



Standard Classification System for Poly (Phenylene Sulfide) Injection Molding and Extrusion Materials Using ISO Methods¹

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1. Scope *

1.1 This classification system covers unfilled, reinforced and filled materials suitable for injection molding and extrusion using ISO methods. The system allows for the use of poly(phenylene sulfide) (PPS) plastic materials that are recycled, reconstituted recycled-regrind, recovered or reprocessed, or both, provided that the requirements as stated in this specification are met. It is the responsibility of the supplier and the buyer of recycled, reconstituted, recycled-regrind, recovered or reprocessed, or both, poly(phenylene sulfide) plastic materials to ensure compliance (see Guide D 5033).

1.2 The properties included in this classification are those required to identify the compositions covered. There may be other requirements necessary to identify particular characteristics important to specialized applications that may be specified by using the suffixes as given in Section 5.

1.3 This classification system and subsequent line callout (specification) 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 required 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.

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

NOTE 1—There is not equivalent ISO standard for PPS.

NOTE 2—The last prior ASTM standard is Specification D 4067, which uses ASTM test methods.

¹ This classification system is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials (Section D20.15.17).

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2. Referenced Documents

2.1 ASTM Standards:

- D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing²
- D 883 Terminology Relating to Plastics²
- D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer²
- D 1600 Terminology for Abbreviated Terms Relating to Plastics²
- D 1999 Guide for Selection of Specimens and Test Parameters for International Commerce²
- D 3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials³
- D 3835 Test Method for Determination of Properties of Polymeric Materials by Means of a Capillary Rheometer³
- D 3892 Practice for Packaging/Packing of Plastics³
- D 4000 Classification System for Specifying Plastic Materials³
- D 4067 Specification for Reinforced and Filled Polyphenylene Sulfide Injection Molding and Extrusion Materials³
- D 5033 Guide for the Development of Standards Relating to the Proper Use of Recycled Plastics⁴
- D 5630 Test Method for Ash Content in Thermoplastics⁴
- D 5937 Test Method for Determination of Tensile Properties and Test Conditions for Moulding and Extrusion Plastics⁴
- D 5938 Test Method for Determination of Tensile Properties—General Principles⁴
- D 5939 Practice for Preparing Multipurpose Test Specimens and Bars of Thermoplastics by Injection Moulding⁴
- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications⁵

2.2 IEC and ISO Standards:

² Annual Book of ASTM Standards, Vol 08.01.

³ Annual Book of ASTM Standards, Vol 08.02.

⁴ Annual Book of ASTM Standards, Vol 08.03.

⁵ Annual Book of ASTM Standards, Vol 14.02.

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

IEC 60112 Recommended Methods for Determining the Comparative Tracking Index of Solid Insulation Materials⁶

IEC 60243 Recommended Methods for Electric Strength of Solid Insulating Materials at Power Frequencies⁶

ISO 62 Plastics—Determination of Water Absorption⁶

ISO 75/C Plastics—Determination of Temperature of Deflection Under Load⁶

ISO 178 Plastics—Determination of Flexural Properties of Rigid Plastics⁶

ISO 180/1A Plastics—Determination of Izod Impact Strength of Rigid Materials⁶

ISO 294-1 Plastics—Injection Moulding Test Specimens of Thermoplastic Materials⁶

ISO 527 Plastics—Determination of Tensile Properties⁶

ISO 604 Plastics—Determination of Compressive Properties⁷

ISO 1133 Plastics—Determination of the Melt Mass-Flow Rate (MFR) and the Melt Volume-Flow Rate (MVR) of Thermoplastics⁶

ISO 1183 Plastics—Methods for Determining the Density and Relative Density of Noncellular Plastics⁶

2.3 *UL Standards:*⁸

UL 94 Test for Flammability of Plastic Materials for Parts in Devices and Appliances

2.4 *NTIS Standards:*⁹

AD297457 Procedures and Analytical Method for Determining Toxic Gases Produced by Synthetic Compounds

2.5 *Military Standards:*¹⁰

MIL-M-24519

MIL-P-46174

3. Terminology

3.1 *Definitions*—The terminology used in this classification system is in accordance with Terminologies D 883 and D 1600.

