SAE The Engineering Society For Advancing Mobility Land Sea Air and Space

400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 3609B

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Superseding AMS 3609A

PLASTIC SHEET
Methyl Methacrylate, Heat Resistant

1. SCOPE:

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

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 3608, and excellent outdoor weatherability.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM D149 - Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D150 - A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials
ASTM D256 - Impact Resistance of Plastics and Electrical Insulating Materials
ASTM D257 - D-C Resistance or Conductance of Insulating Materials
ASTM D542 - Index of Refraction of Transparent Organic Plastics

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2.2 (Continued):

ASTM D570 - Water Absorption of Plastics
ASTM D635 - Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D637 - Surface Irregularities of Flat Transparent Plastic Sheets
ASTM D638 - Tensile Properties of Plastics
ASTM D648 - Deflection Temperature of Plastics Under Flexural Load
ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D792 - Specific Gravity and Density of Plastics by Displacement
ASTM D1003 - Haze and Luminous Transmittance of Transparent Plastics
ASTM E308 - Computing the Colors of Objects by Using the CIE System

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 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 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 following requirements; tests shall be performed on the sheet supplied and in accordance with specified ASTM methods:

3.3.1	Index of Refraction (Applicable only to clear sheet)	$n\frac{23°C}{D}$	$(n\frac{73°F}{D})$	1.48 to 1.50	ASTM D542
3.3.2	Specific Gravity, 23°/23°C (73°/73°F)			1.18 to 1.20	ASTM D792, Method A
3.3.3	Haze, max [Applicable only to clear sheet 1/2 in. (12 mm) and under in nominal thickness]			3.0%	ASTM D1003, Procedure A
3.3.4	Water Absorption (gain) at 23°C ± 1 (73°F ± 2), max [Specimens 1/8 in. (3.2 mm) in nominal thickness]			0.65%	ASTM D570

3.3.5 Luminous Transmittance, min (Applicable to colorless, transparent sheet only) — ASTM E308

Nominal Thickness		
Inches	Millimetres	
Up to 0.187, incl	Up to 4.75, incl	91%
Over 0.187 to 1.000, incl	Over 4.75 to 25.00, incl	89%
Over 1.000 to 2.000, incl	Over 25.00 to 50.00, incl	87%

3.3.6 Displacement Factor (Optical), max (Applicable to flat sheets only) — ASTM D637 *Measurements made at least 3 in. (75 mm) from the edge of sheet.

Nominal Thickness		
Inches	Millimetres	
0.060 to 0.250, incl	Over 1.50 to 6.25, incl	50
Over 0.250 to 0.500, incl	Over 6.25 to 12.50, incl	50*
Over 0.500 to 1.000, incl	Over 12.50 to 25.00, incl	80*
Over 1.000 to 2.000, incl	Over 25.00 to 50.00, incl	125*

3.3.7 Heat Distortion Temperature (264 psi (1.82 MPa) fiber stress), min — ASTM D648 (Heating Rate: 2°C (3.6°F) per min.)

Nominal Thickness		
Inches	Millimetres	
Up to 0.06, incl	Up to 1.5, incl	85.2°C (185°F)
1.0	25.0	87.5°C (190°F)
2.0 and over	50.0 and over	90.0°C (195°F)

3.3.7.1 For intermediate thicknesses, use linear interpolation.

3.3.8	Tensile Strength, min	7500 psi (50 MPa)	ASTM D638
3.3.9	Elongation, min	2%	ASTM D638
3.3.10	Flexural Strength, min	14,000 psi (95 MPa)	ASTM D790
3.3.11	Impact Resistance, per unit of notch, min	0.3 ft-lb per in. (16 J/m)	ASTM D256, Method C
3.3.12	Flammability, max	2.4 in. per min. (1.00 mm/s)	ASTM D635; Use specimens 1/8 in. (3 mm) in nominal thickness
3.3.13	Shrinkage, max	1.0%	4.5.1

3.3.14	Insulation Resistance, min	1.0×10^7 MΩ	4.5.2
3.3.15	Dielectric Strength, short-time, min	400 V per mil (15,750 V/mm)	ASTM D149; specimens shall be 1/8 in. (3 mm) in nominal thickness
3.3.16	Dielectric Breakdown, short-time, min [Applicable only to sheet 1/2 in. (12.50 mm) and over in nominal thickness]	50 kV	4.5.3
3.3.17	Dielectric Constant at 1 MHz, max	2.50 ± 0.05	ASTM D150
3.3.18	Dissipation Factor at 1 MHz, max	0.002	ASTM D150

