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AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 3902B

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Superseding AMS 3902A

CLOTH, ORGANIC FIBER, (PARA-ARAMID) HIGH MODULUS
For Structural Composites

1. SCOPE:

1.1 Form: This specification covers cloths woven from high-modulus, continuous, multifilament yarn.

1.2 Application: Primarily for use as reinforcements in composites for structural 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 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 3901 - Organic Fiber (Para-Aramid) Yarn and Roving, High Modulus, For Structural Composites

REAFFIRMED
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2.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103.

ASTM D123 - Terminology Relating to Textile Materials
ASTM D579 - Greige Woven Glass Fabrics
ASTM D629 - Quantitative Analysis of Textiles
ASTM D1682 - Breaking Load and Elongation of Textile Fabrics
ASTM D1777 - Measuring Thickness of Textile Materials
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 Material:

3.1.1 Yarn: The cloth shall be woven from AMS 3901 organic fiber yarns as specified in Table I.

3.1.2 Weave: Shall be as specified in Table I.

3.1.3 Color: Shall be essentially yellow.

3.1.4 Finish: A finish or treatment may be applied, if required, to promote Ø compatibility with the resin system with which it is used in making laminates.

3.1.5 Residual Nonfibrous Material: Shall not exceed 0.4% by weight, determined Ø in accordance with ASTM D629.

3.2 Properties: Shall be as specified in Table I except that sizing content shall be as agreed upon by purchaser and vendor; tests shall be made on the product supplied and in accordance with test methods specified in 4.5.

3.3 Quality: Cloth, as received by purchaser, shall be uniform in quality and Ø condition, smooth, and free from foreign materials and from imperfections detrimental to usage of the cloth.

3.3.1 Ø Imperfections: In any 100 yards (91 m) of cloth supplied, there shall be no more than the equivalent of 10 major imperfections (2 minors = 1 major), based on the following imperfection classification; definitions of terms shall be in accordance with ASTM D123:

Imperfection	Description and Limitation	Classification
Bias or bowed filling	Distorted from horizontal by more than 3 inches (76 mm) for 38-inch (965-mm) widths and proportionately for all other widths.	Major
Baggy, ridgy, or wavy cloth	Clearly noticeable.	Major
Crease	Hard, embedded, and folded over on self.	Major
Brittle or fused area	Any.	Major
Uneven finish	Thin areas where finishing compound is missing or insufficient.	Major
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, or stains	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

Imperfection	Description and Limitation	Classification
Broken or missing ends or picks	3 or more contiguous regardless of length or 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 (12.7 mm) in width causing thickness outside of limits specified in Table I.	Minor
Selvage defects	Cut or torn.	Major
	Curled or folded under.	Minor
Oil stains	Any size	Major

3.4 Tolerances: Shall be as follows:

3.4.1 Width: Shall be within ±1/2 inch (±12.7 mm) from the standard or specified width.

3.4.2 Weight: Shall conform to Table I within the following limits:

Nominal Weight		Permissible Variation
Ounces/Square Yard	g/m^2	%, Plus and Minus
Up to 4.00, incl	Up to 135.6, incl	10
Over 4.00	Over 135.6	6

3.4.3 Fabric Count:

3.4.3.1 Warp: The average count of warp ends shall be within ±2 ends from the nominal count listed in Table I.

3.4.3.2 Fill: The average count of filling picks shall be within ±2 picks from the nominal count listed in Table I.

3.4.4 Thickness: Permissible variation in thickness shall be as specified in Table II.

TABLE II

Nominal Thickness Inch	Tolerance, Inch plus and minus
Up to 0.0030, incl	0.0005
Over 0.0030 to 0.0100, incl	0.0010
Over 0.0100 to 0.0150, incl	0.0020
Over 0.0150	0.0030

TABLE II (SI)

Nominal Thickness Millimetre	Tolerance, Millimetre plus and minus
Up to 0.076, incl	0.013
Over 0.076 to 0.254, incl	0.025
Over 0.254 to 0.381, incl	0.051
Over 0.381	0.076

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of cloth shall supply all samples Ø 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 cloth conforms to the requirements of this specification.

4.2 Classification of Tests: Tests to determine conformance to all technical Ø 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 and/or processing 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:

4.3.1 For Acceptance Tests: Shall be as follows, a lot shall be all cloth Ø produced in a single production run under the same fixed conditions and presented for vendor's inspection at one time. A lot may be packaged in smaller quantities and delivered under the basic lot approval provided lot identification is maintained.

4.3.1.1 Quality: 100% of each lot.

4.3.1.2 Other Tests: Samples shall be taken at random from rolls in each lot; Ø sample size shall be in accordance with Table III.

TABLE III

SAMPLE SIZE FOR TESTS OF ORGANIC CLOTH

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

TABLE III (SI)

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

4.3.1.3 Statistical Sampling: When a statistical sampling plan and acceptance Ø 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 4.3.1.1 and 4.3.1.2 and the report of 4.6.1 shall state that such plan was used.

4.3.2 For Preproduction Tests: Shall be not less than 5 random samples, each Ø not less than one linear yard (0.9 linear m).

4.4 Approval:

4.4.1 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.

4.4.2 Vendor shall use ingredients, manufacturing procedures, processes, and methods of inspection on production cloth which are essentially the same as those used on the approved sample cloth. 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 and/or processing and, when requested, sample cloth. Production cloth made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Test Methods: Tests to determine conformance to the requirements of this Ø specification shall be as follows:

Weight	ASTM D3776
Nominal Thickness	4.5.1
Fabric Count	ASTM D3775
Sizing Content	4.5.2
Breaking Strength	4.5.3

4.5.1 Thickness: Shall be determined in accordance with ASTM D1777, using a Ø 0.250 inch ± 0.010 (6.35 mm ± 0.25) diameter pressure foot with a 19.6 ounce ± 0.2 (556 g ± 5) weight.

