Designation: D7436 – 17

Standard Classification System for Unfilled Polyethylene Plastics Molding and Extrusion Materials with a Fractional Melt Index Using ISO Protocol and Methodology[1]

This standard is issued under the fixed designation D7436; 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.

INTRODUCTION

This material specification is intended to provide a callout system for polyethylene utilizing specimen preparation procedures and test methods based primarily on ISO standards.

1. Scope*

1.1 This classification system provides for the identification of unfilled polyethylene plastics molding and extrusion materials, with a melt index of <1g/10 min, in such a manner that the supplier and the user 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 classification system to provide specific engineering data for design purposes.

1.2 This classification system allows for the use of recycled polyethylene materials provided that the requirements as stated in this classification system are met. The proportions of recycled material used, as well as the nature and amount of any contaminant, however, will not be covered in this specification.

NOTE 1—See Guide D7209 for information and definitions related to recycled plastics.

1.3 The properties included in this classification system are those required to identify the compositions covered. There may be other requirements necessary to identify particular characteristics important to specialized applications. These shall be agreed upon between the user and the supplier by using the suffixes given in Section 5.

1.4 This classification system and subsequent line callout (specifications) are intended to provide a means of calling out plastic materials used in the fabrication of end items or parts. It is not intended for the selection of materials. Material selection should be made by those having expertise in the plastic field after careful consideration of the design and the performance requirements of the part, the environment to which it will be exposed, the fabrication process to be employed, the costs involved, and the inherent properties of the material other than those covered by this classification system.

1.5 The values stated in SI units are regarded as the standard.

1.6 The following precautionary caveat pertains to the test method portion only, Section 12 of this classification system. *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.*

1.7 For information regarding plastic pipe materials, see Specification D3350. For information regarding wire and cable materials, see Specification D1248. For information regarding classification of PE molding and extrusion materials using ASTM test methods, see Specification D4976.

NOTE 2—There is no known ISO equivalent to this standard.

1.8 *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]

D883 Terminology Relating to Plastics

[1] This classification system 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 May 1, 2017. Published May 2017. Originally approved in 2012. Last previous edition approved in 2012 as D7436 - 12. DOI:10.1520/D7436-17.

[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.

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

D1248 Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
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
D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials
D3763 Test Method for High Speed Puncture Properties of Plastics Using Load and Displacement Sensors
D3892 Practice for Packaging/Packing of Plastics
D4000 Classification System for Specifying Plastic Materials
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
D6436 Guide for Reporting Properties for Plastics and Thermoplastic Elastomers
D7209 Guide for Waste Reduction, Resource Recovery, and Use of Recycled Polymeric Materials and Products (Withdrawn 2015)[3]
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.2 *ISO Standards:*

ISO 293 Plastics—Compression Molding of Test Specimens of Thermoplastic Materials
ISO 527-1 Plastics—Determination of Tensile Properties—Part 1: General Principles
ISO 527-2 Plastics—Determination of Tensile Properties—Part 2: Test Conditions for Moulding and Extrusion Plastics
ISO 1133 Plastics—Determination of the Melt Mass-Flow Rate (MFR) and Melt Volume-Flow Rate (MVR) of Thermoplastics
ISO 1183-2 Plastics—Methods for Determining the Density and Relative Density of Non-Cellular Plastics—Density Gradient Column Method
ISO 1872-2 Plastics—Polyethylene (PE) Moulding and Extrusion Materials—Part2: Preparation of Test Specimens and Determination of Properties
ISO 2818 Preparation of Test Specimens by Machining
ISO 3167 Dimensions of Test Specimens

2.3 *SAE Standards:*

SAE J2412 Accelerated Exposure of Automotive Interior Trim Components Using a Controlled Irradiance Xenon-Arc Apparatus
SAE J2527 Performance Based Standard for Accelerated Exposure of Automotive Exterior Materials Using a Controlled Irradiance Xenon-Arc Apparatus

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

3. Terminology

3.1 *Definitions*—For definitions of technical terms pertaining to plastics used in this specification, see Terminology D883 and Terminology D1600.

