

MIL-C-44273

1 June 1987

MILITARY SPECIFICATION

CLOTH, LAMINATED, WATERPROOF, MOISTURE VAPOR PERMEABLE, AND
FLAME RESISTANT (4.6 OZ)

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This document covers a two-layered laminated cloth which is waterproof, moisture vapor permeable, and flame resistant.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Documents. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issue of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS

FEDERAL

P-D-245 - Detergent, Laundry and Hand Dishwashing (Granular)
PPP-P-1136 - Packaging of Coated (Plastic; Rubber) and
Laminated Fabrics

MILITARY

MIL-T-5624 - Turbine, Fuel, Aviation Grades JP-4 and JP-5
MIL-A-8243 - Anti-Icing and De-Icing, Defrosting Fluid
MIL-C-83429 - Cloth, Plain and Basket Weave, Aramid

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: U.S. Army Natick Research, Development, and Engineering Center, Natick, MA 01760-5014 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 8305

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STANDARDS

FEDERAL

FED-STD-191 - Textile Test Methods

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection
by Attributes.

(Copies of documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.1.2 Other Government documents. The following other Government documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues shall be those in effect on the date of the solicitation.

FEDERAL TRADE COMMISSION

Rules and Regulations Under the Textile Fiber Products Identification Act

(Copies may be obtained without charge from the Federal Trade Commission, Washington, DC 20580.)

2.2 Other publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issues of the nongovernment documents which are current on the date of the solicitation.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 1424 - Tear Resistance of Woven Fabrics by Falling-Pendulum
(Elmendorf) Apparatus

E 96 - Water Vapor Transmission of Materials, Procedure B

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

(Technical society and technical association documents are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

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2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document shall take precedence. Nothing in this document, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Standard sample. The laminated cloth shall match the standard sample for shade and appearance and shall be equal to or better than the standard sample with respect to all characteristics for which the standard sample is referenced (see 6.3).

3.2 First article. When specified in the contract or purchase order, a sample shall be subjected to first article inspection (see 4.3, 6.2, and 6.7).

3.3 Materials.

3.3.1 Basic materials.

3.3.1.1 Face. The face cloth shall be an aramid cloth conforming to MIL-C-83429, type II, class 1, Sage Green 1590.

3.3.1.2 Plastic film. The plastic film shall contain microporous polytetrafluoroethylene weighing 0.7 ± 0.3 ounces per square yard.

3.3.1.3 Adhesive. The adhesive for laminating the layers together shall be such that the laminated cloth will meet the requirements of this document. The adhesive shall have no adverse health hazard when used as intended.

3.4 Laminated cloth. The cloth specified in 3.3.1.1 shall be laminated to the plastic film specified in 3.3.1.2 in such a manner as to provide a finished cloth conforming to the requirements specified in table I when tested as specified in 4.5.

TABLE I. Physical requirements

Characteristics	Minimum	Maximum
Laminated cloth weight, oz/sq.yd.	4.6	6.3
Breaking strength, lbs.		
Warp	160	-
Filling	120	-
Tearing strength, lbs.		
Warp	5.5	-
Filling	4.0	-
Hydrostatic resistance, psi		
Fabric side facing water	50	-
Film side facing water	215	-

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TABLE I. Physical requirements (cont'd)

Characteristics	Minimum	Maximum
Moisture vapor transmission rate, Procedure B, g/in ² /24 hrs.	650	-
Flame resistance, warp and filling		
After flame, seconds	-	2
After glow, seconds	-	25
Char length, inches	-	5
Water permeability		
Initial	No leakage	-
After synthetic perspiration	No leakage	-
After exposure to aircraft fluids	No leakage	-

3.4.1 Width. The minimum overall width shall be as specified (see 6.2). Selvages shall be trimmed to give straight, uniform, fully laminated edges.

3.4.2 Resistance to delamination. When tested as specified in 4.5, delamination between the cloth and film after five launderings shall not exceed 0.25 linear inches.

3.5 Color. The color of the face side of the laminated cloth shall be Sage Green 1590 and shall match the standard sample (see 6.3).

