Designation: D1248 – 16

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

This standard is issued under the fixed designation D1248; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

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. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

1.4 The following safety hazards caveat pertains only to the test method portion, 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—There is no known ISO equivalent to this standard.

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 D4976. For information regarding plastic pipe materials, see Specification D3350.

NOTE 3—See Guide D7209and 3.1.2 of this standard for information and definitions related to recycled plastics.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation

D257 Test Methods for DC Resistance or Conductance of Insulating Materials

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

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

D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

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 (Withdrawn 2012)[3]

D1603 Test Method for Carbon Black Content in Olefin Plastics

D1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics

D2565 Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications

D2633 Test Methods for Thermoplastic Insulations and Jackets for Wire and Cable

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

D2951 Test Method for Resistance of Types III and IV

[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] 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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

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

Polyethylene Plastics to Thermal Stress-Cracking (Withdrawn 2006)[3]
D3182 Practice for Rubber—Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets
D3349 Test Method for Absorption Coefficient of Ethylene Polymer Material Pigmented with Carbon Black
D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials
D3636 Practice for Sampling and Judging Quality of Solid Electrical Insulating Materials
D3892 Practice for Packaging/Packing of Plastics
D4329 Practice for Fluorescent Ultraviolet (UV) Lamp Apparatus Exposure of Plastics
D4703 Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets
D4976 Specification for Polyethylene Plastics Molding and Extrusion 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 (Withdrawn 2015)[3]
E1131 Test Method for Compositional Analysis by Thermogravimetry
G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources
G153 Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
G154 Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials
G155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

2.2 *Federal Specification:*[4]
L-P-390C Plastic, Molding, and Extrusion Materials, Polyethylene and Copolymers (Low, Medium, and High Density)

NOTE 4—In accordance with the DOD: "L-P-390C, dated 10 August 1971, is inactivated for new design and is no longer used, except for replacement purposes. Future acquisition for this product, when used in new design, should refer to ASTM D4976, 'STANDARD SPECIFICATION FOR POLYETHYLENE PLASTICS MOLDING AND EXTRUSION MATERIALS.'"

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.

3.1.2 *recycled plastics, n*—plastics feedstocks or products that include a percentage of post-consumer material, but not including those materials and by-products generated from, and commonly reused, within an original manufacturing process and, reworked, reprocessed, and regrind plastic and purge from the same manufacturing process.

[4] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://dodssp.daps.dla.mil.

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 (0, I, II, III, IV) = density ranges (same, respectively, as Class 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 (5, 1, 2, 3, 4) = density ranges (same, respectively, as Type 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 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 12.1.1, and the requirements prescribed in Table 1 and Note 5, Note 6, and Note 12.

NOTE 5—It is recognized that some high-density polyethylene plastics

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 12).

of very high molecular weight typically 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 6—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 12).

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.

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, with or without any antioxidants 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, with or without any antioxidants 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 7), dispersed by such means and to such degree as necessary to impart weather resistance with or without any antioxidants or other additives in such proportions as agreed upon between the seller and the purchaser.

NOTE 7—Carbon black 35 nm 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 antioxidants and UV stabilizers to allow electrical insulation and jackets to meet the requirements outlined in 12.1.12.

NOTE 8—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 9—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.

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

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

NOTE 11—The grade shall be associated with the appropriate type, class, and category designations; for example, IA5-E4 or IC5-J3 as required. Other grades are added as necessary by revision of this specification in established manner. Also, it is anticipated that additional requirements are to be added as necessary under a given grade designation by future revision to provide more meaningful characterization of the material covered by such designation.

4.1.4.2 If additional requirements specific to the application are necessary, these shall be specified by the purchaser with the agreement of the seller.

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 It is acceptable for further definition to be agreed upon between the seller and the purchaser as follows:

5.2.1 Nominal density.

NOTE 12—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 13.1).

TABLE 3 Detail Requirements for Molded Test Specimens

Property and Unit	Grade[A]									
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
Tensile stress, min:[B]										
MPa	8	10	10	12	12	17	17	19	19	22
(psi)	(1200)	(1500)	(1500)	(1800)	(1800)	(2400)	(2400)	(2800)	(2800)	(3200)
Elongation, min, %[B]	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,[C,D] min, f_{20} h	. . .	. . .	. . .	48	48	. . .	. . .	48	48	48
Thermal stress-crack resistance, h without cracking, min	. . .	. . .	. . .	. . .	. . .	. . .	. . .	96	96	168
Dissipation factor,[E] 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[E] max increase over nominal[F]:										
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	[G]	[G]	[G]	[G]	[G]	[G]	[G]	[G]	[G]	[G]

	E11	J1	J3	J4	J5
Tensile stress, min:[B]					
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,[C,D] min, f_{20} h	48	. . .	24	24	24
Thermal stress-crack resistance, h without cracking, min	168	. . .	. . .	. . .	. . .
Dissipation factor,[E] 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[E] max increase over nominal[F]:					
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	[G]	. . .	. . .	. . .	. . .

[A] The letters associated with these grades identify areas of potential applicability as indicated below:
E = Electrical Insulation (in some instances these materials also have the potential to serve as jacketing).
J = Jacketing (in some instances these materials also have the potential to serve as primary insulation).
[B] At break.
[C] f_{20} is the time required for failure of 20 % of the samples tested in accordance with Test Method D1693 as further directed by 12.1.6.1 – 12.1.6.4 of this specification.
[D] Requirements for environmental stress-crack resistance apply only to Class B, Class C, and Class D compounds unless otherwise specified (see 5.2.5).
[E] At any frequency from 1 kHz through 1 MHz (see also 12.1.8.1 – 12.1.8.3).
[F] 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.
[G] Dissipation factor and dielectric constant must not exceed the limits specified above after immersion of the test specimens in water as described in 12.1.9. 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).

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, the acceptable level of contamination shall be agreed upon between the seller and the purchaser.