



Standard Specification for Polyethylene Plastics Pipe and Fittings Materials¹

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1. Scope *

1.1 This specification covers the identification of polyethylene plastic pipe and fittings materials according to a cell classification system. It is not the function of this specification to provide specific engineering data for design purposes, to specify manufacturing tolerances, or to determine suitability for use for a specific application.

1.2 Polyethylene plastic materials, being thermoplastic, are reprocessable and recyclable (Note 2). This specification allows for the use of those polyethylene materials, provided that all specific requirements of this specification are met.

NOTE 1—The notes in this specification are for information only and shall not be considered part of this specification.

NOTE 2—See Guide D 5033 for information and definitions related to recycled plastics.

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

1.4 *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 3—There is no similar or equivalent ISO standard.

1.5 For information regarding Molding and Extrusion Materials see D 4976 Specification for Polyethylene Plastics Molding and Extrusion Materials. For information regarding Wire and Cable Materials see D 1248 Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.

2. Referenced Documents

2.1 ASTM Standards:

- D 618 Practice for Conditioning Plastics for Testing²
- D 638M Test Method for Tensile Properties of Plastics³
- D 746 Test Method for Brittleness Temperature of Plastics and Elastomers by Impact²
- D 790 Test Methods for Flexural Properties of Unreinforced

and Reinforced Plastics and Electrical Insulating Materials²

D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement²

D 883 Terminology Relating to Plastics²

D 1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer²

D 1248 Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable²

D 1505 Test Method for Density of Plastics by the Density-Gradient Technique²

D 1603 Test Method for Carbon Black in Olefin Plastics²

D 1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics²

D 1898 Practice for Sampling of Plastics³

D 1928 Practice for Preparation of Compression-Molded Polyethylene Test Sheets and Test Specimens⁴

D 2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials⁵

D 3892 Practice for Packaging/Packing of Plastics⁶

D 4976 Specification for Polyethylene Plastics Molding and Extrusion Materials⁷

D 5033 Guide for the Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics⁷

F 1473 Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins⁵

2.2 ISO Standards

ISO 9080 Plastics Piping and Ducting Systems Determination of Long-Term Hydrostatic Strength of Thermoplastics Materials in Pipe Form by Extrapolation

ISO 12162 Thermoplastic Materials for Pipes and Fittings for Pressure Applications— Classification and Designation— Overall Service (Design) Coefficient

3. Terminology

3.1 *Definitions*—Terms as described in Terminology D 883 shall apply in this specification.

3.1.1 *polyethylene plastics*—as defined by this specification, plastics or resins prepared by the polymerization of no less than 85 % ethylene and no less than 95 % of total olefins with

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² *Annual Book of ASTM Standards*, Vol 08.01.

³ Discontinued; see *1996 Annual Book of ASTM Standards*, Vol 08.01.

⁴ Discontinued; see *2001 Annual Book of ASTM Standards*, Vol 08.01.

⁵ *Annual Book of ASTM Standards*, Vol 08.04.

⁶ *Annual Book of ASTM Standards*, Vol 08.02.

⁷ *Annual Book of ASTM Standards*, Vol 08.03.

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

additional compounding ingredients.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 materials—polyethylene (PE) resins with the added compounding ingredients.

3.2.2 PE compounds—has the same meaning as PE plastics materials, compounds, and plastics.

3.3 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:

3.3.1 Specification D 1248:

3.3.1.1 Type (0, I, II, III, IV) = density ranges (same, respectively, as Class in Specification D 4976).

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

3.3.1.3 Category (1, 2, 3, 4, 5) = melt index ranges (same as Grade in Specification D 4976).

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

3.3.2 Specification D 3350:

3.3.2.1 Type (I, II, III) = density ranges (same as Types I, II, and III in Specification D 1248 and Classes 1, 2, and 3 in Specification D 4976).

3.3.2.2 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.

