



Standard Classification System for Polyetherimide (PEI) Materials¹

This standard is issued under the fixed designation D 5205; 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 classification system covers unfilled, filled, and reinforced polyetherimide materials suitable for injection molding and extrusion.

1.2 This classification system is not intended for the selection of materials, but only as a means to call out plastic materials to be used for the manufacture of parts. The selection of these materials is to be made by personnel with expertise in the plastics field where the environment, inherent properties of the materials, performance of the parts, part design, manufacturing process, and economics are considered.

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 specific applications. These may be specified by using suffixes as described in Section 5.

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

1.5 The following precautionary caveat pertains only to the test methods portion, 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.* Specific precautionary statements are given in Note 4.

2. Referenced Documents

2.1 ASTM Standards:

D 149 Test Methods for Dielectric Breakdown Voltage and Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies²

D 150 Test Methods for A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation²

D 257 Test Methods for D-C Resistance or Conductance of Insulating Materials²

D 618 Practice for Conditioning Plastics for Testing³

D 638 Test Method for Tensile Properties of Plastics³

D 648 Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position³

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials³

D 792 Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement³

D 883 Terminology Relating to Plastics³

D 1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer³

D 1600 Terminology for Abbreviated Terms Relating to Plastics³

D 1897 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials⁴

D 2584 Test Method for Ignition Loss of Cured Reinforced Resins⁵

D 2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)⁵

D 3892 Practice for Packaging/Packing of Plastics⁵

D 4000 Classification System for Specifying Plastic Materials⁵

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications⁶

E 662 Test Method for Specific Optical Density of Smoke Generated by Solid Materials⁷

2.2 Military Standards:⁸

MIL-P-46184 Plastic Molding and Extrusion Materials, Polyetherimide (PEI).

MIL-M-24519 Molding Plastics, Electrical, Thermoplastic

2.3 Underwriters Laboratories Standards:⁹

UL 94 Tests for Flammability of Plastic Materials for Parts

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 August 10, 2003. Published October 2003. Originally approved in 1991. Last previous edition approved in 1996 as D 5205 – 96.

² Annual Book of ASTM Standards, Vol 10.01.

³ Annual Book of ASTM Standards, Vol 08.01.

⁴ Discontinued—See 1991 Annual Book of ASTM Standards, Vol 08.02.

⁵ Annual Book of ASTM Standards, Vol 08.02.

⁶ Annual Book of ASTM Standards, Vol 14.02.

⁷ Annual Book of ASTM Standards, Vol 04.07.

⁸ Available from Standardization Documents Order Desk, Bldg. 4 Section D, Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

⁹ Available from Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60066.

in Devices and Appliances

3. Terminology

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

3.2 *Abbreviations: Abbreviation*—The polyetherimide materials will be designated “PEI” as specified in Terminology D 1600.

4. Classification

4.1 Unfilled polyetherimide materials are classified into groups according to their composition. These groups are subdivided into classes and grades as shown in Table PEI.

NOTE 1—An example of this classification system is given as follows. The designation PEI 0114 indicates the following:

- PEI = polyetherimide as found in Terminology D 1600,
- 01 = polyetherimide (group),
- 1 = general purpose (class), and
- 4 = requirements given in Table PEI (grade).

4.1.1 To facilitate incorporation of future or special materials the “other” category (0) for group, class, and grade is shown in Table PEI. The basic properties of these materials can be obtained from Tables A or B as they apply.

4.2 Reinforced, pigmented, filled, and lubricated versions of polyetherimide materials are classified in accordance with Tables PEI and A or B. Table PEI is used to specify the unreinforced material and Table A or B is used to specify the property requirements after the addition of reinforcements, pigments, fillers, or lubricants at the nominal level indicated (see 4.2.1).

