Designation: D 1248 – 00a

Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable[1]

This standard is issued under the fixed designation D 1248; 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 (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification provides for the identification of polyethylene plastics extrusion materials for wire and cable in such a manner that the seller and the purchaser 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 according to the types, classes, categories, and grades covered. It is not the function of this specification to provide specific engineering data for design purposes.

1.2 This specification does not allow for the use of recycled plastics (see Note 3).

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

1.4 The following safety hazards caveat pertains only to the test method portion, Section 11, 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.*

NOTE 1—No ISO equivalent.

NOTE 2—This standard has undergone major revision from the reapproval of 1989 and now covers only polyethylene for wire and cable applications. For information regarding molding and extrusion materials, see Specification D 4976. For information regarding plastic pipe materials, see Specification D 3350.

NOTE 3—See Guide D 5033 for information and definitions related to recycled plastics.

2. Referenced Documents

2.1 *ASTM Standards:*

D 150 Test Methods for A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials[2]

D 257 Test Methods for D-C Resistance or Conductance of Insulating Materials[2]

D 470 Test Methods for Crosslinked Insulations and Jackets for Wire and Cable[2]

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[3]

D 638 Test Method for Tensile Properties of Plastics[3]

D 746 Test Method for Brittleness Temperature of Plastics and Elastomers by Impact[3]

D 792 Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement[3]

D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer[3]

D 1505 Test Method for Density of Plastics by the Density-Gradient Technique[3]

D 1531 Test Method for Relative Permittivity (Dielectric Constant) and Dissipation Factor of Polyethylene by Liquid Displacement Procedure[2]

D 1603 Test Method for Carbon Black in Olefin Plastics[3]

D 1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics[3]

D 1898 Practice for Sampling of Plastics[3]

D 1928 Practice for Preparation of Compression-Molded Test Sheets and Test Specimens[3]

D 2565 Practice for Operating Xenon-Arc Type Light Exposure Apparatus With and Without Water for Exposure of Plastics[4]

D 2633 Test Methods for Thermoplastic Insulations and Jackets for Wire and Cable[5]

D 2839 Test Method for Use of a Melt Strand for Determining Density of Polyethylene[4]

D 2951 Test Method for Resistance of Types III and IV Polyethylene Plastics to Thermal Stress-Cracking[4]

D 3182 Practice for Rubber-Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets[6]

D 3349 Test Method for Absorption Coefficient of Carbon Black Pigmented Ethylene Plastic Film[5]

D 3350 Specification for Polyethylene Plastics Pipe and Fittings Materials[4]

[1] 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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[2] *Annual Book of ASTM Standards*, Vol 10.01.

[3] *Annual Book of ASTM Standards*, Vol 08.01.

[4] *Annual Book of ASTM Standards*, Vol 08.02.

[5] *Annual Book of ASTM Standards*, Vol 10.02.

[6] *Annual Book of ASTM Standards*, Vol 09.01.

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

D 3636 Practice for Sampling and Judging Quality of Solid Electrical Insulating Materials[5]
D 3892 Practice for Packaging/Packing of Plastics[4]
D 4329 Practice for Operating Light and Water Apparatus (Fluorescent UV Condensation Type) for Exposure of Plastics[7]
D 4976 Specification for Polyethylene Plastics Molding and Extrusion Materials[7]
D 5033 Guide for the Development of Standards Relating to the Proper Use of Recycled Plastics[7]
E 1131 Test Method for Compositional Analysis by Thermogravimetry[8]
G 53 Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials[8]
G 151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices That Use Laboratory Light Sources[8]
G 153 Practice for Operating Enclosed Carbon-Arc Light Apparatus for Exposure of Nonmetallic Materials[8]
G 154 Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials[8]
G 155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials[8]

2.2 *Federal Specification:*[9]
L-L-390 Plastic, Molding, and Extrusion Materials, Polyethylene and Copolymers (Low, Medium, and High Density)

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *polyethylene plastics*, *n*—plastics or resins prepared by the polymerization of no less than /50 % ethylene and no less than 95 weight % of total olefins.