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

3.3.3 Specification D 4976:

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

3.3.3.2 Class (5, 1, 2, 3, 4) = density ranges (same, respectively, as Type in Specification D 1248).

3.3.3.3 Grade (1, 2, 3, 4, 5) = melt index ranges (same as Category in Specification D 1248).

4. Classification

4.1 Polyethylene plastic pipe and fittings compounds are classified according to density, melt index, flexural modulus tensile strength at yield, environmental stress-crack resistance, and the hydrostatic design basis at 23°C in Table 1.

NOTE 4—It has been a long-standing practice to use the following terms in describing polyethylene plastics:

- Type I (0.910 to 0.925) = Low Density
- Type II (0.926 to 0.940) = Medium Density
- Type III (0.941 to 0.965) = High Density

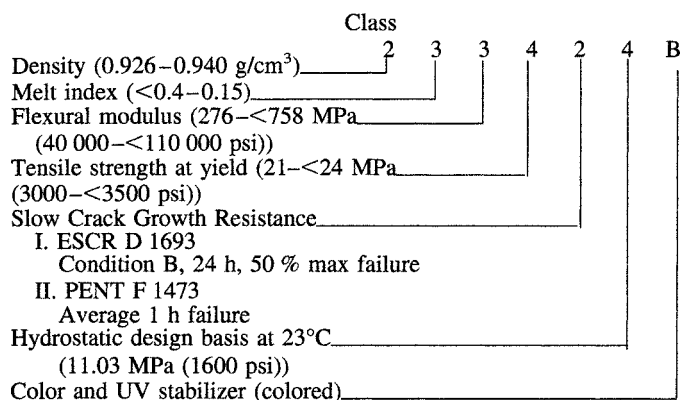
NOTE 5—The manner in which materials are identified in the cell

TABLE 1 Primary Properties—Cell Classification Limits

Property	Test Method	0	1	2	3	4	5	6	7
1 Density, g/cm ³	D 1505	Unspecified	0.925 or lower	>0.925 – 0.940	>0.940 – 0.955	>0.955	...	...	specify value
2 Melt index	D 1238	Unspecified	>1.0	1.0 to 0.4	<0.4 to 0.15	<0.15	A		specify value
3 Flexural modulus, MPa (psi)	D 790	Unspecified	<138 (<20 000)	138 – <276 (20 000 to <40 000)	276 – <552 (40 000 to 80 000)	552 – <758 (80 000 to 110 000)	758 – <1103 (110 000) to <160 000)	>1103 (>160 000)	specify value
4 Tensile strength at yield, MPa (psi)	D 638	Unspecified	<15 (<2200)	15 – <18 (2200–<2600)	18 – <21 (2600–<3000)	21 – <24 (3000–<3500)	24 – <28 (3500–<4000)	>28 (>4000)	specify value
5 Slow Crack Growth Resistance									
I. ESCR	D 1693	Unspecified							
a. Test condition (100% Igepal.)			A	B	C	C	...	...	specify value
b. Test duration, h			48	24	192	600			
c. Failure, max, %		Unspecified	50	50	20	20			specify value
II. PENT (hours)	F 1473								
Molded plaque, 80°C, 2.4 MPa			0.1	1	3	10	30	100	
Notch depth, F 1473, Table 1		Unspecified							specify value
6 Hydrostatic Strength Classification									
I. Hydrostatic design basis, MPa (psi), (23°C)	D 2837	NPR ^B	5.52 (800)	6.89 (1000)	8.62 (1250)	11.03 (1600)	...	...
II. Minimum required strength, MPa (psi), (20°C)	ISO 9080	...	...	...	...	...	8 (1160)	10 (1450)	

^A Refer to 10.1.4.1.
^B NPR = Not Pressure Rated.

classification is illustrated for Class PE233424B as follows (refer also to Table 1 and 6.2):



4.2 Materials used in polyethylene plastic pipe and fittings shall use a cell-type format for the identification, close characterization, and specification of material properties. The information from the format is to be used alone or in combination.

NOTE 6—This type format, however, is subject to possible misapplication since unobtainable property combinations can be selected if the user is not familiar with commercially available materials. The manufacturer should be consulted. Additionally, the appropriate ASTM standard specification should be reviewed to assure materials utilized will meet all the material and piping requirements as specified in the standard.