4. Classification

4.1 Poly(phenylene sulfide) materials are classified according to their composition. These classes are subdivided into grades as shown in the Basic Property Table (Table PPS).

NOTE 3—An example of this classification system for fiberglass reinforced poly(phenylene sulfide) is given as follows: The designation PPS011G40 indicates the following:

PPS	=	poly(phenylene sulfide) as found in Terminology D 1600.
01	=	general purpose (group),
1	=	glass reinforced (class), and
G40	=	nominal 40 % glass with the requirements given in Table PPS (grade).

4.1.1 To facilitate incorporation of future or special materials the “other” category for group (00), class (0), and grade (0)

is shown in Table PPS. The basic properties of these materials can be obtained from Table A as they apply.

4.2 Reinforced, filled, and unfilled versions of poly(phenylene sulfide) materials that are not in Table PPS are classified in accordance with Tables PPS, A, and B. Table PPS is first used to specify the groups and class of poly(phenylene sulfide). Table A then is used to specify the property requirements after the addition or reinforcements, pigments, fillers, or lubricants at the nominal level indicated (see 4.2.1) or Table B is used to specify the property requirements of unfilled/unreinforced versions of poly(phenylene sulfide).

4.2.1 Reinforced versions of the basic materials are identified by a single letter that indicates the reinforcement used and two digits that indicate the nominal quantity in percent by weight; thus, a letter designation G for glass-reinforced and 30 for percent of reinforcement, G30, specifies a filled material with a nominal glass level of 30 %. The reinforcement letter designations and associated tolerance levels are shown as follows:

Symbol	Material	Tolerance (Based on Total Mass)
C	carbon and graphite fiber reinforced	±2 percentage points
G	glass-reinforced	±3 percentage points
L	lubricants (such as PTFE, graphite, silicone)	depends upon material and process. to be specified by supplier/user agreement.
M	mineral-reinforced	±3 percentage points
R	combinations of reinforcements or fillers, or both	±3 percentage points

NOTE 4—This part of the classification system uses the percent of reinforcements or additives, or both, in the callout of the modified basic material. The types and percentages of reinforcements and additives should be shown on the supplier’s technical data sheet unless they are proprietary in nature. If necessary, additional callout of these reinforcements and additives can be accompanied by use of the suffix part of the system (see Section 5).

4.2.2 Specific requirements for reinforced, filled, or lubricated poly(phenylene sulfide) materials shall be shown by a six-character designation. The designation will consist of the letter “A” and the five digits comprising the cell number for the property requirements in the order as they appear in Table A.

4.2.2.1 Although the values listed are necessary to include the range of properties available in existing materials, users should not infer that every possible combination of the properties exists or can be obtained.

4.2.3 When the grade of the basic material is not known, or is not important, the use of the “0” grade classification shall be used for the reinforced materials in this system.

NOTE 5—An example of this classification for a reinforced PPS material is given as follows. The designation PPS0110G20A31042 would indicate the following material requirements:

PPS0110	=	Glass reinforced poly(phenylene sulfide), from Table PPS,
G20	=	Glass reinforced at 20 % nominal,
A	=	Table A property requirements,
3	=	110 mPa tensile strength, min,
1	=	6000 mPa flexural modulus, min,
0	=	Unspecified Izod strength,
4	=	160 mPa flexural strength, min, and
2	=	1.5 × 10 ³ kg/m ³ density, min.

If no properties are specified, the designation would be PPS010G20A00000.

NOTE 6—An example of this classification for a unfilled/unreinforced PPS material is given as follows. The designation PPS000B32030 would

⁶ ISO and IEC Selected Standards for the Plastics Industry, ASTM, PCN29-420096-19.

