



Designation: ~~D3350-10a~~ Designation: D3350 - 12

## Standard Specification for Polyethylene Plastics Pipe and Fittings Materials<sup>1</sup>

This standard is issued under the fixed designation D3350; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

### 1. Scope\*

1.1 This specification covers the identification of polyethylene plastic pipe and fittings materials in accordance with 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 reprocessible 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 D5033 for information and definitions related to recycled plastics.

1.3 The values stated in SI units are to be regarded as 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 known ISO equivalent to this standard.

1.5 For information regarding molding and extrusion materials see Specification D4976. For information regarding wire and cable materials see Specification D1248.

### 2. Referenced Documents

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

D618 Practice for Conditioning Plastics for Testing

D638 Test Method for Tensile Properties of Plastics

D746 Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

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

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

D1603 Test Method for Carbon Black Content in Olefin Plastics

D1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics

D1898 Practice for Sampling of Plastics

D2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products

D2839 Practice for Use of a Melt Index Strand for Determining Density of Polyethylene

D3892 Practice for Packaging/Packing of Plastics

D4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds By the Muffle-Furnace Technique

D4703 Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets

D4883 Test Method for Density of Polyethylene by the Ultrasound Technique

D4976 Specification for Polyethylene Plastics Molding and Extrusion Materials

D5033 Guide for Development of ASTM Standards Relating to Recycling and Use of Recycled 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. Current edition approved Nov. 15, 2010; April 1, 2012. Published January 2011; May 2012. Originally approved in 1974. Last previous edition approved in 2010 as D3350 - 10A. DOI: 10.1520/D3350-10A; 10.1520/D3350-12.

<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.

F1473 Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins

2.2 ISO Standard:

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

**3. Terminology**

3.1 *Definitions:*

3.1.1 Terms as described in Terminology Definitions—Terms as described in Terminology D883 shall apply in this specification.

3.1.2

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 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 D1248:*

3.3.1.1 Type (0, I, II, III, IV) = density ranges (same, respectively, as Class in Specification D4976).

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 D4976).

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

3.3.2 *Specification D3350:*

3.3.2.1 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).

3.3.2.2 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 D4976:*

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

3.3.3.2 Class (0, 1, 2, 3, 4) = density ranges (same, respectively, as Type in Specification D1248).

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

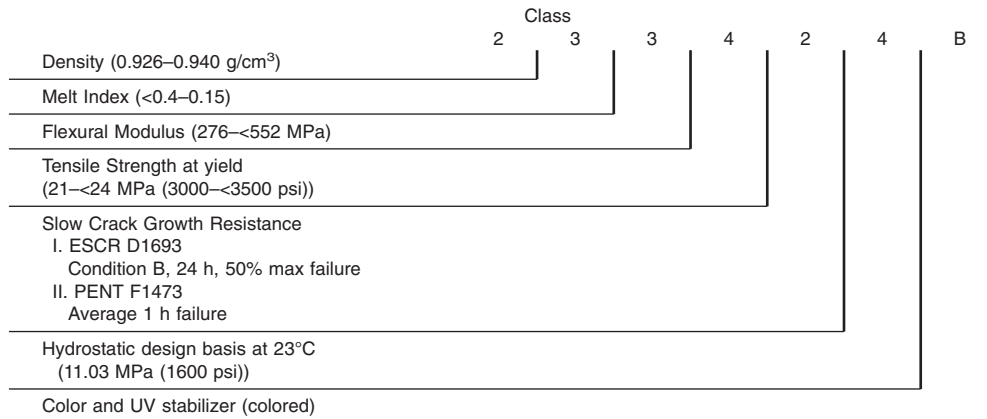
**4. Classification**

4.1 Polyethylene plastic pipe and fittings compounds are classified in accordance with density, melt index, flexural modulus, tensile strength at yield, slow crack growth resistance, and hydrostatic strength classification 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 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.

