



Designation: D 6100 – 97

Standard Specification for Extruded, Compression Molded and Injection Molded Acetal Shapes (POM)¹

This standard is issued under the fixed designation D 6100; 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 specification is intended to be a means of calling out plastic product used in the fabrication of end items or parts.

1. Scope

1.1 This specification covers requirements and test methods for the material, dimensions, and workmanship, and the properties of extruded, compression molded and injection molded acetal sheet, plate, rod, and tubular bar manufactured from acetal.

1.2 The properties included in this specification are those required for the compositions covered. Requirements necessary to identify particular characteristics important to specialized applications may be described by using the classification system given in Section 4.

1.3 This specification allows for the use of recycled plastics as defined in Guide D 5033.²

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 included in Table S-POM and Table 1 only.

1.5 The following precautionary caveat pertains only to the test method portions, Section 11, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—There is no similar or equivalent ISO Standard.

2. Referenced Documents

2.1 ASTM Standards:

- D 256 Test Methods for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics³
- D 618 Practice for Conditioning Plastics for Testing³

¹ This specification is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.20 on Plastic Products (Section D20.20.02).

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² As defined in Guide D 5033.

³ *Annual Book of ASTM Standards*, Vol 08.01.

D 638 Test Method for Tensile Properties of Plastics³

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

D 883 Terminology Relating to Plastics³

D 3892 Practice for Packaging/Packing of Plastics⁴

D 4000 Classification System for Specifying Plastic Materials⁴

D 4181 Classification for Acetal (POM) Molding and Extrusion Materials⁴

D 5033 Guide for the Development of Standards Relating to the Proper Use of Recycled Plastics⁵

2.2 ANSI Standard:

Z1.4-1993 Sampling Procedures and Tables for Inspection by Attributes⁶

3. Terminology

3.1 Definitions:

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

3.1.2 For definitions of other technical terms pertaining to plastics used in this specification, see Terminology D 883 or Guide D 5033.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *centerline porosity, n*—microvoids which are visibly detectable with the unaided eye using the dye penetration procedure detailed in 7.4.1.

3.2.2 *low porosity, n*—product which either exhibits no white centerline or a white centerline but no dye remains when tested in accordance with section 7.4.1.

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

3.2.4 *Porosity Level 1, n*—products containing microvoids with a pore size greater than 50 μm (0.002 in.) in which dye

⁴ *Annual Book of ASTM Standards*, Vol 08.02.

⁵ *Annual Book of ASTM Standards*, Vol 08.03.

⁶ Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

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remains either in a broken or continuous line which does not exceed 4 % centerline porosity when tested in accordance with 7.4.1.

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

3.2.6 *rod, n*—solid cylindrical shape with a minimum diameter of 1/8 in.

3.2.7 *sheet, n*—flat stock less than and including 1/4 in. (mm) thickness.

3.2.8 *tubular bar, n*—annular shapes with minimum inside diameter of 3/8 in. and minimum wall thickness of 1/16 in.

3.2.9 *virgin plastic shape, n*—product that is produced from 100 % plastic resin that has not been subjected to subsequent melt processing.

TABLE S-POM Requirements for Acetal (Polyoxymethylene) Shapes

Type	Description	Class	Description	Grade	Specification D 4181 Resin Callout ^A	Description	Ultimate Tensile Strength min, psi (MPa)	Tensile Elongation % at break, mm	Tensile Modulus min, psi	Dimensional Stability %, max				
01	Homopolymer	1	Unfilled	1	POM 111 ^B	General Purpose	9000 (62)	25	350 000	0.4				
				2	POM110B44350 ^B	General Purpose	9000 (62)	15	350 000	0.4				
				0	As Specified	Recycle Grade	8000 (55)	25	275 000	0.4				
		2	Lubricated	1	POM110L20A21720 ^B	General purpose	6100 (42)	10	345 000	0.4				
				3	POM110L13 ^B	General Purpose	6800 (47)	10	340 000	0.4				
02	Copolymer	1	Unfilled	1	POM 211 ^B	General Purpose	8000 (55)	25	350 000	0.4				
				2		Recycle Grade	7000 (48)	25	275 000	0.4				
				0	As Specified					
				00	Other Acetals	0	As Specified	1	As Specified	General Purpose
								2		Recycle Grade

^A Applicable Specification D 4181 resin type to be specified on purchase order.

