

INCH-POUND

MIL-C-44187C  
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SUPERSEDING  
MIL-C-44187B  
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## MILITARY SPECIFICATION

### CLOTH, LAMINATED, WATERPROOF AND MOISTURE VAPOR PERMEABLE

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 three-layered laminated cloth which is waterproof and moisture vapor permeable.

#### 2. APPLICABLE DOCUMENTS

##### 2.1 Government documents

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this specification to the extent specified herein. Unless otherwise specified, the issues 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.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Personnel Support Center, Clothing and Textiles Directorate, Attn: DPSC-FSSD, 2800 South 20th Street, Philadelphia, PA 19101-8419, by using the 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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Approved for public release;  
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## SPECIFICATIONS

## FEDERAL

- O-I-503 - Insect Repellent, Clothing and Personal Application
- P-D-245 - Detergent, Laundry and Hand Dishwashing (Granular)
- PPP-P-1136 - Packaging of Coated (Plastic; Rubber) and Laminated Fabrics

## MILITARY

- MIL-C-21852 - Cloth, Taffeta, Nylon

## STANDARDS

## FEDERAL

- FED-STD-101 - Test Procedures for Packaging Materials
- FED-STD-191 - Textile Test Methods
- FED-STD-601 - Rubber: Sampling and Testing

## MILITARY

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

(Copies of specifications, standards, and handbooks 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, drawings, and publications. The following other Government documents, drawings, and publications form a part of this specification 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 from the Federal Trade Commission, Correspondence Branch, Pennsylvania Avenue at Sixth Street, N.W., Washington, DC 20580.)

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## DRAWINGS

U.S. ARMY NATICK RESEARCH, DEVELOPMENT, AND  
ENGINEERING CENTER

2-1-1516B - Woodland Pattern - 60 inches

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

\* 2.2 Other publications. The following documents form a part of this specification 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 non-Government documents which are current on the date of the solicitation.

## AMERICAN ASSOCIATION OF TEXTILES CHEMISTS AND COLORISTS (AATCC)

- \* Evaluation Procedure 1 - Gray Scale for Color Change
- \* Evaluation Procedure 3 - AATCC Chromatic Transference Scale
- 119 - Color Change Due to Flat Abrasion (Frosting):  
Screen Wire Method
- \* 135 - Dimensional Changes in Automatic Home Laundering  
of Woven and Knit Fabrics

(Copies should be obtained from the American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709-2215.)

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- D 618 - Conditioning of Plastics and Electrical Insulating  
Materials for Testing
- D 2582 - Puncture-Propagation Tear Resistance of Plastic  
Film and Thin Sheeting
- \* D 5034 - Breaking Force and Elongation of Textile Fabrics  
(Grab Test)
- E 96 - Water Vapor Transmission of Materials, Procedure B  
and BW

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(Copies should be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187.)

(Non-Government standards and other publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence. Nothing in this specification; 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 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 6.8).

### 3.3 Materials

#### 3.3.1 Base cloths

\* 3.3.1.1 Plain weave. The plain weave cloth shall be nylon,  $2.8 \pm 0.2$  ounces per square yard Woodland Pattern Camouflage or Blue, Air Force Shade 1613 (see 6.2). The cloth shall be woven with a minimum of 101 ends per inch and 63 two-ply textured picks per inch.

\* 3.3.1.2 Tricot knit. The tricot knit cloth shall be nylon,  $1.5 \pm 0.3$  ounces per square yard, Olive Green 106 or Camouflage Green 483 or Blue, Air Force Shade 1613 (see 6.2). The cloth shall be knit on 2 bars using 40 denier multifilament and 15 denier monofilament yarn.

\* 3.3.2 Plastic film. The plastic film shall be one of the following:

\* 3.3.2.1 Microporous polytetrafluoroethylene film weighing  $0.5 \pm 0.2$  ounces per square yard.

\* 3.3.2.2 Solid film, weighing  $0.5 \pm 0.2$  ounces per square yard, consisting of a polyolefin microporous membrane fully saturated with a hydrophilic urethane.

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3.3.3 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 one side of the plastic film specified in 3.3.2 and the cloth specified in 3.3.1.2 shall be laminated to the other side of the plastic film. The face side of the laminated cloth shall be the side with the cloth specified in 3.3.1.1. An approved water repellent finish shall be applied to the face side of the laminated cloth (see 3.5.1 and 6.4).