⁷ Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

⁸ Available from Underwriters Laboratories, 333 Pfingsten Rd., Northbrook, IL 60062-2096.

⁹ Available from NTIS, 5285 Port Royal Rd., Springfield, VA 22161.

¹⁰ Available from Standardization Documents Order Desk, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

indicate the following material requirements:

PPS000	= unfilled/unreinforced poly(phenylene sulfide), from Table PPS,
B	= Table B property requirements,
3	= 60 mPa flexural modulus, min,
2	= 2000 mPa flexural modulus, min,
0	= unspecified Izod strength,
3	= 80 mPa flexural strength min, and
0	= unspecified.

If no properties are specified, the designation would be PPS0000B00000.

5. Suffixes

5.1 When additional requirements are needed that are not covered by the basic requirements or cell-table requirements, they shall be indicated through the use of suffixes.

5.2 A list of suffixes can be found in Classification System D 4000 (Table 3) and may be used for additional requirements as appropriate. Additional suffixes will be added to that standard as test methods and requirements are developed and requested.

6. General Requirements

6.1 Basic requirements from the property tables or cell tables are always in effect unless superseded by specific suffix requirements, which always take precedence.

6.2 The plastics composition shall be uniform and shall conform to the requirements specified herein.

7. Detail Requirements

7.1 The materials shall conform to the requirements in Table PPS, A, and B, and suffix requirements as they apply.

7.2 For purposes of determining conformance, all specified limits for a specification (line callout) based on this classification system are absolute limits, as defined in Practice E 29. With the absolute method, an observed value or a calculated value is not rounded, but is to be compared directly with the limiting value. Conformance or nonconformance is based on this comparison.

8. Sampling

8.1 Sampling shall be adequate statistically to satisfy the requirements of 12.4.

8.2 A batch or lot shall be constituted as a unit of manufacture as prepared for shipment and may consist of a blend of two or more "production runs."

9. Specimen Preparation

9.1 The test specimens shall be prepared by an injection molding process as specified in ISO 294-1 and Practice D 3641. Accurate, reproducible settings of the processing parameters are essential to obtain specimens with comparable properties. Processing conditions are:

Drying	2 h at 135°C
Plastic melt temperature	320°C
Mold temperature	140°C

Average injection velocity

275 ± 75 mm/s

10. Conditioning

10.1 Test specimens shall be conditioned for a minimum of 4 h at 23 ± 2°C and 50 ± 5 % relative humidity before performing the required tests.

10.2 Conduct those tests influenced by ambient conditions in the standard laboratory atmosphere of 23 ± 2°C and 50 ± 5 % relative humidity in accordance with Practice D 618 (4/23/50).

11. Test Methods

11.1 Determine the properties enumerated in this classification system in accordance with the test methods in 2.1.

11.1.1 The number of tests shall be consistent with the requirements of Sections 8 and 12.4.

12. Inspection and Certification

12.1 Inspection and certification of the material supplied with reference to a specification based on this classification system shall be for conformance to the requirements specified herein.

12.2 Lot-acceptance inspection shall be the basis on which acceptance or rejection of the lot is made. The lot-acceptance inspection shall consist of apparent shear viscosity (Test Method D 3835) or flow rate (Test Method D 1238); reinforcement or filler content (reinforced and filled products only) (Test Method D 5630); and, tensile strength (reinforced and filled products only) (Test Method D 5937).

12.3 Periodic check inspection with reference to a specification based upon this classification system shall consist of the tests for all requirements of the material under the specification. Inspection frequency shall be adequate to ensure the material is certifiable in accordance with 12.4.

12.4 Certification shall be that the material was manufactured by a process in statistical control; sampled, tested, and inspected in accordance with this classification system; and that the average values for the lot meet the requirements of the specification (line callout).

