INCH POUND

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DETAILED SPECIFICATION

CLOTH, 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 the requirements for four types of woodland camouflage cloth, which are waterproof, and moisture vapor permeable.

1.2 Classification. (see 6.2).

Type I - For Bivy Covers
Class 1 – Woodland Camouflage
Class 2 – Desert Camouflage

Type II - For Rainsuits
Class 1 – Woodland Camouflage
Class 2 – Desert Camouflage

Type III - For Extended Cold Weather Clothing System – Second Generation(2GECWCS) Parkas and Trousers
Class 1 – Woodland Camouflage
Class 2 – Desert Camouflage

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Supply Center Philadelphia, Clothing and Textiles Directorate, Attn: DSCP-COTC, 700 Robbins AVE, Philadelphia PA 19111-5096.

AMSC N/A **FSC 8305**
DISTRIBUTION STATEMENT A. ***Approved for public release; distribution is unlimited.***

Type IV – For Extended Cold Weather Clothing System (ECWCS) Parkas and Trousers and for Air Force Security Police Jackets and Hoods

Class 1 – Woodland Camouflage
Class 2 - Desert Camouflage
Class 3 – Air Force Blue

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

MILITARY

MIL-L-63460 - Lubricant, Cleaner and Preservative for Weapons and Weapons Systems (METRIC)

MIL-T-83133 - Turbine Fuel, Aviation NATO F-34 (JP-8) and NATO F-35

STANDARDS

FEDERAL

FED-STD-595B - Colors Used in Government Procurement

(Unless otherwise indicated, copies of Federal and military specifications, standards and handbooks are available from the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

* 2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

CODE OF FEDERAL REGULATIONS

16 CFR Part 1500 - Federal Hazardous Substances Act Regulations
29 CFR Part 1910 - Occupational Safety and Health Standards

(Applications for copies of referenced documents should be addressed to U. S. Government Printing Office, Superintendent of Documents, Mail Stop: SSOP, Washington, DC 20402-9328.)

FEDERAL TRADE COMMISSION

Rules and Regulations Under-the Textile Fiber Products Identification Act

(Copies are available from the Federal Trade Commission, Pennsylvania Avenue at Sixth Street, N.W., Washington, DC 20580-0001.)

CODE OF FEDERAL REGULATIONS

Title 40, part 798.4470 (Primary Dermal Irritation)

(This reference may be found on the Internet at www.access.gpo.gov/nara/cfr/cfr-table-search.html.)

BUREAU OF ALCOHOL, TOBACCO AND FIREARMS, DEPARTMENT OF THE TREASURY

Formulas for Denatured Alcohol (27 CFR Part 21)

(Applications for copies of referenced documents should be addressed to the Bureau Of Alcohol, Tobacco And Firearms, Department Of The Treasury, 1200 Pennsylvania Ave. Washington, DC 20226.)

ENVIRONMENTAL PROTECTION AGENCY

Regulations for the Enforcement of the Federal Insecticide, Fungicide and Rodenticide Act (40 CFR Part 162)

(Applications for copies of referenced documents should be addressed to the Environmental Protection Agency, 401 M Street SW, Washington, DC 20460.)

DRAWINGS

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

2-1-1516B - Woodland Pattern
2-1-2240 - 3 Color Desert Pattern

(Copies of drawings are available from the U. S. Army Soldier and Biological Chemical Command, ATTN: AMSSB-OIM-IC(N), Natick, MA 01760.)

* 2.3 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM-E-96 - Test Methods for Water Vapor Transmission of Materials
ASTM-F-392 - Test Method for Flex Durability of Flexible Barrier Materials
ASTM-D-751 - Standard Test Method for Coated Fabrics
ASTM-D-975 - Specification for Diesel Fuel Oils
ASTM-D-1424 - Tear Resistance of Woven Fabrics by Falling Pendulum (Elmendorf) Apparatus
ASTM-D-1776 - Practice for Conditioning Textiles for Testing
ASTM-D-2582 – Film, Plastic and Thin Sheeting, Puncture Propagation Tear Resistance Of
ASTM-D-3393 - Specification for Coated Fabrics - Waterproofness
ASTM-D-3776 - Mass Per Unit Area (Weight) of Woven Fabric
ASTM-D-3886 - Abrasion Resistance of Textile Fabrics (Inflated Diaphragm Method)
ASTM-D-4485 - Performance Specification for Automotive Engine Oils
ASTM-D-5034 - Breaking Force and Elongation of Textile Fabrics (Grab Test)

(Copies should be obtained from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19426-2959.)

