



Designation: D4976 – 12a

# 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 necessary to identify particular characteristics important to specialized applications 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 reprocessable 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 [D7209](#) 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](#).

NOTE 2—There is no known ISO equivalent to this 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 Burning and/or Extent and Time of Burning of Flexible Plastics in a Vertical Position \(Withdrawn 1991\)](#)<sup>3</sup>
- [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](#)
- [D883 Terminology Relating to Plastics](#)

<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.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

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

- D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
- D1248 Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
- D1499 Practice for Filtered Open-Flame Carbon-Arc Exposures of Plastics
- 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
- D2565 Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications
- 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 (Withdrawn 2006)<sup>3</sup>
- D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials
- D3801 Test Method for Measuring the Comparative Burning Characteristics of Solid Plastics in a Vertical Position
- D3892 Practice for Packaging/Packing of Plastics
- D4000 Classification System for Specifying Plastic Materials
- D4329 Practice for Fluorescent UV Exposure of Plastics
- D4703 Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets
- D4804 Test Method for Determining the Flammability Characteristics of Nonrigid Solid Plastics
- D4883 Test Method for Density of Polyethylene by the Ultrasound Technique
- D4986 Test Method for Horizontal Burning Characteristics of Cellular Polymeric Materials
- D6360 Practice for Enclosed Carbon-Arc Exposures of Plastics
- D7209 Guide for Waste Reduction, Resource Recovery, and Use of Recycled Polymeric Materials and Products
- E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- E1354 Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter
- F1473 Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins

2.2 *Military Standard:*  
**MIL-STD-105** Sampling Procedures and Tables for Inspection by Attributes

NOTE 3—According to the DOD, “MIL-STD-105E, dated 10 May 1989, is hereby canceled without replacement” (1995).

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:*

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>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, <b>D1238</b> , g/10 min	Tensile Stress at Yield, <b>D638</b> , min, MPa	Nominal Strain at Break, <b>D638</b> , min, %	Flexural Modulus at 2 % Strain, <b>D790</b> , 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

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
			...	4	>0.4 to 1	9.5	300	125
			...	5	to 0.4	9.5	400	150
			...	0	...	...	...	...
		2	medium density	1	>25	8	40	200
			...	2	>10 to 25	11	50	200
			>0.925–0.940	3	>1 to 10	11	70	200
			...	4	>0.4 to 1	11	200	250
			...	5	to 0.4	12	400	300
			...	0	...	...	...	...
		0	...	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	10	400	350
			...	5	to 0.4	12	500	400
			...	0	...	...	...	...
		2	medium density	1	>25	14	90	500
			...	2	>10 to 25	14	100	500
			>0.925–0.940	3	>1 to 10	14	100	550
			...	4	>0.4 to 1	15	200	600
			...	5	to 0.4	19	400	600
			...	0	...	...	...	...
		3	high density	1	>25	17	10	400
			...	2	>10 to 25	17	50	400
			>0.940–0.960	3	>1 to 10	18	200	450
			...	4	>0.4 to 1	19	400	500
			...	5	to 0.4	20	600	600
			...	0	...	...	...	...
		4	high density	1	>25	24	10	500
			...	2	>10 to 25	24	10	600
			>0.960	3	>1 to 10	25	30	800
			...	4	>0.4 to 1	28	300	900
			...	5	to 0.4	28	400	1000
			...	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 4—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 5—It is recognized that some high-density polyethylene plastics of very high molecular weight 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 6—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

Although Classes 3 and 4 cover two ranges of density, both are 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 can 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	D257	1 × 10 <sup>15</sup>
Ω-cm		
Water immersion stability	D1531	shall meet the dielectric constant and dissipation factor requirements

5.1.2 Flammability requirements for polyethylene plastics shall be assessed by one or more of the following small scale flammability tests:

5.1.2.1 The rate of burning and/or extent and time of burning in a horizontal orientation for polyethylene plastics shall be assessed by Test Method D635. A plastic shall be classified HB if: (a) the rate of burning in the test does not exceed 40 mm per minute over a 75 mm span for specimens having a thickness of 3.0 – 13 mm, or b) the rate of burning does not exceed 75 mm per minute over a 75 mm for specimens having a thickness less than 3.0 mm, or c) the test specimen ceases to burn before the 100 mm reference mark.

5.1.2.2 The rate of burning and/or extent and time of burning in a horizontal orientation for foamed polyethylene plastics shall be assessed by Test Method D4986. A foamed plastic shall be classified HBF if: (a) the rate of burning in the test does not exceed 40 mm per minute over a 100 mm span b)

the test specimen ceases to burn before flaming or glowing reaches the 125 mm gage mark.

5.1.2.3 The burning characteristics in a vertical orientation of polyethylene plastics shall be assessed by Test Method D3801. A plastic shall be classified V0, V1 or V2 as indicated in Appendix X1 of Test Method D3801.

5.1.2.4 The burning characteristics in a vertical orientation of nonrigid polyethylene plastics that, due to specimen thickness or lack of rigidity, would distort or shrink when tested using Test Method D3801 shall be assessed by Test Method D4804. A plastic shall be classified VTM0, VTM1 or VTM2 as indicated in Appendix X1 of Test Method D4804.

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

- First digit
- 0 = To be specified by user.
  - 1 = Rigid
  - 2 = Foam
  - 3 = Non-rigid
- Second Digit
- 0 = To be specified by user.
  - 1 = Meets the classification requirements for HB when tested per D 635
  - 2 = Meets the classification requirements for HBF when tested per D4986
  - 3 = Meets the classification requirements for V0 when tested per D3801
  - 4 = Meets the classification requirements for V1 when tested per D3801
  - 5 = Meets the classification requirements for V2 when tested per D3801
  - 6 = Meets the classification requirements for VTM0 when tested per D4804
  - 7 = Meets the classification requirements for VTM1 when tested per D4804
  - 8 = Meets the classification requirements for VTM2 when tested per D4804

5.1.2.6 The above call-out table reflects changes due to the withdrawal of D568 in 1991. For reference, the original call-out table can be found in Appendix X1 of this document. The table in Appendix X1 is included only for reference and shall not be used for future specification of materials.

5.1.2.7 If requested, the heat release rate and ignitability in a horizontal orientation of polyethylene plastics shall be assessed when tested using Test Method E1354.

5.1.3 *W* = Weatherability requirements as designated by the following digits:

- First Digit
- 0 = To be specified by user.
  - 1 = Specimens exposed to xenon-arc type light source, in accordance with Practice D2565, Type BH. Specimens shall be Test Method D638, Type IV tensile bars.
  - 2 = Specimens exposed to enclosed carbon-arc type light source, in accordance with Practice D6360. Specimens shall be Test Method D638, Type IV tensile bars.
  - 3 = Specimens exposed to fluorescent-UV-condensation type light source, in accordance with Practice D4329. Specimens shall be Test Method D638, Type IV tensile bars.
  - 4 = Specimens exposed to filtered open-flame carbon arc type light source in accordance with Practice D1499. Specimens shall be Test Method D638, Type IV tensile bars
- Second Digit
- 0 = To be specified by user.
  - 1 = 200-h exposure.
  - 2 = 500-h exposure.
  - 3 = 1000-h exposure.
  - 4 = 2000-h exposure.

<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.