Designation: D6098 – 16

Standard Classification System and Basis for Specification for Extruded and Compression Molded Shapes Made from Polycarbonate (PC)[1]

This standard is issued under the fixed designation D6098; 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 classification system is intended to be a means of calling out mechanical grade plastic product used in the fabrication of end items or parts.

1. Scope*

1.1 This classification system covers requirements and test methods for the material, dimensions, and workmanship, and the properties of extruded and compression molded plate, rod, and tubular bar manufactured from polycarbonate. This classification system allows for the use of recycled materials provided that all specifications are met.

1.2 This standard is not intended to cover materials used in glazing and signage as defined in 3.1.2 and 3.1.8. It is intended to be a means of calling out mechanical grade plastic products used for fabrication of end items or parts as defined in 3.1.3.

1.3 The properties included in this standard are those required for the compositions covered. Other requirements necessary to identify particular characteristics important to specialized applications are to be described by using the callout system given in Section 4.

1.4 The values stated in inch-pound units are to be regarded as the standard in all property and dimensional tables. For reference purposes, SI units are also included in Table S-PC and Table 1 only.

1.5 The following precautionary caveat pertains only to the test method portions, Section 12, of this standard. *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 no known ISO equivalent to this standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

D618 Practice for Conditioning Plastics for Testing

D638 Test Method for Tensile Properties of Plastics

D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D883 Terminology Relating to Plastics

D1600 Terminology for Abbreviated Terms Relating to Plastics

D3892 Practice for Packaging/Packing of Plastics

D3935 Classification System and Basis for Specification for Polycarbonate (PC) Unfilled and Reinforced Material

D4000 Classification System for Specifying Plastic Materials

2.2 *ANSI Standard:*

Z1.4-1993 Sampling Procedures and Tables for Inspection by Attributes[3]

3. Terminology

3.1 *Definitions:*

3.1.1 Except for the terms defined below, the terminology used in this classification system is in accordance with Terminologies D883 and D1600.

3.1.2 *glazing product, n*—a finished product which is glazed or set in frame or sash and not held by mechanical fasteners which pass through the product.

[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.

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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] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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

3.1.3 *mechanical grade plastic product, n*—extruded or compression molded shapes made from polycarbonate used for fabrication of end items or parts.

3.1.4 *plate, n*—flat stock greater than ¼ in.

3.1.5 *recycled-plastic shape, n*—a product made from up to 100 % recycled plastic.

3.1.6 *regrind plastic, n*—a product or scrap such as sprues and runners and edge trim that have been reclaimed by shredding and granulating for use in-house.

3.1.7 *rod, n*—an extruded solid cylindrical shape with a minimum diameter of ⅛ in.

3.1.8 *signage product, n*—a fabricated sign or outdoor/indoor structure, consisting of any letter, figure, character, mark, point, plane, marquee sign, design, poster, pictorial, picture, stripe, line, trademark, reading matter or illuminating device, which is constructed, attached, erected, fastened, or manufactured in any manner so that the same shall be used for the attraction of the public to any place, subject, person, firm, corporation, public performance, article, machine or merchandise, and displayed in any manner for recognized advertising purposes.

3.1.9 *tubular bar, n*—an extruded annular shape with minimum inside diameter of ⅜ in. and minimum wall thickness of 1/16 in.

4. Classification and Material

4.1 Product shape and size as defined in the applicable purchase order.

4.2 This classification system covers product extruded and compression molded as listed in Table 1 S-PC. Products included in the designations refer to specification callouts from D3935 where applicable.

4.2.1 The polycarbonate shape product is categorized by type, class, and grade depending on resin and filler compositions as defined in Table 1 S-PC.

4.2.2 Each polycarbonate shape is categorized into one of several grades:

4.2.2.1 *Grade 1—General Purpose*—Extruded or compression molded product made using only 100 % virgin polycarbonate resin.

4.2.2.2 *Grade 2—Recycled*—Extruded or compression molded product made using any amount up to 100 % recycled polycarbonate plastics.