TECHNICAL MANUAL OF THE AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC-8 - Colorfastness to Crocking: AATCC Crockmeter Method
AATCC-16 - Colorfastness to Light
AATCC-22 - Water Repellency: Spray Test
AATCC-61 - Colorfastness to Laundering, Home and Commercial: Accelerated
AATCC-96 - Dimensional Changes in Commercial Laundering of Woven and Knitted Fabrics Except Wool
AATCC-119 - Color Change Due to Flat Abrasion (Frosting): Screen Wire Method
AATCC-135 - Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics

(Applications for copies of referenced documents should be addressed to the American Association of Textile Chemists and Colorists, PO Box 12215, Research Triangle Park, NC 27709-2215.)

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY (TAPPI)

TAPPI Method T-451- Flexure Properties of Paper (Clark Stiffness)

(Applications for copies of referenced documents should be addressed to TAPPI Press, Technology Park/Atlanta, PO Box 105113, Atlanta, GA 30348-5113.)

SEARS ROEBUCK AND COMPANY 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).

MISCELLANEOUS

Principles and Methods of Toxicology, A. Wallace Hayes (editor), 1989, pp 394-396.

(Applications for copies of referenced documents should be addressed to Raven Press, 1185 Avenue of the Americas, New York, NY 10036)

2.4 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 takes precedence. Nothing in this document however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 4.2).

3.2 Standard sample. The cloth shall match the standard sample for shade and appearance on the face side and shall be equal to or better than the standard sample with respect to all characteristics for which the standard sample is referenced.

* 3.3 Performance requirements. The cloth shall conform to the requirements specified in Table I and 3.4 through 3.12.

TABLE I. Physical requirements

Characteristic	Type I	Type II	Type III	Type IV
Weight, oz/sq. yd. (max)	6.0	5.0	6.0	6.0
Breaking strength, lbs. (min)				
Warp	135	135	135	135
Filling	100	100	100	100
Tearing resistance, kgf (min)				
Warp	2.2	0.6	3.0	3.0
Filling	2.8	0.9	3.0	3.0
Hydrostatic resistance, psi (min) or No leakage (min) as applicable:				
Initial	90	90	No leakage	90
After strength of coating	80	80	No leakage	80
After abrasion	70	----	No leakage	80
After high humidity, psi.	80 1/	70 1/	No leakage 1/	----

TABLE I. Physical requirements (continued)

Characteristic	Type I	Type II	Type III	Type IV
After diethyltoluamide				
Initial	80	70	No leakage	80
After Laundering	----	----	No leakage	----
After diesel fuel				
Initial and After Laundering	----	----	No leakage	----
After weapons lubricant				
Initial and After Laundering	----	----	No leakage	----
After motor oil				
Initial and After Laundering	----	----	No leakage	----
After JP-8 fuel				
Initial and After Laundering	----	----	No leakage	----
Moisture Vapor Transmission Rate $g/m^2/24$ hr initial (min)				
Initial				
Procedure B	400	350	600	600
Procedure BW	5000	5000	3600	3600
After synthetic perspiration				
Procedure B	----	----	600	600
Procedure BW	----	----	3600	3600
Stiffness, warp only, cm (max)				
At 70°F	12.0	10.0	10.0	12.0
At 32° F	----	11.5	----	----
At 0°F	13.0	----	----	----
Blocking, rating (max)	No. 2	No. 2	----	----
Adhesion of coating (min) 2/ lbs./2 inch width				
Dry	----	12.0	----	----
Wet	----	5.0	----	----
Water permeability (min)				
Initial	No leakage	No leakage	No leakage	No leakage
After synthetic perspiration initial & after laundering	----	----	No leakage	No leakage
After physical surface appearance	No leakage	No leakage	----	----
After flex (70°F)				
Warp and filling directions	----	----	No leakage	No leakage
After cold flex (-25°F)				
Warp and filling directions	No leakage	----	----	No leakage
After cold flex (-40°F)				
Warp and filling directions	----	----	No leakage	----
After diethyltoluamide				
Initial and After Laundering	----	----	No leakage	----

