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AEROSPACE MATERIAL SPECIFICATION

SAE AMS-3581 REV B

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Submitted for recognition as an American National Standard

CAST RODS, TUBES, AND SHAPES, METHYL METHACRYLATE PLASTIC
Heat Resistant

1. SCOPE:

1.1 Form: This specification covers one grade of methyl methacrylate plastic in the form of cast rods, tubes, and shapes.

1.2 Application: Primarily for fabricated parts, formed or otherwise, requiring dimensional stability, optical clarity, good electrical properties, improved heat resistance over that of AMS-3580, and excellent outdoor weatherability.

1.3 Safety - Hazardous Materials: While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The applicable issue of referenced publications shall be the issue in effect on the date of the purchase order.

2.1 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM D 149 - Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D 150 - A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials
ASTM D 256 - Impact Resistance of Plastics and Electrical Insulating Materials
ASTM D 257 - D-C Resistance or Conductance of Insulating Materials

2.1 (Continued):

ASTM D 542 - Index of Refraction of Transparent Organic Plastics
ASTM D 570 - Water Absorption of Plastics
ASTM D 635 - Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D 638 - Tensile Properties of Plastics
ASTM D 638M - Tensile Properties of Plastics (Metric)
ASTM D 648 - Deflection Temperature of Plastics under Flexural Load
ASTM D 790 - Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D 790M - Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials (Metric)
ASTM D 792 - Specific Gravity (Relative Density) and Density of Plastics by Displacement
ASTM D 1003 - Haze and Luminous Transmittance of Transparent Plastics
ASTM E 308 - Computing the Colors of Objects by Using the CIE System

2.2 U.S. Government Publications: Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

2.2.1 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

3. TECHNICAL REQUIREMENTS:

3.1 Material: Shall be made from pure methyl methacrylate monomers.

3.2 Color and Condition: Castings shall be colorless and transparent, except that, when so ordered, castings shall be transparent, translucent, or opaque and in the color specified. Castings shall have a highly polished surface finish.

3.3 Properties: Castings shall conform to the following requirements; tests shall be performed on the castings supplied and in accordance with specified ASTM methods, insofar as practicable:

3.3.1	Index of Refraction (Applicable only to clear castings)	$n_D^{23°C}$ $n_D^{(73.4°F)}$	1.48 to 1.50	ASTM D 542
3.3.2	Specific Gravity at 23°/23°C (73°/73°F)		1.18 to 1.20	ASTM D 792, Method A
3.3.3	Haze, maximum (Applicable only to clear sections 1/2 inch (12.7 mm) thick and under		3%	ASTM D 1003, Procedure A
3.3.4	Water Absorption (gain) at 23°C ± 1 (73°F ± 2), maximum		0.65%	ASTM D 570

3.3.5	Luminous Transmittance, minimum Nominal Thickness 0.250 inch (6.35 mm) and (6.35 mm) and under	90%	ASTM E 308
3.3.6	Heat Distortion Temperature at 264 psi (1.82 MPa) fiber stress, minimum		ASTM D 648; Heating rate 2°C (4°F) per minute

Nominal Thickness			
Inches	Millimetres		
Up to 0.06, incl	Up to 1.5, incl	85°C	185°F
1.0	25	88°C	190°F
2.0 and over	51 and over	90°C	194°F

(For intermediate thicknesses, use interlinear interpolation.)

3.3.7	Tensile Strength, minimum	7500 psi (51.7 MPa)	ASTM D 638 or ASTM D 638M
3.3.8	Elongation, minimum	2%	ASTM D 638 or ASTM D 638M
3.3.9	Flexural Strength, minimum	14,000 psi (96.5 MPa)	ASTM D 790 or ASTM D 790M
3.3.10	Impact Resistance, per unit of notch, minimum	0.3 foot-pound/inch (16 J/m)	ASTM D 256, Method C
3.3.11	Flammability, burning rate, maximum (See 8.2)	2.4 inches per minute (1.00 mm/s)	ASTM D 635, Use specimen 1/8 inch (3.2 mm) in nominal thickness
3.3.12	Insulation Resistance, minimum	1.0 x 10^7 MΩ	4.5.1
3.3.13	Dielectric Strength short-time, minimum	400 volts per mil (15,750 V/mm)	ASTM D 149; Specimens shall be 1/8 inch (3.2 mm) in nominal thickness
3.3.14	Dielectric Breakdown, short-time test, minimum (Applicable only to castings over 1/2 inch (12.7 mm) in nominal thickness	50 kilovolts	4.5.2