4.3 Grade—A code for polyethylene pipe and fittings materials that consists of the two letter abbreviation for polyethylene (PE) followed by two numbers that designate the density cell (Property 1) and the slow crack growth resistance cell (Property 5), as defined by either Test Method F 1473 or Test Method D 1693, of the thermoplastic, as specified in Table 1. For the requirements of Property 5 (slow crack growth resistance), consult the materials section of the appropriate ASTM standard specification for the end-use application.

NOTE 7—Grade designations were adapted from Specification D 1248 - 84 prior to the withdrawal of D 1248 - 84. Former Specification D 1248 - 84 grades for PE pipe materials were P14, P23, P24, P33, and P34. Equivalent Specification D 3350 grade designations for these materials are PE11, PE20, PE23, PE30, and PE33, respectively.

5. Materials and Manufacture

5.1 The molding and extrusion material shall be polyethylene plastic in the form of powder, granules, or pellets.

5.2 The molding and extrusion materials shall be as uniform in composition and size and as free of contamination as is achieved by good manufacturing practice. If necessary, the level of contamination may be agreed upon between the manufacturer and the purchaser.

5.3 When specified, the color and translucence of molded or extruded pieces formed, under the conditions specified by the manufacturer of the materials, shall be comparable within commercial match tolerances to the color and translucence of standard samples supplied in advance by the manufacturer of the material.

6. Physical Properties

6.1 Cell Classification—Test values for specimens of the PE

material prepared as specified in Section 9 and tested in accordance with Section 10 shall conform to the requirements given in Table 1. A typical property value for a PE material is to be the average value from testing numerous lots or batches and determines the cell number. When, due to manufacturing tolerances and testing bias, individual lot or batch values fall into the adjoining cell, the individual value shall not be considered acceptable unless the user, or both the user and the producer, determine that the individual lot or batch is suitable for its intended purpose.

6.2 Color and Ultraviolet (UV) Stabilizer—The color and UV stabilization shall be indicated at the end of the cell classification by means of a letter designation in accordance with the following code:

Code Letter	Color and UV Stabilizer
A	Natural
B	Colored
C	Black with 2 % minimum carbon black
D	Natural with UV stabilizer
E	Colored with UV stabilizer

6.3 Thermal Stability—The PE material shall contain sufficient antioxidant so that the minimum induction temperature shall be 220°C when tested in accordance with 10.1.9.

6.4 Brittleness Temperature—The brittleness temperature shall not be warmer than -60°C when tested in accordance with Test Method D 746.

6.5 Density—The density used to classify the material shall be the density of the PE base resin (uncolored PE) determined in accordance with 10.1.3. When the average density of any lot or shipment falls within ±0.002 g/cm³ of the nominal value, it shall be considered as conforming to the nominal value and to all classifications based on the nominal value.

6.5.1 For black compounds, containing carbon black, determine the density, *D_p*, and calculate the resin density, *D_r*, as follows:

$$D_r = D_p - 0.0044C$$

where:

C = weight percent of carbon black.

6.5.2 For colored compounds, the nominal density of the base resin shall be provided by the manufacturer, on request.

6.6 Tensile Strength at Yield—The tensile strength at yield used to classify the material shall be the tensile strength at yield of the PE resin determined in accordance with 10.1.6. When the average tensile strength at yield of any lot or shipment falls within ±3.45 MPa (±500 psi) of the nominal value, it shall be considered as conforming to the nominal value and to all classifications based on the nominal value.

6.7 Elongation at Break—As tested per 10.1.6, all pressure rated materials shall have a minimum extension at break of 500 % as determined by grip separation.

7. Sampling

7.1 A batch or lot shall be considered as a unit of manufacture and shall consist of one production run or as a blend of two or more production runs of material.

7.2 Unless otherwise agreed upon between the manufacturer and the purchaser, the material shall be sampled in accordance with the procedure described in Sections 9 through 12 of