\* 3.4.1 Color. The color of the face side of the laminated cloth shall be Woodland Pattern Camouflage or Blue, Air Force Shade 1613 (see 6.2). The color of the back side of the laminated cloth shall be OG 106 or Camouflage Green 483 or Blue, Air Force shade 1613 (see 6.2). Both sides of the fabric shall match the respective side of the standard sample.

\* 3.4.2 Matching. The color and appearance of the laminated cloth shall match the standard sample when viewed under filtered tungsten lamps that approximate artificial daylight and that have a correlated color temperature of  $7500 \pm 200\text{K}$ , with illumination of  $100 \pm 20$  foot candles and shall be a good match to the standard sample under incandescent lamplight at  $2300 \pm 200\text{K}$ .

\* 3.4.3 Colorfastness. The laminated cloth shall meet the following colorfastness requirements when tested in accordance with 4.4.3 for the characteristics listed below:

<u>Colorfastness characteristics</u>	<u>Requirements</u>
Fastness to laundering (after 3 cycles)	Equal to or better than a rating of "good" for color change and equal to or better than a rating of "fair" for staining of color transfer cloth.
Fastness to accelerated laundering (Black print only)	Equal to or better than "3-4" rating on AATCC Gray Scale for evaluating change in color when compared to the unlaundered sample.
Fastness to light (after 40 hrs)	Equal to or better than the standard sample, or equal to or better than "fair".

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Colorfastness characteristicsRequirements - continued


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Fastness to perspiration	Equal to or better than the standard sample, or equal to or better than "good". <u>1/</u>
Fastness to crocking	Equal to or better than the standard sample or not less than AATCC Chromatic Transference Scale Rating of 3.5. <u>2/</u>
Fastness to abrasion (Black 357 only)	Equal to or better than the standard sample or not less than "3-4" rating on AATCC Gray Scale for evaluating change in color when compared to the unabraded sample.

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- \* 1/ Except the fastness of Dark Green 355 and Brown 356 for Woodland Pattern Camouflage shall be not less than "fair" when tested for fastness to alkaline perspiration.
- 2/ Except Black 357 shall show an AATCC Chromatic Transference Scale Rating of not less than 1.0.

3.4.4 Pattern execution. The pattern shall reproduce the standard sample in respect to design, colors, and registration of the respective areas. The pattern repeat of the printed and laminated cloth shall be 27.25 + 1.25, - 2.50 inches in the warp direction. Each pattern area shall show solid coverage; skitteriness exceeding that shown by the standard sample in any of the printed areas will not be acceptable. When the standard sample is not referenced for pattern execution on design, the pattern of the base cloth shall match the standard Woodland Camouflage Pattern Drawing 2-1-1516B.

\* 3.4.5 Spectral reflectance. The camouflage printed and water repellent treated side of the laminated cloth shall conform to the spectral reflectance requirements specified in Table I, when tested as specified in 4.4.3.

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TABLE I. Spectral Reflectance Requirements

Wavelength Nanometers	Reflectance Values (percent)			
	Light Green 354		Dark Green 355 and Brown 356	
	Min.	Max.	Min.	Max.
600	8	20	3	13
620	8	20	3	13
640	8	20	3	13
660	8	22	3	13
680	8	36	3	22
700	14	60	8	46
720	26	78	20	66
740	40	90	30	80
760	50	92	32	88
780	55	92	32	90
800	55	92	32	90
820	55	92	32	90
840	55	92	32	90
860	55	92	32	90

3.5 Physical requirements. The laminated cloth shall conform to the requirements in Table II when tested as specified in 4.4.3.

TABLE II. Physical Requirements

Characteristics	Minimum	Maximum
Weight, oz/sq yd	--	5.9
Breaking strength, lbs:		
Warp	135	--
Filling	100	--
Tearing resistance, kgf:		
Warp	3.5	--
Filling	3.2	--
Moisture vapor transmission rate, g/m <sup>2</sup> /24 hour:		
Procedure B		
Initial	600	--
After synthetic perspiration	600	--
Procedure BW		
Initial	3600	--

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TABLE II. Physical Requirements - continued

Characteristics	Minimum	Maximum
Hydrostatic resistance, psi:		
Initial	90	--
After strength of coating	80	--
After abrasion		
Face	80	--
Back	80	--
* After diethyltoluamide	80	--
Stiffness (warp only), cm	--	12.0
Water permeability:		
Initial	no leakage	
After synthetic perspiration	no leakage	
After flex (70°F)		
Warp	no leakage	
Filling	no leakage	
After cold flex (-25°F)		
Warp	no leakage	
Filling	no leakage	

3.5.1 Water repellency. The laminated cloth shall be given an approved Quarpel type water repellent treatment on the face side of the cloth and shall conform to the water repellency requirements. The use of materials other than approved water repellents are prohibited (see 6.4).