4.2.1 A single letter shall be used to indicate the major category of the reinforcement, along with two numbers that indicate the percentage of additive(s) by mass, with the tolerances as tabulated as follows:

Category	Material	Tolerance (Based on the Total Mass)
C	Carbon and graphite fiber-reinforced	±2 percentage points
G	Glass-reinforced	
	< 15 % glass content	±2 percentage points
	> 15 % glass content	±3 percentage points
L	Lubricants (such as PTFE, graphite, silicone, and molybdenum disulfide)	Variable. To be specified by user.
M	Mineral-reinforced	±2 percentage points
R	Reinforced-combination/mixtures of reinforcements or other fillers/reinforcements	±3 percentage points based on the total reinforcement

NOTE 2—If necessary, additional requirements may be specified using suffixes as described in Section 5. Special agreements on tolerances may be required when levels are below 5 %. Ash content of filled or reinforced materials may be determined using Test Method D 2584 where applicable.

4.2.2 Specific requirements for reinforced, filled, or lubricated polyetherimide materials shall be shown by a six-character designation. The designation will consist of the letter “A” or “B” and the five digits comprising the cell numbers for the property requirements in the order as they appear in Tables PEI or 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 materials is not shown, or is not important, the use of “O”-grade classification shall be used for reinforced materials in this system.

NOTE 3—An example of this classification for a polyetherimide material is given as follows. The designation PEI0110G10A48266 would indicate the following material requirements:

- PEI 0110 = general-purpose polyetherimide from Table PEI,
- G10 = glass reinforced at nominal 10 % level,
- A = Table A property requirements,
- 4 = 110-MPa tensile strength, min,
- 8 = 13790-MPa flexural modulus, min,
- 2 = 4 g/10 min; melt flow, min,
- 6 = 205-MPa flexural strength, min, and
- 6 = 230°C deflection temperature, min.

If no properties are specified, the designation would be PEI0110G10A00000.

5. Suffixes

5.1 When requirements not covered by the basic cell tables need to be specified, suffixes shall be used. The following suffixes shall be used when appropriate. Additional suffixes may also be defined according to Classification System D 4000 when needed.

5.1.1 *E* = Electrical requirements as designated by the following digits:

- First Digit
- 0 = specimen to be specified by user
- 1 = specimens as appropriate for test methods as defined in Table 1
- Second Digit
- 0 = to be specified by user
- 1 = meets requirements of Table 1, Column A
- 2 = meets requirements of Table 1, Column B
- 3 = meets requirements of Table 1, Column C
- 4 = meets requirements of Table 1, Column D
- 5 = meets requirements of Table 1, Column E

5.1.2 *F* = Flammability requirements as designated by the following digits:

NOTE 4—**Precaution:** By publication of this classification system and its use of flammability ratings, ASTM does not intend that their use in any way reflects hazards presented under actual fire conditions.

- First Digit
- 0 = to be specified by user,
- 1 = product is tested according to UL94 at 3.05-mm minimum thickness,
- 2 = product is tested according to UL94 at 1.47-mm minimum thickness,
- 3 = product is tested according to UL94 at 0.71-mm minimum thickness,
- 4 = product is tested according to Test Method D 2863,
- 5 = product is tested according to Test Method E 662.
- Second Digit
- 0 = To be specified by user
- 1 = 94V-0 flammability class
- 2 = 94V-1 flammability class
- 3 = 94V-2 flammability class
- 4 = 94-5V flammability class
- 5 = Oxygen index 44 % minimum
- 6 = Specific optical density, flaming mode, D4 ≤ 2, D max ≤ 50.

6. General Requirements

6.1 The plastic compositions shall be uniform and shall conform to the requirements specified herein.

TABLE PEI Polyetherimide Materials Detail Requirements

NOTE 1—The values listed were developed for “natural colors.” Pigments or other additives, or both, may alter these properties.