3.3.15	Dielectric Constant at 1 MHz, maximum	2.50 ± 0.05	ASTM D 150
3.3.16	Dissipation Factor at 1 MHz, maximum	0.002	ASTM D 150

3.3.17 Corrosion: Castings shall not have a corrosive effect on other materials when exposed to conditions normally encountered in service, determined by a procedure agreed upon by purchaser and vendor. Discoloration of metal shall not be considered objectionable. Ø

3.3.18 Weathering: When specified, castings shall have weather resistance acceptable to purchaser, determined by a procedure agreed upon by purchaser and vendor.

3.4 Quality: Castings, as received by purchaser, shall be uniform in quality and condition, smooth, and free from foreign materials and from imperfections detrimental to usage of the castings. Ø

3.5 Tolerances: Shall be as follows:

3.5.1 Rods:

TABLE I

Nominal Diameter (See 3.5.1.1)		Tolerance, plus and minus	
Inches	Millimetres	Inch	Millimetre
0.375 to 0.625, incl	9.52 to 15.88, incl	0.005	0.13
Over 0.625 to 1.250, incl	Over 15.88 to 31.75, incl	0.010	0.25
Over 1.250 to 2.000, incl	Over 31.75 to 50.80, incl	0.015	0.38
Over 2.000 to 3.000, incl	Over 50.80 to 76.20, incl	0.030	0.76

3.5.1.1 Rods, 0.375 to 0.625 inch (9.52 to 15.88 mm) in nominal diameter, are machined and may have a frosted finish.

3.5.2 Tubes:

3.5.2.1 Outside Diameter:

TABLE II

Nominal OD Inches	OD Tolerance, Inch plus	OD Tolerance, Inch minus	Ovality, max (See 3.5.2.1.1) Inch
1.500 to 3.000, incl	0.010	0.020	0.025
Over 3.000 to 3.750, incl	0.015	0.030	0.040
Over 3.750 to 6.094, incl	0.015	0.045	0.060
Over 6.094 to 12.000, incl	0.015	0.065	0.080

TABLE II (SI)

Nominal OD Millimetres	OD Tolerance, Millimetres plus	OD Tolerance, Millimetres minus	Ovality, max (See 3.5.2.1.1) Millimetres
38.10 to 76.20, incl	0.25	0.51	0.64
Over 76.20 to 95.25, incl	0.38	0.76	1.02
Over 95.25 to 154.79, incl	0.38	1.14	1.52
Over 154.79 to 306.32, incl	0.38	1.65	2.03

3.5.2.1.1 Ovality shall be the difference between the minor and major diameter measurements at the same transverse plane on the tube.

3.5.2.2 Wall Thickness:

TABLE III

Nominal Wall Thickness Inch	Nominal Wall Thickness Millimetres	Tolerance plus and minus Inch	Tolerance plus and minus Millimetres
Up to 0.125, incl	Up to 3.18, incl	0.015	0.38
Over 0.125 to 0.187, incl	Over 3.18 to 4.75, incl	0.019	0.48
Over 0.187 to 0.250, incl	Over 4.75 to 6.35, incl	0.025	0.64
Over 0.250 to 0.375, incl	Over 6.35 to 9.52, incl	0.035	0.89
Over 0.375 to 0.500, incl	Over 9.52 to 12.70, incl	0.045	1.14

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: Ø The vendor of castings shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the castings conform to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests for specific gravity (3.3.2), water absorption (3.3.4), heat distortion temperature (3.3.6), and impact resistance (3.3.10) are acceptance tests and shall be performed on each lot.

4.2.2 Preproduction Tests: Tests for all technical requirements are preproduction tests and shall be performed prior to or on the initial shipment of a casting to a purchaser, when a change in ingredients and/or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.2.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, contracting officer, or request for procurement.