TABLE I. Physical requirements (continued)

Characteristic	Type I	Type II	Type III	Type IV
After diesel fuel				
Initial and After Laundering	----	----	No leakage	----
After weapons lubricant				
Initial and After Laundering	----	----	No leakage	----
After motor oil				
Initial and After Laundering	----	----	No leakage	----
After JP-8 fuel				
Initial and After Laundering	----	----	No leakage	----

1/ The cloth shall not become stiff and brittle nor soft and tacky and there shall be no evidence of cracking or crazing under visual examination.
2/ Applicable to fabrics with a continuous film or coating.

3.4 Spray rating. Equal to or better than 100,90, 90 initially (Types I, II & IV) and 90, 90, 80 after 3 launderings (Types I, II, III & IV). Not applicable to fabrics with a continuous film or coating on the face side.

3.5 Resistance to organic liquids. The cloth shall show no wetting. Not applicable to fabrics with a continuous film or coating on the face side.

3.6 Physical surface appearance after laundering. The cloth shall show no change in physical surface appearance after 5 laundering and drying cycles (Types I and II) or 20 laundering cycles (Types III & IV) as specified in 4.4.4..

3.7 Dimensional stability (Types III & IV only). The shrinkage or elongation of the cloth shall not be greater than 4.0 percent in the warp direction and not greater than 2.0 percent in the filling direction when tested as specified in Table IV.

3.8 Colorfastness. The face side of the cloth shall meet the following colorfastness requirements when tested in accordance with 4.3.3 for the characteristics listed below:

Colorfastness characteristics	Requirements
Fastness to laundering	Equal to or better than "3-4" rating on AATCC Gray Scale for Color Change
Fastness to accelerated laundering (Black print only)	Equal to or better than "3-4" rating on AATCC Gray Scale for Color Change
Fastness to light	Equal to or better than "3-4" rating on AATCC Gray Scale for Color Change
Fastness to crocking	Equal to or better than the standard sample or not less than AATCC chromatic transference scale rating of 3.5. 1/
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 Color Change.
Fastness to high humidity (except Type IV)	No appreciable change 2/

1/ Except Black 357 shall show an AATCC chromatic transference scale rating of not less than 1.0.
2/ An appreciable change in color means a change that is immediately noticeable on comparison of the test specimen with the original, unexposed sample. If closer inspection or a change of

angle of light is required to make apparent a slight change of color, then change is not considered appreciable.

* 3.9 Color.

3.9.1 Class 1, Woodland Camouflage. The color of the face side of the cloth shall be Woodland Camouflage pattern and shall match Light Green 354, Dark Green 355, Brown 356, and Black 357, each area of the specific color of the pattern in accordance with the applicable standard sample. The color of the back side of the cloth shall be Camouflage Green 483 matching color chip 34094 of FED-STD-595B. Both sides of the fabric shall match the respective side of the standard sample.

3.9.2 Class 2, Desert Camouflage The color of the face side of he cloth shall be Desert Camouflage pattern and shall match Light Tan 492, Light Khaki 494, and Light Brown 493, each area of the specific color of the pattern in accordance with the applicable standard sample. The color of the backside of the cloth shall be Light Tan 492. If a Standard Sample is available Both sides of the fabric shall match the respective side of the standard sample.

* 3.9.3 Class 3 Air Force Blue The color of the face side of the cloth shall be Air Force Blue, Shade 1613 (see 6.2). The color of the backside of the cloth shall approximate Air Force Blue Shade 1613.

* 3.10 Pattern execution.

