MIL-F-87121A(USAF)
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SUPERSEDING
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MILITARY SPECIFICATION

FABRIC, GRAPHITE FABRIC

This specification is approved for use by the Air Force Materials Laboratory, MXA, Department of the Air Force, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the materials requirements and quality assurance provisions for an eight harness satin weave graphite fabric.

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-C-45662	Calibration System Requirements
MIL-Y-87125	Yarn Graphite, 1000/3000 Filaments

STANDARDS

FEDERAL

FED-STD-191	Textile Test Methods

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to the Aeronautical Systems Division, ENESS, W-PAFB, Ohio 45433 by using the self-addressed Standardization Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 8305

MILITARY

MIL-STD-129	Marking For Shipment and Storage
MIL-STD-130	Identification Marking of U.S. Military Property

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D629	Method for Quantitative Analysis of Textiles
ASTM D1682	Methods of Test for Breaking Load and Elongation of Textile Fabrics
ASTM D1910	Test for Construction Characteristics of Woven Fabrics

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

3. REQUIREMENTS

3.1 Physical characteristics.

3.1.1 Weave construction. The material shall be an eight harness satin weave graphite fabric. The graphite yarn used in the fabric shall be in accordance with MIL-Y-87125, Type I.

3.1.2 Yarn count. Yarn count in the fabric shall be as follows:

Direction	Ends/Inch
Warp	29 to 31
Fill	29 to 31

3.1.3 Weight. The fabric weight shall be 4 to 6 ounces per square yard.

3.1.4 Color. The fabric shall have a uniform color.

3.1.5 Fabric thickness. The thickness of the fabric shall be 0.012 ± 0.002 inches.

3.2 Composition.

3.2.1 Volatile content. The volatile content of the fabric shall not exceed 5.0 percent by weight.

3.2.2 Carbon content. The carbon content of the fabric shall be 99.6 percent by weight, minimum, after the volatiles are removed.

3.3 Mechanical properties.

3.3.1 Breaking strength. The minimum breaking strength of the fabric shall be as follows:

Direction	Minimum Breaking Strength (Pounds per Inch Width)
Warp	100
Fill	100

3.4 Identification and marking. Identification and marking shall be in accordance with MIL-STD-130. Each roll of fabric shall be identified using a label affixed to the inside of the winding tube. The label shall contain the following information:

a. Vendor serial number and lot number
b. Vendor trade name
c. Specification number.

3.5 Workmanship. The fabric shall be woven so as to yield a product which is uniform in appearance and weave construction.

3.5.1 Defects. The fabric shall not have more then 2 holes and 2 torn selvages per 3 yards of fabric length. A hole is defined as a preforation 0.125 inch or larger.

3.5.2 Contamination. There shall be no dirt, metal particles, or other foreign matter present in the fabric.

3.6 Preproduction. When specified, a preproduction sample roll of fabric at least 100 yards long shall be produced using the same methods proposed for the preparation of subsequent production lot.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own facilities or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspection. The inspections requirements specified herein are classified as follows:

a. Preproduction tests (see 4.3).
b. Quality conformance inspection (see 4.4).

4.3 Preproduction tests. The preproduction sample roll of fabric shall be subjected to the following tests:

a.	Defects and contamination	4.5.2
b.	Color	4.5.7
c.	Identification and marking	4.5.10
d.	Workmanship	4.5.11
e.	Preservation, packaging and packing	4.5.12

4.3.1 After completion of the above tests, randomly select three (3) samples (approximately 3 yards long) from the sample roll and subject each sample to the following tests:

a.	Weave construction	4.5.1
b.	Volatile content	4.5.3
c.	Carbon content	4.5.4
d.	Yarn count	4.5.5
e.	Weight	4.5.6
f.	Fabric thickness	4.5.8
g.	Breaking strength	4.5.9

4.4 Quality conformance inspections.

4.4.1 Acceptance tests. Acceptance tests shall consist of the individual and sampling tests of 4.4.1.1 and 4.4.1.2.

4.4.1.1 Individual tests. Each roll of fabric shall be subjected to the following individual tests:

a.	Defects and contamination	4.5.2
b.	Color	4.5.7
c.	Identification and marking	4.5.10
d.	Workmanship	4.5.11
e.	Preservation, packaging and packing	4.5.12

4.4.1.2 Sampling tests. From the start of each sample roll, take a one (1) yard ± 6 inch strip of fabric and subject it to the following tests:

a.	Weave construction	4.5.1
b.	Volatile content	4.5.3
c.	Yarn count	4.5.5
d.	Weight	4.5.6
e.	Fabric thickness	4.5.8
f.	Breaking strength	4.5.9

4.4.1.3 Sampling plan. Sample rolls of fabric shall be randomly selected from each lot in accordance with the following schedule.

