

AEROSPACE MATERIAL SPECIFICATION

Cloth, Carbon Fiber,
Resin Impregnated

1. SCOPE:

- 1.1 Form:** This specification and its supplementary detail specifications cover continuous multifilament carbon tow woven into fabric and impregnated with uncured resin.
- 1.2 Application:** Primarily for fabricating composite parts where the characteristics of woven fabric are desired.
- 1.3 Classification:** The requirements specified herein and in the applicable detail specifications define each cloth by fiber, resin, style, and type of weave.
- 1.4 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 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
- AMS 2825 - Material Safety Data Sheets
- AMS 3892 - Fibers, Carbon (Graphite) Tow and Yarn, for Structural Composites

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SAE WEB ADDRESS:

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

- ASTM D123 - Terminology Relating to Textile Materials
- ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- ASTM D792 - Specific Gravity (Relative Density) and Density of Plastics by Displacement
- ASTM D1505 - Density of Plastics by the Density-Gradient Method
- ASTM D1682 - Breaking Load and Elongation of Textile Fabrics
- ASTM D2344 - Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short Beam Method
- ASTM D2734 - Void Content of Reinforced Plastics
- ASTM D3039 - Tensile Properties of Fiber-Resin Composites
- ASTM D3171 - Fiber Content of Resin-Matrix Composites by Matrix Digestion
- ASTM D3410 - Compressive Properties of Unidirectional or Crossply Fiber-Resin Composites
- ASTM D3529 - Resin Solids Content of Carbon Fiber-Epoxy Prepreg
- ASTM D3530 - Volatiles Content of Carbon Fiber-Epoxy Prepreg
- ASTM D3531 - Resin Flow of Carbon Fiber-Epoxy Prepreg
- ASTM D3532 - Gel Time of Carbon Fiber-Epoxy Prepreg
- ASTM D3775 - Fabric Count of Woven Fabric
- ASTM D3776 - Mass per Unit Area (Weight) of Woven Fabric

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 Detail Specifications:** The requirements for a specific cloth shall consist of all the requirements specified herein in addition to the requirements specified in the applicable detail specification. In case of conflict between requirements of this basic specification and an applicable detail specification, requirements of the detail specification shall govern.

3.2 Material:

- 3.2.1 Construction:** The product shall consist of parallel continuous carbon fibers, woven into the specified fabric style, impregnated with uncured resin, and arranged in a single in-plane layer.

3.2.2 Fiber: The cloth shall be woven from AMS 3892/___ carbon fiber tows or as otherwise specified by purchaser. The carbon fiber tow shall be an untwisted strand for both the warp and fill. A resin compatible finish or treatment may be applied to promote weaving, impregnation, or fiber-matrix interaction.

3.2.3 Resin Matrix: The woven fabric shall be impregnated with a matrix resin yielding a product meeting the requirements of the detail specification. Impregnation shall be either by the solvent or hot melt method.

3.2.4 Alignment: The alignment of the warp and fill yarns shall be perpendicular to each other and shall be parallel to the warp and fill direction of the impregnated cloth within three degrees (four degrees for the first and last 10 yards (9 m) on a roll).

3.2.5 Selvage: Shall not exceed 1.5 inches (38 mm) on each side.

3.2.6 Tracer Yarns: Tracer yarns shall be placed in the woven cloth. Tracer yarns shall be aramid or other material specified by purchaser. No carbon fiber warp or fill yarns may be deleted to incorporate the tracer yarn. Tracer yarns shall be as follows:

	Tracer	Spacing
Warp	195 Denier	1.75 - 2.25 inches (44.4 - 57.2 mm)
Fill	380 Denier	5 - 7 inches (127 - 178 mm)

3.2.7 Storage Life: The product, when packaged in waterproof, heat-sealed bags, shall meet the requirements of the applicable detail specification after storage as specified therein.

3.2.8 Working Life: The product shall meet the requirements of the applicable detail specification after exposure for a continuous period at the relative humidity and temperature specified in Figure 1.

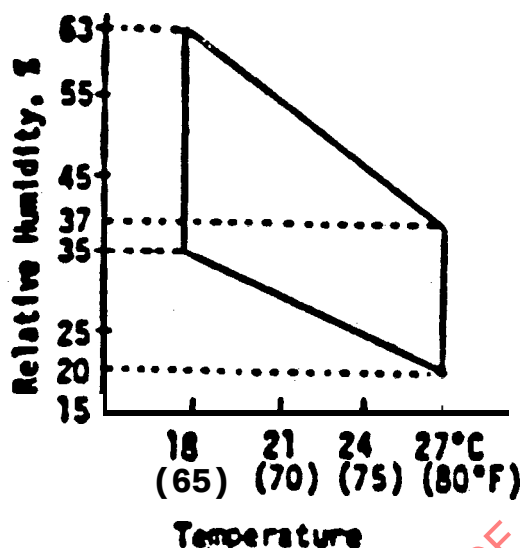


FIGURE 1

- 3.3 Properties of Uncured Impregnated Material:** The as-received product shall conform to the requirements of this specification and to the applicable detail specification. Tests shall be performed on the product as-supplied in accordance with test procedures specified herein.
- 3.4 Properties of Cured Laminate:** Test laminates shall conform to the requirements of this specification and the applicable detail specification. Tests shall be performed on specimens cut from laminates prepared and tested in accordance with 4.4.1.
- 3.5 Quality:** The product, as received by purchaser, shall be uniform in quality and condition and free from foreign material and from imperfections detrimental to usage of the product.
- 3.6 Imperfections:** In any 100 yd (91.4 m) of fabric supplied, there shall be no more than ten major, or equivalent minor (2 minors = 1 major) imperfections, based on the following imperfection classification:

