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SAE INTERNATIONAL
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 3846C

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Superseding AMS 3846B

Submitted for recognition as an American National Standard

(R) CLOTH, QUARTZ
Finished for Resin Laminates

1. SCOPE:

1.1 Form:

This specification covers high-purity (99.95%) silica in the form of woven cloth.

1.2 Application:

This cloth has been used typically for resin laminates with finishes suitable for use with various resin matrices intended for service up to 400 °C (752 °F), 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 applicable issue of referenced publications shall be the issue in effect on the date of the purchase order.

2.1 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM D 123 Terminology Relating to Textile Materials
ASTM D 578 Glass Fiber Yarns
ASTM D 579 Greige Woven Glass Fabrics
ASTM D 1777 Measuring Thickness of Textile Materials
ASTM D 3775 Fabric Count of Woven Fabric
ASTM D 3776 Mass per Unit Area (Weight) of Woven Fabric

2.2 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

FED-STD-4 Glossary of Fabric Imperfections

3. TECHNICAL REQUIREMENTS:

3.1 Material:

3.1 1 Cloth: Shall be woven from high-purity (99.95% minimum) fused silica (nominal density 2.2 grams per cubic centimeter), Quartz 2 or Quartz 3 continuous-filament yarns as shown in Table 1 (See 8.2).

TABLE 1 - Yarn Classes

Yarn Class	Description
1	Quartz 1: The original quartz yarn was composed of (9 µm) filaments. The yam binder was composed of A- 1100 aminosilane with film formers and lubricants. Cloth woven from Quartz 1 is generally not commercially available. Quartz 1 is included in this table and Table 4 for comparison only (See 8.2).
2	Quartz 2: Quartz 2 is yarn composed of the same 0.000375 inch (9 µm) filaments as quartz 1, but is made with a high performance yarn binder, which provides superior protection to the yarn during textile processing. In some cloth styles this has resulted in increases of 100% or more in cloth strength over the same styles in quartz 1. Quality is also greatly improved.
3	Quartz 3: The lower cost quartz 3 yarns are composed of 0.00054 inch (14 µm) filaments with the same high performance yarn binder as quartz 2. Quartz 3 is generally supplied as singles yarns, with a low twist, rather than the higher twist plied yams of quartz 2.

3.1.1.1 Weave: Shall be in accordance with Table 2.

TABLE 2A - Construction and Properties of Finished Fabrics, Inch/Pound Units

Style	Weave	Warp Yarn	Fill Yarn	Count Yarns per inch Warp	Count Yarns per Inch Fill	Nominal Weight Ounces per Square Yard	Nominal Thickness Inch	Breaking strength Quartz 2 Pounds per Inch Width Warp	Breaking Strength Quartz 2 Pounds per Inch Width Fill	Breaking Strength Quartz 3 Pounds per Inch Width Warp	Breaking Strength Quartz 3 Pounds per Inch Width Fill
503	Plain	QCG 300 1/2	QCG 300 1/2	50	40	3.6	0.005	150	120		
507	Plain	QCG 300 1/2	QCG 300 1/2	27	25	2.0	0.004	80	60		
525	Plain	QCG 300 1/0	QCG 300 1/0	50	50	2.0	0.003	60	40		
527	Plain	QCG 300 2/2	QCG 300 2/2	42	32	5.6	0.009	250	200		
531	8H Satin	QCG 300 1/2	QCG 300 1/2	68	65	5.2	0.007	225	200		
533	2 x 2 Basket	QCG 300 2/2	QCG 300 2/2	36	36	5.3	0.007	250	250		
557	Crow Foot	QCG 300 2/2	QCGG 300 1/0	57	31	5.0	0.006	475	40		
570	5H Satin	QCG 300 2/8	QCG 300 2/8	38	24	19.5	0.027	800	700		
572	Plain	QCG 300 2/8	QCG 300 2/8	17	16	9.9	0.017	590	480		
581	8H Satin	QCG 300 2/2	QCG 300 2/2	57	54	8.4	0.011	400	375		
591	Formable	QCG 300 2/2	QCG 300 2/2	57	54	8.6	0.012	420	340		
593	5H Satin	QCG 300 2/2	QCG 300 2/2	49	46	7.5	0.010	270	270		
594	Leno	QCG 300 2/2	QCG 300 2/2	20	10	2.4	0.008	100	50		
4503	Plain	QCK 125 1/0	QCK 125 1/0	40	31	3.3	0.005			150	120
4581	8H Satin	QCK 125 2/0	QCK 125 2/0	47	44	8.5	0.010			400	330