Group	Description	Class	Description ^A	Grade	Description	Flow-Rate, ^B Test Method D 1238, g/10, min	Specific Gravity, Test Method D 792	Deflection ^A Temperature (DTUL), min, Test Method D 648, °C, min	Tensile ^B Strength, Test Method D 638, MPa, min	Flexural ^C Strength, Test Methods D 790, MPa, min	Flexural ^E Modulus, Test Methods D 790, MPa, min
01	Polyetherimide	1	General-Purpose	1		< 2	1.25–1.30	194	103	152	3030
				2		2–8	1.25–1.30	194	103	152	3030
				3		6–12	1.25–1.30	194	103	152	3030
				4		10–16	1.25–1.30	194	103	152	3030
				5		15–22	1.25–1.30	194	103	152	3030
				6		20–30	1.25–1.30	192	90	138	2900
				7		> 30	1.25–1.30	190	83	138	2900
				0	Other	...	...	...	...	...	...
				1	Other	...	...	...	...	...	...
				2	Other	...	...	...	...	...	...
		2	Impact-Modified	1		< 2	1.22–1.28	180	83	117	2410
				2		2–8	1.22–1.28	180	83	117	2410
				3		6–12	1.22–1.28	180	83	117	2410
				4		10–16	1.22–1.28	180	83	117	2410
				5		15–22	1.22–1.28	180	83	117	2410
				6		20–30	1.22–1.28	180	69	103	2280
				7		> 30	1.22–1.28	180	69	103	2280
				0	Other	...	...	...	...	...	...
				0	Other	...	...	...	...	...	...
				02	PEI Chemical Resistant	1	General-Purpose	1		<2	1.25–1.30	198	93	128	2760
2		2–8	1.25–1.30					198	93	128	2760
3		6–12	1.25–1.30					198	93	128	2760
4		10–16	1.25–1.30					198	93	128	2760
5		15–22	1.25–1.30					198	93	128	2760
6		20–30	1.25–1.30					196	90	124	2760
7		> 30	1.25–1.30					196	90	124	2760
0	Other	...	...					...	...	...	...
1	Other	...	...					...	...	...	...
2	Impact-Modified	1						< 2	1.22–1.28	184	69	90	2070
		2				2–8	1.22–1.28	184	69	90	2070
		3				6–12	1.22–1.28	184	69	90	2070
		4				10–16	1.22–1.28	184	69	90	2070
		5				15–22	1.22–1.28	184	69	90	2070
		6				20–30	1.22–1.28	184	69	90	2070
		7				> 30	1.22–1.28	184	69	90	2070
		0	Other			...	...	...	...	...	...
		0	Other			...	...	...	...	...	...
		3	High-Heat Resistant			1		< 2	1.27–1.32	215	97	145	2760
2						2–8	1.27–1.32	215	97	145	2760
3				6–12	1.27–1.32	215	97	145	2760		
4				10–16	1.27–1.32	215	97	145	2760		
5				15–22	1.27–1.32	215	97	145	2760		
6				20–30	1.27–1.32	215	97	145	2760		
7				> 30	1.27–1.32	215	97	145	2760		
0	Other			...	...	...	...	...	...
0	Other			...	...	...	...	...	...
4	High-Heat Impact-Modified			1		< 2	1.23–1.30	200	69	103	2070
		2		2–8	1.23–1.30	200	69	103	2070		
		3		6–12	1.23–1.30	200	69	103	2070		
		4		10–16	1.23–1.30	200	69	103	2070		
		5		15–22	1.23–1.30	200	69	103	2070		
		6		20–30	1.23–1.30	200	69	103	2070		
		7		> 30	1.23–1.30	200	69	103	2070		
		0	Other	...	...	...	...	...	...
		0	Other	...	...	...	...	...	...
		03	PEI Heat-Resistant	1	General-Purpose	1		< 2	1.27–1.31	210	103	145	2760
2						2–8	1.27–1.31	210	103	145	2760
3						6–12	1.27–1.31	210	103	145	2760
4						10–16	1.27–1.31	210	103	145	2760
5						15–22	1.27–1.31	210	103	145	2760
6						20–30	1.27–1.31	210	90	131	2760
7						> 30	1.27–1.31	210	90	131	2760
0	Other					...	...	...	...	...	...
0	Other					...	...	...	...	...	...