3.10.1 Class 1, Woodland Camouflage pattern execution. The Woodland Camouflage pattern shall reproduce the standard sample in respect to design, colors, and registration of the respective areas. The pattern repeat of the dyed, printed, and finished cloth shall be 27.25 inches (+2.50 inches, -2.50 inches) in the warp direction. The various areas of the pattern shall be properly registered in relation to each other and shall present definite sharp demarcations with a minimum of feathering or spew. Each pattern area shall show solid coverage; skitteriness exceeding that shown by the standard sample in any of the printed areas shall not be acceptable. When the standard sample is not referenced for pattern execution or design, a pattern drawing shall be provided, and the pattern on the finished cloth shall match that of drawing 2-1-1516B.

3.10.2 Class 2, Desert Camouflage pattern execution. The Desert Camouflage pattern shall reproduce the standard sample in respect to design, colors, and registration of the respective areas. The pattern repeat of the dyed, printed, and finished cloth shall be 16.75 inches (+ 1.25 inches, -1.75 inches) in the warp direction. The various areas of the pattern shall be properly registered in relation to each other and shall present definite sharp demarcations with a minimum of feathering or spew. Each pattern area shall show solid coverage; skitteriness exceeding that shown by the standard sample in any of the printed areas shall not be acceptable. When the standard sample is not referenced for pattern execution or design, a pattern drawing shall be provided, and the pattern on the finished cloth shall match that of drawing 2-1-2240.

* 3.11 Spectral reflectance.

3.11.1 Spectral reflectance, Class 1 Woodland Camouflage. The spectral reflectance of the colors in the woodland camouflage cloth shall conform to the requirements specified in Table

II , initially (all types) and after laundering (Types II, III and IV)when tested as specified in 4.4.16.

3.11.2 Spectral reflectance Class 2, Desert Camouflage. The spectral reflectance of the colors in the desert camouflage cloth shall conform to the requirements specified in Table III initially (all types) and after laundering (Types II, III and IV) when tested as specified in 4.4.16.

TABLE II. Spectral reflectance requirements Reflectance values (percent)

Wavelength,	Black 357		Light Green 354		Dark Green 355 & Brown 356	
Nanometers (nm)	min	max	min	max	min	max
600	-	-	8	20	3	9
620	-	-	8	20	3	9
640	-	-	8	20	3	9
660	-	-	8	20	3	12
680	-	-	10	30	3	16
700	-	20	18	50	5	32
720	-	30	22	54	7	44
740	-	33	30	56	12	52
760	-	33	35	58	18	56
780	-	34	40	62	26	56
800	-	34	55	80	34	56
820	-	35	55	80	42	60
840	-	35	55	84	44	60
860	-	35	60	84	44	60

TABLE III Spectral reflectance requirements Reflectance values (percent)

Wavelength,	Light Tan 492		Light Brown 493		Light Khaki 494	
Nanometers (nm)	min	max	min	max	min	max
700	38	53	19	36	25	48
720	38	58	20	36	25	52
740	39	62	20	36	25	54
760	40	66	21	36	26	56
780	41	72	21	38	27	57
800	43	76	22	43	28	58
820	45	76	23	45	30	58
840	48	78	24	46	33	58
860	50	78	25	46	36	59

3.12 Toxicity. The finished cloth shall not present a dermal health hazard when used as intended. (see 4.4.18).

3.13 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

4. VERIFICATION

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

1. First article inspection (see 4.2)
2. Conformance inspection (see 4.3)

4.2 First article inspection. The first article, submitted in accordance with 3.1, shall be inspected as specified in 4.3.2 through 4.4 for compliance with design, construction, workmanship and dimensional requirements.

4.3 Conformance inspection. Sampling for inspection shall be performed as specified in the contract or order.

4.3.1 Component and material inspection. In accordance with 4.1 above, components and materials shall be inspected in accordance with all the requirements of referenced specifications, drawings, and standards unless otherwise excluded, amended, modified, or qualified in this specification or applicable procurement documents.

* 4.3.2 Examination of the end item. Examination of the end item shall be in accordance with 4.3.2.1. The cloth shall be examined 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 number of rolls from which the sample yardage is to be selected shall be in accordance with the table below. The sample yardage shall be apportioned equally among the selected rolls.

