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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 3609D

Issued AUG 1958
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Superseding AMS 3609C

Submitted for recognition as an American National Standard

Methyl Methacrylate Plastic, Sheet
Heat Resistant

FOREWORD

Changes in this revision are format/editorial only.

1. SCOPE:

1.1 Form:

This specification covers one grade of cast methyl methacrylate plastic in the form of sheet.

1.2 Application:

This sheet has been used typically for fabricated parts, formed or otherwise, requiring dimensional stability, optical clarity, good electrical properties, and excellent outdoor weatherability, but usage is not limited to such applications.

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.

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7154 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS: http://www.sae.org

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
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 637	Surface Irregularities of Flat Transparent Plastic Sheets
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 the 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 DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-2073-1	DOD Materiel, Procedures for Development and Application of Packaging Requirements

3. TECHNICAL REQUIREMENTS:

3.1 Material:

Shall be made from pure methacrylate monomers.

3.2 Color and Condition:

Colorless and transparent with a highly polished surface finish except that, when so ordered, sheet shall be transparent, translucent, or opaque, in the color specified.

3.3 Properties:

Sheet shall conform to the requirements shown in Table 1, 3.3.19, and 3.3.20; tests shall be performed on the sheet supplied and in accordance with specified ASTM methods.

Table 1 - Properties

Paragraph	Property	Requirement	Test Method
3.3.1	Index of Refraction (Applicable only to clear sheet) $n_{\frac{23\ °C}{D}}\left(n_{\frac{73\ °F}{D}}\right)$	1.48 to 1.50	ASTM D 542
3.3.2	Specific Gravity, 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 sheet 1/2 inch (12.7 mm) and under in nominal thickness]	3.0%	ASTM D 1003 Procedure A
3.3.4	Water absorption (gain) at 23 °C ± 1 (73 °F ± 2), maximum [Specimens 1/8 inch (3.2 mm) in nominal thickness]	0.65%	ASTM D 570
3.3.5	Luminous Transmittance, minimum (Applicable to colorless, transparent sheet only)		ASTM E 308
	Nominal Thickness Inches		
	Up to 0.187, incl	91%	
	Over 0.187 to 1.000, incl	89%	
	Over 1.000 to 2.000, incl	87%	
	Nominal Thickness Millimeters		
	Up to 4.75, incl	91%	
	Over 4.75 to 25.40, incl	89%	
	Over 25.40 to 50.80, incl	87%	

Table 1 - Properties (Continued)

Paragraph	Property	Requirement	Test Method
3.3.6	Displacement Factor (Optical), maximum (Applicable to flat sheets only)		ASTM D 637 *Measurements made at least 3 inches (76 mm) from the edge of sheet.
	Nominal Thickness Inches		
	Over 0.060 to 0.250, incl	50	
	Over 0.250 to 0.500, incl	50*	
	Over 0.500 to 1.000, incl	80*	
	Over 1.000 to 2.000, incl	125*	
	Nominal Thickness Millimeters		
	Over 1.52 to 6.35, incl	50	
	Over 6.35 to 12.70, incl	50*	
	Over 12.70 to 25.40, incl	80*	
	Over 25.40 to 50.80, incl	125*	
3.3.7	Heat Distortion Temperature, minimum		
	Nominal Thickness Inches		
	Up to 0.06, incl	185 °F	
	1.06	190 °F	
	2.00 and over	195 °F	
	Nominal Thickness Millimeters		
	Up to 1.5, incl	85 °C	
	25.4	88 °C	
	50.8 and over	91 °C	
3.3.7.1	For intermediate thicknesses, use linear interpolation		
3.3.8	Tensile Strength, minimum	7500 psi (51.7 MPa)	ASTM D 638 or ASTM D 638M
3.3.9	Elongation, minimum	2%	ASTM D 638 or ASTM D 638M
3.3.10	Flexural Strength, minimum	14.0 ksi (96.5 MPa)	ASTM D 790 or ASTM D 790M