3.5.1 Matching. The color of the finished cloth shall match the standard sample when viewed under filtered tungsten lamps which approximate artificial daylight having a correlated color temperature of 7000 \pm 500 K, with illumination of 100 \pm 20 foot candles, and shall be a good match to the standard sample under incandescent lamplight at 2300 \pm 100 K.

3.5.2 Colorfastness. The laminated cloth shall show colorfastness to light after 6 standard fading hours and laundering (after one cycle) equal to or better than the standard sample when tested as specified in 4.5.

3.5.3 pH. The pH value of the water extract of the finished cloth shall be not less than 5.0 and not greater than 8.0 when tested as specified in 4.5.

3.5.4 Dimensional stability. The shrinkage in the warp shall be not greater than 4.5 percent for the individual sample unit and not greater than 4.0 percent for the lot average after five launderings when tested as specified in 4.5. The shrinkage in the filling shall not be greater than 2.0 percent for the individual sample unit and not greater than 1.5 percent for the lot average after five launderings when tested as specified in 4.5.

3.5.5 Infrared reflectance. The infrared reflectance of the laminated cloth shall be specified in table II, when tested as specified in 4.5.

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TABLE II. Spectral reflectance requirements

Wavelength (nanometers)	Percent	
	Minimum	Maximum
600	8	13
620	8	13
640	8	13
660	8	13
680	10	18
700	16	28
720	22	40
740	30	51
760	35	61
780	40	70
800	45	77
820	50	81
840	55	82
860	60	82

3.6 Length and put-up. Unless otherwise specified (see 6.2), the laminated cloth shall be put-up in rolls in lengths of not less than 50 linear yards. Each roll shall contain no more than three continuous pieces and no single piece shall be less than 10 yards in length. Acceptance of shorter lengths, if permitted, shall be based on the conditions stipulated in the contract or purchase order (see 6.2). The cloth shall be put-up on full width rolls as specified in 5.1.

3.7 Fiber identification. Each roll shall be labeled, and ticketed for fiber content in accordance with the Textile Fiber Products Identification Act.

3.8 Workmanship. The laminated cloth shall conform to the quality of product established by this document. The occurrence of defects shall not exceed the acceptable quality levels.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own 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 this document where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

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* 4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection set forth in this document shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the document shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

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

- a. First article inspection (see 4.3).
- b. Quality conformance inspection (see 4.4).

4.3 First article inspection. When a first article is required (see 6.2), it shall be examined for the appearance, color, and finish defects and shall be tested for the characteristics specified in table III. The presence of any defect or failure to pass any test shall be cause for rejection of the first article.

4.4 Quality conformance inspection. Unless otherwise specified, sampling for inspection shall be performed in accordance with MIL-STD-105.

4.4.1 Component and material inspection. In accordance with 4.1, components and materials shall be inspected in accordance with all the requirements of referenced documents unless otherwise excluded, amended, modified, or qualified in this document or applicable purchase document.

4.4.1.1 Film overall weight test. The plastic film shall be tested in accordance with Method 5041 of FED-STD-191 except that each specimen shall be 25 square inches and the specimens shall be cut in diagonal fashion from each sample unit and may be tested under ambient conditions. The specimens shall be equally spaced across the full width of the sample unit no closer than 2 inches to the edges of the sample unit. The distance between the top of a specimen and the bottom of the next specimen shall be 3 inches. The sample unit shall be 1.5 yards full width of the film. No two specimens shall overlap in the width or lengthwise direction. The lot shall be rejected if any specimen weighs less than 0.4 ounces or greater than 1.0 ounces per square yard. The sample size shall be in accordance with the following:

<u>Lot size (yards)</u>	<u>Sample size (sample units)</u>
800 or less	2
801 up to and including 22,000	3
22,001 and over	5

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4.4.2 End item examination.

4.4.2.1 Yard by yard examination of face side. The cloth shall be examined on the face side for the defects listed below. All defects found shall be counted regardless of their proximity to each other except where two or more defects represent a single local condition, in which case only the more serious defect shall be counted. A continuous defect shall be counted as one defect for each warpwise yard or fraction thereof in which it occurs. The lot size shall be expressed in yards. The sample unit shall be 1 linear yard. The inspection level shall be II and the acceptable quality level (AQL), expressed in terms of defects per hundred units, shall be 4.0 for major defects and 10.0 for total (major and minor combined) defects. The number of rolls from which the sample yardage is to be selected shall be in accordance with table III. The sample yardage shall be apportioned equally among the selected rolls.