Lot size in yards	Sample size in rolls
1,200 or less 1/	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.

4.3.2.1 Visual examination. The cloth shall be examined (on both sides) for the defects listed in Table IV.

Table IV End item visual defects

Defect	Classification Major	Minor
Any hole, cut, tear or scratch, including edges	101	
Abrasion resulting in a thin or weak place	102	

Table IV End item visual defects con't

Defect		Classification Major	Minor
Multiple floats or skips, 1/2 inch or more in either warp or filling direction of face fabric	103		
Any pit, blister, tunnel, bubbles, or delamination of components		104	
Crease or wrinkle resulting in doubling or adhesion of surfaces that cannot be corrected by manual pressure, adhesion of surfaces against each other, or any diagonal distortion of face side surface		105	
Any solid lump, defined as a slub C or 4, or knot which exceeds level C on the respective Sears Fabric Defect Scale (see 2.3)		106	
Fabric edges rolled, folded, doubled, scalloped or wavy		107	
Any spot, stain 1/ or foreign matter 2/		108	
Any odor other than that which is characteristic of the component materials of the cloth			201
Any color off shade, not uniform, mottled or spotted (face side only)		109	
Any tackiness		110	
Any pinhole		111	
Any area without waterproof finish (i.e., coating or laminating film, where required)		112	
Any scorch or burn		113	
Multiple floats or skips, 1/2 inch or more in either warp or filling direction of face fabric		114	
Not clean		115	
Camouflage pattern (face side)			
Any skitteriness of pattern exceeding that shown by the standard sample		116	
Pattern design not equal to standard sample		117	
Excessive feathering or spew of pattern		118	
Pattern repeat not equal to the standard sample		118	
Warpwise pattern repeat Woodland Camouflage pattern less than 24.75 inches or more than 29.75		119	
Desert Camouflage pattern Less than 15.00 inches or more than 18.00 inches		120	
Any color off shade, not uniform, mottled, or spotted (face side only)		121	

1/ Clearly visible at normal inspection distance (approx. 3 ft).

2/ For the back side, any spot, stain, off-shade area, or discoloration that is a result of the distortion of a backing fabric (if used) or a result of uneven dyeing of a backing fabric shall not be scored for this condition. Foreign matter shall be defined as waste, fly, or extraneous material that has been formed into the fabric system.

* 4.3.3 End item testing. The cloth shall be tested for the characteristics listed in Table V. The methods of testing specified wherever applicable and as listed in Table V shall be followed. The sample unit for testing shall be 6 continuous yards full width of the finished cloth, put up in a

manner to prevent folding/creasing. The lot shall be unacceptable if any sample unit fails to meet any requirement specified. All test reports shall contain the individual values utilized in expressing the final results. The sample size shall be in accordance with the following:

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

TABLE V. End item tests

Characteristic	Requirement paragraph	Test methods*
Weight	3.3	ASTM D-3776 (Method C)
Breaking strength	3.3	ASTM D-5034 (G-E or G-T)
Tearing strength		
Types I, III & IV	3.3	4.4.1.1
Type II	3.3	4.4.1.2
Hydrostatic resistance		
Initial		
Types I, II & IV	3.3	4.4.2.1
Type III	3.3	4.4.2.2
After strength of coating	3.3	4.4.2.3
After abrasion	3.3	4.4.2.4
After high humidity	3.3	4.4.2.5
After diethyltoluamide		
Types I, II & IV	3.3	4.4.2.6
Type III	3.3	4.4.13
After diesel fuel		
Initial and After Laundering	3.3	4.4.13 & 4.4.14
After weapons lubricant		
Initial and After Laundering	3.3	4.4.13 & 4.4.14
After motor oil		
Initial and After Laundering	3.3	4.4.13 & 4.4.14
After JP-8 fuel		
Initial and After Laundering	3.3	4.4.13 & 4.4.14
Stiffness		
At 70°F	3.3	4.4.3.1
At 32° F	3.3	4.4.3.2
At 0°F	3.3	4.4.3.3
Blocking	3.3	4.4.5
Adhesion of coating		
Dry	3.3	4.4.6.1
Wet	3.3	4.4.6.2
Water permeability		
Initial	3.3	4.4.7
After synthetic perspiration	3.3	4.4.12 & 4.4.7
After physical surface appearance	3.3	4.4.5 & 4.4.7
After flex (70°F)	3.3	4.4.7.1 & 4.4.7