4.3 The type, class and grade is further differentiated based on dimensional stability (elevated temperature excursion test), Table 1 S-PC, and dimensional requirements, Table 2 A-1, Table 3 B-1, and Table 4 B-2.

4.4 *Property Tables:*

4.4.1 Table 1 S-PC is used to describe both extruded and compression molded products.

4.4.2 Table 5 is used to describe extruded or compression molded products not included in Table 1 S-PC via a cell callout that includes the applicable Table 1 S-PC polycarbonate type and specific properties (Designations 1-7).

4.4.3 To facilitate the incorporation of future or special materials not covered by Table 1 S-PC, the "as specified" category (00) for type, class and grade is shown in the table with the basic properties to be obtained from Table 5, as they apply.

4.4.4 *Reinforcements and Additive Materials*—A symbol (single-letter) is used for the major reinforcement or combination, or both, along with two numbers that indicate the percentage of reinforcement and/or additive by mass with the tolerances as tabulated below. This must be included in all Table 5 callouts (Specifications).

TABLE 1 S-PC Requirements for Polycarbonate (PC) Shapes

Type	Description	Class	Description	Grade	Resin Type[A]	Description	Ultimate Tensile Strength, min, psi (MPa)	Tensile Elongation, % at break, min	Tensile Modulus, min, psi (MPa)	Dimensional Stability, max, %
01	Polycarbonate	1	Unfilled	1	PC111,[B] PC112,[B] PC113,[B] PC114,[B] PC115,[B] PC116,[B] PC117,[B] or PC110B34720[B]	General Purpose	8000 (55)	50	300 000 (2070)	0.4
				2	As Specified[C]	Recycled	. . .	. . .	. . .	. . .
				0	As Specified[C]	As Specified	. . .	. . .	. . .	. . .
		2	UV Stabilized	1	PC0135[B] or PC0136	General Purpose	8000 (55)	50	300 000 (2070)	0.4
				2	As Specified[C]	Recycled	. . .	. . .	. . .	. . .
		0	As Specified	0	As Specified[C]	As Specified	. . .	. . .	. . .	. . .
00	Other Polycarbonates	0	As Specified	1	As Specified	General Purpose	. . .	. . .	. . .	. . .
				2	As Specified	Recycled	. . .	. . .	. . .	. . .
				0	As Specified[C]	As Specified	. . .	. . .	. . .	. . .

[A] In accordance with Classification System D3935.
[B] Applicable D3935 resin type to be specified on purchase order.
[C] Alphanumeric sequence indicating filler type and quantity must precede Table 5 callouts for modified products (see 4.4.4).

TABLE 2 A-1 Dimensional Requirements for Polycarbonate Rod[A]

Size, in.	Diameter Tolerance, in.	Roundness TIR, in.	Camber, in./ft
⅛ to ⅞	+0.002/-0.001	0.002	2½ /8
1	+0.005/-0	0.002	1¼ /8
1⅛ to 1¼	+0.005/-0	0.004	1¼ /8
1⅜ to 1⅞	+0.005/-0	0.005	1¼ /8
2	+0.005/-0	0.010	1¼ /8
2⅛ to 2½	+0.030/-0	0.025	1¼ /8
2⅝ to 6	+0.250/-0	0.050	¼ /4

[A]To convert inches to millimetres multiply by 25.40.

TABLE 3 B-1 Dimensional Requirements for Extruded Polycarbonate Plates (Grade 1)[A]

Size, in.	Thickness Tolerances, in.	Length Camber, in./ft	Width Bow, in./ft
¼ to 2	+0.025/-0	¾ /4	3⁄16 /2
2⅛ to 3	+0.050/-0	¼ /4	1⁄16 /2
3⅛ and over	+0.050/-0	¼ /4	1⁄16 /1

[A]To convert inches to millimetres multiply by 25.40.