3.5.2 Spray ratings. The results of the three individual determinations on the sample unit for spray rating shall be equal to or better than ratings 100, 90, 90 initially and the ratings shall be equal to or better than ratings of 90, 90, 80 after three launderings.

3.5.3 Resistance to organic liquids. The finished cloth shall show no wetting by n-tetradecane, initially and after three launderings. Different specimens shall be used for initial and after laundering specimens.

\* 3.5.4 Physical surface appearance changes after laundering. Both sides of the sample shall be visually examined for any evidence of physical surface appearance changes after 20 laundering cycles as specified in 4.5.5. The physical surface appearance of the laundered sample shall show no difference when compared to the unlaundered sample.



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3.5.5 Dimensional stability. The shrinkage or elongation in the warp direction of the finished cloth shall not be greater than 4.5 percent for the individual sample unit and not greater than 4.0 percent for the lot average, and in the filling direction of the finished cloth, the shrinkage or elongation shall not be greater than 2.5 percent for the individual sample unit and not greater than 2.0 percent for the lot average when tested as specified in 4.4.3.

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

3.7 Length and put-up. Each roll shall contain no more than five 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.

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

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

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 requirement 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.

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4.1.2 Certificate of compliance. When certificates of compliance are submitted, the Government reserves the right to inspect such items to determine the validity of the certification.

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 defects listed in Table III and shall be tested for the characteristics specified in Table IV. The presence of any defect or failure of 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 Plastic 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 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. No two specimens shall overlap in the width or lengthwise direction. The sample unit shall be 1.5 yards full width of the plastic film. The lot shall be rejected if any specimen weighs less than 0.3 or greater than 0.7 ounces per square yard, or if the difference in weight between any two specimens in the sample unit is greater than 0.25 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 up to and including 150,000	5

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4.4.1.2 Certification. Components listed below shall be accepted on the basis of a contractor's certificate of compliance with the indicated requirements.

<u>Component</u>	<u>Requirement paragraph</u>
Plain weave nylon cloth	3.3.1.1
Tricot knit nylon cloth	3.3.1.2

#### 4.4.2 End item examination

4.4.2.1 Yard-by-yard examination. The cloth shall be examined on both sides for the defects in Table III. 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 acceptance 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 for the face side of the laminated cloth and 4.0 for major defects and 10.0 for total (major and minor combined) defects for the back side of the laminated cloth, but with an AQL of no more than 6.5 for total combined major defects for the front and back sides of the laminated cloth. Any effects scored on one side of the laminated 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 IV. The sample yardage shall be apportioned equally among the selected rolls.

TABLE III. End Item Visual Defects

Defects	Classification	
	<u>Major</u>	<u>Minor</u>
Any hole, cut, or tear, including edges	X	
Abrasion resulting in a thin or weak place	X	
Multiple floats or skips, 1/2 inch or more in either warp or filling direction		X
* Blisters, tunnels, bubbles	X	

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TABLE III. End Item Visual Defects - continued

Defects	Classification	
	<u>Major</u>	<u>Minor</u>
Crease or wrinkle resulting in doubling that cannot be corrected by manual pressure, adhesion of surfaces against each other, or any diagonal distortion of woven (face) fabric surface	X	
Any solid lump, defined as a slub C or 4, or knot which exceeds level C on the respective Sears Fabric Defect Scale (see 6.7)	X	
Fabric edges rolled, folded, doubled, scalloped, or wavy	X	
Any spot, stain, or foreign matter <u>1/</u>		X
Width less than minimum specified	X	
Any odor other than that which is characteristic of the laminating compound or water-repellent finish		X
Any color off shade, not uniform, mottled, or spotted <u>2/</u>		X
Any tackiness	X	

1/ For the knit (back) side, any spot, stain, streak, off-shade area, or discoloration that is a result of the distortion of the knit when laminated or a result of uneven dyeing shall not be scored for this condition. Foreign matter shall be defined as waste, fly, or extraneous material that has been knit into fabric or spun into yarn.