TABLE *Continued*

Group	Description	Class	Description ^A	Grade	Description	Flow-Rate, ^B Test Method D 1238, g/10, min	Specific Gravity, Test Method D 792	Deflection ^A Temperature (DTUL), min, Test Method D 648, °C, min	Tensile ^B Strength, Test Method D 638, MPa, min	Flexural ^C Strength, Test Methods D 790, MPa, min	Flexural ^E Modulus, Test Methods D 790, MPa, min						
04	PEI—Flexible Resistant	2	Impact-Modified	1		< 2	1.22–1.28	196	69	110	2070						
				2		2–8	1.22–1.28	196	69	110	2070						
				3		6–12	1.22–1.28	196	69	110	2070						
				4		10–16	1.22–1.28	196	69	110	2070						
				5		15–22	1.22–1.28	196	69	110	2070						
				6		20–30	1.22–1.28	196	69	110	2070						
				7		> 30	1.22–1.28	196	69	110	2070						
				0	Other				
				3	High-Heat			1		< 2	1.28–1.32	225	103	138	2760		
								2		2–8	1.28–1.32	225	103	138	2760		
								3		6–12	1.28–1.32	225	103	138	2760		
								4		10–16	1.28–1.32	225	103	138	2760		
								5		15–22	1.28–1.32	225	103	138	2760		
								6		20–30	1.28–1.32	225	103	138	2760		
		7						> 30	1.28–1.32	225	103	138	2760				
		0	Other							
		4	High-Heat Impact-Modified							1		< 2	1.24–1.28	210	69	97	2070
										2		2–8	1.24–1.28	210	69	97	2070
				3		6–12	1.24–1.28			210	69	97	2070				
				4		10–16	1.24–1.28			210	69	97	2070				
				5		15–22	1.24–1.28			210	69	97	2070				
				6		20–30	1.24–1.28			210	69	97	2070				
				7		> 30	1.24–1.28			210	69	97	2070				
				0	Other			
				0	Other General-Purpose Resistant					0	Other
										1		< 2	1.16–1.20	N/A ^F	34	52	690
		2						2–8	1.16–1.20	N/A	34	52	690				
		3						6–12	1.16–1.20	N/A	34	52	690				
		4						10–16	1.16–1.20	N/A	34	52	690				
		5						15–22	1.16–1.20	N/A	34	52	690				
		6						20–30	1.16–1.20	N/A	34	52	690				
		7						> 30	1.16–1.20	N/A	34	52	690				
		0	Other							
		2	Semirigid							1		< 2	1.16–1.20	N/A ^F	21	14	69
										2		2–8	1.16–1.20	N/A	21	14	69
										3		6–12	1.16–1.20	N/A	21	14	69
4										10–16	1.16–1.20	N/A	21	14	69		
5										15–22	1.16–1.20	N/A	21	14	69		
6				20–30	1.16–1.20	N/A	21			14	69						
7				> 30	1.16–1.20	N/A	21			14	69						
0	Other							
3	Nonrigid					1				< 2	1.10–1.20	N/A ^D	7	7	<69		
						2				2–8	1.10–1.20	N/A	7	7	<69		
		3				6–12	1.10–1.20	N/A	7	7	<69						
		4				10–16	1.10–1.20	N/A	7	7	<69						
		5				15–22	1.10–1.20	N/A	7	7	<69						
		6				20–30	1.10–1.20	N/A	7	7	<69						
		7				> 30	1.10–1.20	N/A	7	7	<69						
		0	Other							
0	Other	0	Other	...	...	...	...	...	...		

^ANo descriptions are listed unless needed to describe a special grade under the class. All other grades are listed by requirements.