TABLE 4 B-2 Dimensional Requirements for Compression Molded Polycarbonate Plates[A,B]

Size, in.	Thickness Tolerance, in.	Length Camber, in./ft	Width Bow, in./ft
⅜ to ⅞	+0.090/-0	⅜ /4	3⁄32 /2
1 and over	+0.090/-0	⅛ /4	3⁄64 /2

[A]To convert inches to millimetres multiply by 25.40.
[B]Compression molded plate is supplied sufficiently oversize to finish to nominal dimension listed.

TABLE 5 Additional Detail Requirements–Reinforced/Unreinforced Extruded and Compression Molded Polycarbonates

NOTE 1—The applicable table polycarbonate type (including fillers in accordance with 4.4.4) must precede this table designation.

Designation Order Number	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile strength, Test Method D638, min, psi (MPa)	Unspecified	6000 (41)	8000 (55)	10 000 (69)	12 000 (83)	14 000 (97)	16 000 (110)	20 000 (138)	25 000 (172)	Specify Value
2	Elongation at Break Test Method D638, %, min	Unspecified	1	3	5	10	20	50	100	200	Specify Value
3	Tensile Modulus, min, Test Method D638 min, psi (MPa)	Unspecified	100 000 (690)	200 000 (1379)	300 000 (2073)	400 000 (2760)	500 000 (3448)	600 000 (4137)	800 000 (5516)	1 000 000 (6895)	Specify Value
4	Dimensional Stability, % max, per 12.2	Unspecified	0.1	0.2	0.3	0.4	0.6	0.8	1.0	1.5	Specify Value
5	Flexural Modulus, Test Method D790, min, psi (MPa)	Unspecified	250 000 (1649)	350 000 (2400)	450 000 (3100)	550 000 (3792)	650 000 (4482)	750 000 (5171)	1 000 000 (6895)	1 500 000 (10 343)	Specify Value
6	Izod impact, Test Method D256, min ft·lb/in. (J/m)	Unspecified	0.5 (27)	0.75 (40)	1.0 (53)	2.5 (133)	5.0 (266)	10.0 (533)	15.0 (800)	18.0 (960)	Specify Value
7	To be determined	Unspecified	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .

Symbol	Material	Tolerance (Based on the Total Mass)
C	Carbon and graphite fiber reinforced	±2 %
G	Glass-reinforced	
	<15 % glass content	±2 %
	>15 % glass content	±3 %
L	Lubricants (for example, PTFE, graphite, and silicone)	Depends upon material and process—to be specified
M	Mineral	±2 %
R	Combinations of reinforcements or fillers, or both	±3 % for the total reinforcement

4.5 *Callout Designation*—A one-line system shall be used to specify polycarbonate materials covered by this classification system. The system uses pre-defined cells to refer to specific aspects of this classification system as illustrated below:

4.5.1 *Examples:*

4.5.1.1 *Example 1*—Product made from general purpose polycarbonate:

CELL CALLOUT: S-PC0111
S-PC01 = Product made from PC in accordance with Table 1 S-PC
1 = Unfilled class
1 = General purpose grade product

4.5.1.2 *Example 2*—Product made from 20 % glass reinforced general purpose polycarbonate:

CELL CALLOUT: S-PC0100G2053454430

S-PC0100	=	Product made from PC in accordance with Table 1 S-PC
G20	=	20 % glass
1	=	Table 5 properties
3	=	Tensile strength (10,000 psi)
4	=	Elongation at break (10 %)
5	=	Tensile Modulus (500,000 psi)
4	=	Dimensional stability (0.4 %)
4	=	Flexural Modulus (550,000 psi)
3	=	Izod Impact (1.0 ft-lb/in.)
0	=	Unspecified

4.5.2 These two examples illustrate how a one-line, alphanumeric sequence can identify (specify) the product composition, commercial parameters and physical characteristics of extruded or compression molded product. A space must be used as a separator between the specification number and the type designation. No separators are needed between type, class and grade. When special notes are to be included, such information shall be preceded by a comma. Special tolerances must be noted at the time of order and are inserted after the grade in parenthesis and preceded by a comma.