4. Classification

4.1 Unfilled 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). Material classification callouts used in this system and in Specification D4976 look similar but decode into dramatically different materials. In order to differentiate materials classified under this system from those classified under other systems, materials classified herein are preceded with the classification system D7436.

NOTE 3—An example of this classification system is as follows: The designation D7436 PE 232 would indicate PE, polyethylene as found in Terminology D1600, 2 (group) linear, 3 (class) high density, 2 (grade) >7 to ≤ 11 melt flow rate (190°C/21.6Kg).

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 Class 4 materials. Similarly, there are other polyethylene plastics of very high molecular weight having densities less than 0.941 that, in all other aspects, are more characteristic of Class 2 than of Class 3 materials.

NOTE 5—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-low range
Class 4 (>0.960) = high density-high range

4.1.1 Specific requirements for variations of polyethylene materials shall be indicated by a six-character designator. The designation will consist of the letter “A” and the five digits comprising the cell numbers for the property requirements in the order as they appear in Table A.

4.1.2 Although the values listed are necessary to include the range of properties available in the existing materials, users shall not assume that every combination of properties are attainable or exist.

4.1.3 When the cell designation is not known or is not required, the use of a “0” designation shall be used (see Note 6).

NOTE 6—An example of a high density polyethylene material of this classification system is as follows. The designation D7436 PE230A34350 would indicate the following material requirements from Table A:

PE230 = High Density Polyethylene, from Table PE of this standard,
A = Table A for property requirements,
3 = tensile strength, 12 MPa, min,
4 = tensile break elongation, 400 %, min,
3 = tensile modulus, 200 MPa, min,
5 = environmental stress-crack resistance, 336 F_{50} hours, min
0 = unspecified

If no properties are specified, the designation would be D7436 PE230A00000.

TABLE PE Basic Requirement of Polyethylene Plastics

Group	Description	Class	Description	Grade	Melt Flow Rate[A]	Melt Flow Rate[B]	Tensile Stress at Yield,[C] MPa, min	Nominal Strain at Break,[C] %, min	Tensile Modulus,[D] MPa, min
1	Branched	1	Low Density 0.910 ≤ 0.925	1	≤7	...			
				2	>7 ≤11	...			
				3	>11	...			
				4		0.1 ≤ 0.4	9.5	400	
				5		0.4 ≤ 1	9.5	300	
				0					
		2	Medium Density >0.925 ≤0.940	1	≤7	...			
				2	>7 ≤11	...			
				3	>11	...			
				4		0.1 ≤ 0.4	11	400	
				5		0.4 ≤ 1	11	200	
				0					
		0	other	0					
2	Linear	1	Low Density 0.910 ≤ 0.925	1	≤7	...			
				2	>7 ≤11	...			
				3	>11	...			
				4		0.1 ≤ 0.4	11	500	
				5		0.4 ≤ 1	11	400	200
				0					
		2	Medium Density >0.925 ≤ 0.940	1	≤7	...			
				2	>7 ≤ 11	...			
				3	>11	...			
				4		0.1 ≤ 0.4	16	400	600
				5		0.4 ≤ 1	16	200	500
				0					
		3	High Density >0.940 ≤0.960	1	≤7	...	19	550	700
				2	>7 ≤ 11	...	21	250	900
				3	>11	...	23		900
				4		0.1 ≤ 0.4	24	600	1000
				5		0.4 ≤ 1	25	400	1100
				0					
		4	High Density >0.960	1	≤7	...			
				2	>7 ≤ 11	...			
				3	>11	...			
				4		0.1 ≤ 0.4	28	400	
				5		0.4 ≤ 1	28	300	1200
				0					
		0	other	0					
00	Other	0	other	0					

[A] ISO 1133 melt flow rate = g/10 min at 190°C/21.6 Kg.
[B] ISO 1133 melt flow rate = g/10 min at 190°C/2.16 Kg.
[C] ISO 3167, Type 1B tensile bars, HDPE and MDPE tested at 50 mm/min. For densities ≤ 0.925 test at 500 mm/min.
[D] ISO 527-1 and ISO 527-2 at 1 mm/min strain rate, chord modulus between 0.05 % and 0.25 % strain.