2/ Woven (face) fabric side only.

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TABLE IV. Sample Size

Lot size in yards	Sample size in rolls
1,200 or less <u>1/</u>	3
1,201 up to and including 3,200	5
3,201 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. During the yard-by-yard examination, each roll in the sample shall be examined for shade and appearance. If any one component color in any roll of the sample is off shade or does not have the same appearance as the sample it shall be cause for rejection of the entire lot represented by the sample.

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 V. The methods of testing specified in FED-STD-191 wherever applicable and as listed in Table V 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 6 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 (sample units)</u>
800 or less	2
801 up to and including 22,000	3
22,001 up to and including 150,000	5

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TABLE V. End Item Tests

Characteristic	Requirement paragraph	Test method <u>1/</u>
Colorfastness to:		
Light	3.4.3	5660
Laundrying (after 3 cycles)	3.4.3	5614 <u>2/</u>
* Accelerated laundrying (Black 357 only)	3.4.3	4.5.9
Perspiration	3.4.3	5680
Crocking	3.4.3	5651
* Abrasion (Black 357 only)	3.4.3	AATCC 119 <u>3/</u>
Spectral reflectance	3.4.5	4.5.1
Overall weight	3.5	5041
Breaking strength	3.5	ASTM-D 5034, G <u>4/</u>
Tearing resistance	3.5	ASTM-D 2582 <u>5/</u>
* Moisture vapor transmission rate Procedure B		
* Initial	3.5	ASTM-E 96 <u>6/ 14/</u>
* After synthetic perspiration	3.5	4.5.8 and ASTM-E 96 <u>6/ 14/</u>
Procedure BW		
* Initial	3.5	ASTM-E 96 <u>7/ 14/</u>
Hydrostatic resistance:		
Initial	3.5	5512 <u>8/</u>
After strength of coating	3.5	5972 <u>9/</u> and 5512 <u>8/</u>
After abrasion		
Face	3.5	5302 <u>10/</u> and 5512 <u>8/</u>
Back	3.5	5302 <u>10/</u> and 5512 <u>8/</u>
After diethyltoluamide	3.5	<u>11/</u>
Stiffness (warp only), cm	3.5	5204
Water permeability		
Initial	3.5	5516 <u>12/</u>
After synthetic perspiration	3.5	4.5.7 and 5516 <u>12/</u>
After flex (70°F)		
Warp	3.5	4.5.2 and 5516 <u>12/</u>
Filling	3.5	4.5.2 and 5516 <u>12/</u>
After cold flex (-25°F)		
Warp	3.5	4.5.3 and 5516 <u>12/</u>
Filling	3.5	4.5.3 and 5516 <u>12/</u>

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TABLE V. End Item Tests - continued

Characteristic	Requirement paragraph	Test method <u>1/</u>
Water repellency	3.5.1	<u>13/</u>
Spray rating		
Initial	3.5.2	5526
After 3 launderings	3.5.2	5552 and 5526
Resistance to organic liquid		
Initial	3.5.3	4.5.4
After 3 launderings	3.5.3	5552 and 4.5.4
* Physical surface appearance changes after laundering	3.5.4	4.5.5
Dimensional stability	3.5.5	5552

1/ The face side of the laminated cloth shall be used to orient the test specimens in either the warp or filling direction as required by the applicable test method.

\* 2/ Specimen size shall be 4 grams  $\pm$  0.1 gram. All colors shall be tested, except for the Black.

3/ Except that the number of abrasion cycles shall be 300.

4/ Measurements shall be read from either dial or recording mechanism and a tensioning clamp shall not be required.

5/ Five warp and five filling specimens shall be tested in accordance with Section 4 of FED-STD-191. Specimen size shall be 8 inches by 8 inches. Only one tear shall be made on a single specimen. The specimen shall be positioned with the face side toward the probe and with the designated yarns of the face fabric at right angles to the direction of tear. The test shall be conducted using carriage number 4 (0.4536 kgs) and the standard drop height of  $508 \pm 2$  mm. If the tear is not straight on face side of the laminate, the result shall be considered invalid and another specimen shall be tested. The thickness of the specimen shall not be measured.