Lot Size (rolls)	Sample Size (rolls)
1 - 2	All
3 - 15	2
16 - 65	3
66 - 110	5
111 - 300	7

4.4.1.4 Rejection. When the fabric fails to meet any acceptance requirements, the lot shall be retested using double the number of samples. If a failure occurs during the second retest, the lot shall be rejected.

4.4.1.5 Test condition. Unless otherwise specified, the tests required by this specification shall be made at an atmospheric pressure of 30 ± 2 inches of mercury, and at a temperature of 24.5 ± 2°C (76 ± 4°F) and a relative humidity of 50 ± 10 percent.

4.4.1.6 Measurements. All measurements shall be made with instruments whose accuracy has been verified in accordance with MIL-C-45662.

4.5 Test methods.

4.5.1 Weave construction. Perform test in accordance with ASTM D1910. Verify compliance with 3.1.1.

4.5.2 Defects and contamination. Visually examine a minimum of 2 yards of fabric from each roll. Verify compliance with 3.5.1 and 3.5.2.

4.5.3 Volatile content. Weigh approximately 1 gram of fabric into a tared (50 milliliters (mL) porcelain crucible. Heat 16 hours minimum in a muffle furnace at 400 ± 20°C (204 ± 68°F). Cool in a desiccator and reweigh. Calculate the loss in weight. Verify compliance with 3.2.1.

4.5.4 Carbon content. Determine the carbon content by gas chromatography using the test method of 4.6.1. Verify compliance with 3.2.2.

4.5.5 Yarn count. Perform the test in accordance with ASTM D1910. Verify compliance with 3.1.2.

4.5.6 Weight. Perform test in accordance with ASTM D1910. Verify compliance with 3.1.3.

4.5.7 Color. Visually examine a minimum of 2 yards of fabric from each roll. Verify compliance with 3.1.4.

4.5.8 Fabric thickness. Measure the fabric thickness in accordance with FED-STD-191, Method 5030. Verify compliance with 3.1.5.

4.5.9 Breaking strength. Perform test in accordance with the ravelled strip test of ASTM D1682 using 5 specimens. Verify compliance with 3.3.1.

4.5.10 Identification and marking. Visually examine the fabric roll. Verify compliance with 3.4.

4.5.11 Workmanship. Visually examine the fabric. Verify compliance with 3.5.

4.5.12 Preservation, packaging and packing. To verify compliance with Section 5, examinations shall be performed to ensure that all requirements have been met.

4.6 Test procedures.

4.6.1 Carbon content.

4.6.1.2 Sample preparation. Weigh approximately 1 gram of fabric into a tared 50 milliliter (mL) porcelain crucible. Heat 16 hours minimum

in a muffle furnace at 400 ± 20°C (752 ± 68°F). Cool in a desiccator. Determine the carbon content by gas chromatography using an F&M Model 185 CHN Analyzer in association with a Cahn ratio-recording electrobalance (or equivalent equipment) and appropriate accessories and standards as follows.

4.6.1.3 Apparatus. The apparatus used is the F&M Model 185 CHN Analyzer which includes a Cahn Ratio-Recording Electrobalance for weighing samples and a Honeywell Electronik 18 0-1 millivolt strip chart recorded to trace the nitrogen, carbon dioxide, and water peaks. Peak heights are measured with an accurate millimeter rule. In this laboratory, a Lufkin 30 millimeter rule graduated in one-half millimeter divisions is used. Sample boats, catalyst, sample rods, "O" rings, etc., are supplied with the instrument.

4.6.1.4 Reagents. Standard materials of known elemental composition such as acetanilide, cyclohexanone-2, 4-dinitrophenylhydrazone (2, 4-D), and melamine are supplied with the instrument.

4.6.1.5 Operation.

4.6.1.5.1 Instrument operating conditions.

a.	Oxidation Furnace Temperature:	1050°C
b.	Reduction Furnace Temperature:	400 - 550°C
c.	Column Oven Temperature:	90 ± 10°C
d.	Oven Shell Temperature:	75 ± 10°C
e.	Bridge Current:	155 milliamperes

4.6.1.5.2 Instrument conditioning. At the beginning of each day's work, the instrument shall be conditioned by repeated combustion of cyclohexanone-2, 4-dinitrophenylhydrazone (2, 4-D) until the N_2, CO_2 and H_2O peaks are well defined. The amount of 2, 4-D need only be estimated (rather than weighed) for the condition. Usually, no more than three combustions are necessary.