TABLE A Detail Requirements[A] for Polyethylene Plastics

Designation or Order No.	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile stress at yield,[B] MPa ISO 527-1 and ISO 527-2, min	unspecified	4	8	12	16	21	30	35	...	specify value[C]
2	Nominal strain at break,[B] %, ISO 527-1 and ISO 527-2, min	unspecified	25	50	200	400	600	800	1000	...	specify value[C]
3	Tensile Modulus,[D] MPa, ISO 527-1 and ISO 527-2, min	unspecified	50	100	200	400	600	800	1000	...	specify value[C]
4[F]	Environmental stress-crack resistance, hrs, min F_{50},[E] Test Method D1693	unspecified	24	48	96	168	336	672	1008	...	specify value[C]
5	To be determined	unspecified									specify value[C]

[A] It is recognized that detailed test values may not predict nor even correlate with performance of parts molded of these materials.
[B] ISO 3167, Type 1B tensile bars, HDPE and MDPE tested at 50 mm/min. For densities <0.925 test at 500 mm/min.
[C] If a specific value is required, it must appear on the drawing or contract, or both.
[D] ISO 527-1 and ISO 527-2 at 1 mm/min strain rate, chord modulus between 0.05 % and 0.25 % strain.
[E] F_{50} is the time required for failure of 50 % of the samples tested in accordance with Test Method D1693 using undiluted Igepal CO-630. Mold samples in accordance with Procedure C of Practice D4703, Annex A1.
[F] There are environmental concerns regarding the disposal of Polyoxyethylated Nonylphenol (Nonylphenoxy poly(ethyleneoxy) ethanol (CAS 68412-54-4) e.g. 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.

5. Suffixes

5.1 When additional requirements are needed that are not covered by the basic or cell table requirements, they shall be indicated through the use of suffixes. The following suffixes may 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 W = Weatherability requirements, as designated by the following digits:

First Digit

0 = To be specified.
1 = Specimens exposed to xenon-arc type light source, in accordance with Practice D2565, Cycle 1. Specimens shall conform to ISO 3167 tensile bars.
2 = Specimens exposed to fluorescent-UV-condensation type apparatus, in accordance with Practice D4329, Cycle A. Specimens shall conform to ISO 3167 tensile bars.
3 = Specimens exposed to xenon-arc type light source in accordance to SAE J2412. (Typically used to represent the effects of exposure to window glass filtered solar radiation). Specimens shall conform to ISO 3167 tensile bars.
4 = Specimens exposed to xenon-arc type light source in accordance to SAE J2527. (Typically used to represent the effects of direct exposure to solar radiation). Specimens shall conform to ISO 3167 tensile bars.

Second Digit

1 = 601.6 kJ/m^2 @ 340 nm
2 = 1200 kJ/m^2 @ 340 nm
3 = 2500 kJ/m^2 @ 340 nm

5.1.1.1 The exposed specimens shall not exhibit surface changes (such as dulling or chalking) or deep-seated changes (such as checking, crazing or warping). The tensile stress at yield after exposure shall be no less than 50 % of the original.

5.1.2 P = Impact requirements, Total Energy in Joules at Maximum Load, as designated by the following digits:

First Digit

0 = To be specified by user.
1 = Instrumented impact test in accordance to Practice D3763, 100 mm diameter (or 100 mm by 100 mm plaque) by 3.2 mm thick. Test speed = 2.2 m/s. Conducted at 23°C.
2 = Instrumented impact test in accordance to Practice D3763, 100 mm diameter (or 100 mm by 100 mm plaque) by 3.2 mm thick. Test speed = 6.6 m/s. Conducted at 23°C.
3 = Instrumented impact test in accordance to Practice D3763, 100 mm diameter (or 100 mm by 100 mm plaque) by 3.2 mm thick. Test speed = 2.2 m/s. Conducted at -30°C.
4 = Instrumented impact test in accordance to Practice D3763, 100 mm diameter (or 100 mm by 100 mm plaque) by 3.2 mm thick. Test speed = 6.6 m/s. Conducted at -30°C.