3.3.19 Weathering: 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 I

Nominal Thickness Inches	Tolerance, Inch Plus and Minus, Except as Indicated		
	Size 1	Size 2 (See 3.5.1.1)	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 I (SI)

Nominal Thickness Millimetres	Tolerance, Millimetres Plus and Minus, Except as Indicated		
	Size 1	Size 2 (See 3.5.1.1)	Size 3
Up to 1.50, incl	+0.50 -0.30	--	--
Over 1.50 to 2.00, incl	+0.45 -0.30	0.75	--
Over 2.00 to 2.50, incl	0.30	0.75	--
Over 2.50 to 3.12, incl	0.38	0.75	1.25
Over 3.12 to 3.75, incl	0.42	0.75	1.25
Over 3.75 to 4.75, incl	0.50	0.75	1.25
Over 4.75 to 5.50, incl	0.62	0.75	1.25
Over 5.50 to 6.25, incl	0.75	0.88	1.25
Over 6.25 to 7.80, incl	0.88	1.00	1.50
Over 7.80 to 9.50, incl	1.12	1.12	1.75
Over 9.50 to 12.50, incl	1.50	1.50	2.00
Over 12.50 to 15.50, incl	1.62	1.62	2.12
Over 15.50 to 18.75, incl	1.75	1.75	2.25
Over 18.75 to 22.00, incl	1.88	1.88	2.38
Over 22.00 to 25.00, incl	2.00	2.00	2.50
Over 25.00 to 31.25, incl	2.50	--	--
Over 31.25 to 37.50, incl	3.00	--	--
Over 37.50 to 43.75, incl	3.50	--	--
Over 43.75	4.00		

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

Size 1: Up to and including 36 x 60 in. (900 x 1500 mm) and 40 x 50 in. (1000 x 1250 mm).
Size 2: Larger than size 1 up to and including 53 x 60 in. (1325 x 1500 mm) and 60 x 72 in. (1500 x 1800 mm).
Size 3: Larger than size 2 up to and including 67 x 102 in. (1675 x 2550 mm) and 72 x 72 in. (1800 x 1800 mm).

3.5.2 Sheet 2.000 in. (50.00 mm) and over in nominal thickness is available in 0.250 in. (6.25 mm) increments to a maximum thickness of 4.000 in. (100.00 mm) (unfinished grade) with a tolerance of ±0.080 in. per in. (±0.080 mm/mm) of nominal thickness.

4. QUALITY ASSURANCE PROVISION:

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. Results of such tests shall be reported to the purchaser as required by 4.6. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the sheet conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to requirements for specific gravity (3.3.2), water absorption (3.3.4), heat distortion temperature (3.3.7), and impact resistance (3.3.11) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests and shall be performed prior to or on the initial shipment of sheet to a purchaser, when a change in material, processing, or both 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, the contracting officer, or the request for procurement.

4.3 Sampling: 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 sq ft (140 m^2); a lot may be packaged and delivered in smaller quantities under the basic lot approval provided lot identification is maintained.

4.3.1.2 When a statistical sampling plan and acceptance quality level (AQL) have 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 4.6.1 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 sheet. 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 material, processing, or both 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 in. (300 x 450 mm) test specimen, at one end mark off a 12 x 12 in. (300 x 300 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 in. (50 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 in. (0.25 mm). Suspend the specimen from the support end in a circulating-air oven and heat for 30 min. + 1 at 125°C + 1 (255°F + 2). For nominal thicknesses over 0.250 in. (6.25 mm), extend the time in proportion to 1.3 times the direct ratio of the thickness to 0.250 in. (6.25 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, Fig. 3 of ASTM D257, 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.

4.5.2.2 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 (150°F + 4) and expose for 18 hr + 1. Lower the relative humidity to 87% + 2 while holding the temperature constant and stabilize the specimens at this condition for 2 - 2-1/4 hours. Apply 500 V DC between terminal leads and maintain electrification time for 1 minute. Immediately thereafter, measure insulation resistance in accordance with ASTM D257, using a megohm bridge (General Radio Type 544B or equivalent). Measurements shall be performed while the relative humidity is 87% ± 1.