4.6.1.6 Weighing procedure.

4.6.1.6.1 Calbiration of balance.

a. Move the range switch to the extreme clockwise position.
b. Rotate the range switch counterclockwise two click stops (x 10 range).
c. Using tweezers, place a sample boat on each stirrup.
d. Move the main switch to the "ZERO" position.
e. Turn the "BALANCE" control to the full counterclockwise position.

f. Move the coarse lever until the beam is just slightly below the reference lines (viewed through the illuminated lens).
g. Close the door and precisely align the beam and the reference lines using the "BALANCE" control.
h. Depress the meter switch and hold it down while rotating the "ZERO" control to precisely align the null meter needle with the center mark. Use the mirror to be certain that parallax does not produce a false reading. Release the meter switch when properly nulled. Depress momentarily to note any slight deflection. Null again if there is.
i. Turn the "BALANCE" control clockwise to the sixth clock position. Using tweezers, place the 10mg calibrating weight on the left sample boat.
j. Close the sliding glass door.
k. Turn the main switch to the "CAL" position.
l. Align the beam with the reference lines by slowly rotating the "BALANCE" control counterclockwise.
m. Hold the meter switch depressed while nulling the meter with "CALIBRATE" control. Release the meter switch when properly nulled.
n. Move the main switch to the "ZERO" position.
o. Open the sliding door and remove the calibrating weight.
p. Rotate the range switch to the X1 position (fully clockwise).

4.6.1.6.2 Obtaining sample weight.

a. Rotate the "BALANCE" control to the extreme counterclockwise position past all six click stops.
b. Rotate the "BALANCE" control slowly clockwise until the beam aligns with the reference line. Do not rotate the "BALANCE" control to a point where it passes the first click stop. If the beam cannot be aligned without going past the first clock stop, return the "BALANCE" control to the extreme counterclockwise position and adjust the coarse level until the beam approaches the reference lines. At this point, return to the "BALANCE" control for the precise final alignment.
c. Depress the meter switch and hold while nulling the meter with the "ZERO" control.
d. Rotate the "BALANCE" to the fourth clock position.
e. Open the door and carefully tap sample from the spatula into the left sample boat until the beam approaches the reference lines.

f. Close the door and move the main switch to the "READ" position.
g. Slowly turn the "BALANCE" control counterclockwise (fine range) to precisely align the beam with the reference lines.
h. Hold meter switch depressed while nulling meter using the weight dial. When perfectly nulled, release meter switch.
i. The weight of the sample can be read directly from the dial in decimals of mg., e.g., 6198 equals .6198 mg.

NOTE: If reading is above 0.8000 mg., remove some sample; if below 0.6000 mg., add sample.

4.6.1.7 Preparation of sample for combustion.

a. Position one of the combustion rod assemblies on the rod holder and slide the retaining nuts to within 2 inches of the rod end. The small retaining nut must not be tightened into the large nut.
b. Using tweezers, remove the weighed sample from the balance and place it in the boat cavity of the rod.
c. Pack the boat with oxidizing catalysts until it is even with the top of the boat. Tap the catalyst down firmly with the spatula. NOTE: Samples that are difficult to burn should be mixed with a small amount of catalyst prior to filling boat.
d. Remove the hot combustion rod from the furnace by unscrewing the large retainer nut and pulling the entire assembly outward. Place the hot rod in the cooling position.
e. Position the loaded rod in the "SAMPLE PORT" and immediately secure in position by tightening the large retaining nut. Use only hand pressure for this step. Never use a wrench or pliers.
f. Hand tighten the small retaining nut. Be careful to keep the handle grip in a perfectly vertical position while tightening the nut, or the sample will fall out into the neck of the combustion tube. NOTE: When the hot rod was removed, the carrier system was partially opened to atmosphere; and when the loaded rod was installed, the system was resealed. As a result, the atmosphere "slug" that was admitted in the interim will now be carried onto the chromatographic column by the restored carrier gas flow. The detector and recorder will show this chain of events.

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g. After the atmosphere peak is recorded and the baseline is returned to the approximate normal position, loosen the small retaining knob slightly while holding the rod handle to prevent it from turning. Depress the "START TIME CYCLE" pushbutton, then push the rod into the combustion tube as far as it will go.