5. Ordering Information

5.1 All shapes covered by this standard shall be ordered using the proper callout designation (see 4.5).

6. Physical Property Requirements

6.1 The physical property values listed in the tables of this standard are to be considered minimum specification values. Any requirement for specific test data for a given production lot shall be specified at the time of order. Physical properties for products not yet included in Table 1 S-PC are specified using Table 5 for extruded or compression molded products.

7. Dimensional Requirements

7.1 The type, class and grade is differentiated based on dimensional stability (elevated temperature excursion test), as indicated in Table 1 S-PC.

7.2 Products shall be produced within commercial tolerances and with the lowest stress levels for machined parts as delineated in Table 2 A-1, Table 3 B-1, and Table 4 B-2.

7.3 Tubular bar dimensions shall be supplied in the unfinished condition, unless otherwise specified at time of order, sufficient to finish to the nominal dimension ordered.

7.4 The maximum allowable camber and/or bow shall be within the limits referenced in Table 2 A-1, Table 3 B-1, and Table 4 B-2.

8. Workmanship, Finish, and Appearance

8.1 *Appearance*—The resin material color is transparent with water-white or light straw color. Natural resin is also offered with various amounts of blue tinting. The product color shall be as published by the shapes manufacturer. They shall be uniform in color throughout the thickness. Specific colors and color matching only as agreed to by order.

8.1.1 Physical properties, although unaffected by tinting, can be affected if coloring by other means.

8.2 *Finish*—All products shall be free of blisters, wrinkles, cracks, gouges and defects that restrict commercial use of the product. Special surface finish shall be supplied only when specified in the purchase order or contract.

8.3 *Defects*—All products shall be free of voids, dirt, foreign material and embedded particles exceeding 0.040 in. maximum diameter as defined in 8.3.1.

8.3.1 The criteria for determining the internal cleanliness shall be external visual inspection. A maximum number of two internal defects per square foot of plate and one foot length of rod and tubular bar are allowed. Clusters of defects less than 0.040 in. diameter are to be counted as a single defect.

8.3.2 For compression molded products, four defects up to 0.080 in. diameter per square foot of plate are allowed.

9. Sampling

9.1 Sampling shall be statistically adequate to satisfy the requirements of this classification system as applicable (see ANSI Z1.4 - 1993).

9.2 For purposes of sampling, an inspection lot for examination and tests shall consist of all material of the same type, class, grade and nominal size submitted for inspection at one time.

10. Number of Tests

10.1 Routine lot inspection shall consist of all the criteria specified in the applicable product tables.

10.2 The criteria listed in these product tables and definitions are sufficient to establish conformity of the sheet, plate, rod or tubular bars to this standard. When the number of test specimens is not stated in the test method, a single determination is sufficient. If more than single determinations and separate portions of the same sample are made, the results shall be averaged. The final result shall conform to the requirements prescribed in this standard.

11. Test Conditions

11.1 *Conditioning of Specimens*—The property values and dimensions are based on conditioning techniques outlined in Procedure A of Practice D618.

11.2 The tests shall be conducted at the standard laboratory atmosphere of 73.4°F (23°C) and 50 % relative humidity as described in subsection 3.1.1 of Practice D618.

12. Test Methods

12.1 Test tensile strength at break, elongation at break, and tensile modulus (tangent) in accordance with Test Method D638, at the rate of 0.2 in./min.

12.1.1 Test all plate specimens in accordance with Type I of Test Method D638.

12.1.2 Test all rod specimens in accordance with Test Method D638.

12.1.3 Test all tubular bar specimens in accordance with Test Method D638.

12.2 *Dimensional Stability:*

12.2.1 *Specimen Preparation (a Minimum of Three Test Specimens is Required):*

12.2.1.1 *Rods and Tubular Bar*—Prepare each specimen by cutting a 1.5 in. long slice from the shape to be tested. Machine

the slice using a coolant and good machining practices to a length of 1.000 ± 0.005 in. Each end of the specimen shall have a machined surface.