Table 1 - Properties (Continued)

Paragraph	Property	Requirement	Test Method
3.3.11	Impact Resistance, per unit of notch, minimum	0.3 foot-pound per inch (16 J/m)	ASTM D 256, Method C
3.3.12	Flammability, maximum (See 8.2)	2.4 inches per minute (1.02 mm/s)	ASTM D 635; Use specimens 1/8 inch (3.2 mm) in nominal thickness
3.3.13	Shrinkage, maximum	1.0%	4.5.1
3.3.14	Insulation Resistance, minimum	1.0×10^7 MΩ	4.5.2
3.3.15	Dielectric Strength, short-time, minimum	400 volts per mil (15.7 kV/mm)	ASTM D 149; specimens shall be 1/8 inch (3.2 mm) in nominal thickness
3.3.16	Dielectric Breakdown, short-time, minimum [Applicable only to sheet 1/2 inch (12.7 mm) and over in nominal thickness]	50 kV	4.5.3
3.3.17	Dielectric Constant at 1 MHz, maximum	2.50 ± 0.05	ASTM D 150
3.3.18	Dissipation Factor at 1 MHz, maximum	0.002	ASTM D 150

3.3.19 Weather Resistance: When specified, sheet shall have weather resistance acceptable to purchaser, determined by a procedure agreed upon by purchaser and vendor.

3.3.20 Corrosion: Sheet shall not have a corrosive effect on other materials when exposed to conditions normally encountered in service. Discoloration of metal shall not be considered objectionable. Method of test and standards for acceptance shall be as agreed upon by purchaser and vendor.

3.4 Quality:

Sheet, 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 sheet.

3.5 Tolerances:

Shall be as follows:

3.5.1 Thickness:

TABLE 2A - Thickness Tolerances, Inch/Pound Units (See 3.5.1.1)

Nominal Thickness Inches	Tolerance, Inch Plus and Minus Size 1	Tolerance, Inch Plus and Minus Size 2	Tolerance, Inch Plus and Minus Size 3
Up to 0.060, incl	+0.020 -0.012	--	--
Over 0.060 to 0.080, incl	+0.018 -0.012	0.030	--
Over 0.080 to 0.100, incl	0.012	0.030	--
Over 0.100 to 0.125, incl	0.015	0.030	0.050
Over 0.125 to 0.150, incl	0.017	0.030	0.050
Over 0.150 to 0.187, incl	0.020	0.030	0.050
Over 0.187 to 0.220, incl	0.025	0.030	0.050
Over 0.220 to 0.250, incl	0.030	0.035	0.050
Over 0.250 to 0.312, incl	0.035	0.040	0.060
Over 0.312 to 0.375, incl	0.045	0.045	0.070
Over 0.375 to 0.500, incl	0.060	0.060	0.080
Over 0.500 to 0.625, incl	0.065	0.065	0.085
Over 0.625 to 0.750, incl	0.070	0.070	0.090
Over 0.750 to 0.875, incl	0.075	0.075	0.095
Over 0.875 to 1.000, incl	0.080	0.080	0.100
Over 1.000 to 1.250, incl	0.100	--	--
Over 1.250 to 1.500, incl	0.120	--	--
Over 1.500 to 1.750, incl	0.140	--	--
Over 1.750 (See 3.5.2)	0.160	--	--

TABLE 2B - Thickness Tolerances, SI Units (See 3.5.1.1)