NOTES: Do not completely loosen the small nut to perform the above step. It is only necessary to loosen it to the point when the rod can be pushed in about 1/4 turn.

The instrument will now combust the sample for 40 seconds. The gases will then be swept into the reduction furnace and chromatographic column. If automatic attenuation mode is used, the instrument will automatically attenuate the recorded signal to keep all the peaks on scale. If the manual mode of attenuation is used, adjust attenuation for each peak as follows:

Peak 1, Nitrogen x 8
Peak 2, Carbon Dioxide, x 32
Peak 3, Water, x 8

4.6.1.8 Calibration.

a. Set the weight dial to read 700 and set the "SENSITIVITY SELECTOR" to "MANUAL". Move the "ATTENUATION" control to the "8" position. Place an empty sample boat in the rod cavity.
b. Fill the boat with catalyst and pack the catalyst lightly with a spatula.
c. Load the catalyst-only rod into the instrument and run a chromatogram.
d. The resulting chromatogram will show how much C-H-N is contained in the catalysts. Under normal conditions, the first peak (N) will not exceed 1 scale division high; the second peak (C) will not exceed 4 scale divisions; and the third peak (H) will not exceed 5 divisions. If the peaks fall within the tolerances shown in Table I (at a manual x 8 attenuation), skip the next step and go to step f).

TABLE I. Tolerances.

	Normal Height (Scale Divisions)	Upper Limit (Scale Divisions)
1st peak (N)	1	1
2nd peak (C)	4	8
3rd peak (H)	5	10

e. If the peaks exceeded the upper limit shown in column 3 of Table I, recondition the catalysts according to the manufacturer's instructions.

f. If the blank peak heights are within tolerance, continue running blanks until the peaks are at a minimum level and are reproducible. NOTE: Contaminats used in the manufacturing of the combustion rods will also be eliminated as the blanks are run.

g. Record the peak height of the C, H, & N peaks to be used later in calibrating the instrument. Remember to divide the peak height by a factor of 4, as we will now switch back to automatic operating, and the C peak will be attenuated (x 32).

h. Move the "SENSITIVITY SELECTOR" switch to the "AUTOMATIC" position. If desired, however, analysis can be made with this switch in the "MANUAL" position. In this case, peaks must be attenuated by the operator.

4.6.1.9 Standard sample. A standard sample whose carbon content most closely matches that of the unknown and therefore gives a CO_2 peak similar in height to that obtained on the unknown is used to obtain the correction contents. From the measured peak height values, the constants are computed as follows; using 2, 4-D as an example:

$$\text{Carbon } K_C = \frac{51.79\%}{(\text{Measured C Peak Height from sample run}) - (\text{Measured C Peak Height from blank run})}$$

4.6.1.10 Unknown sample. The unknown sample is treated in exactly the same manner, and using the above calculated constraints of proportionality, the contents are computed, e.g., percent C equals peak height unknown by K_C.

5. PACKAGING

5.1 Preservation and packaging. The graphite fabric shall be preserved and packaged by winding the fabric on a cardboard, plastic or metal tube. The tube shall be a minimum of 2 inches in diameter and a maximum of 12 inches in diameter. The length of the tube shall be a minimum of 1 inch longer than the fabric is wide. Each roll shall be overwrapped with a plastic or paper overwrap material. Each roll shall then be placed in a cardboard or wood container. The inside dimensions of the container shall be larger than the outside diameter of a single roll. When placed in the container, the roll of fabric shall not move from side to side or up and down.

5.2 Marking for shipment. Interior and exterior container shall be marked in accordance with MIL-STD-129 and shall include the following:

a. The title, number and date of this specification
b. Manufacturer's name and address
c. Manufacturer's complete product designation
d. Lot number
e. Contract or purchase order number.

6. NOTES

6.1 Intended use. The graphite fabric covered by this specification is intended for use in the fabrication of reinforced composites.

6.2 Definitions. For the purpose of this specification, the following definitions apply.

6.2.1 Lot. The quantity of fabric produced during a single set up of a loom.

6.2.2 Roll. The quantity of fabric on a single roll shall be between 20 and 200 linear yards.

6.3 Ordering data. Procurement documents shall specify the following:

a. The title, number and date of this specification.
b. Whether a preproduction sample is required (see 3.6).
c. Whether the sampling tests of Section 4 are to be performed by the manufacturer.
d. Test data and certification required from the manufacturer.

Custodian:
Air Force - 11

Review activity:
DLA - CT

Preparing activity:
Air Force - 11

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