^BConditions—Method A, 6.7 kg, 2.0955-mm inside diameter orifice:

Group-Class	Test Temperatures, °C
011, 012, 021, 022	337
023, 024, 031, 032, 033, 034	367
041, 042, 043	295 ^{A,B,C,D}

^A Specimens 6.4 mm tested at 1.82 MPa.

^BType 1 bar, speed 5.1 mm/min.

^CMethod I, Procedure A, speed = 2.5 mm/min, span-to-depth ratio 16/1 (tangent modulus).

^D"N/A" indicates the particular data so designated is considered "Not Applicable" to the product being considered.

TABLE A Detail Requirements Filled or Reinforced PEI, or Both

NOTE 1—Resin samples should be dried 4 h at 160°C in an air-circulating oven before molding specimens to be used in these tests and before determining melt-flow rate.

Designation Order	Property/ASTM Test Method	Units	0	1	2	3	4	5	6	7	8	9
1	Tensile strength, min, D638, ^A Type I bar, 0.2 in./min	MPa ^B	^C	25	55	80	110	135	165	190	220	^D
2	Flexural modulus, min, D 790 ^E	MPa ^B	^C	690	1720	3450	5170	6900	8620	10340	13790	^D
3	Flow Rate, min, D1238 ^F	g/10 min	^C	1	4	7	10	13	16	20	24	^D
4	Flexural strength, min, D 790 ^E	MPa ^B	^C	30	65	100	135	170	205	240	275	^D
5	Deflection Temperature, min, D 648 ^{GG}	°C	^C	180	190	200	210	220	230	240	250	^D

^A Type I bar, speed = 5.1 mm/min.

^B MPa × 145 = psi.

^C Unspecified.

^D Specific value (must be shown).

^E Method 1, Procedure A; speed = 2.55 mm/min.

^F Conditions—Method A, 6.7 kg, 2.0955-mm inside diameter orifice:

^G 6.4-mm thick specimen tested at 1.82 MPa.

Group-Class	Test Temperatures, °C
011, 012, 021, 022	337
023, 024, 031, 032, 033, 034	367
041, 042, 043	295

TABLE B Detail Requirements Unreinforced/Unfilled PEI

NOTE 1—Resin samples should be dried 4 h at 160°C in an air-circulating oven before molding specimens to be used in these tests and before determining melt-flow rate.

Designation Order	Property/ASTM Test Method	Units	0	1	2	3	4	5	6	7	8	9
1	Tensile strength, min, D638 ^A	MPa ^B	^C	14	25	40	55	65	80	95	110	^D
2	Flexural modulus, min, D790 ^E	MPa ^B	^C	7	30	65	340	690	1380	2070	2760	^D
3	Flow Rate, min, D1238 ^F	g/10 min	^C	2	6	10	14	18	22	26	30	^D
4	Flexural strength, min, D790 ^E	MPa ^B	^C	7	30	65	90	110	130	150	170	^D
5	Deflecting Temperature, min, D648 ^{GG}	°C	^C	170	180	190	200	210	220	230	240	^D

^A Type I bar, speed = 5.1 mm/min.

^B MPa × 145 = psi.

^C Unspecified.

^D Specific value (must be shown).

^E Method 1, Procedure A; speed = 2.55 mm/min.

^F Conditions—Method A, 6.7 kg, 2.0955-mm inside diameter orifice:

^G 6.4-mm thick specimen tested at 1.82 MPa.

Group-Class	Test Temperatures, °C
011, 012, 021, 022	337
023, 024, 031, 032, 033, 034	367
041, 042, 043	295

TABLE 1 Detail Requirements

NOTE 1—Resin samples should be dried 4 h at 160°C in an air-circulating oven before molding specimens to be used in these tests.

