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400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 3605F

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Submitted for recognition as an American National Standard

Superseding AMS 3605E

Plastic Sheet, Post-Forming
Cotton Fabric Reinforced Phenol-Formaldehyde

FOREWORD

Changes in this reaffirm are editorial/format only.

1. SCOPE:

1.1 Form:

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

1.2 Application:

This sheet has been used typically 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, and used for fair leads and tubing supports, 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 latest issue of SAE publications shall apply. The applicable issue of other 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 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2825 Material Safety Data Sheets

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 256 Impact Resistance of Plastics and Electrical Insulating Materials
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 695 Compressive Properties of Rigid Plastics
ASTM D 695M Compressive Properties of Rigid Plastics (Metric)
ASTM D 709 Laminated Thermosetting Materials
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)

2.3 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

2.4 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 resin and properly cured.

3.1.1 Color: Shall be natural (tan). 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.

3.2 Properties:

Sheet in both the warp and fill directions of the base fabric, except as otherwise specified, shall conform to the requirements shown in Table 1 and the following: 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, unless otherwise indicated.

TABLE 1 - Properties

Paragraph	Property	Requirement	Test Method
3.2.1	Tensile Strength, minimum	7.5 ksi (51.7 MPa)	ASTM D 638 or ASTM D 638 M
3.2.2	Compressive Strength, Flatwise, minimum	30.0 ksi (207 MPa)	ASTM D 695 or ASTM D 695M
3.2.3	Flexural Strength, flatwise, minimum	16.0 ksi (110 MPa) warp 15.0 ksi (103 MPa) fill	ASTM D 790 or ASTM D 790M
3.2.4	Impact Strength, edgewise, minimum per unit of notch	1.5 foot-pounds per inch (80 J/m)	ASTM D 256
3.2.5	Bend Radius, Room Temperature	40T	4.5.1

3.2.6 Post-Forming: The time range specified shall permit forming to the radii indicated for the thickness shown in Table 2, determined in accordance with 4.5.2. The optimum heating time for each thickness shall be within the heating time range limits shown in Table 2.

TABLE 2 - Forming Requirements

Nominal Thickness Inch	Nominal Thickness Millimeters	Heating Time Range Limits Seconds	Inside Radius Inch	Inside Radius Millimeters
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	7.9
5/32	4.0	100 to 160	7/16	11.1
3/16	4.8	130 to 200	9/16	14.3
7/32	5.6	160 to 240	13/16	20.6
1/4	6.4	180 to 260	1	25.4

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

3.2.8 Drawing: Sheet shall withstand drawing to the depths indicated in Table 3, determined in accordance with 4.5.4.

TABLE 3 - Depth of Draw

Nominal Thickness Inch	Nominal Thickness Millimeters	Depth of Draw Inch	Depth of Draw Millimeters
1/32	0.8	1-3/8	34.9
3/64	1.2	1-3/8	34.9
1/16	1.6	1-1/4	31.8
3/32	2.4	1-1/8	28.6
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 shown in Table 4, determined in accordance with ASTM D 570 on specimens immersed for 24 hours ± 0.5 at room temperature:

TABLE 4 - Water Absorption

Nominal Thickness Inch	Nominal Thickness Millimeters	Maximum Gain Percentage
1/32	0.8	7.5
3/64	1.2	5.2
1/16	1.6	4.4
3/32	2.4	3.2
1/8	3.2	2.5
5/32	4.0	2.2
3/16	4.8	1.9
7/32	5.6	1.8
1/4	6.4	1.6

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 four seconds, determined in accordance with 4.5.5 (See 8.2).

3.2.12 Afterglow, After Conditioning: Shall not exceed 15 seconds, determined in accordance with 4.5.6 (See 8.2).

3.2.13 Weather Resistance: When specified, sheet shall have weather resistance acceptable to 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 inch (3.2 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:

Shall be as follows:

3.4.1 Thickness: Standard thicknesses and tolerances shall be in accordance with Table 5.

TABLE 5A - Thickness Tolerances, Inch/Pound Units

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 5B - Thickness Tolerances, SI Units

Nominal Thickness Millimeters	Tolerance Millimeter 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	0.36
6.4	0.76

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

3.4.3 Warp and Twist: Shall not exceed 1% based on a 36-inch (914-mm) length, determined in accordance with ASTM D 709.

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 conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests for flexural strength (3.2.3), post-forming dimensional stability (3.2.7), and afterglow as received (3.2.11) 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 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 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 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 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 Bend Radius: A 1-inch (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 degrees around the radius specified. Permanent set of the specimen is permissible.

4.5.2 Post-forming: Six 2 x 6 inch (51 x 152 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 (473 to 527 °F) for the time given in 3.2.6. Immediately (within 10 seconds) after heating, the specimens shall be bent through an angle of 90 degrees between wooden or cast resin forms to conform to the bending fixture shown in Figure 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 inch (6.4 mm) in diameter are permissible after heating, but prior to forming, provided they do not exceed four per square foot (43/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 inch (3.2 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 five seconds 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 °C ± 1 (180 °F ± 2) for one hour. After removing from the water and cooling unrestrained, the amount of springback shall be measured.

4.5.4 Drawing: Specimens, 6 inches (152 mm) in diameter, shall be heated as specified in 4.5.2. Immediately (within 10 seconds) after 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 inch (76 mm) diameter cylinder with a 1.5 inch (38 mm) spherical radius on the contact end. The draw ring (female die) shall have a cylindrical hole (diameter equal to 3 inches (76 mm) plus 2.5 times the thickness of sheet) through which the mandrel travels in making the draw, and shall be maintained between 135 and 150 °C (275 and 302 °F). A draw radius of 0.125 inch (3.18 mm) shall be provided on the inside of the draw ring. The specimen shall be clamped at 20 psi (138 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 inch (152 x 12.7 mm) as received, shall be placed in a shielded area of subdued light, such as an unlighted fume hood, mounted horizontally as in ASTM D 635, except that the screen need not be used. A Meker or similar large top burner with a flame 1 inch (25 mm) long shall be placed so that the tip of the flame contacts the plastic, and 1 inch (25 mm) of the plastic is covered by the flame. The specimens shall be heated 15 seconds for each 1/32 inch (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, As Conditioned: Three specimens shall be conditioned for not less than 168 hours at 105 °C ± 3 (221 °F ± 5) and tested as in 4.5.5.

4.6 Reports:

The vendor of sheet shall furnish with each shipment 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. This report shall include the purchase order number, lot number, AMS 3605F, vendor's material designation, optimum heating time (See 3.2.6), size, and quantity.

4.6.1 A material safety data sheet conforming to AMS 2825, or equivalent, shall be supplied to each purchaser prior to, or concurrent with, the report of preproduction test results or, if preproduction testing be waived by purchaser, concurrent with the first shipment of sheet for production use. Each request for modification of sheet formulation shall be accompanied by a revised data sheet for the proposed formulation

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. Results of all tests shall be reported.