TABLE 2B - Construction and Properties of Finished Fabrics, SI Units

Style	Weave	Warp Yarn	Fill Yarn	Count Yarns per 5 cm Warp	Count Yarns per 5 cm Fill	Nominal Weight Grams per Square Meter	Nominal Thickness mm	Breaking Strength Quartz 2 Newtons per 5 cm Width Warp	Breaking Strength Quartz 2 Newtons per 5 cm Width Fill	Breaking Strength Quartz 3 Newtons per 5 cm Width Warp	Breaking Strength Quartz 3 Newtons per 5 cm Width Fill
503	Plain	QCG 300 1/2	QCG 300 1/2	98	79	122.0	0.127	1313	1050		
507	Plain	QCG 300 1/2	QCG 300 1/2	53	49	68.0	0.102	700	525		
525	Plain	QCG 300 1/0	QCG 300 1/0	98	98	68.0	0.076	525	350		
527	Plain	QCG 300 2/2	QCG 300 2/2	83	63	190.0	0.229	2169	1751		
531	8H Satin	QCG 300 1/2	QCG 300 1/2	134	128	176.0	0.178	1970	1751		
533	2 x 2 Basket	QCG 300 2/2	QCG 300 2/2	71	71	180.0	0.178	2189	2189		
557	Crow Foot	QCG 300 2/2	QCG 300 1/0	112	61	170.0	0.154	4159	350		
570	5H Satin	QCG 300 2/8	QCG 300 2/8	75	47	661.0	0.686	7005	6129		
572	Plain	QCG 300 2/8	QCG 300 2/8	33	31	336.0	0.432	5166	4203		
581	8H Satin	QCG 300 2/2	QCG 300 2/2	112	106	285.0	0.278	3503	3284		
591	Formable	QCG 300 2/2	QCG 300 2/2	112	106	292.0	0.304	3678	2977		
593	5H Satin	QCG 300 2/2	QCG 300 2/2	96	91	254.0	0.254	2364	2364		
594	Leno	QCG 300 2/2	QCG 300 2/2	39	20	81.0	0.203	876	438		
4503	Plain	QCK 125 1/0	QCK 125 1/0	79	61	112.0	0.127			1313	1050
4581	8H Satin	QCK 125 2/0	QCK 125 2/0	93	87	288.0	0.254			3503	2890

3.1.1.2 Finish: Shall be compatible with and shall produce the required performance characteristics for the resin system specified in the applicable impregnated quartz cloth or laminate specification. Three general classes of finishes are provided by manufacturers in accordance with Table 3. The choice of finish and its specification shall be acceptable to purchaser.

TABLE 3 - Finish Classes

Finish Class	Description
1	Resin Compatible Yam Binders: In addition to organofunctional silane coupling agents, these yam finishes contain film former and lubricants necessary to provide a weavable yarn.
2	Scoured Fabric: Fabric is washed to remove the film former and lubricant components of the yam binder. The silane coupling agent in the quartz 2 and quartz 3 binder is only partially removed, and the scoured fabric is the finish of choice for some resin systems.
3	Post Finished Fabric: Scoured fabric is treated with additional silane coupling agent having alternative organofunctionality to meet the needs of the purchaser's resin system.

Note: Nonplied low twist yarns such as 300 1/0, 125 1/0, and 1252/0 require additional sizing for efficient weaving. Fabrics woven from these yarns, such as Styles 525, 4503, and 4581, should always be specified scoured or scoured and post finished.

3.1.1 2.1 The finish concentration shall be determined by loss on ignition.

3.1.2 Yarns: Quartz yarns shall be in accordance with Table 4.

TABLE 4 - Quartz Yarns and Properties

Yarn Designation	Yarn [1] Class	Nominal Yield Yards per Pound	Nominal Yield TEX grams per 1000 m	% Binder (LOI)	Breaking Strength min Average Pounds	Breaking Strength min Average daN
QCG 300 1/0	2	30 000	16.5	0.30 to 1.00	1.28	0.57
QCG 300 1/2	1	15 000	33	0.30 to 1.00	1.80	0.80
QCG 300 1/2	2	15 000	33	0.30 to 1.00	2.12	0.94
QCG 300 2/2	1	7 500	66	0.30 to 1.00	3.62	1.61
QCG 300 2/2	2	7 500	66	0.30 to 1.00	7.04	3.13
QCG 300 2/8	1	1 875	265	0.30 to 1.00	14.58	6.48
QCG 300 2/8	2	1 875	265	0.30 to 1.00	28.58	12.70
QCK 125 1/0	3	12 500	40	0.30 to 1.00	2.60	1.16
QCK 125 2/0	3	6 250	80	0.30 to 1.00	5.81	2.58

