AEROSPACE MATERIAL SPECIFICATION

AMS3902	REV. E

Issued 1974-06
Revised 2000-04
Reaffirmed 2013-07

Superseding AMS3902D

Cloth, Organic Fiver (Para-Aramid), High Modulus For Structural Composites

RATIONALE

AMS3902E has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

1.1 Form:

This specification covers cloth woven from high-modulus, continuous, multifilament yarn.

1.2 Application:

This cloth has been used typically for reinforcements in composites for structural applications, but usage is not limited to such applications. Each application should be considered individually.

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 issue of the following documents in effect on the date of the purchase order form a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

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

AMS 3901 Organic Fiber (Para-Aramid), Yarn and Roving, High Modulus

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS3902E

2.2 ASTM Publications:

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

ASTM D 123	Terminology Relating to Textiles
ASTM D 579	Greige Woven Glass Fabrics
ASTM D 629	Quantitative Analysis of Textiles
ASTM D 1777	Thickness of Textile Materials
ASTM D 3775	Fabric Count of Woven Fabric
ASTM D 5034	Breaking Strength and Elongation of Textile Fabrics (Grab Test)
ASTM D 5035	Breaking Strength and Elongation of Textile Fabrics (Strip Method)

3. TECHNICAL REQUIREMENTS:

3.1 Material:

3.1.1 Yarn: The cloth shall be woven from AMS 3901 organic fiber yarns as shown in Table 1.

3.1.2 Weave: Shall be as shown in Table 1.

3.1.3 Color: Shall be essentially yellow.

3.1.4 Finish: A finish or treatment may be applied, if required, to promote 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 in accordance with ASTM D 629.

3.2 Properties:

Shall be as shown in Table 1 except that sizing content shall be acceptable to purchaser; tests shall be made on the product supplied and in accordance with test methods specified in 4.5.

TABLE 1 - Construction of Woven Organic Cloth

Fabric Style	Fabric Count per Inch (25.4 mm) Warp	Fabric Count per Inch (25.4 mm) Fill	Yarn Type (1) Warp	Yarn Type(1) Fill	AMS No. Yarn Warp	AMS No. Yarn Fill	Weave	Weight ounce per square yard (g/m2)	Nominal Thickness Inch (mm)	Breaking Strength pound force per inch width (kN/m width)
120	34	34	195-1/0	195-1/0	3901/1	3901/1	Plain	1.8 (61)	0.0038 (0.097)	200 x 200 (35.0 x 35.0)
124	34	34	195-1/0	195-1/0	3901/1	3901/1	4-H Satin	1.8 (61)	0.0038 (0.097)	200 x 200 (35.0 x 35.0)
220	22	22	380-1/0	380-1/0	3901/2	3901/2	Plain	2.2 (75)	0.0050 (0.127)	250 x 250 (43.8 x 43.8)
181	50	50	380-1/0	380-1/0	3901/2	3901/2	8-H Satin	5.0 (170)	0.0090 (0.229)	550 x 550 (96.3 x 96.3)
281	17	17	1140-1/0	1140-1/0	3901/3	3901/3	Plain	5.1 (173)	0.0095 (0.241)	500 x 500 (87.6 x 87.6)
285	17	17	1140-1/0	1140-1/0	3901/3	3901/3	Crowfoot	5.1 (173)	0.0095 (0.241)	500 x 500 (87.6 x 87.6)
143	100	20	380-1/0	195-1/0	3901/2	3901/1	Crowfoot	5.6 (190)	0.0100 (0.254)	1000 x 100 (175 x 17.5)
243	38	18	1140-1/0	380-1/0	3901/3	3901/2	Crowfoot	6.7 (227)	0.0130 (0.330)	1200 x 150 (210 x 26.3)
328	17	17	1420-1/0	1420-1/0	3901/4	3901/4	Plain	6.5 (220)	0.0130 (0.330)	600 x 600 (105 x 105)
1033	40	40	1420-1/0	1420-1/0	3901/4	3901/4	8 x 8 Basket	15.0 (509)	0.0240 (0.610)	1200 x 1200 (210 x 210)
1050	28	28	1420-1/0	1420-1/0	3901/4	3901/4	4 x 4 Basket	10.5 (356)	0.0200 (0.508)	850 x 850 (149 x 149)

NOTE: (1) Denier and Number of piles/twist (turns per inch (25.4 mm))

3.3 Quality:

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

3.3.1 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 imperfection classification shown in Table 2. Definitions of terms shall be in accordance with ASTM D 123. The term “clearly noticeable” used in Table 2 shall be interpreted to mean visible at normal inspection distance of approximately 3 feet (0.9 m).

TABLE 2 - Classification of Imperfections

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
Broken or missing ends or picks	Three or more contiguous regardless of length or two contiguous over 36 inches (914 mm) in length	Major
	Two 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 1	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 1 within the limits shown in Table 3.

TABLE 3 - Weight Tolerances

Nominal Weight Ounces/Square Yard	Nominal Weight g/m^2	Permissible Variations %, Plus and Minus
Up to 4.0, incl	Up to 136, incl	10
Over 4.0	Over 136	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 1.

