10	30	100	300	...	specify value

NOTE 3—An example of this classification system is as follows: The designation PE 112 would indicate PE, polyethylene as found in Terminology D1600, 1 (group) branched, 1 (class) low density, 2 (grade) >25 melt index.

4.2 Cell Tables A or B shall be used to specify the physical property requirements that shall be shown by a five-digit designation. The designation shall consist of the letter A and the five digits comprising the cell numbers for the property requirements in the order they appear in Cell Table A.

4.2.1 Although the values listed are necessary to include the range of properties available in the existing materials, users should not infer that every possible combination of the properties exist or can be obtained.

NOTE 4—It is recognized that some high-density polyethylene plastics of very high molecular weight may have densities slightly less than 0.960, yet

in all other respects they are characteristic of Class 4 materials. Similarly, there are other polyethylene plastics of very high molecular weight having densities slightly less than 0.941 that, in all other respects, are more characteristic of Class 2 than of Class 3 materials.

NOTE 5—Use the following terms in describing polyethylene plastics:

- Class 1 (0.910 to 0.925) = low density,
- Class 2 (>0.925 to 0.940) = medium density,
- Class 3 (>0.940 to 0.960) = high density,
- Class 4 (>0.960) = high density, and

While Class 3 has been divided into two ranges of density, (Classes 3 and 4), both are still described by the term “high density.”

## 5. Suffixes

5.1 When using the call-out for the materials covered by this specification, the following suffixes may be used for specific requirements of the material for the application intended. In general, the suffix letter indicates the requirement needed; the first number (digit) indicates the test condition, and the second number (digit) indicates the specimen requirement. The suffixes are as follows:

5.1.1 *E* = Electrical requirements as designated by the following digits:

First Digit		
0	=	To be specified by user.
1	=	Specimens preconditioned 40 h at 23°C and 50 % relative humidity, then 14 days in distilled water at 23 ± 1°C.
Second Digit		
0	=	To be specified by user.
1	=	Volume resistivity, permittivity, and dissipation factor meet property limits as shown as follows. These are electrical limits usually applied to unreinforced polyethylene plastics when control of their electrical properties is required.

Electrical Properties:

	Test Methods	
Permittivity, max	D1531	2.30
Dissipation factor, max	D1531	0.001
Volume resistivity, min Ω-cm	D257	1 × 10 <sup>15</sup>
Water immersion stability	D1531	shall meet the dielectric constant and dissipation factor requirements

5.1.2 *F* = Flammability requirements<sup>5</sup> as designated by the following digits:

		First digit
0	=	To be specified by user.
1	=	Product is 3.05-mm thickness, min.
2	=	Product is 1.47-mm thickness, min.
3	=	Product is 0.71-mm thickness, min.
4	=	Product is 0.38-mm thickness, min.
5	=	Motor Vehicle Safety Standard 302.
		Second Digit
0	=	To be specified by user.
1	=	When burned horizontally in accordance with Test Method D635, a material: (a) Does not have a burning rate exceeding 38.1 mm/min over a 76.2-mm span for specimens of 3.05 to 12.7-mm thickness; or (b) Does not have a horizontal burning rate exceeding 76.2 mm/min over a 76.2-mm span for specimens of less than 3.05-mm thickness; or (c) Ceases to burn, horizontally, before the 102-mm reference mark.
2	=	When burned vertically in accordance with Test Method D568, the material: (a) Does not have any specimens that burn with flaming combustion for more than 30 s after two applications of the test flame; (b) Does not have a total flaming combustion time exceeding 250 s for 10 flame applications for each set of five specimens; (c) Does not have any specimens that burn with flaming or glowing combustion up to the holder clamp; (d) Has specimens that drip flaming particles that ignite the dry absorbent surgical cotton placed 305 mm [12 in.] below the test specimen;

<sup>5</sup> By publication of this specification and its use of flammability ratings, ASTM does not suggest that their use in any way reflects hazards presented under actual fire conditions.