^B In accordance with Specification D 4181.

4. Classification and Material

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

4.2 This specification covers product as listed in Table S-POM. Products included in the designations reference Specification D 4181 callouts where applicable.

4.2.1 The type of acetal extruded, compression molded or injection molded product may be categorized by type, grade and class depending on resin and filler compositions as defined in Table S-POM.

4.3 Every type of acetal shape may be categorized into one of several grades as follows:

4.3.1 *Grade 1—General Purpose:*

4.3.1.1 Extruded, compression molded and injection molded product made using only 100 % virgin acetal resin.

4.3.1.2 Up to 20 % acetal regrind plastic developed during the internal processing steps, may be reused for sheet product.

4.3.2 *Grade 2—Recycle Grade:*

4.3.2.1 Extruded, compression molded or injection molded product made using any amount up to 100 % of recycled acetal plastic.

4.4 The type class and grade is further differentiated based on dimensional stability (elevated temperature excursion test), Table S-POM and dimensional requirements, Tables A and B.

4.4.1 When the level of centerline porosity needs to be documented it will be designated as either low porosity (LP) or P1 (Porosity Level 1) that is determined using the procedure detailed in 7.4 and will be added to the callout as a suffix (see Example 2 in 4.6.1.2).

4.5 *Property Tables:*

4.5.1 Table S-POM may be used to describe extruded, compression molded and injection molded products.

4.5.2 Table 1 may also be used to describe extruded, compression molded and injection molded products not included in Table S-POM via a cell callout which includes the applicable Table S-POM acetal type and specific properties (Designations 1 through 7).

4.5.3 To facilitate the incorporation of future or special materials not covered by Table S-POM, the “as specified” category (OO) for type, class and grade is shown on the table with the basic properties to be obtained from Table 1, as they apply.

4.5.4 *Reinforcements and Additive Materials*—A symbol (single-letter) will be used for the major reinforcement or combination, or both, along with two numbers that indicate the

TABLE A-1 Dimensional Requirements for Acetal Rod (Grade 1)

Size, in.	Diameter Tolerance, in.	Roundness TIR, in.	Camber, in./ft
1/8 to 7/8	+0.002/−0.001	0.002	2 1/2/8
1	+0.005/−0	0.002	1 1/4/8
1 1/8 to 1 1/4	+0.005/−0	0.004	1 1/4/8
1 3/8 to 1 7/8	+0.005/−0	0.005	1 1/4/8
2	+0.005/−0	0.010	1 1/4/8
2 1/8 to 2 1/2	+0.030/−0	0.025	1 1/4/8
2 5/8 to 6	+0.250/−0	0.050	1/8
Over 6	+0.250/−0	0.060	1/4/4

percentage of addition by mass with the tolerances as tabulated below. This must be included in all Table 1 callouts (see Example 3 in 4.6.1.3).

Symbol	Material	Tolerance (Based on the Total Mass)
C	Carbon and graphite fiber	±2 %
G	Glass	±2 %
L	Lubricants (for example, PTFE, graphite, silicone and molybdenum disulfide)	by agreement between the supplier and the user
M	Mineral	±2 %
R	Combinations of reinforcements or fillers, or both	±3 % for the total reinforcement

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

4.6.1 Description:

4.6.1.1 Example 1—Product made from general purpose acetal homopolymer:

CELL CALLOUT: S-POM0111

- S-POM01 = Product made from POM homopolymer in accordance with Table S-POM
- 1 = Unfilled class
- 1 = General purpose grade product

4.6.1.2 Example 2—Product made from general purpose acetal copolymer, low porosity:

CELL CALLOUT: S-POM0211,LP

- S-POM02 = Product made from POM copolymer in accordance with Table S-POM
- 1 = Unfilled class
- 1 = General purpose grade product
- LP = Low porosity material

4.6.1.3 Example 3—Product made from 20 % PTFE reinforced general purpose acetal homopolymer resin:

CELL CALLOUT: S-POM0121

- S-POM01 = Product made from POM homopolymer in accordance with Table S-POM
- 2 = Lubricated
- 1 = PTFE filled

4.6.2 The three examples illustrate how a one-line, alpha-numeric sequence can identify the product composition, commercial parameters and physical characteristics of extruded, compression molded and injection 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 should be preceded by a comma. Special tolerances must be noted at time of order and are inserted after the grade in parenthesis and preceded by a comma.