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 D 1248*:

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

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 D 4976).

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

3.2.2 *Specification D 3350*:

3.2.2.1 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).

3.2.2.2 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 D 4976*:

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

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

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

4. Classification

4.1 This specification recognizes that polyethylene plastics are identified primarily on the basis of two characteristics, namely, density and flow rate (previously identified as melt index). The former is the criterion for assignment as to type, the latter for designation as to category. Other attributes important to the user for certain applications are covered by three general classes and by specifying in greater detail, by grades, a minimum number of key characteristics covered too broadly or not at all by the type, class, and category designations.

4.1.1 *Types*:

4.1.1.1 This specification provides for the identification of five types of polyethylene plastics extrusion materials for wire and cable by density in accordance with 10.1 and 11.1.3 and the requirements prescribed in Table 1 and Note 4, Note 5, and Note 10.

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 Type IV materials. Similarly, there are other polyethylene plastics of very high molecular weight having densities slightly less than 0.941 which in all other respects are more characteristic of Type III than of Type II materials.

NOTE 5—While the original Type III now has been divided into two ranges of density (Types III and IV), both are still described by the term *high density*.

4.1.1.2 Material supplied under these types shall be of such nominal density, within the ranges given, as agreed upon between the manufacturer and the purchaser subject to the tolerances specified in 4.1.1.3 (Note 10).

4.1.1.3 In view of production, sampling, and testing variables, a commercial lot or shipment for which a nominal density has been agreed upon between the seller and the purchaser shall be considered as conforming and commercially acceptable when the density value found on a sample from the lot or shipment falls within the tolerance range of ±0.004 of the nominal value.

4.1.1.4 If the nominal value is unknown or unspecified, classification shall be based on the tested value without tolerance consideration.

TABLE 1 Classification of Polyethylene Plastics Extrusion Materials for Wire and Cable According to Type

Type	Nominal Density,[A] g/cm^3
0	<0.910
I	0.910 to 0.925
II	>0.925 to 0.940
III	>0.940 to 0.960
IV	>0.960

[A]Uncolored, unfilled material (see Note 10).

[7] *Annual Book of ASTM Standards*, Vol 08.03.
[8] *Annual Book of ASTM Standards*, Vol 14.02.
[9] Available from Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120.

4.1.2 *Classes*—Each of the five types is subdivided into four classes according to composition and use as follows:

4.1.2.1 *Class A*—Natural color only, without any or with such antioxidant or other additives in such proportions as agreed upon between the seller and the purchaser.

4.1.2.2 *Class B*—Colors including white and black, without any or with such antioxidant or other additives in such proportions as agreed upon between the manufacturer and the purchaser.

4.1.2.3 *Class C*—Black (weather-resistant), containing not less than 2 % carbon black of a kind and particle size (Note 6), dispersed by such means and to such degree, all as may be agreed upon between the seller and the purchaser; without any or with such antioxidant or other additives in such proportions as agreed upon between the seller and the purchaser.

NOTE 6—Carbon black 35 mm or less in average particle diameter is used as required in black electrical and jacketing materials (Grades E and J) to impart maximum weather resistance.

4.1.2.4 *Class D*—Colored (UV resistant), including black and white, with antioxidant and UV stabilizers to allow electrical insulation and jackets to meet the requirements outlined in 11.1.14. (**Warning**—The expected service lifetime of Class D materials is very dependent upon the specific material formulation including selected colorants. Contact your supplier for additional information regarding this issue.)

4.1.3 *Categories*:

4.1.3.1 The four classes of each type are divided into five categories on the basis of broad ranges of flow rate in accordance with the requirements prescribed in Table 2.

NOTE 7—Some Type II and Type III polyethylene plastics of very high molecular weight cannot be categorized by flow rate. Solution viscosity is recommended as a means of distinguishing such materials.

4.1.3.2 Material supplied under these categories shall be of such nominal flow rate, within the ranges given, as agreed upon between the seller and the purchaser subject to the tolerances specified in 4.1.3.3.