4.3 Sampling and Testing: Shall be in accordance with the following; an Ø inspection lot shall be all castings produced in a single production run from the same batch of raw materials under the same fixed conditions and presented for vendor's inspection at one time.

4.3.1 For Acceptance Tests: Sufficient castings shall be selected at random Ø from each lot to perform all required tests. The number of determinations for each requirement shall be as specified in the applicable test procedure or, if not specified therein, not less than three. An inspection lot shall not exceed 200 pounds (91 kg) of castings but may be packaged in smaller quantities and delivered under the basic lot approval provided lot identification is maintained.

4.3.1.1 When a statistical sampling plan has been agreed upon by purchaser and Ø vendor, sampling shall be in accordance with such plan in lieu of sampling as in 4.3.1 and the report of 4.6 shall state that such plan was used.

4.3.2 For Preproduction Tests: As agreed upon by purchaser and vendor.

4.4 Approval:

4.4.1 Sample castings shall be approved by purchaser before castings for production use are supplied, unless such approval be waived by purchaser. Results of tests on production castings shall be essentially equivalent to those on the approved sample.

4.4.2 Vendor shall use ingredients, manufacturing procedures, processes, and methods of inspection on production castings which are essentially the same as those used on the approved sample castings. If necessary to make any change in ingredients, in type of equipment for processing, or in manufacturing procedures, vendor shall submit for reapproval a statement of the proposed changes in ingredients and/or processing and, when requested, sample castings. Production castings made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Test Methods:

4.5.1 Insulation Resistance:

4.5.1.1 Attachment of Lead Wires: Drill necessary holes in the plate specimen, Figure 3 of ASTM D 257, and solder lead wires into the holes using a pencil-type soldering iron or gun and water-white, unactivated rosin flux, filling the hole with a plug of solder. Remove excess flux and other contaminants by rinsing in a clean mixture of 90% ethanol and 10% distilled water by volume. Air dry. Care should be exercised to avoid touching critical areas of the clean specimen with bare hands.

4.5.1.2 Measurement: Mount test specimens in a circulating-air humidity chamber (provided with suitable specimen lead wire insulators on the chamber) maintained at 95% ± 2 relative humidity at 65°C ± 2 (149°F ± 4) and expose for 18 hours ± 1. Lower the relative humidity to 87% ± 2 while holding the temperature constant and stabilize the specimens at this condition for 2 to 2-1/4 hours. Apply 500 volts direct current between terminal leads and maintain for 60 seconds ± 5. Immediately thereafter, measure insulation resistance in accordance with ASTM D 257 using a megohm bridge. Measurements shall be performed while the relative humidity is 87% ± 1.

4.5.2 Dielectric Breakdown: Test specimens shall be nominally 1/2 inch (12.7 mm) thick by 4 inches (102 mm) square and shall have two 3/16 inch (4.8 mm) diameter through holes, centrally located 1 inch (25 mm) apart and perpendicular to the face of the specimens. Each specimen shall have three pairs of such holes, at random locations, spaced no closer than 1 inch (25 mm) apart. Holes shall be reamed to fit No. 3 American Standard tapered pins which serve as electrodes. The electrodes shall be fitted with 1/2-inch (12.7-mm) diameter spheres on the extremities, to decrease the tendency to flashover during test. Perform dielectric breakdown test in accordance with procedures and apparatus described in ASTM D 149.

4.6 Reports: The vendor of castings shall furnish with each shipment a report showing the results of tests to determine conformance to the acceptance test requirements and stating that the castings conform to the other technical requirements. This report shall include the purchaser order number, lot number, AMS-3581B, vendor's compound number, form and size or part number, and quantity.

4.7 Resampling and Retesting: If any specimen used in the above tests fails to Ø meet the specified requirements, disposition of the castings may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the castings represented. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

5.1.1 Each rod and tube shall be legibly marked, near the outside of one end, with the manufacturer's identification and AMS-3581B. Shapes shall be legibly marked with the same information in an inconspicuous area. The method of marking is optional but shall have no deleterious effect on the castings or their performance. The characters shall be sufficiently stable to withstand normal handling.

5.1.2 Packaging shall be accomplished in such a manner as to ensure that the castings, during shipment and storage, will not be distorted and will be protected against damage from exposure to moisture, weather, or any other normal hazard.