Imperfection	Description and Limitation	Classification
Bias or bowed filling	Distorted from horizontal by more than 3 inches (76 mm) for 38 inches (965 mm) and proportionately for all other widths	Minor
Baggy, ridgy, or wavy cloth	Clearly noticeable	Major

AMS 3897	SAE	AMS 3897
Cut or tear	2 inches (51 mm) or over in combined directions	Major
	Under 2 inches (51 mm) but over 1/4 inch (6.4 mm) in combined directions	Minor
Hole	1/2 inch (12.7 mm) or over in diameter	Major
	Under 1/2 inch (12.7 mm) in diameter	Minor
Spots, streaks	Clearly noticeable 2 inches (51 mm) or over in combined directions	Major
	Clearly noticeable under 2 inches (51 mm) in combined directions	Minor
Tender or weak spot	Clearly noticeable 2 inches (51 mm) or over in combined directions	Major
	Clearly noticeable under 2 inches (51 mm) but over 1/4 inch (6.4 mm) in combined directions	Minor
Smash	3 inches (76 mm) or over in combined directions	Major
	Under 3 inches (76 mm) in combined directions	Minor
Broken or missing ends or picks	3 or more contiguous regardless of length of 2 contiguous over 36 inches (914 mm) in length	Major
	2 contiguous under 36 inches (914 mm) in length	Minor
Floats	2 inches (51 mm) or over in combined directions	Major
	Under 2 inches (51 mm) in combined directions	Minor
Coarse or light place	Over 1/2 inch (51 mm) in width causing thickness outside limits specified in 3.2.2	Minor

Selvage defects	Cut or torn	Major
	Curled or folded under	Minor
Crease over on self	Hard, embedded and folded	Major
Brittle or fused area	Any	Major
Uneven finish	Thin areas where impregnation resin is missing or insufficient	Major

3.7 Tolerances: Shall be as follows:

3.7.1 Width:

TABLE I

Width, Inches	Tolerance, Inch (Plus Only)
Up to 42, incl	0.50
Over 42 to 49, incl	0.75
Over 49	1.00

TABLE I (SI)

Width, Millimetres	Tolerance, Millimetres (Plus Only)
Up to 1067, incl	12.7
Over 1067 to 1245, incl	19.0
Over 1245	25.4

4. QUALITY ASSURANCE PROVISIONS:

- 4.1 Responsibility for Inspection:** The vendor of cloth 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 4.5. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the cloth conforms to the requirements of this specification.
- 4.2 Classification of Tests:** Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests and as preproduction tests and shall be performed prior to or on the initial shipment of cloth to a purchaser, on each lot, when a change in material, processing, or both requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.1 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:** Shall be as follows; a lot shall be all cloth produced in a single production run under the same fixed conditions and presented for vendor's inspection at one time:

4.3.1 **Visual Examination of Rolls:** 100% of each roll, on loom as woven and as impregnated.

4.3.2 **Fabric Tests:** Samples for test shall be taken at random from each lot in accordance with Table II. Except as noted in 4.3.2.1, the number of determinations for each requirement shall be as specified in the applicable test procedure or, if not specified therein, in accordance with 4.4.

TABLE II

SAMPLE SIZE FOR TESTS OF CARBON CLOTH

Lot Size, Yards		Sample Size, Yards
Upto	3,200, incl	2
Over	3,200 to 22,000, incl	3
Over	22,000	5

TABLE II (SI)

Lot Size, Metres		Sample Size, Metres
Upto	2,926, incl	1.8
Over	2,926 to 20,117, incl	2.7
Over	20,117	4.6

4.3.2.1 When a statistical sampling plan and acceptance quality level (AQL) have been agreed upon purchaser and vendor, sampling shall be in accordance with such plan in lieu of sampling as in 4.3.2 and the report of 4.5.1 shall state that such plan was used.

4.4 Test Methods: Tests to determine conformance to the requirements of the supplementary detail specifications shall be conducted as follows:

Requirement	Minimum Number of Specimens per Test	Test Procedure
Volatile Content	1	ASTM D3530
Resin Solids Content	3	ASTM D3529
Resin Flow	1	ASTM D3531
Gel Time	1	ASTM D3532
Tensile Strength and Modulus of Elasticity	4	ASTM D3039
Compressive Strength and Modulus of Elasticity	4	ASTM D3410
Flexural Strength and Modulus of Elasticity	4	ASTM D790
Interlaminar Shear Strength	4	ASTM D2344
Density	3	4.4.3
Void Content	3	ASTM D2734
Fiber Content	3	ASTM D3171

- 4.4.1 Preparation of Test Laminates:** Test laminates of suitable thickness and area shall be prepared from sufficient plies of impregnated material cured in an autoclave or equivalent at a temperature and pressure as specified by the detailed specification to provide optimum properties. Details of time, temperature, rate of heating, and pressures used in the cure cycle shall be noted in the report. The resultant laminate shall be uniform in thickness within ± 0.003 inch (± 0.08 mm) and shall have a fiber volume as specified. The thickness per ply shall be within $\pm 10\%$ of the specified cured thickness determined from the equation:

$$T = \frac{A}{B}$$

Where, T = Thickness per ply in inches (mm)

A = Thickness of test panel in inches (mm)

B = Number of plies in panel

- 4.4.2 Tack:** Shall be determined as agreed upon by purchaser and vendor.
- 4.4.3 Density:** Shall be determined in accordance with ASTM D792 using a suitable nonaqueous liquid or in accordance with ASTM D1505 on the test laminate prepared as specified in 4.4.1.

4.5 Approval:

- 4.5.1 Sample cloth** shall be approved by purchaser before cloth for production use is supplied, unless such approval be waived by purchaser. Results of tests on production cloth shall be essentially equivalent to those on the approved sample.