TABLE B-1 Dimensional Requirements for Acetal Sheets and Plates (Grades 1 and 2)^A

NOTE 1—*Squareness*—All sizes 1/8 in. max, gap when measured in accordance with 11.4.

Size, in.	Thickness Tolerances	Length Camber, in./ft	Width Bow, in./ft
1/16 to 3/16	±10 %	3/4/4	3/16/2
1/4 to 1	+0.025/−0	3/4/4	3/16/2

1 1/8 to 3	+0.050/−0	1/4/4	1/16/2
3 1/8 and over	+0.125/−0	1/4/4	1/8/2

^ACompression molded plate is supplied sufficiently oversize to finish to nominal dimension listed.

TABLE B-2 Dimensional Requirements for Acetal Compression Molded Plates (Grade 1)

Size in.	Thickness Tolerances	Length Camber, in./ft	Width Bow, in./ft
1/4	+0.090/−0	3/8/4	0.090/2
5/16	+0.090/−0	3/8/4	0.090/2
3/8	+0.090/−0	3/8/4	0.090/2
7/16	+0.090/−0	3/8/4	0.090/2
1/2	+0.090/−0	3/8/4	0.090/2
5/8	+0.090/−0	3/8/4	0.090/2
3/4	+0.090/−0	3/8/4	0.090/2
7/8	+0.090/−0	3/8/4	0.090/2
1	+0.090/−0	1/8/4	0.050/2
1 1/8	+0.090/−0	1/8/4	0.050/2
1 1/4	+0.090/−0	1/8/4	0.050/2
1 3/8	+0.090/−0	1/8/4	0.050/2
1 1/2	+0.090/−0	1/8/4	0.050/2
1 5/8	+0.090/−0	1/8/4	0.050/2
1 3/4	+0.090/−0	1/8/4	0.050/2
1 7/8	+0.090/−0	1/8/4	0.050/2
2	+0.090/−0	1/8/4	0.050/2

5. Physical Property Requirements

5.1 The physical property values listed within this specification's tables are to be considered minimum specification values. Any requirement for specific test data for a given production lot should be specified at the time of order. Physical properties for products not yet included in Table S-POM may be specified using Table 1 for extruded, compression molded and injection molded products.

6. Dimensional Requirements

6.1 The type, class and grade is further differentiated based on dimensional stability (elevated temperature excursion test), Table S-POM, and dimensional requirements, Tables A and B. Products shall be produced within commercial tolerances and with the lowest stress levels for machined parts as delineated in Tables A and B for extruded, compression molded or injection molded products. The manner in which the tolerances are obtained is not relevant.

6.2 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.

6.3 The maximum allowable camber and/or bow shall be within the limits referenced in Tables A-1 and B-1.

7. Workmanship, Finish, and Appearance

7.1 *Appearance*—The color of products 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. Physical properties may be affected by colors.

7.2 *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.

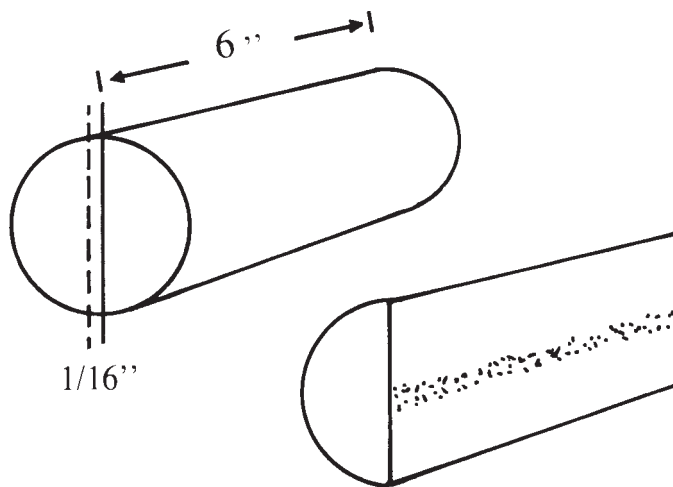
7.3 *Defects*—All products shall be free of dirt, foreign material and embedded particles exceeding 1/32 in. maximum diameter as defined in 7.3.1.