Defects	Classification	
	Major	Minor
Any hole, cut, or tear, including edges	X	
Abrasion, resulting in a thin or weak place	X	
Floats or skips, multiple 1/2 inch, or more in either warp or filling direction		X
Any solid lump, defined as a slub or knot which exceeds level C on the respective Sears Fabric defect Scale	X	
Fabric edges rolled, folded, doubled, scalloped or wavy	X	
Any spot, stain, or foreign matter		X
Width less than minimum specified	X	
Color off shade, not uniform, mottled, or spotted		X

4.4.2.1.1 Yard by yard examination of back. The cloth shall be examined on the back side for the defects listed below. The same sample rolls selected for the face side examination may be utilized for the back side examination. All defects found shall be counted regardless of their proximity to each other except where two or more defects represent a single local condition, in which case only the more serious defect shall be counted. The lot size shall be expressed in yards. The sample unit shall be 1 linear yard. The inspection level shall be II and the AQL, expressed in terms of defects per hundred units, shall be 2.5 for major defects and 4.0 for total (major and minor combined) defects. Any single defect scored on one side of the laminate cloth shall not be scored on the opposite side. The number of rolls from which the sample yardage is to be selected shall be in accordance with table III. The sample yardage shall be apportioned equally among the selected rolls.

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Defects	Classification	
	Major	Minor
Any hole, cut, or tear, including edges	X	
Abrasion, resulting in a thin or weak place	X	
Blisters, tunnels, or delamination of cloth	X	
Crease or wrinkle resulting in doubling that cannot be corrected by manual pressure or, adhesion of surfaces against each other, or any diagonal distortion of surface	X	
Any odor other than that which is characteristic of the laminating compound	X	
Any spot, stain, or foreign matter		X
Any tackiness	X	

TABLE III. Sample size

Lot size in yards	Sample size in rolls
1200 or less ^{1/}	3
1201 up to and including 3200	5
3201 up to and including 10,000	8
10,001 up to and including 35,000	13
35,001 up to and including 150,000	20
150,001 and over	32

^{1/} If lot contains fewer than three rolls, each roll in the lot shall be examined.

4.4.2.2 Length examination. During the yard-by-yard examination, each roll in the sample shall be examined for length. Any length found to be less than the minimum specified or more than 2 yards less than the length marked on the ticket shall be considered a defect with respect to length. The lot shall be unacceptable if two or more rolls in the sample are defective in respect to length or if the total of the actual lengths of rolls in the sample is less than the total of the lengths marked on the tickets.

4.4.2.3 Shade and appearance examination (face side only). During the yard-by-yard examination, each roll in the sample shall be examined for shade and appearance. If the color in any roll of the sample is off shade or does not have the same appearance as the standard sample it shall be cause for rejection of the entire lot represented by the sample.

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4.4.2.4 Roll identification examination. During the yard-by-yard examination, each roll in the sample shall be examined for proper identification. The lot shall be unacceptable if two or more rolls in the sample are not labeled or ticketed in accordance with the Textile Fiber Products Identification Act.

4.4.3 End item testing. The cloth shall be tested for the characteristics listed in table IV. The methods of testing specified in FED-STD-191 wherever applicable and as listed in table IV shall be followed. All test reports shall contain the individual values utilized in expressing the final results. The sample unit for all testing shall be 3 continuous yards, full width, of the finished cloth supplied on a tube to prevent folding. The lot shall be rejected if one or more sample units fail to meet the requirement specified. The maximum lot size shall be 150,000 linear yards. The sample size shall be in accordance with the following:

<u>Lot size (yards)</u>	<u>Sample size</u>
800 or less	2
801 up to and including 22,000	3
22,001 up to and including 150,000	5

