

**AEROSPACE
MATERIAL
SPECIFICATION**

AMS 3605E
Superseding AMS 3605D

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PLASTIC SHEET, POST-FORMING
Cotton Fabric Reinforced Phenol-Formaldehyde

1. SCOPE:

1.1 Form: This specification covers phenol/formaldehyde-resin-impregnated, cotton fabric laminates in the form of sheet.

1.2 Application: Primarily for drawing and bending by the post-forming method into parts where good mechanical and burn resistance properties are important but electrical properties are of secondary importance. This product is often used for fair leads and tubing supports.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) 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 D256 - Impact Resistance of Plastics and Electrical Insulating Materials

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 D638 - Tensile Properties of Plastics

ASTM D695 - Compressive Properties of Rigid Plastics

ASTM D709 - Laminated Thermosetting Materials

ASTM D790 - Flexural Properties of Plastics and Electrical Insulating Materials

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AMS 3605E

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120, except as specified in 2.3.2.

2.3.1 Military Standards:

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

2.3.2 Federal Aviation Regulations: Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

FAR Part 25, Airworthiness Standards, Transport Category Airplanes

3. TECHNICAL REQUIREMENTS:

3.1 Material and Fabrication: Sheet shall be constructed of laminations of cotton fabric which have been impregnated with a phenolic-type synthetic resin and properly cured.

3.1.1 Color: Shall be natural (tan), unless otherwise specified. Supplementary coloring, when specified, shall be substantially uniform throughout the sheet. Faces of sheet shall be substantially free from streaks and stains.

3.1.2 Finish: Shall be semi-gloss, unless otherwise specified.

3.2 Properties: Sheet shall conform to the following requirements in both the warp and fill directions of the base fabric except as otherwise specified;
Ø tests shall be performed on the sheet supplied and in accordance with specified test methods, insofar as practicable. Where requirements vary with standard thickness, use the value for the next lower thickness for thicknesses not specified.

3.2.1	Tensile Strength, min	7,500 psi (51.5 MPa)	ASTM D638
3.2.2	Compressive Strength, Flatwise, min	30,000 psi (205 MPa)	ASTM D695
3.2.3	Flexural Strength, flatwise, min Ø	16,000 psi (110 MPa) warp 15,000 psi (105 MPa) fill	ASTM D790
3.2.4	Impact Strength, edgewise, min per unit of notch	1.5 ft-lb per in. (80 J/m)	ASTM D256
3.2.5	Bend Radius, Room Temperature	40T	See 4.5.1

- 3.2.6 Post-Forming: The time range specified shall permit forming to the radii indicated for the thickness shown, determined in accordance with 4.5.2. The optimum heating time for each thickness shall be within the heating time range limits.

Nominal Thickness		Heating Time Range Limits Sec	Inside Radius	
Inch	Millimetres		Inch	Millimetres
1/32	0.8	20 to 35	1/32	0.8
3/64	1.2	30 to 50	1/16	1.6
1/16	1.6	40 to 70	3/32	2.4
3/32	2.4	60 to 95	3/16	4.8
1/8	3.2	80 to 120	5/16	8.0
5/32	4.0	100 to 160	7/16	11.0
3/16	4.8	130 to 200	9/16	14.0
7/32	5.6	160 to 240	1 1/16	20.5
1/4	6.2	180 to 260	1	25.0

- 3.2.7 Dimensional Stability, Springback: The maximum springback shall be 37 deg, determined in accordance with 4.5.3.

- 3.2.8 Drawing: Sheet shall withstand drawing to the depths indicated, determined in accordance with 4.5.4.

Nominal Thickness		Depth of Draw	
Inch	Millimetres	Inch	Millimetres
1/32	0.8	1-3/8	34.5
3/64	1.2	1-3/8	34.5
1/16	1.6	1-1/4	31.0
3/32	2.4	1-1/8	28.0
1/8	3.2	3/4	19.0

- 3.2.8.1 For intermediate thicknesses, the value for the next larger thickness shall apply.