Nominal Thickness Millimeters	Tolerance Millimeters Plus and Minus Size 1	Tolerance Millimeters Plus and Minus Size 2	Tolerance Millimeters Plus and Minus Size 3
Up to 1.52, incl	+0.51 -0.30	--	--
Over 1.52 to 2.03, incl	+0.46 -0.30	0.76	--
Over 2.03 to 2.54, incl	0.30	0.76	--
Over 2.54 to 3.18, incl	0.38	0.76	1.27
Over 3.18 to 3.81, incl	0.43	0.76	1.27
Over 3.81 to 4.75, incl	0.51	0.76	1.27
Over 4.75 to 5.59, incl	0.64	0.76	1.27
Over 5.59 to 6.35, incl	0.76	0.89	1.27
Over 6.35 to 7.92, incl	0.89	1.02	1.52
Over 7.92 to 9.52, incl	1.14	1.14	1.78
Over 9.52 to 12.70, incl	1.52	1.52	2.03
Over 12.70 to 15.88, incl	1.65	1.65	2.16
Over 15.88 to 19.05, incl	1.78	1.78	2.29
Over 19.05 to 22.22, incl	1.90	1.90	2.41
Over 22.22 to 25.40, incl	2.03	2.03	2.54
Over 25.40 to 31.75, incl	2.54	-	-
Over 31.75 to 38.10, incl	3.05	-	-
Over 38.10 to 44.45, incl	3.56	-	-
Over 44.45	4.06	-	-

3.5.1.1 Sizes 1, 2, and 3 are as follows:

Size 1: Up to and including 36 x 60 inches (914 x 1524 mm) and 40 x 50 inches (1016 x 1270 mm).
Size 2: Larger than size 1 up to and including 53 x 60 inches (1346 x 1524 mm) and 60 x 72 inches (1524 x 1829 mm).
Size 3: Larger than size 2 up to and including 67 x 102 inches (1702 x 2591 mm) and 72 x 72 inches (1829 x 1829 mm)

3.5.2 Sheet 2.000 inches (50.80 mm) and over in nominal thickness is available in 0.250 inch (6.35 mm) increments to a maximum thickness of 4.000 inches (101.60 mm) (unfinished grade) with a tolerance of ±0.080 inch per inch (±0.080 mm/mm) of nominal thickness.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of sheet 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 sheet 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 (3.3.7), and impact resistance (3.3.11) 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 sheet 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 as follows:

4.3.1 For Acceptance Tests: Sufficient sheet shall be taken at random 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.

4.3.1.1 A lot shall be all sheet of the same nominal thickness produced from the same batch of raw material in a single production run under the same fixed conditions and presented for vendor's inspection at one time but shall not exceed 1500 square feet (139 m^2).

4.3.1.2 When a statistical sampling plan has been agreed upon by purchaser and 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 sheet shall be approved by purchaser before sheet for production use is supplied, unless such approval be waived by purchaser. Results of tests on production sheet 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 sheet which are essentially the same as those used on the approved sample. If necessary to make any change in ingredients, in type of 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 sheet. Production sheet made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Test Methods:

4.5.1 Shrinkage: Using a 12 x 18 inch (305 x 457 mm) test specimen, at one end mark off a 12 x 12 inch (305 x 305 mm) test area and use the remainder of the specimen for supporting attachments during the heating period. Scribe two fine lines at right angles to each other entirely across the test area from the midpoints of opposite sides. Across each of these lines, scribe fine gage marks 2 inches (50.8 mm) in from the edges of the test area. Measure and average the distance between these pairs of gage marks to the nearest 0.01 inch (0.25 mm). Suspend the specimen from the support end in a circulating-air oven and heat for 30 minutes ± 1 at 125 °C ± 1 (257 °F ± 2). For nominal thicknesses over 0.250 inch (6.35 mm), extend the time in proportion to 1.3 times the direct ratio of the thickness to 0.250 inch (6.35 mm). Remove the specimen from the oven and allow to cool to room temperature while still suspended. Remeasure the distance between the pairs of gage marks and average the results. Calculate the shrinkage as the percentage change in distance between gage marks based upon the original distance.

4.5.2 Insulation Resistance:

4.5.2.1 Attachment of Lead Wires: Drill necessary holes in the plate specimen, as in Figure 3 of ASTM D 257, and solder lead wires into the holes using a pencil-type soldering iron or gun and water-white, inactivated 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.

4.5.2.2 Measurement: Mount 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 DC between terminal leads and maintain electrification time for one minute. 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.