12.5 A report to test results shall be furnished when requested. The report shall consist of results of the lot-acceptance inspection for the shipment and may include the results of the most recent periodic-check inspection. If requested, the report shall include that recycled, reconstituted, recycled-regrind, recovered or reprocessed, or both, poly(phenylene sulfide) plastic was used and the nominal weight percent.

13. Packaging, Packing, and Marking

13.1 The provisions of Practice D 3892 apply to packaging, packing, and marking of containers for plastic materials.

14. Keywords

14.1 line callout; plastic materials; poly(phenylene sulfide); recycled

TABLE PPS Requirements for Poly(Phenylene Sulfide) Materials^A

Group	Description	Class	Description	Grade	Description	Tensile Strength, ISO 527, ^B MPa, min	Flexural Modulus, ISO 178, ^C MPa, min	Notched Izod, ISO 180/1A, ^D kJ/m ² , min	Flexural Strength, ISO 178, ^C MPa, min	Density, ISO 1183, kJ/m ³ × 10 ³
01	General purpose	1	glass reinforced	G40	40 %	105	11 500	5.0	180	1.6 to 1.7
				0	other					
		2	combinations of fillers and reinforcements	R53	53 %	120	13 500	3.0	210	1.5 to 1.8
				R60	60 %	100	13 000	3.5	170	1.5 to 2.2
				R66	66 %	85	14 500	3.0	165	1.5 to 2.2
				0	other					
0	Other	0	other	0	other					

^AIt is recognized that detailed test values, particularly Izod impact, may not predict nor even correlate with performance of parts molded or these materials.

^BTensile strength shall be determined using a Type IA tensile specimens, as described in ISO 527. Crosshead speed shall be 5 mm/min ± 10 % for unreinforced and 5 mm/min ± 25 % for filled and reinforced.

^CIzod impact shall be determined on Test Method ISO 180 test specimens 80 ± 2 mm by 10 ± 0.2 by 4 ± 0.2 mm (Method A).

^DFlexural modulus and strength shall be determined on Test Method ISO 178 test specimen 80 ± 2 mm by 10 ± 0.2 mm by 4 ± 0.2 mm (Method A).

TABLE A Detail Requirements for Reinforced Poly(Phenylene Sulfide)^A

Designation Order Number	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile Strength, min, mPa ISO 527 ^C	unspecified	60	90	110	130	150	170	190	220	specify value ^B
2	Flexural Modulus, min, mPa ISO 178 ^D	unspecified	6 000	9 000	12 000	15 000	18 000	21 000	24 000	27 000	specify value ^B
3	Izod Impact, min, kJ/m ² ISO 180/1A ^E	unspecified	2.0	3.5	5.0	6.5	8.0	9.5	11.0	12.5	specify value ^B
4	Flexural Strength, min, mPa ISO 178 ^D	unspecified	80	100	130	160	190	220	250	280	specify value ^B
5	Density, kg/m ³ × 10 ⁻³ ISO 1183	unspecified	1.3	1.5	1.6	1.7	1.8	1.9	2.1	2.3	specify value ^B

^AIt is recognized that detailed test values, particularly Izod Impact, may not predict nor even correlate with performance of parts molded of these materials.

^BIf specific value is required, it must appear on the drawing or contract, or both.

^CTensile strength shall be determined using a Type 1A tensile specimen, as described in ISO 527. Crosshead speed shall be 5 mm/min ± 25 %.

^DFlexural modulus and strength shall be determined on Test Method ISO 178 test specimen 80 ± 2 mm by 10 ± 0.2 mm (Method A).

^EIzod shall be determined on Test Method ISO 180/1A test specimen 80 ± 2 mm by 10 ± 0.2 by 4 ± 0.2 mm (Method A).