- 3.2.9 Water Absorption: Shall be as follows, determined in accordance with ASTM D570 on specimens immersed for 24 hr $\pm$ 0.5 at room temperature:

Nominal Thickness			Nominal Thickness		
Inch	Millimetres	% Gain max	Inch	Millimetres	% Gain max
1/32	0.8	7.5	1/8	3.2	2.5
3/64	1.2	5.2	5/32	4.0	2.2
1/16	1.6	4.4	3/16	4.8	1.9
3/32	2.4	3.2	7/32	5.6	1.8
			1/4	6.2	1.6

AMS 3605E

- 3.2.10 Horizontal Burn Requirement: Sheet shall meet the requirements of FAR 25.853 appendix b-3.
- 3.2.11 Afterglow, as Received: Shall not exceed 4 sec, determined in accordance with 4.5.5 (See 8.2).
- 3.2.12 Afterglow After Conditioning: Shall not exceed 15 sec, determined in accordance with 4.5.6 (See 8.2).
- 3.2.13 Weather Resistance: When specified, sheet shall have weather resistance acceptable to the purchaser, determined by a procedure agreed upon by purchaser and vendor.
- 3.2.14 Corrosion: Sheet shall not have a corrosive effect on other materials when exposed to conditions normally encountered in service. Discoloration of metals shall not be considered objectionable. Method of test and standards for acceptance shall be as agreed upon by purchaser and vendor.
- 3.2.15 Machinability: Sheet, at room temperature, shall not split, crack, chip, or delaminate when punched in nominal thickness 1/8 in. (3 mm) and under or when drilled, sawed, or machined in any thickness.
- 3.3 Quality: Sheet, as received by purchaser, shall be uniform in quality and condition and free from blisters, wrinkles, cracks, crazing, delamination, and surface roughness, and reasonably free from other imperfections such as scratches and dents.
- 3.4 Sizes and Tolerances: Unless otherwise specified, the following shall apply:
- 3.4.1 Thickness: Standard thicknesses and tolerances shall be in accordance with Table I.

TABLE I

Nominal Thickness Inch	Tolerance Inch plus and minus
1/32	0.0065
3/64	0.0075
1/16	0.0075
3/32	0.009
1/8	0.010
5/32	0.011
3/16	0.0125
7/32	0.014
1/4	0.030

TABLE I (SI)

Nominal Thickness Millimetres	Tolerance Millimetre plus and minus
0.8	0.165
1.2	0.190
1.6	0.190
2.4	0.23
3.2	0.25
4.0	0.28
4.8	0.318
5.6	0.35
6.2	0.75

3.4.2 Length and Width: Shall not vary more than ± 1 in. (± 25 mm) from the nominal dimensions ordered.

3.4.3 Warp and Twist: Shall not exceed 1% based on a 36 in. (900 mm) length, determined in accordance with ASTM D709.

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. 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 flexural strength (3.2.3), post-forming dimensional stability (3.2.7), and afterglow as received (3.2.11) 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 or 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 batches of raw materials in a single production run under the same fixed conditions and presented for vendor's inspection at one time.

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 or 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 Bend Radius: A 1-in. (25 mm) wide specimen cut in any direction from sheet shall not split, crack, craze, or delaminate when bent, at room temperature, through an angle of 180 deg around the radius specified. Permanent set of the specimen is permissible.

4.5.2 Post-forming: Six 2 x 6 in. (50 x 150 mm) specimens, three longitudinal and three transverse, shall be tested. The specimens shall be heated in a forced-circulation type air oven which is within the range 245° to 275°C (475° to 525°F) for the time given in 3.2.6. Immediately (within 10 sec) after heating, the specimens shall be bent through an angle of 90 deg between wooden or cast resin forms to conform to the bending fixture shown in Fig. 1 and allowed to cool in the form. After removal from the form, the specimen shall retain an angle of not over 95 degrees.