Second Digit

0 = To be specified by user.
1 = 6 Joules, min
2 = 9 Joules, min
3 = 12 Joules, min
4 = 18 Joules, min
5 = 21 Joules, min
6 = 24 Joules, min
7 = 27 Joules, min

5.1.3 E = Environmental Stress-Crack Resistance, hours, as designated by the following digits:

First Digit

0 = To be specified by user
1 = ESCR in accordance to Test Method D1693 Undiluted surface active agent Igepal CO-630 and a graphical method time of F_{10}.
2 = ESCR in accordance to Test Method D1693 Undiluted surface active agent and a graphical method time of F_{50}.

Second Digit

0 = To be specified by user
1 = 24 hours, min
2 = 48 hours, min
3 = 96 hours, min
4 = 168 hours, min
5 = 336 hours, min
6 = 672 hours, min
7 = 1008 hours, min

5.1.4 Z = Other special requirements (for example, internal mold release agent) not covered by existing callout capabilities may be assigned by the user. These will be spelled out in detail and identified in sequence, that is, 01 UV-stabilized, 02 special color, and 03 etc.

5.2 A list of suffixes can also be found in Classification D4000 (Table 3) and used for additional requirements, as appropriate. Additional suffixes will be added to that classification system as test methods and requirements are developed and requested.

6. Basic Requirements

6.1 Basic requirements from property or cell tables, as they apply, are always in effect unless these requirements are superseded by specific suffix requirements, that always take precedence.

7. Physical Requirements

7.1 The color and form of the material shall be as agreed upon between the supplier and the user. Specification changes due to the effects of colorants shall be noted by both parties and, when necessary, covered by suffixes.

8. Other Requirements

8.1 Test specimens shall conform to the requirements prescribed in Tables PE and Table A and to suffix requirements as they apply.

8.2 Observed or calculated values obtained from analysis, measurement or test, shall be rounded in accordance with the rounding method in Practice E29 to the nearest unit in the last right-hand place of figures used in expressing the specified limiting value. The value obtained is compared directly with the specified limiting value. Conformance or nonconformance with the specification is based on this comparison. See Guide D6436 for reporting properties.

9. Sampling

9.1 Sampling shall be statistically adequate to satisfy the requirements of 13.4. A batch or lot of resin shall be considered as a unit of manufacture as prepared for shipment and may consist of a blend of two or more production runs of material.

10. Specimen Preparation

10.1 Unless otherwise specified, plaques shall be prepared in accordance with ISO 293 and ISO 1872-2. Test specimens shall be machined or die cut from the plaques in accordance with ISO 2818. If insufficient flow or inadequate adhesion between particles is observed, materials can be roll milled to ensure homogeneity in accordance with Practice D4703, Annex A1.4. If samples are prepared using roll-milling, it must be noted.

10.2 ESCR test specimens shall be prepared in accordance with Procedure C of Practice D4703.

10.3 The specimen thickness shall be 4.0 mm for modulus, tensile and strain testing, 3.2 mm for Condition “A” ESCR and impact testing, and 1.9 mm for Condition “B” ESCR testing. Conditioning shall be as specified in 11.1 and any departure from that conditioning shall be reported.

11. Conditioning

11.1 *Conditioning*—Once specimens are molded, they shall be moved to a standard laboratory atmosphere or a controlled laboratory atmosphere. For natural unfilled polyethylene plastics the controlled laboratory atmosphere shall be 23 ± 2°C. Test specimens shall be conditioned for a minimum of 40 h immediately prior to testing.

11.2 *Test Conditions*—Natural unfilled polyethylene plastics shall be tested in a controlled laboratory atmosphere of 23 ± 2°C.

12. Test Methods

12.1 Determine the properties enumerated in this specification in accordance with the ISO and ASTM test methods, unless otherwise stated in this specification.

12.1.1 *Melt Flow Rate*—Test Method in accordance with ISO 1133, using condition 190ºC/21.6 kg or 190ºC/2.16 kg as specified in Table PE, (see Note 7). Make duplicate determinations on the material in the form of powder, granules, or pellets. No conditioning is required.

NOTE 7—Since only condition 190°C/2.16 is truly considered “melt index,” the test in this standard will always be referred to as “Melt Flow Rate” as many of the material grades in this document require shear rate values that are higher than this to accurately differentiate.