TABLE B Detail Requirements for Unfilled/Unreinforced Poly(Phenylene Sulfide)^A

Order Number	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile Strength, min, mPa ISO 527 ^C	unspecified	20	40	60	80	100	...	...	...	specify value ^B
2	Flexural Modulus, min, mPa ISO 178 ^D	unspecified	1000	2000	3000	4000	5000	...	...	...	specify value ^B
3	Izod Impact, min, kJ/m ² ISO 180/1A ^E	unspecified	1	3	5	7	9	...	...	...	specify value ^B
4	Flexural Strength, min, mPa ISO 178 ^D	unspecified	40	60	80	100	120	...	...	...	specify value ^B
5	Unspecified										

^AIt is recognized that detailed test values, particularly Izod impact, may not predict nor even correlate with performance of parts molded of these materials.

^BIf specific value is required, it must appear on the drawing or contract, or both.

^CTensile strength shall be determined using a Type 1A tensile specimen, as described in ISO 527. Crosshead speed shall be 50 mm/min \pm 10 %.

^DFlexural modulus and strength shall be determined on Test Method ISO 178 test specimen 80 \pm 2 mm by 10 \pm 0.2 mm by 4 \pm 0.2 mm (Method A).

^EIzod impact shall be determined on Test Method ISO 180/1A test specimen 80 \pm 2 mm by 10 \pm 0.2 by 4 \pm 0.2 mm (Method A).

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified by the inquiry, contract or order, or agencies of the United States Government.

S1. Special End Uses

S1.1 Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all testing and inspections. Except as otherwise noted, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government may reserve the right to perform any of the testing or inspections set forth in the specification requirements. This testing assures qualifications on a one time basis unless the manufacture makes a significant change in formulation, raw material or process.

S2. Physical Requirements

S2.1 The physical and electrical property requirements for initial material qualification are given in Table S2.1 and the test methods in Table S2.2. Unless otherwise stated, the values are minimum requirements.

S3. Quality Assurance

S3.1 *Acceptable Criteria*—Failure to confirm to requirements in Table S2.1 shall result in rejection of the material.

TABLE S2.1 Property Values for Initial Physical and Electrical Qualification Testing

Property	Units	Type GST-40F
Flammability	...	V-0
Water Absorption	%, max	0.08
Compressive strength	MPa	138
Dielectric strength		
Short time test 1	kV/mm	12.6
Short time test 2	kV/mm	11.8
Tracking index	V	150

S3.2 *Sample Size*—The minimum number of test specimens to be tested shall be as specified in Table S2.2.

S3.3 *Test Method*—Testing shall be in accordance with the methods specified in Table S2.2.

S3.4 *Conditioning*—Standard test specimens shall be conditioned before testing as specified in Table S2.2 and described in Section S4.

S4. Conditioning

S4.1 *Nomenclature:*

S4.1.1 *Condition A*—As-received.

S4.1.2 *Condition C*—Humidity conditioning.

S4.1.3 *Condition D*—Immersion conditioning in distilled water.

S4.1.4 *Condition E*—Temperature conditioning.

S4.1.5 *Condition des*—Desiccation condition, cooling over silica gel or calcium chloride in a desiccator at 23°C for 16 to 20 h after temperature conditioning.

S4.2 *Designation*—Conditioning procedures shall be designated as follows:

S4.2.1 A capital letter indicating the general conditioning,

S4.2.2 A number indicating the duration of conditioning, h,

S4.2.3 A number indicating the conditioning temperature, °C, and

S4.2.4 A number indicating the relative humidity when it is controlled.

S4.3 *Tolerances:*

S4.3.1 *Relative Humidity*—Standard tolerance shall be \pm 5 %.

S4.3.2 *Temperature*—Standard tolerance shall be \pm 2°C. For water immersion the standard tolerance shall be \pm 1°C.