- 4.5.2.1 Small blisters up to 1/4 in. (6.2 mm) in diameter are permissible after heating but prior to forming provided they do not exceed four per square foot ($43/\text{m}^2$) per side and are not gathered together in clusters. After forming, specimens shall show no signs of splitting or delamination which cause a break in the fabric reinforcement. Small checks in the resin not exceeding 1/8 in. (3 mm) long are permissible on the formed specimens when heated within the time limits of 3.2.6 except that no blisters, cracks, checks, or delaminations are permissible on the specimen when formed within 5 sec of the optimum heating time determined as in 3.2.6.
- 4.5.3 Dimensional Stability: The specimens successfully formed as in 4.5.2 shall be heated by immersing in water at $82^\circ\text{C} \pm 1$ ($180^\circ\text{F} \pm 2$) for 1 hour. After removing from the water and cooling unrestrained, the amount of springback shall be measured.
- 4.5.4 Drawing: Specimens 6 in. (150 mm) in diameter shall be heated as specified in 4.5.2. Immediately (within 10 sec) after the heating, the specimens shall be drawn in a suitable jig having a steel mandrel and draw ring. The mandrel (male die) shall be a 3-in. (75 mm) diameter cylinder with a 1.5-in. (37.5 mm) spherical radius on the contact end. The draw ring (female die) shall have a cylindrical hole (diameter equal to 3 in. (75 mm) plus 2.5 time the thickness of sheet) through which the mandrel travels in making the draw, and shall be maintained between 135° and 150°C (275° and 300°F). A draw radius of 0.125 in. (3.1 mm) shall be provided on the inside of the draw ring. The specimen shall be clamped at 20 psi (240 kPa) against the draw ring before the draw begins. Under these conditions, the sheet shall produce satisfactory draws as specified in 3.2.8.
- 4.5.5 Afterglow as Received: Three specimens, 6 x 1/2 in. (150 x 12.5 mm) as received, shall be placed in a shielded area of subdued light, such as an unlighted fume hood, mounted horizontally as in ASTM D635, except that the screen need not be used. A Meker or similar large top burner with a flame 1 in. (25 mm) long shall be placed so that the tip of the flame contacts the plastic, and 1 in. (25 mm) of the plastic is covered by the flame. The specimens shall be heated 15 sec for each 1/32 in. (0.8 mm) of thickness and fraction thereof. At the end of the ignition period, the burner shall be removed and the flame on the specimen shall be blown out. The duration of visible glow shall then be noted.
- 4.5.6 Afterglow Conditioned: Three specimens shall be conditioned for not less than 168 hr at $105^\circ\text{C} \pm 3$ ($225^\circ\text{F} \pm 5$) and tested as in 4.5.5.

AMS 3605E

4.6 Reports:

- 4.6.1 The vendor of sheet shall furnish with each shipment three copies of a report showing the results of tests to determine conformance to the acceptance test requirements and stating that the sheet conforms to the other technical requirements of this specification. This report shall include the purchase order number, lot number, AMS 3605E, vendor's material designation, optimum heating time (See 3.2.6), size, and quantity.
- 4.6.2 The vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, AMS 3605E, contractor or other direct supplier of sheet, supplier's material designation, part number, and quantity. When sheet for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of sheet to determine conformance to the requirements of this specification and shall include in the report either a statement that the sheet conforms or copies of laboratory reports showing the results of tests to determine conformance.
- 4.7 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the sheet 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 sheet represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

- 5.1.1 Each sheet shall be marked on one corner with the manufacturer's identification and AMS 3605E. The characters shall be of such size as to be legible, shall be applied using a suitable marking fluid, and shall be sufficiently stable to withstand normal handling.
- 5.1.2 Packaging shall be accomplished in such a manner as to ensure that the sheet, during shipment and storage, will not be permanently distorted and will be protected against damage from exposure to moisture, weather, or any other normal hazard.
- 5.1.3 Each package shall be permanently and legibly marked to show not less than the following information:

PLASTIC SHEET, POST-FORMING, COTTON FABRIC REINFORCED PHENOL-FORMALDEHYDE
AMS 3605E
PURCHASE ORDER NUMBER _____
SIZE _____
QUANTITY _____
MANUFACTURER'S IDENTIFICATION _____