6/ The back side of the laminated cloth shall face the water. The free stream air velocity shall be  $550 \pm 50$  FPM as measured 2 inches above the fabric specimen. The air flow shall be measured at least 2 inches from any other surface. The test shall be run for 24 hours and weight measurements shall be taken



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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  $3/4 \pm 1/16$  inch. Five initial and three after synthetic perspiration shall be tested.

- 7/ The back side of the laminated cloth shall face the water. The free stream air velocity shall be  $550 \pm 50$  FPM as measured 2 inches below the fabric specimen. The airflow shall be measured at least 2 inches from any other surface. The test shall be run for 2 hours and weight measurements shall be taken at only the start and completion of the test. Five specimens shall be tested. The specimen shall be sealed in any manner which prevents wicking and/or leakage of water out of the cup.
- 8/ The water pressure shall be applied to the face side of the laminated cloth. A taffeta fabric restraint, conforming to Type III, Class 1 of MIL-C-21852 shall be placed across the back of the laminate during testing. No area of the taffeta restraint may be used more than once.
- 9/ Except that the specimens shall be stretched at 20 pounds.
- 10/ The abrasion test shall be conducted in multidirectional mode using the face side of the laminate as the abradant. A load of 6 pounds shall be applied to the abradant. The test shall be completed at 10,000 cycles.
- 11/ Each of five 4 inch by 4 inch specimens shall be laid flat, face side up, on a glass plate 4 inches by 4 inches by  $1/4$  inch. Three drops of diethyltoluamide conforming to Type II, concentration A of O-I-503 shall be applied to the center of each specimen. A glass plate shall be placed on each specimen and a four pound weight placed on top. After 16 hours, remove the five specimens and test immediately in accordance with Method 5512 of FED-STD-191, with the water pressure being applied to the face side. A taffeta fabric restraint, conforming to Type III, Class 1 of MIL-C-21852 shall be placed across the back of the laminate during testing. No area of the taffeta restraint may be used more than once.
- 12/ The water permeability shall be measured as specified in Method 5516 of FED-STD-191, except that the face 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 only include measurement of the appearance of water drops. Leakage is defined as the appearance of water any place within 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.



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- 13/ The contractor shall report the water repellents used and certify that no other material has been added.
- \* 14/ All test specimens shall be taken from areas of the laminated cloth that do not contain the Black printed areas of the camouflage pattern of the face side.

4.4.3.1 Standard test conditions. Unless otherwise specified, results of physical tests obtained under testing conditions defined in FED-STD-191, ASTM-D-618, or FED-STD-601 will be acceptable except in cases of dispute and in the determination of moisture vapor transmission rate. In dispute cases, the tests shall be conducted with both the specimen and test apparatus under standard conditions as defined in FED-STD-191.

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 Spectral reflectance test. Reflectance data shall be obtained from 600 to 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; e.g., Halon, magnesium oxide or vitrolite tile. The spectral bandwidth at 860 nm shall be less than 26 nm. Reflectance measurements shall be made using either the monochromatic or polychromatic mode of operation of a spectrophotometer (see 6.5). When the polychromatic mode is used, the spectrophotometer shall operate with the specimen diffusely illuminated with the full emission of a source that simulates either CIE Source A or CIE Source D65. Each shade of the pattern shall be measured as a single layer of laminate backed with six layers of unlaminated outer shell material of the same shade. 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 with specular component included. Photometric accuracy of the spectrophotometer shall be within 1 percent and the wavelength accuracy shall be within 2 nm. The standard aperture size used in the color measurement device shall be 1.0 to 1.25 inches in diameter. Any color having spectral reflectance values falling outside the limits at four or more of the wavelengths specified in Table I shall be considered a test failure.

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4.5.2 Water permeability after flex (70°F) test. One 8 inch by 12 inch area shall be cut from the sample unit with the 8 inch dimension in the indicated direction (warp or filling as applicable). The specimen shall be conditioned and flexed as specified in Method 2017 of FED-STD-101 except the specimen shall not be aged, the short edges shall not be heat sealed or otherwise joined, and the specimen shall be flexed for 1500 cycles. Two 6 inch by 8 inch specimens shall be cut from the 8 inch by 12 inch flexed specimen and tested for hydrostatic resistance in accordance with Method 5516 of FED-STD-191 with water pressure applied to the face side.