4.5.2 Sizing Content: Shall be determined as follows: Ø

4.5.2.1 Weigh, to the nearest milligram, a 1.0 - 2.0 gram sample of cloth (W_1). Place sample in a pure cellulose cotton thimble previously extracted with acetone.

4.5.2.2 Pour approximately 200 mL of freshly distilled water into a 300 mL Ø boiling flask previously cleaned, dried, and weighed to the nearest milligram (W_2).

4.5.2.3 Place the thimble containing the sample in a Soxhlet-type extraction Ø apparatus with condenser and attach the boiling flask containing the water.

4.5.2.4 Adjust the rate of condensation dripping into the thimble to not less than 1 mL per minute.

4.5.2.5 Extract for not less than 4 hours at this rate.

4.5.2.6 Remove flask and distill off all but approximately 5 - 10 mL of water. Ø Place flask in oven which is at 100°C ± 5 (212°F ± 9) and allow to remain until completely dry.

4.5.2.7 Reweigh the flask to the nearest milligram (W_3). Determine weight of Ø sizing extracted from the sample and calculate percent by weight of size as follows:

$$\text{Sizing Content, \% by weight} = \frac{(W_3 - W_2)}{W_1} \times 100$$

where, W_1 = Weight of original cloth sample
W_2 = Weight of clean, dry flask
W_3 = Weight of flask plus extracted resin

4.5.3 Breaking Strength: Shall be determined in accordance with ASTM D1682, Ø modified as follows:

4.5.3.1 Cut two swatches from the cloth, one with the warp yarns and one with Ø the filling yarns parallel to the shorter dimension, using a template 8 x 10 inches (203 x 254 mm).

4.5.3.2 Mark sample number and whether warp or fill in upper right hand corner Ø of a piece of suitable lined paper, marked to show the area to be glued, See Figure 1.

4.5.3.3 Apply a layer of suitable glue to the areas marked on Figure 1. Do not glue the center of the specimens. The glue specified in ASTM D579 should be suitable.

4.5.3.4 Ø Lay cloth swatch on the lined paper so that the yarns are parallel to the lines on the paper, being careful not to distort the cloth during handling.

4.5.3.5 Ø Brush additional glue on top of the cloth to ensure a good glue bond.

4.5.3.6 Ø Dry the glue at room temperature for not less than 24 hours.

4.5.3.7 Ø When the glue is dry, cut six test specimens 1-1/2 inches (38 mm) wide parallel to the short direction.

4.5.3.8 Ø Cut the center section of the unglued area to 1.000 inch ± 0.010 (25.40 mm ± 0.25) in width, leaving the glued portions of the specimen 1-1/2 inches (38 mm) in width.

4.5.3.9 Ø Cut the paper backing midway between the glued ends.

4.5.3.10 Ø Set the suitable tensile tester on the proper range for the cloth to be tested.

4.5.3.11 Ø With the testing clamps 3.0 inches (76 mm) apart, insert the prepared specimens so that the yarns under test are parallel to the direction of load application.

4.5.3.12 Ø Make at least six tests in both the warp and fill directions, disregarding any test if the specimen slips in the clamps or breaks at the edge of the clamps.

4.5.3.13 Ø Report the average of five tests as the breaking strength in pounds force/inch (kN/m) of width for both warp and fill directions. The five values selected to compute the average shall be the five values closest to the average. If a specimen breaks in the clamps or slips in the clamps, prepare a new swatch and test the new specimen.

4.6 Reports:

4.6.1 The vendor of cloth shall furnish with each shipment a report showing the results of tests to determine conformance to the technical requirements of this specification. This report shall include the purchase order number, AMS 3902B, lot number, fabric style number, vendor's material and finish designation, date of finishing, and quantity.

4.6.2 The vendor of finished or semi-finished parts shall furnish with each shipment a report showing the purchase order number, AMS 3902B, fabric style number, contractor or other direct supplier of cloth, supplier's material and finish designation, and quantity. When cloth for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of cloth to determine conformance to the requirements of this specification and shall include in the report either a statement that the cloth 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 cloth 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 cloth 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 roll of cloth shall have attached a tag showing the manufacturer's name or trademark and the phrase "CLOTH, ORGANIC FIBER, HIGH MODULUS, STYLE _____".

5.1.2 Packaging shall be accomplished in such a manner as to ensure that the cloth, during shipment and storage, will be protected against damage from exposure to moisture, weather, or any other normal hazard.

5.1.3 Each package of cloth shall be marked with not less than the following information; characters shall be of such size as to be legible and shall not be obliterated by normal handling:

CLOTH, ORGANIC FIBER, (PARA-ARAMID) _____ HIGH MODULUS STYLE FABRIC
AMS 3902B
YARDAGE _____
WIDTH _____
PURCHASE ORDER NUMBER _____
MANUFACTURER'S IDENTIFICATION _____
LOT _____
WEIGHT OF PACKAGE _____

5.1.4 Packages of cloth shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the cloth to ensure carrier acceptance and safe delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.1.5 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-794, Level A or Level C, as specified in the request for procurement. Commercial packaging as in 5.1.2 and 5.1.4 will be acceptable if it meets the requirements of Level C.

6. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS: Cloth not conforming to this specification, or to modifications authorized by purchaser, will be subject to rejection.