4.1.3.3 In view of production, sampling, and testing variables, a commercial lot or shipment for which a nominal flow rate has been agreed upon between the seller and the purchaser shall be considered as conforming and commercially acceptable when the flow rate value found on a sample from the lot or shipment falls within the tolerance range of ±20 % of the nominal flow rate.

4.1.3.4 If the nominal value is unknown or unspecified, classification shall be based on the tested value without tolerance consideration.

4.1.4 *Grades*:

4.1.4.1 If further definition is necessary, one of the grades given in Tables 3-5 shall be selected.

NOTE 8—Tables 4 and 5, are included to correspond with the grades specified in Federal Specification L-P-390.

NOTE 9—The grade shall be associated with the appropriate type, class, and category designations; for example, IA5-E4 or IC5-J3 as required. Other grades may be added as necessary by revision of this specification in established manner. Also, it is anticipated that additional requirements may be added under a given grade designation by future revision to provide more meaningful characterization of the material covered by such designation.

4.1.4.2 Instead of such selection, additional requirements specific to the application may be specified by the purchaser with the agreement of the seller.

TABLE 2 Classification of Polyethylene Plastics Extrusion Materials for Wire and Cable According to Category

Category	Nominal Flow Rate, g/10 min (190°C, 2.16 kg load)
1	>25
2	>10 to 25
3	>1.0 to 10
4	>0.4 to 1.0
5	0.4 max

5. Basis of Purchase

5.1 The purchase order or inquiry for these materials shall state the specification number, type, class, category, and, if needed, the appropriate grade, for example, D1248–IA5-E4.

5.2 Further definition may be agreed upon between the seller and the purchaser as follows:

5.2.1 Nominal density.

NOTE 10—For Class B, Class C, and Class D material, the nominal density of the base resin will be identified by the manufacturer upon request.

5.2.2 Nominal flow rate.

5.2.3 *Antioxidant(s) or Other Additive(s) and Proportions*:

5.2.3.1 *Class A*—As stated in 4.1.2.1,

5.2.3.2 *Class B*—As stated in 4.1.2.2,

5.2.3.3 *Class C*—As stated in 4.1.2.3, and

5.2.3.4 *Class D*—As stated in 4.1.2.4.

5.2.4 Contamination level (see 6.2).

5.2.5 Other supplementary definition, unless grade is sufficient and is identified (see 4.1.4.1 and 4.1.4.2).

5.3 Inspection (see 12.1).

6. Materials and Manufacture

6.1 The extrusion material for wire and cable shall be polyethylene plastic in the form of powder, granules, or pellets.

6.2 The extrusion materials for wire and cable shall be as uniform in composition and size and as free of contamination as can be achieved by good manufacturing practice. If necessary, level of contamination may be agreed upon between the seller and the purchaser.

6.3 Unless controlled by requirements specified elsewhere (see 4.1.4.1 and 4.1.4.2), the color and translucence of extruded pieces formed under conditions recommended by the manufacturer of the material, shall be comparable within commercial match tolerances to the color and translucence of standard molded or extruded samples of the same thickness supplied in advance by the manufacturer of the material.

7. Physical Requirements

7.1 Test specimens of the material prepared as specified in 10.1, and tested in accordance with 11.1, shall conform to the requirements prescribed by the material designation for type in Table 1, for class in 4.1.2, for category in Table 2, and for grade in Tables 3-5.