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7.3.1 The criteria for determining the internal cleanliness shall be external visual inspection. A maximum number of two internal defects per square foot of plate/sheet and one foot length of rod and tubular bar. Clusters of defects less than 1/32in. diameter are to be counted as a single defect.

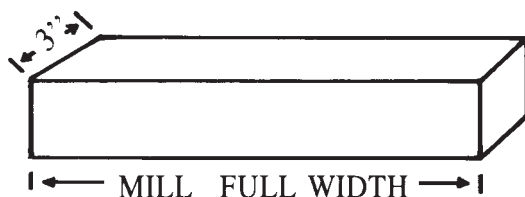
7.4 *Centerline Porosity*—Maximum allowable porosity level for products designated as porosity Level 1 shall not exceed 4% as described in 7.4.1. Products identified low porosity (LP) shall not have any centerline porosity.

7.4.1 A rod (see Fig. 1) or plate (see Fig. 2) or tubular bar wall, full cross-section sample shall have a milled surface of approximately 72 RMS prior to testing. Color over this centerline or dot with red permanent magic marker and allow one minute for the markings to dry. For colored product a more sensitive ultraviolet fluorescent yellow permanent magic marker is required. Clean off the colored area with acetone. The ink or dye will not be washed from inside the porosity and will show up as colored particles. Measure the widest part or largest diameter of the porosity line. Colored product must be examined using a UV light sensor (long wavelength). This value is then divided by the diameter of the rod, thickness of the plate, or tubular bar wall thickness, and multiplied by 100 to obtain the percent centerline porosity value.



NOTE 1—A 6 in. length of acetal rod is cut in half, approximately 1/16 in. off center to reveal center core of rod sample.

FIG. 1 Acetal Rod



NOTE 1—A full-width sample of plate is cut to approximately a 3 in. length then face-milled 1/16 in. to properly display centerline of plate.

FIG. 2 Plate

TABLE 1 Additional Detail Requirements—Reinforced/Unreinforced Acetal Shapes

NOTE 1—The applicable Table S-POM callout (including resin type, fillers) must precede this table designation.

Designation Order Number	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile strength, Test Method D 638, 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 D 638, %, min	Unspecified	1	3	5	10	20	50	100	200	Specify Value
3	Tensile modulus, Test Method D 638, 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, %, in accordance with 11.2	Unspecified	0.1	0.2	0.3	0.4	0.6	0.8	1.0	1.5	Specify Value
5	Flexural modulus, Test Method D 790, 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 D 256, ft-lb/in. (J/m) of notch, min	Unspecified	0.4 (21)	0.6 (32)	0.8 (43)	1.0 (53)	2.0 (107)	3.0 (160)	4.5 (240)	6.0 (320)	Specify Value

8. Sampling

8.1 Sampling shall be statistically adequate to satisfy the requirements of this specification as applicable (see 2.2).

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

9. Number of Tests

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

9.2 The criteria listed in these product tables and definitions are sufficient to establish conformity of the sheet, plate, rod or tubular bars to this specification. When the number of test specimens is not stated in the test method, a single determination may be made. 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 specification.

10. Test Conditions

10.1 *Conditioning of Specimens*—The specification values and dimensions are based on conditioning techniques outlined in Procedure A of Practice D 618.

10.2 *Standard Temperature*—Conduct the tests at the standard laboratory temperature of $73.4 \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$) and $50 \pm 5\%$ relative humidity (RH).

11. Test Methods

11.1 Test tensile strength at break, elongation at break, and tensile modulus (tangent) in accordance with Test Method D 638, at the rate of 0.2 in./min.

11.1.1 Test all plate and sheet specimens in accordance with Test Method D 638, Type 1. Whenever possible areas of acceptable porosity should be avoided.

11.1.2 Test all rod specimens in accordance with Test Method D 638. Whenever possible, areas of acceptable porosity should be avoided.