[1] Yarn Classes:
Quartz 1: G Filament - 0.00036 inch (9 µm) nominal diameter; A - 1100 Yarn Binder (9288)
Quartz 2: G Filament - 0.00036 inch (9 µm) nominal diameter: High Performance Yarn Binder (9779)
Quartz 3: K Filament - 0.00054 inch (14 µm) nominal diameter; High Performance Yarn Binder (9779)

3.2 Composition of Cloth:

3.2.1 Silica Content: Shall be not less than 99.95% silicon dioxide, determined in accordance with 4.5.1.

3.2.2 Boron Content: Shall not exceed 50 ppm calculated as elemental boron, determined by a procedure acceptable to purchaser.

3.3 Color:

The color of cloth and yarn shall be white to light yellow or tan.

3.4 Properties:

Shall be as specified in Table 2, determined by the following methods:

Weight:	ASTM D 3776, Option C - Small swatch of fabric
Nominal Thickness:	ASTM D 1777
Fabric Count:	ASTM D 3775
Breaking Strength:	ASTM D 579
Loss on Ignition (LOI):	ASTM D 578

3.5 Quality:

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

3.5.1 Imperfections: Acceptability of each roll of cloth shall be based on a defect point basis with defects defined in FED-STD4 and herein, and defect points assigned as specified in Table 5. Definitions of terms used herein are covered by ASTM D 123.

3.5.1.1 Acceptability Limits: There shall be not more than four defect points in any one linear yard (0.9 linear meter), not more than 50 critical defect points in any 100 yards (91 meters), or not more than 100 total defect points in any 100 yards (91 meters) of cloth.

3.5.1.2 Counting Defects: Each occurrence of all critical and noncritical defects listed in Table 5 shall be counted regardless of their proximity to each other. Where two or more defects occur in the same yard (0.9 meter) length, the critical defect shall be counted.

TABLE 5A - Classification and Point Value of Defects, Inches

Yard-by-Yard Examination	Points
Critical Defects	
Stains, area equivalent to a diameter of:	
Up to 0.25, excl, but general or repetitive	4
0.25 to 0.50, incl	1
Over 0.50 to 1.00, incl	2
Over 1.00 to 1.50, incl	3
Over 1.50	4
Hole, cut, or tear	4
Smash	4
Dirty filling (full width), linear	
Up to 1.00, incl	1
Over 1.00 to 2.00, incl	2
Over 2.00 to 3.00, incl	3
Over 3.00	4
Cut or torn selvage	None allowed
Noncritical Defects	
Single dirty yam (warp or filling)	1
Any clean defect, full width or one linear yard	1
Single dirty end throughout piece, max per piece	1
Puckered, baggy, or wavy cloth	1

TABLE 5B - Classification and Point Value of Defects, Millimeters

Meter-by-Meter Examination	Points
Critical Defects	
Stains, area equivalent to a diameter of (3.5.1.3):	
Up to 6.4, excl, but general or repetitive	4
6.4 to 12.7, incl	1
Over 12.7 to 25.4, incl	2
Over 25.4 to 38.1, incl	3
Over 38.1	4
Hole, cut, or tear	4
Smash	4
Dirty filling (full width), linear (3.5.1.4)	
Up to 25.4, incl	1
Over 25.4 to 50.8, incl	2
Over 50.8 to 76.2, incl	3
Over 76.2	4
Cut or torn selvage	None allowed
Noncritical Defects	
Single dirty yarn (warp or filling)	1
Any clean defect, full width or 0.9 linear meter	1
Single dirty end throughout piece, max per piece	1
Puckered, baggy, or wavy cloth	1

3.5.1.3 Stain: Shall be defined as a spot or streak of discoloration of the surface caused by a foreign substance such as dirt, oil, or water covering more than one linear yard (0.9 meter). Discolorations caused by the yarn binder shall not be classified as a stain.

3.5.1.4 Dirty Filling: Shall be defined as an area of cloth running from edge to edge containing a group of dirty filling yarns. Such dirty yarns may be either continuous or appear as flashes. In order to be considered “dirty filling”, there shall be more than ten individual dirty yarns per linear inch (25 mm). Single dirty yarns or flashes comprising the group of yarns shall be longer than 1.5 inches (38 mm) to be considered dirty filling. Dirt shall be defined as foreign substances on the yarn. Variations in the color of the yarn binder, including flashes, shall not be classified as dirt.