TABLE S2.2 Sampling and Conditioning for Initial Qualification Testing

Property to be Tested	Test Method	Test Method Modified Per	Specimens	Number Tested	Conditioning	Units
Flammability	UL 94	...	125 × 13 mm × thickness	10	per UL 94	per UL 94
Compressive strength	ISO 604	...	25 × 10 × 4 mm	5	E-48/50+C-96/23/50	Percent (max. average)
Water absorption	ISO 62	...	50 mm disk, 3mm thick	3	E-24/100+des+D-48/50	Percent (max. average)
Dielectric strength:	IEC 60243	S5.1	60 × 60 × 2mm	3	E-48/50+C-96/23/50	kV/mm
Short-time test			plaque	3	E-48/50+C-96/23/50	(min average)
Short-time test					E-48/50+D-48/50	
Tracking index	IEC 60112	...	80 × 10 × 4mm	4	A	V

NOTE S4.1—The numbers shall be separated from each other by slant (/) marks, and from the capital letter by a dash (-). A sequence of conditions shall be denoted by use of a plus (+) sign between successive conditions.

Examples: C-96/23/50 Humidity condition; 96 h at 23°C and 50 % RH.
 D-48/50 Immersion condition; 48 h at 50°C.
 E-48/50 Temperature condition; 48 h at 50°C.

S5. Test Method Modification

S5.1 Dielectric Strength:

S5.1.1 The test shall be performed under oil at a frequency not exceeding 100 Hz at the temperature of the final conditioning.

S5.1.2 *Short-Time Test*—The voltage shall be increased uniformly at the rate of 500 V/s.

S6. Toxicity Requirements

S6.1 Thermoplastic molding compounds shall be tested for toxicity in accordance with NTIS AD297457. Specimens shall meet the requirements in Table S6.1, expressed as the maximum level permissible.

TABLE S6.1 Toxicity When Heated

Compounds	Units	Type GST-40F
Carbon Dioxide	ppm	1500
Carbon Monoxide	ppm	200
Ammonia	ppm	100
Aldehydes as HCNO	ppm	20
Cyanide as HCN	ppm	0
Oxides of Nitrogen as NO ₂	ppm	25
Hydrogen Chloride	ppm	0

APPENDIX

(Nonmandatory Information)

X1. CROSS REFERENCE FROM MIL-P-46174 (MR) AND MIL-M-24519 TO CLASSIFICATION D 4000 AND D 6358

X1.1 This specification contains pertinent specification items from MIL-P-46174 (MR) and MIL-M-24519, for plastic molding material, poly(phenylene sulfide), glass reinforced.

X1.2 These military specifications are based on prior Specification D 4067 test protocols and not on the test protocols in this classification system. The following cross-reference designations are believed to accurately provide comparable callout information relative to the intent of the designated military specifications; however, it is recommended that someone knowledgeable in the requirements of the military specifications review this information before use.

X1.3 Should additional property requirements need to be specified, appropriate suffixes are to be used as needed.

ASTM D 6358 PPS011G40A33443	MIL-M-24519 GST-40F
ASTM D 6358 PPS0110G15A21221 PPS0110G15A21221 EA117ED041EE020 PPS0110G30A32332 PPS0110G30A32332 EA117ED041EE020 PPS0110G40A33443 PPS0110G40A33443 EA117ED041EE020 PPS0110G50A44454 PPS0110G50A44454 EA117ED041EE020	MIL-P-466174(MR) CLASS 15 GRADE A CLASS 15 GRADE E CLASS 30 GRADE A CLASS 30 GRADE E CLASS 40 GRADE A CLASS 40 GRADE E CLASS 50 GRADE A CLASS 50 GRADE E

SUMMARY OF CHANGES

This section identifies the location of selected changes to this classification. For the convenience of the user, Committee D-20 has highlighted those changes that may impact the use of this classification. This section may include descriptions of the changes or the reasons for the changes, or both.

D 6358-99:

(1) In 2.2, added references to IEC 60112, IEC 60243, ISO 62, and ISO 604. Added 2.3 and 2.4 and renumbered subsequent section.

(2) In X1.3, changed “PPS011G40E01EA124” to “PPS011G40A33443.”

(3) Added Supplementary Requirements S1 through S6.

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