11.1.3 Test all tubular bar specimens in accordance with Test Method D 638. Whenever possible, areas of acceptable porosity should be avoided.

11.2 *Dimensional Stability:*

11.2.1 *Specimen Preparation (a Minimum of Three Test Samples Required):*

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

11.2.1.2 *Plate and Sheet*—The test is not applicable to sheet under $\frac{3}{16}$ in. thick. 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.). Use the same care in the machining as described above. 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.

11.2.2 *Testing Procedure*—Measure the outside diameter and thickness or length of the specimen as applicable at $73.4 \pm$

1.8°F ($23 \pm 1^\circ\text{C}$) to the nearest 0.0001 in. Do all measurements on the center line and 90° from the center of the plate. Also take measurements for thickness halfway to center and for diameter at mid-point. Place the specimen in an oil bath consisting of polyalkylene glycol or an air circulating oven and heat to the applicable temperature for acetal type as noted below. See 11.2.3. After 6 h, allow the specimen to slowly cool to room temperature at a rate not to exceed 40°F (22°C) per hour. Then measure the specimen at $73.4 \pm 1.8^\circ\text{F}$ ($23 \pm 1^\circ\text{C}$) and calculate the percent change in each dimension.

11.2.3 *Test Temperatures:*

11.2.3.1 *Acetal* = $300 \pm 5.4^\circ\text{F}$ ($149 \pm 3^\circ\text{C}$).

11.3 *Lengthwise Camber and Widthwise Bow:*

11.3.1 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 11.3.2. The shape shall be oriented such that the weight of the product doesn't influence the results.

11.3.2 *Rod, Sheet and Plate:*

11.3.2.1 *Rod*—Rod will be laid on side and measured with concave side facing the straight edge. Measure camber from the straight edge to the maximum concave point on rod. Camber may not exceed the values of Table A-1 for the specified lengths of extruded, compression molded, or injection molded product.

11.3.2.2 *Sheet and Plate up to and Including $\frac{5}{8}$ in. Thick*—Plate up to and including $\frac{5}{8}$ in. in thickness shall meet the requirements of Tables B-1 or B-2 for extruded, compression molded or injection molded products with a straight edge, positioned in a lengthwise and widthwise direction, with the plate standing on its edge.

11.3.2.3 *Sheet and Plate Greater than $\frac{5}{8}$ in. Thick*—Plate above $\frac{5}{8}$ in. thick shall not exceed the requirements of Table B-1 for extruded, compression or injection molded product on the lengthwise ends and widthwise edges when laid on a flat surface (crown side up).

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

11.4.1 Measure and compare diagonal lengths (corner to corner). Accept the product if the difference is $\frac{1}{16}$ in. or less and the measured minimums diagonal meets the following requirements:

11.4.1.1 One foot wide is $49 \frac{1}{2}$ in. minimum, 2 ft wide is 53 $\frac{3}{4}$ in. minimum, and 4 ft wide is 68 in. minimum.

11.4.2 If the diagonal difference exceeds $\frac{1}{16}$ in., proceed to measure the gap (that is the deviation from a 2 ft framing square). The maximum allowable gap shall not exceed $\frac{1}{8}$ in. except for the 1 ft wide sizes of sheet and plate that should not exceed $\frac{1}{16}$ in.

11.5 Test flexural modulus in accordance with Test Method D 790, specimen $\frac{1}{4}$ in. thick maximum, testing speed 0.11 in./min. Whenever possible areas of acceptable porosity should be avoided.

11.6 Test Izod impact, in accordance with Method A of Test Method D 256 Fig. 4, notched, $\frac{1}{4}$ in. thick maximum specimen. Whenever possible areas of acceptable porosity should be avoided.



12. Certification

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

13. Packing, Packaging and Package Marking

13.1 All packing, packaging, and marking provisions of Practice D 3892 shall apply to this specification.

14. Ordering Information

14.1 All shapes covered by this specification shall be ordered using the proper callout designation (see 4.6).

15. Keywords

15.1 acetal; centerline porosity—acetal; copolymer—acetal; homopolymer—acetal; low porosity—acetal; plates—acetal; porosity level 1—acetal; recycled—acetal; rod—acetal; shapes—acetal; sheet—acetal; tubular bar—acetal

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