**TABLE 1 Primary Properties<sup>A</sup>—Cell Classification Limits**

Property	Test Method	0	1	2	3	4	5	6	7	8
1. Density, g/cm <sup>3</sup>	D1505	Unspecified	0.925 or lower	>0.925-0.940	>0.940-0.947	>0.947-0.955	>0.955	...	Specify Value	
2. Melt index	D1238	Unspecified	>1.0	1.0 to 0.4	<0.4 to 0.15	<0.15	<sup>B</sup>		Specify Value	
2. Melt index	D1238	Unspecified	>1.0	1.0 to 0.4	<0.4 to 0.15	<0.15 <sup>B</sup>	<sup>C</sup>		Specify Value	
3. Flexural modulus, MPa (psi)	D790	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)	D638	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	D1693	Unspecified								
a. Test condition (100% Igepal)			A	B	C	C	...	...	...	Specify Value
a. Test condition (100% Igepal) <sup>D</sup>			A	B	C	C	...	...	...	Specify Value
b. Test duration, h			48	24	192	600				
c. Failure, max. %		Unspecified	50	50	20	20				
II. PENT (hours)	F1473	Unspecified	...	...	...	10	30	100	500	Specify Value
Molded plaque, 80°C, 2.4 MPa		Unspecified	...	...	...	10	30	100	500	Specify Value
Notch depth, F1473, Table 1		Unspecified	...	...	...	...	...	...	...	Specify Value
6. Hydrostatic Strength Classification										
I. Hydrostatic design basis, MPa (psi), (23°C)	D2837	NPR <sup>C</sup>	5.52 (800)	6.89 (1000)	8.62 (1250)	11.03 (1600)	...	...		
I. Hydrostatic design basis, MPa (psi), (23°C)	D2837	NPR <sup>E</sup>	5.52 (800)	6.89 (1000)	8.62 (1250)	11.03 (1600)	...	...		
II. Minimum required strength, MPa (psi), (20°C)	ISO 12162	...	...	...	...	...	8 (1160)	10 (1450)		

<sup>A</sup>Compliance with physical properties in accordance with Section 8 is required including requirements for cell classification, color, and ultraviolet (UV) stabilizer, thermal stability, brittleness temperature, density, tensile strength at yield, and elongation at break.

<sup>B</sup>Refer to 10.1.4.1.

<sup>C</sup>Refer to 10.1.4.2.

<sup>D</sup>There are environmental concerns regarding the disposal of Nonylphenoxy poly(ethyleneoxy) ethanol (CAS 68412-54-4) for example, Igepal CO-630. Users are advised to consult their supplier or local environmental office and follow the guidelines provided for the proper disposal of this chemical.

<sup>E</sup>NPR = Not Pressure Rated.

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 F1473 or Test Method D1693, 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 D1248 - 84 prior to the removal of pipe material from D1248 - 84. Former Specification D1248 - 84 grades for PE pipe materials were P14, P23, P24, P33, and P34. Equivalent Specification D3350 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	Black with a carbon black in the range as noted in 6.2.1 and 6.2.2
E	Natural with UV stabilizer
	Colored with UV stabilizer

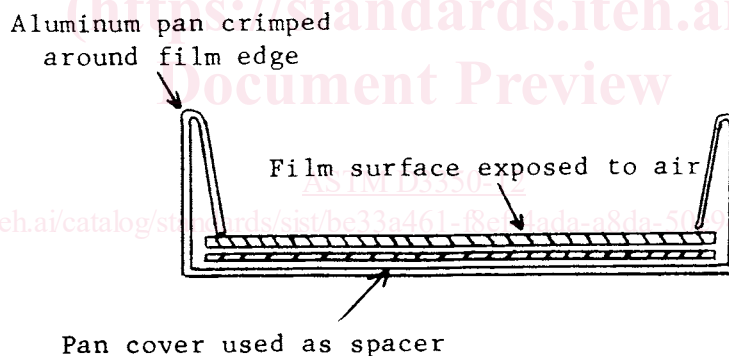
6.2.1 For PE compounds with a hydrostatic strength classification cell class 0 (not pressure-rated), the carbon black content shall be in the range of 2.0 % to 4.0 %.

6.2.2 For PE compounds with a pressure rating as noted by a hydrostatic strength classification other than cell class 0, the carbon black content shall be in the range of 2.0 % to 3.0 %.

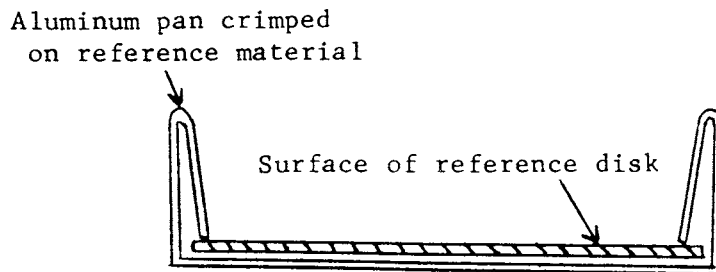
6.3 *Thermal Stability*—The PE material shall contain sufficient antioxidant so that the minimum induction temperature shall be 220°C when tested in accordance with 10.1.9.

6.4 *Brittleness Temperature*—The brittleness temperature shall not be warmer than -60°C when tested in accordance with Test Method D746.

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/cm<sup>3</sup> of the nominal value, it shall be considered as conforming to the nominal value and to all classifications based on the nominal value.



(a) Specimen in pan.



(b) Reference—Temperature standard shall be placed under reference disk in reference pan or alternatively under pan cover (spacer).

FIG. 1 Mounting Film Specimen in Cup