3.4.3.2 Fill: The average count of filling picks shall be within ±2 picks from the nominal count listed in Table 1.

3.4.4 Thickness: Permissible variation in thickness shall be as specified in Table 4.

TABLE 4A - Thickness Tolerances, Inch/Pound Units

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 4B - Thickness Tolerances, SI Units

Nominal Thickness Millimeter	Tolerance, Millimeter 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:

Manufacturer of cloth shall supply all samples and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the cloth conforms to the specified requirements.

4.2 Classification of Tests:

All technical requirements are acceptance tests and 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 ingredients and/or processing requires reapproval as in 4.4.1, and when purchaser deems confirmatory testing to be required.

4.3 Sampling and Testing:

Shall be as follows:

4.3.1 For Acceptance Tests: Shall be as follows; a lot shall be all cloth produced in a single production run under the same fixed conditions and presented for manufacturer's inspection at one time.

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; sample size shall be in accordance with Table 5.

TABLE 5A - Sample Size, Inch/Pound Units

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 5B - Sample Size, SI Units

Lot Size Meters	Sample Size Meters
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 A statistical sampling plan, acceptable to purchaser, may be used in lieu of sampling as in 4.3.1.

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

4.4 Approval:

4.4.1 Sample product shall be approved by purchaser before product for production use is supplied, unless such approval is waived by purchaser. Results of tests on production product shall be essentially equivalent to those on the approved sample. Production product made by a revised procedure shall not be shipped prior to receipt of reapproval. If necessary to make any change in parameters for the process control factors, manufacturer shall submit for reapproval a statement of the proposed changes in ingredients and/or processing and, when requested, sample product.

4.4.2 Manufacturer of the product shall make no significant change in material, processes, or control factors from those on which the approval was based, unless the change is approved by the cognizant engineering organization. A significant change is one which, in the judgment of the cognizant engineering organization, could affect the properties or performance of the product.

4.5 Test Methods:

Tests to determine conformance to the technical requirements shall be as follows:

Weight: 4.5.1
Nominal Thickness: 4.5.2
Fabric Count: ASTM D 3775
Sizing Content: 4.5.3
Breaking Strength: 4.5.4

4.5.1 Weight: Shall be determined on a scoured, bone-dry basis as follows:

4.5.1.1 Cut a square or round sample of the fabric that is a minimum of 20 square inches (130 cm^2). Dry the sample at 105 °C ± 5 (221 °F ± 9) for at least four hours. Cool the sample for a minimum of one hour in a desiccator.

4.5.1.2 Immediately weigh the fabric sample to the nearest milligram.

4.5.1.3 Convert from sample weight to ounces per square yard using either Equation 1 or 2 (depending on units of measure):

$$FW = (W/A_i) \times 45.7 \quad \text{(Eq. 1)}$$

$$FW = (W/A_c) \times 294.9 \quad \text{(Eq. 2)}$$

where:

FW = Fabric Weight, ounces/yard^2
W = Weight of sample, g
A_i = Area of sample, inch^2
A_c = Area of sample, cm^2

4.5.2 Thickness: Shall be determined in accordance with ASTM D 1777, using a 0.250 inch ± 0.010 (6.35 mm ± 0.25) diameter pressure foot with a 19.6-ounce ± 0.2 (556-gram ± 5) weight.

4.5.3 Sizing Content: Shall be determined as follows

4.5.3.1 Weigh a 1.0 to 2.0-gram sample of cloth (W_1) to the nearest milligram. Place sample in a Whatman paper thimble previously extracted with acetone.

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

4.5.3.3 Place the thimble containing the sample in a Soxhlet extraction apparatus with condenser and attach the boiling flask containing the water.

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

4.5.3.5 Extract for not less than four hours at this rate.

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

4.5.3.7 Reweigh the flask to the nearest milligram (W_3). Determine weight of sizing extracted from the sample and calculate percent by weight of size using Equation 3.

$$\text{Sizing Content, \% by weight} = \frac{(W_3 - W_2)}{W_1} \times 100 \quad \text{(Eq. 3)}$$

where

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

4.5.4 Breaking Strength: Shall be determined in accordance with ASTM D 5034 or ASTM D 5035, modified as follows:

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

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

4.5.4.3 Apply a layer of glue as specified in ASTM D 579, or equivalent to the areas marked on Figure 1. Do not glue the center of the specimens.

4.5.4.4 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.

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

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

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

4.5.4.8 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 approximately 1-1/2 inches (38 mm) in width.

4.5.4.9 Cut the paper backing midway between the glued ends.

4.5.4.10 Set the tensile tester on the proper range for the cloth to be tested.

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

4.5.4.12 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.

4.5.4.13 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:

The supplier of cloth shall furnish with each shipment a report from the manufacturer showing the results of tests to determine conformance to the acceptance test requirements and stating that the cloth conforms to the other technical requirements. This report shall include the purchase order number, lot number, AMS 3902E, fabric style number, manufacturer's identification number and finish designation, date of finishing, and quantity.