TABLE IV. End item tests

<u>Characteristics</u>	<u>Requirement paragraph</u>	<u>Test method</u>
Laminated cloth		
Overall weight	3.4	5041
Breaking strength	3.4	5100
Tearing strength	3.4	ASTM D 1424
Hydrostatic resistance		
Fabric side facing water	3.4	5512
Film side facing water	3.4	5512
Moisture vapor transmission rate (procedure B)	3.4	ASTM E 96 <u>1/</u>
Flame resistance	3.4	5903
Water permeability		
Initial	3.4	5516 <u>3/</u>
After synthetic perspiration	3.4	4.5.3, 4.5.4 and 5516 <u>3/</u>
After exposure to aircraft fluids	3.4	5516 <u>4/</u>
Infrared reflectance	3.5.5	4.5.1
Colorfastness to:		
Light	3.5.2	5660
Laundering (after 1 cycle)	3.5.2	5614 <u>5/</u>
pH	3.5.3	2811
Dimensional stability	3.5.4	5556 <u>2/</u>
Resistance to delamination	3.4.2	4.5.2

1/ The film side of the laminated cloth shall face the water and the free stream air velocity shall be 550 \pm 50 feet per min (fpm) as measured 2

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inches above the fabric specimen. Five specimen shall be tested from each sample. The airflow shall be measured at least 2 inches from any other source. The test shall be run for 24 hours and weight measurements shall be taken at only the start and completion of the test. At the start of the 24 hour test period, the air gap between the water surface and the back of the specimen shall be $3/4$ inch.

2/ Cotton laundering procedure.

3/ The water permeability shall be measured as specified in Method 5516 of FED-STD-191, except that the fabric side of the laminated cloth shall contact the water. The hydrostatic head shall be 50 centimeters and shall be held for 5 minutes. The report shall be for the measurement of water penetration. Leakage is defined as the appearance of water any place within the 4-1/2 inch diameter test area. The test may be performed using any device which tests the same specimen area at the equivalent pressure. In cases of dispute, the apparatus described in Method 5516 of FED-STD-191 shall be used. The specimen size shall accomodate the equipment being used.

4/ One specimen per sample unit shall be tested for leakage after exposure to aircraft fluids. The specimens shall be not less than 6 inches in diameter. Specimen shall be placed on a flat surface and 1 mL of JP-4 (jet fuel conforming to MIL-T-5624) spread over the middle, followed by 1 mL of de-icing fluid conforming to MIL-A-8243. Place the horizontal specimen flat in an air circulating oven at 50°C for 30 minutes. Remove from oven and test immediately as specified in footnote 3/.

5/ Specimen size shall be 4 ± 0.1 grams.

4.4.4 Packaging inspection. The inspection shall be in accordance with the quality assurance provisions of PPP-P-1136.

4.5 Methods of inspection.

4.5.1 Infrared reflectance test. Spectral reflectance data shall be obtained from 600-860 nm relative to a barium sulfate standard, the preferred white reference standard. Other reference white standards may be used provided they are calibrated to an absolute white; i.e., Halon, magnesium oxide, or vitrolite tile. The spectral band width at 860 nm shall be less than 26 nm. Reflectance measurements may be made by either the monochromatic or polychromatic mode of operation. When the polychromatic mode is used, the spectrophotometer shall operate with the specimen diffusely illuminated with the full emission of a continuous source that simulates either CIE Source A or CIE Source D65 in the visible spectrum. Specimens shall be measured as a single layer of the laminate backed by eight layers of the unlaminated outershell material without the PTFE film. Readings will be taken on a minimum of two different areas and the data averaged. The specimen shall be viewed at an angle no greater than 10 degrees from normal. Photometric accuracy of the spectrophotometer shall be within 1 percent; and the wavelength accuracy shall be within 2 nm. The standard

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aperture size used in the color measurement device shall be 1.0 to 1.25 inches in diameter. Failure of the near-infrared spectral reflectance requirements will occur when spectral reflectance limits are exceeded at four or more specified wavelengths.