12.1.2 *Density*—Test Method ISO 1183-2. Sample shall be a chip from a molded specimen. The use of an alternative method of suitable accuracy is permitted.

12.1.3 *Tensile Stress at Yield, Nominal Strain at Break*—Test Method ISO 527-1 and ISO 527-2 at a speed of 50 or 500 mm/min as specified in Table PE. Specimens shall conform to the dimensions given for Type 1B in ISO 527 with thickness of 4.0 ± 0.2 mm. Die-cut specimens are recommended; however, machine-cut specimens are acceptable. Percentage elongation at break shall include the cold-drawing distance. Test results for specimens that break outside the gage marks after extensive cold drawing need not be discarded, unless the break occurs between the contact surfaces of a grip.

12.1.4 *Tensile Modulus*—Test Methods ISO 527-1 and ISO 527-2. Use test speed of 1 mm/min strain rate and report the chord modulus between 0.05 % and 0.25 % strain.

12.1.5 *Environmental Stress-Crack Resistance*—Test Method D1693. The material shall meet the minimum requirement shown for the appropriate cell classification (in Cell Table A) when tested in accordance with Test Method D1693. Polyethylene materials with densities less than or equal to 0.925 shall be tested in accordance with Test Method D1693, Condition A. Polyethylenes with densities greater than 0.925 shall be tested in accordance to Test Method D1693, Condition B.

NOTE 8—The specimen dimensions and notch depths are different for these two conditions. An undiluted surface active agent is used for all testing. An F_{10} or F_{50} time determined in accordance with the graphical method described in Test Method D1693 shall be reported.

13. Inspection and Certification

13.1 Inspection and certification of the material supplied under this specification shall be for conformance to the requirements specified herein.

13.2 Lot-acceptance inspection shall be the basis on which acceptance or rejection of the lot is made. The lot-acceptance tests shall consist of density and melt flow rate, which are the tests typically monitored to ensure process control during manufacturing. Other certifiable classification properties, including tensile stress at yield, nominal strain at break, tensile modulus, and environmental stress-crack resistance, are not

considered lot acceptance criteria and shall be judged based on the history of multiple testing on multiple lots.

13.3 Periodic check inspection shall consist of the tests specified for all requirements of the material under this specification that are not considered lot-acceptance tests. Inspection frequency shall be adequate to ensure that the material is certifiable in accordance with 13.4.

13.4 Certification shall be that the material was manufactured, sampled, tested, and inspected in accordance with this classification system and that the average values for the lot meet the requirements of this specification or line callout.

13.5 A report of the test results shall be furnished when requested. The report shall consist of results of the lot-acceptance inspection for the shipment and results of the most recent periodic-check inspection.

14. Rejection

14.1 Material that fails to conform to the requirements of this specification shall not be certified and is subject to rejection.

15. Packaging, Packing, and Marking

15.1 The provisions of Practice D3892 shall apply for packing, packaging and package marking.

16. Keywords

16.1 classification; classification system; line callout; molding and extrusion materials; polyethylene (PE)

SUPPLEMENTARY REQUIREMENTS

The following supplementary items may become part of this specification, when applicable, as agreed upon between the user and the supplier.

S1. Approval

S1.1 Material submitted by a new supplier must be approved by the user. Material or test specimens submitted by the supplier and intended for evaluation shall be accompanied by the supplier's laboratory test report.

S1.2 *New Sources*—The user may elect to temporarily accept shipment on the supplier's certification.

S2. Infrared Spectrophotometry or Thermal Analysis, or Both

S2.1 At the option of the user, infrared or thermal analysis or both may be conducted on material/parts supplied to this specification. The curves established for initial approval shall constitute the reference standard and shall be kept on file at the user's laboratory. All samples shall produce curves that correspond to the reference standard within agreed upon tolerances when tested under the same conditions as those specified on the master set of curves.

S2.2 In the event such tests are to be designated as requirements to be tested by the supplier, this must appear on the part drawing or purchase contract, or both.

SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue (D7436 - 12) that may impact the use of this standard. (May 1, 2017)

(1) Revised Table PE (Group 2, Class 3).