Property	Condition ^A	Units	A	B	C	D	E
Dielectric constant, ^B max	48/50 + D24/23						
1 KHz, 50 % RH, 23°C		...	3.2	3.7	3.7	3.8	...
1 MHz		...	...	...	...	...	3.5
Dissipation factor, ^B max	48/50 + D24/23						
1 KHz, 50 % RH, 23°C		...	0.0015	0.0016	0.0017	0.0017	...
2450 MH, 50 % RH, 23°C		...	0.003	...	...	...	...
1 MH, 50 % RH, 23°C		...	...	...	...	...	0.007
Volume resistivity, ^C min	24/23/50	ohm-cm	10 ¹⁶	10 ¹⁶	10 ¹⁶	10 ¹⁶	...
Dielectric strength, ^D min (1.6-mm thickness, in oil, S/T)	48/50 + 96/23/50	KV/mm (V/mil)	23.6	23.0	22.0	21.0	17.0
Specific gravity ^E	...	...	1.27	1.34	1.42	1.51	...

^A In accordance with Practice D 618.

^B See Test Methods D 150.

^C See Test Methods D 257.

^D See Test Methods D 149.

^E See Test Method D 792 (tolerance ± 0.02).

7. Detail Requirements

7.1 The various materials shall conform to the requirements prescribed in the tables and suffix requirements as they apply.

7.2 For the purpose 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.

7.2.1 With the absolute method, an observed value or a calculated value is not rounded, but is to be compared directly with the specified limiting value. Conformance or nonconformance is based on this comparison.

8. Sampling

8.1 Sampling shall be statistically adequate to satisfy requirements of 13.2. A “lot” of material shall be considered as a unit of manufacture as prepared for shipment, and may consist of a blend of two or more “production runs” or batches.

9. Number of Tests

9.1 The number of tests shall be consistent with the requirements of Section 8 and 13.2.

10. Specimen Preparation

10.1 Unless otherwise specified, test specimens shall be prepared by injection molding in accordance with Practice D 1897 employing the following conditions:

	Minimum Mold Temperature, °C	Minimum Stock Temperature, °C
Unfilled and unreinforced	120	360
Filled or reinforced, or both	150	390

11. Conditioning

11.1 Condition test specimens at least 40 h at $23 \pm 2^\circ\text{C}$ and $50 \pm 5\%$ relative humidity.

12. Test Methods

12.1 Determine the properties enumerated in this classification system using the referenced test methods.

13. Inspection and Certification

13.1 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.

13.2 Lot acceptance inspection shall be the basis on which acceptance or rejection of the lot is made and shall consist of the test listed, as it applies, as follows: flow rate.

13.3 Periodic check inspection shall consist of the tests specified for all requirements of the material under this classification system. Inspection frequency shall be adequate to ensure 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 meet the requirements at the 95 % confidence level.

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 the results of the most recent periodic check inspection.

14. Packing, Packaging, and Package Marking

14.1 Provisions of Practice D 3892 apply for packing, packaging, and marking of containers for plastic materials.

15. Keywords

15.1 classification; line-call-out; polyetherimide resins

APPENDIX

(Nonmandatory Information)

X1. CROSS REFERENCES

X1.1 The following cross references between government specifications and Classification System D 5205 are provided

for information purposes only.

TABLE X1.1 Cross References Designations for Classification System D 5205 and Government Specifications

Government Specification	Classification System D 5205
MIL-P-46184	
Type I (unfilled)	PEI0113 E01 F05 F06
Type II Class 1 (glass reinforced)	PEI0110 G10 A49203 E02 ZU 434OMPa
Class 2 (glass reinforced)	PEI0110 G20 A99103 E03 ZU 5800MPa
Class 3 (glass reinforced)	PEI0110 G30 A99103 E04 ZK 159MPa ZU 7600MPa
MIL-M-24519B	
Type: GLT-10F (glass reinforced)	PEI0110 G10 A00290 E05 EF085 ZN180
GLT-20F (glass reinforced)	PEI0110 G20 A00190 E05 EF085 ZN195
GLT-30F (glass reinforced)	PEI0110 G30 A00190 E05 EF085 ZN215

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).