4.5.2 Delamination test. Place 2 ± 0.2 pounds of laminated cloth (one sample unit, 24 inches by full width plus ballast) in a top-loading, commercially available, home-type washer set on the permanent press (10 minutes sudsing) cycle using a high water level (10 inches). The water temperature shall be warm ($100^\circ \pm 10^\circ\text{F}$). Place 0.5 ounces of type II (P-D-245) detergent to provide suds. The duration of each laundering cycle shall be 30 ± 5 minutes. After laundering, place sample and ballast in a commercially-available home-type dryer set on the permanent press cycle using medium heat ($100^\circ \pm 10^\circ\text{F}$) and dry for approximately 15 minutes. Repeat laundering and drying cycle five times. After the fifth drying cycle, examine both sides for delamination. The sample shall be considered delaminated if the separation between plies exceeds 0.25 inch in any direction.

4.5.3 Preparation of synthetic perspiration. The synthetic perspiration solution shall be made up in a 500 mL glass beaker by combining 3.0 g sodium chloride, 1.0 g trypticase soy broth powder, 1.0 g normal propyl propionate, and 0.5 g of lecithin. Add 500 mL of distilled water, add a magnetic stirring bar, and cover the beaker. Place the beaker on a combination hot plate/magnetic stirrer apparatus. While stirring, heat the solution to 50°C until all ingredients are dissolved. While stirring, cool the solution to 35°C , remove cover, and dispense immediately with a pipet or other suitable measuring device. Dispense 2 mL of perspiration solution at 35°C onto the center of an 8-inch by 8-inch glass plate. Place a specimen on the glass plate with the film side facing the glass. Dispense an additional 2 mL of the synthetic perspiration solution onto the center of the specimen. Place an 8-inch by 8-inch glass plate on top of the specimen with a 4 pound weight positioned in the center.

4.5.4 Water permeability after perspiration. Three specimens, 8 inches by 8 inches, shall be cut and exposed to perspiration as specified in 4.5.3. After 16 hours, remove the specimen (Do Not Rinse) and after air drying test for water permeability.

5. PACKAGING

5.1 Put-up and preservation. Put-up and preservation shall be level A or Commercial as specified (see 6.2).

5.1.1 Levels A and Commercial. The cloth shall be put-up and preserved in accordance with the applicable requirements of PPP-P-1136.

5.2 Packing. Packing shall be level A, B, or Commercial as specified (see 6.2).

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5.2.1 Levels A, B, and Commercial. The cloth shall be packed in accordance with the applicable requirements of PPP-P-1136.

5.3 Marking. In addition to any special marking required in the contract or purchase order, shipments shall be marked in accordance with the requirements of PPP-P-1136.

6. NOTES

6.1 Intended use. The laminated cloth is intended for use as an outer shell material of the Suit, Chemical, Air-Crew, Flame Resistant. Aircrew Uniform Integrated Battlefield (AUIB).

6.2 Ordering data. Acquisition documents should specify the following:

- a. Title, number, and date of this document.
- b. First article (see 3.2, 4.3, and 6.7).
- c. Width of cloth required (see 3.4.1).
- d. Length and put-up required, if other than specified (see 3.6).
- e. Selection of applicable levels of preservation and packing (see 5.1 and 5.2).

6.3 Standard sample. For access to standard sample, address the contracting activity issuing the invitation for bids.

6.4 Spectrophotometers. Suitable spectrophotometers for measuring spectral reflectance in the near-infrared are the Diano Hardy, Diano Match Scan, Hunter D54P-IR and Macbeth 1500 with IR option.

6.5 White standards. Barium sulphate of suitable quality for use as a white reference standard is available from the Eastman Kodak Company. Tiles are available from the instrument manufacturer.

6.6 Fabric defect scales. Fabric Defect Replica Kits are available from Sears Roebuck and Company, Department 817, (ATTN: BSC23-29), Sears Tower, Chicago, IL 60684.

6.7 First article. When a first article sample is required, it shall be inspected and approved under the appropriate provisions of FAR 52.209. The first article should be a preproduction sample. The contracting officer should specify the appropriate type of first article and the number of units to be furnished. The contracting officer should include specific instructions in all acquisition documents regarding arrangements for selection, inspection, and approval of the first article.

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6.8 Subject term (key word) listing.

Cloth, laminated
Flame resistant
Moisture vapor permeable
Waterproof

Custodians:

Army - GL
Navy - NU
Air Force - 11

Preparing activity:

Army - GL
Project No. 8305-0129

Review activity:

Army - MD
Air Force - 99
DLA - CT

User activity:

Navy - MC

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