TABLE 3 Detail Requirements for Molded Test Specimens

Property and Unit	Grade[A]									
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
Tensile strength, min:										
MPa	5	10	10	12	12	17	17	19	19	22
(psi)	(1200)	(1500)	(1500)	(1800)	(1800)	(2400)	(2400)	(2800)	(2800)	(3200)
Elongation, min, %	300	400	400	500	500	400	400	400	400	400
Brittleness temperature, max, °C	–50	–60	–60	–75	–75	–45	–75	–75	–75	–75
Environmental stress-crack resistance,[B,C] min, f_{20} h	. . .	. . .	. . .	48	48	. . .	. . .	48	48	48
Thermal stress-crack resistance, h without cracking, min	. . .	. . .	. . .	. . .	. . .	. . .	. . .	96	96	168
Dissipation factor,[D] max:										
Class A										
Before milling	0.0005	0.0002	0.0005	0.0002	0.0005	0.0002	0.0005	0.0002	0.0005	0.0002
After milling	0.0005	0.0003	0.0005	0.0003	0.0005	0.0003	0.0005	0.0003	0.0005	0.0003
Class B	0.001	0.0005	0.001	0.0005	0.001	0.0005	0.001	0.0005	0.001	0.0005
Class C	0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005
Dielectric constant[D] max increase over nominal[E]:										
Class A	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01
Class B	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04
Class C	0.52	0.30	0.52	0.30	0.52	0.30	0.50	0.30	0.50	0.30
Volume resistivity, min, Ω·cm:										
Classes A, B	10^{15}	10^{15}	10^{15}	10^{15}	10^{15}	10^{15}	10^{15}	10^{15}	10^{15}	10^{15}
Water immersion stability	[F]	[F]	[F]	[F]	[F]	[F]	[F]	[F]	[F]	[F]

	E11	J1	J3	J4	J5
Tensile strength, min:					
MPa	22	10	12	19	22
(psi)	(3200)	(1500)	(1800)	(2800)	(3200)
Elongation, min, %	400	400	500	400	400
Brittleness temperature, max, °C	–75	–60	–75	–75	–75
Environmental stress-crack resistance,[B,C] min, f_{20} h	48	. . .	24	24	24
Thermal stress-crack resistance, h without cracking, min	168	. . .	. . .	. . .	. . .
Dissipation factor,[D] max:					
Class A					
Before milling	0.0005	. . .	. . .	. . .	. . .
After milling	0.0005	. . .	. . .	. . .	. . .
Class B	0.001	. . .	. . .	. . .	. . .
Class C	0.01	. . .	0.01	0.01	. . .
Dielectric constant[D] max increase over nominal[E]:					. . .
Class A	0.05	. . .	. . .	. . .	. . .
Class B	0.12	. . .	. . .	. . .	. . .
Class C	0.50	. . .	0.52	0.52	. . .
Volume resistivity, min, Ω·cm:					
Classes A, B	10^{15}	. . .	. . .	. . .	. . .
Water immersion stability	[F]	. . .	. . .	. . .	. . .

[A] The letters associated with these grades identify areas of potential applicability as indicated below:
E = Electrical Insulation (in some instances these materials also may serve as jacketing).
J = Jacketing (in some instances these materials also may serve as primary insulation).
[B] f_{20} is the time required for failure of 20 % of the samples tested in accordance with Test Method D 1693 as further directed by 11.1.8.1-11.1.8.4 of this specification.
[C] Requirements for environmental stress-crack resistance apply only to Class B, Class C, and Class D compounds unless otherwise specified (see 5.2.5).
[D] At any frequency from 1 kHz through 1 MHz (see also 11.1.10.1-11.1.10.3).
[E] Dielectric constant is a function of density; hence, the nominal value will be different for each type. Based on published information, the nominal values for the five types covered by this specification are as follows: Type 0-2.28, Type I-2.28, Type II-2.31, Types III and IV-2.35 (Lanza, V. L., and Herrmann, D. B., *Journal of Polymer Science*, JPSCA, Vol 28, 1958, p. 622). To illustrate the manner in which the maximum limit for the dielectric constant of a particular, grade is determined, assume that a Type I, Class A material is to be supplied under Grade E2, then its maximum limit for dielectric constant will be 2.28 + 0.01 = 2.29.
[F] Dissipation factor and dielectric constant must not exceed the limits specified above after immersion of the test specimens in water as described in 10.1.11. However, because this test is lengthy, it need not be performed on every lot of material. Rather, the material is to be checked initially for compliance with this requirement and, after that, as often as necessary to assure continued compliance. This requirement is not applicable to weather resistant (Class C and Class D) compounds (see Note 12).

8. Sampling

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

8.2 Unless otherwise agreed between the seller and the purchaser, the material shall be sampled in accordance with the procedure described in Practice D 1898. Adequate statistical sampling prior to packaging shall be considered an acceptable alternative.