3.6 Tolerances:

Unless otherwise specified, tolerances shall conform to the following:

3.6.1 Width: Shall not deviate from the standard or specified width by more than the tolerance shown in Table 6.

TABLE 6A - Width Tolerance, Inch/Pound Units

Nominal Width Inches	Tolerance Inch plus and minus
Up to 6.0, incl	0.13
Over 6.0 to 44.0, incl	0.50
Over 44.0	0.0125 x width

TABLE 6B - Width Tolerance, SI Units

Nominal Width Millimeters	Tolerance Millimeters plus and minus
Up to 152, incl	3.3
Over 152 to 1118, incl	12.7
Over 1118	0.0125 x width

3.6.2 Weight: Shall be within ±5% of the nominal weight specified in Table 2.

3.6.3 Selvage Width: Shall not exceed 0.375 inch (9.52 mm).

3.6.4 Thickness: Shall be within ±15% of the nominal thickness specified in Table 2.

3.6.5 Fabric Count:

3.6.5.1 Warp: The average count of warp ends shall be within ±2 ends from the nominal count specified in Table 2.

3.6.5.2 Fill: The average count of filling picks shall be within ±2 picks from the nominal count specified in Table 2.

3.6.6 Length of Rolls: The nominal length of cloth on each roll shall be 100 yards (91 meters). Each roll shall consist of one continuous piece of cloth.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

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

4.2 Classification of Tests:

All technical requirements are acceptance and preproduction tests and shall be performed on each lot, on or before the initial shipment of cloth by the manufacturer, when a change in ingredients, and/or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.1 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 cloth shall be taken at random from each lot to perform all required tests. The number of determinations for each requirement shall be as specified below or in the applicable test procedure or, if not specified therein, not less than three.

4.3.1.1 A lot shall be 1000 yards (914 m) of cloth or fraction thereof, all woven from the same warp yarns, and processed without significant changes in treater setting or finish batch.

4.3.2 Frequency of Sampling for Cloth:

4.3.2.1 Rolls of Cloth: 100% yard by yard (meter by meter) visual examination of each lot.

4.3.2.2 Woven Cloth: A 1 yard (0.9 m) sample shall be taken from each lot of cloth.

4.3.2.3 A statistical sampling plan, acceptable to purchaser, may be used in lieu of sampling as in 4.3.2.

4.3.3 For Preproduction Tests: Shall be acceptable to purchaser.

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 Manufacturer 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. If necessary to make any change in ingredients, in type of equipment for processing, or in manufacturing procedures, manufacturer shall submit for reapproval a statement of the proposed changes in ingredients 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:

4.5.1 Silica Content: Shall be determined in duplicate. This method does not separate boric oxide from silicon dioxide (See 3.2.2).

4.5.1.1 Cut a 1.5-gram sample into approximately 0.25 inch (6.4 mm) squares. Place in a previously ignited, cooled, and weighed to the nearest 0.01 gram platinum crucible (W_1).

4.5.1.2 Ignite the crucible in a muffle furnace maintained at 1000 °C ± 20 (1832 °F ± 36) for 30 minutes ±1. Cool to room temperature in a desiccator and reweigh the crucible with sample to the nearest 0.01 gram (W_2).

4.5.1.3 Add approximately 2 to 3 mL of 1:1 by volume sulfuric acid into the crucible followed by 20 to 25 mL of 48% hydrofluoric acid. Add slowly and cautiously, drop by drop at first, until effervescence ceases. Addition of hydrofluoric acid should be done in a fume hood.

4.5.1.4 Evaporate the acid in the crucible to apparent dryness on a hot plate in a fume hood.

4.5.1.5 Repeat 4.5.1.3 and 4.5.1.4 one time.

4.5.1.6 Place the crucible containing the residue on a clay triangle and gently fume off the sulfuric acid over a Bunsen burner. Take care to avoid spattering.

4.5.1.7 When all fumes have been expelled, place the crucible in a muffle furnace maintained at 1000 °C ± 20 (1832 °F ± 36) for 30 minutes ±1. Cool to room temperature in a desiccator and reweigh the crucible. Repeat burnout until constant weight (W_3) is achieved.

4.5.1.8 Calculate silicon dioxide content using Equation 1.

$$SiO_2\ \%\ \text{by weight} = \frac{(W_2 - W_1) - (W_3 - W_1)}{(W_2 - W_1)} \times 100 \qquad \text{(Eq.1)}$$

Where:

W_1 = Weight of fired crucible
W_2 = Weight of fired sample + crucible
W_3 = Weight of residue + crucible

4.5.1.9 Report the average for all values for each sample.