12.2.1.2 *Plate*—Each specimen shall consist of a 2 in. diameter disc machined from the flat (diameter shall equal test specimen thickness with a minimum of 2.0 in.). The same care shall be used in the machining as described in 12.1.1. The thickness of the specimen shall be that of the original flat from which it was cut, no machining being done on the top or bottom faces.

12.2.2 *Testing Procedure*—Measure the outside diameter and thickness or length of the specimen as applicable at 73.4 ± 1.8°F (23 ± 1°C) in accordance with Practice D618 to the nearest 0.0001 in. All measurements shall be done on the centerline and 90° from the center line for plate. Also take measurements for thickness halfway to center, and for diameter at mid-point. Place the specimen in a bath consisting of polyalkylene glycol or an air circulating oven heated to 250 ± 5°F (121 ± 3°C). After 6 h, allow the specimen to slowly cool to room temperature at a rate not to exceed 40°F (22°C) / h. Measure the specimen at 73.4 ± 1.8°F (23 ± 1°C) in accordance with Practice D618 to the nearest 0.0001 in. and calculate the percent change in each dimension.

12.3 *Lengthwise Camber and Widthwise Bow—*

12.3.1 Make all measurements for camber and bow using the maximum distance rod, sheet or plate deviates from the straight line extended from edge to edge when measured in accordance with 12.3.2. The shape shall be oriented such that the weight of the product does not influence the results.

12.3.2 *Rod and Plate:*

12.3.2.1 *Rod*—Lay each rod on its side and measure it with concave side facing a straight edge. Measure camber from the straight edge to the maximum concave point on the rod. Camber shall not exceed the values of Table 2 A-1.

12.3.2.2 *Plate*—Plate shall not exceed the requirements of Table 3 B-1 and Table 4 B-2 on the lengthwise ends and widthwise edges when laid on a flat surface (crown side up).

12.4 *Squareness (Based on a 4 ft Nominal Length):*

12.4.1 Measure and compare diagonal lengths (corner to corner). Accept the product if the difference is 1⁄16 in. or less and the measured minimums diagonal meets the following requirements:

12.4.1.1 1 ft wide is 49 ½ in. minimum,

12.4.1.2 2 ft wide is 53 ¾ in. minimum, and

12.4.1.3 4 ft wide is 68 in. minimum.

12.4.2 If the diagonal difference exceeds 1⁄16 in., proceed to measure the gap (that is, the deviation from a 2 ft square). The maximum allowable gap shall not exceed ⅛ in. except for the 1 ft wide sizes of sheet and plate which should not exceed 1⁄16 in.

12.5 Test flexural modulus in accordance with Test Method D790, specimen ¼ in. thick maximum, testing speed 0.11 in./min.

12.6 Test Izod impact, in accordance with Test Method D256, Method A, Fig 4, notched, ¼ in. thick maximum specimen.

13. Certification

13.1 When requested at the time of order, the purchaser shall be furnished a certification that the lot is made from the required polycarbonate plastic (percent recycle, if applicable) and meets the requirements of this classification system.

14. Packing, Packaging, and Package Marking

14.1 All packing, packaging, and marking provisions of Practice D3892 shall apply to this classification system.

15. Ordering Information

15.1 All shapes covered by this classification system shall be ordered using the proper callout (specification) designation (see 4.5).

16. Keywords

16.1 polycarbonate; plates, polycarbonate; rod, polycarbonate; shapes, polycarbonate; tubular bar, polycarbonate; recycled plastic, polycarbonate

SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue (D6098-10) that may impact the use of this standard. (September 1, 2016)

(1) Changed title from Specification to Classification System and Basis for specification.

(2) Where applicable in the standard "specification" was changed to "classification system."

(3) Deleted subsection 1.4 since the information on the use of recycled materials is now included in 1.1

(4) Deleted D7209 from 2.1.

(5) Deleted 3.2 because it is redundant and covered in 3.1.1. Subsections 2.2.1 through 3.2.7 were renumbered 3.1.3 through 3.1.9.

(6) Tables were renumbered in 4.3 and elsewhere to agree with the actual table numbers.

(7) Some editorial changes were made.