4.5.3 Water permeability after cold flex (-25°F) test. The water permeability after cold flex (-25°F) test shall be as specified in 4.5.2 except that the 8 inch by 12 inch specimen shall be mounted on the flex test apparatus, placed in a test chamber at -25°F for 1 hour, and then flexed in the test chamber at -25°F.

4.5.4 Resistance to organic liquid test. Place a small specimen of the cloth on smooth horizontal surface, face up. Using a pipette or eye dropper, gently deposit one drop of n-tetradecane on the surface of the specimen. After 30 seconds examine the specimen under light at an angle. Absence of light reflectance at the cloth drop interface shall be taken as evidence of wetting. Three specimens (or areas) taken at various locations across the sample unit shall be tested. Evidence of wetting on one or more specimens shall be considered a test failure.

\* 4.5.5 Physical surface appearance laundering test. Place  $2 \pm 0.2$  pounds of the finished, laminated cloth and, if needed, ballast in an automatic washing machine set on permanent press cycle, high water level and warm ( $100 \pm 10^\circ\text{F}$ ,  $- 0^\circ\text{F}$ ) wash temperature. Each sample unit, 48 inches in length by full width, shall be cut in half across the width of the fabric. One half of the sample unit (24 inches) will be laundered and the other half retained for final evaluation (unlaundered). Place 0.5 ounces (14 grams) of detergent conforming to Type II of P-D-245 into the washer. The duration of each laundering cycle shall be  $30 \pm 5$  minutes. After laundering, place sample and ballast in an automatic tumble dryer set on permanent press cycle, high heat setting ( $150-160^\circ\text{F}$ ) and dry for approximately 15 minutes. Conduct 20 laundering and drying cycles. After each drying cycle, examine both sides of the cloth for changes in physical surface appearance. Sample shall show no changes in physical surface appearance when compared to the unlaundered sample. The laundering equipment, washer and dryer, shall be in accordance with AATCC test method 135.

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4.5.6 Exposure to synthetic perspiration procedure. The synthetic perspiration solution shall be made up in a 500 mL glass beaker by combining 3.0 grams sodium chloride, 1.0 gram trypticase soy broth powder, 1.0 gram normal propyl propionate, and 0.5 gram of liquid 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 pipette or other suitable measuring device. Dispense 2 mL of perspiration solution at 35°C onto the center of an eight (8) inches by eight (8) inches by 1/4 inch glass plate. Place a specimen on the glass plate with the knit side facing the glass. Dispense an additional 2 mL of the synthetic perspiration solution onto the center of the specimen. Place an eight (8) inches by eight (8) inches by 1/4 inch glass plate on top of the specimen with a 4 pound weight positioned in the center.

4.5.7 Water permeability after perspiration test. Three specimens, eight (8) inches by eight (8) inches, shall be cut and exposed to perspiration as specified in 4.5.6. After 16 hours, remove the specimens (do not rinse) and test after air drying for water permeability.

4.5.8 Moisture vapor transmission rate after perspiration test. Air dry the specimen used in 4.5.7. Cut out an appropriately sized specimen from the center and test for moisture vapor transmission rate.

\* 4.5.9 Accelerated laundering test. The test procedure shall be in accordance with FED-STD-191 test method 5614, except the following deviations shall apply: Five (5) specimens containing predominantly Black print, each 4-1/2 inches by 3 inches, shall be cut from the laminated fabric and then folded in half, with the face side out, on the longer dimension. Machine stitch the open edges together (seam allowance no more than 1/8 inch) to form a bag leaving an opening (approximately one inch in length). Through the opening add 35 stainless steel spheres. Close the bag by stapling or stitching. Place the bag in a stainless steel cylinder without the color transfer cloth, add 50 ml of P-D-245 detergent solution (0.5 percent by weight detergent solution) and 100 stainless steel spheres and close tightly. Place the stainless steel cylinder in a preheated Launder-Ometer set at a water bath temperature of 160 ± 5°F. Agitate cylinder for one (1) hour maintaining a constant temperature. At the end of the laundering cycle, remove the bag from cylinder and rinse each bag thoroughly in a beaker, in running tap water at 100 ± 5°F for five (5) minutes with occasional stirring or hand squeezing. Remove excess water by squeezing in hand (not extracting) and then dry bag in automatic tumble dryer set on permanent press cycle, high heat (150-160°F) for fifteen (15) minutes. If the bag breaks open to

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release the contained spheres at any time during the test, the test shall be considered invalid and another bag specimen shall be prepared and tested. Remove all spheres from the bag and evaluate each face of the bag without pressing or ironing the bag. Each face of the laundered bag shall be compared to the original sample (unlaundered) in accordance with AATCC Evaluation Procedure 1 for evaluation of Gray Scale for Color Change and the rating shall be based on the portion of the Black print exhibiting the most color loss. The lower of the two ratings of each bag shall be recorded as the result for the bag. Failure of any of the five (5) bags to meet the required rating (see 3.4.3), shall be considered a test failure.

## 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).

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 cloth is intended for use in the parka and trousers of the Extended Cold Weather Clothing System.

\* 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, 6.8).
- c. Color (Woodland Pattern Camouflage or Air Force Shade Blue 1613) (see 3.3.1, 3.4.1).
- d. Width of cloth required (see 3.6).
- e. Length required, if other than specified (see 3.7).
- f. Selection of applicable levels of preservation and packaging (see 5.1 and 5.2).

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

6.4 Quarapel water repellent. The "Quarapel type" water repellent treatment consists of the co-application of an emulsified fluorocarbon and a fluorocarbon extender. Approval of components and combinations is the responsibility of U.S. Army Natick Research, Development, and Engineering Center, Natick, MA 01760-5014, and is based on extensive tests, including those for toxicity which are not set forth in this document. Because of the time necessary to conduct full evaluation (approximately 6 months), only those chemical treatments already approved and so listed in the invitation for bids or request for proposals shall be considered acceptable for the related procurement.

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

6.6 White standards. Barium sulphate of suitable quality for use as a white reference standard is available from the Eastman Kodak Company.

6.7 Fabric defect scales. Fabric Defect Replica Kits are available from Sears Roebuck and Company, Department 817, (ATTN: BSC 23-29), Sears Tower, Chicago, IL 60684.

6.8 First article. When a first article is required, it shall be inspected and approved under the appropriate provisions of the Federal Acquisition Regulations (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 instruments regarding arrangements for selection, inspection, and approval of the first article.

\* 6.9 Subject term (key word) listing.

Cloth, laminated, waterproof, moisture vapor permeable  
Physical surface appearance  
Extended cold weather clothing system  
Parka  
Trousers

\* 6.10 Changes from previous issue. The margins of this document are marked with an asterisk (\*) to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were

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made. This was done as a convenience only, and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content, as written, irrespective of the marginal notations and relationship to the last previous issue.

Custodians:

Army - GL  
Navy - NU

Preparing Activity:

DLA - CT

Review Activities:

Army - MD  
Navy - MC

Project Number:

8305 - 0535

User Activities:

Air Force - 99  
Air Force - 45

## STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

<b>1 RECOMMEND A CHANGE:</b>		<b>1 DOCUMENT NUMBER</b> MIL-C-44187C	<b>2 DOCUMENT DATE (YYMMDD)</b> 93/11/22
<b>3 DOCUMENT TITLE</b> CLOTH, LAMINATED, WATERPROOF AND MOISTURE VAPOR PERMEABLE			
<b>4 NATURE OF CHANGE</b> (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)			
<b>5. REASON FOR RECOMMENDATION</b>			
<b>6. SUBMITTER</b>			
<b>a NAME</b> (Last, First, Middle Initial)		<b>b. ORGANIZATION</b>	
<b>c ADDRESS</b> (Include Zip Code)		<b>d TELEPHONE</b> (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	<b>7. DATE SUBMITTED</b> (YYMMDD)
<b>8 PREPARING ACTIVITY</b>			
<b>a NAME</b> Defense Personnel Support Center ATTN: DPSC-FSSD (12-3-D)		<b>b TELEPHONE</b> (Include Area Code) (1) Commercial (2) AUTOVON	
<b>c ADDRESS</b> (Include Zip Code) 2800 South 20th Street P. O. Box 8419 Philadelphia, Pennsylvania 19101-8419		IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT Defense Quality and Standardization Office 5203 Leesburg Pike Suite 1403 Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	