TABLE V. End item tests

Characteristic	Requirement paragraph	Test method*
After cold flex(-25°F)	3.3	4.4.7.2 & 4.4.7
After cold flex (-40°F)	3.3	4.4.7.2 & 4.4.7
After diethyltoluamide	3.3	4.4.13 & 4.4.7
After diesel fuel	3.3	4.4.13 & 4.4.7
After weapons lubricant	3.3	4.4.13 & 4.4.7
After motor oil	3.3	4.4.13 & 4.4.7
After JP-8 fuel	3.3	4.4.13 & 4.4.7
Moisture vapor transmission rate,		
Initial	3.3	4.4.8
Procedure B	3.3	4.4.8.1
Procedure BW	3.3	4.4.8.2
After synthetic perspiration		
Procedure B	3.3	4.4.12 and 4.4.8.1
Procedure BW	3.3	4.4.12 and 4.4.8.2
Spray rating		
Initial	3.4	4.4.9.1
After 3 launderings	3.4	4.4.9.2
Resistance to organic liquids		
Initial	3.5	4.4.10.1
After 3 launderings	3.5	4.4.10.2 and 4.4.10.1
Physical surface appearance	3.6	4.4.4
Dimensional Stability	3.7	AATCC No. 96, Option 1C.
Colorfastness to:		
Laundering	3.8	4.4.11.1
Accelerated laundering (Black 357 only)	3.8	4.4.11.2
Light	3.8	4.4.11.3
Crocking	3.8	AATCC-8
Abrasion (Black 357 only)	3.8	4.4.11.4
High humidity	3.8	4.4.2.5
Color matching	3.9	4.4.17
Pattern execution	3.10	4.4.15
Spectral reflectance	3.11	4.4.16
Spectral reflectance after Accelerated Laundry	3.11	4.4.16.1
Toxicity	3.12	4.4.18

*Paragraph numbers alone indicate the paragraph numbers in section 4 of this document.

4.4 Methods of inspection.

4.4.1 Tear strength.

4.4.1.1 Types I, III and IV. ASTM D-2582 with exceptions as follows: Five warp and five filling specimens shall be tested. 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 the standard drop height of 508 ± 2 mm. If the tear is not straight on face side of the specimen, the result shall be considered invalid and another specimen shall be tested. The thickness of the specimen shall not be measured.

4.4.1.2 Type II . ASTM D-1424.

4.4.2 Hydrostatic resistance.

* 4.4.2.1 Types I, II & IV. ASTM D-751, Hydrostatic Resistance, Procedure A (Pressure Application by Mullen Type Hydrostatic Tester), Procedure 1 with water pressure applied to the face side of the test specimen.

* 4.4.2.2 Type III . ASTM D-3393 except that a water pressure of 40 psi shall be used and applied to the face side of the test specimen.

* 4.4.2.3 Hydrostatic resistance after strength of coating. The test specimen shall be a 152 mm (6 in.) square with diagonal dimensions oriented parallel to the warp and filling directions. The testing machine shall conform to ASTM D-5034 with the following modifications: The face of the clamps shall measure 25 by 51 mm (1 by 2 in.) with the long dimension perpendicular to the direction of application of the load. All machine attachments for determining maximum load shall be disengaged during the test. The test load applied to the test specimen during the test shall be capable of being maintained within a one pound load tolerance for the required period of time. The distance between clamps of the testing machine shall be set at 102 mm (4 in.). The test specimen shall be centered in the clamps of the testing machine with the edges of the specimen parallel to the edges of the clamps. The clamps shall be separated at a rate of 5 mm/sec (12 in/mm) until a load of 133.5 ± 4.5 N (30 ± 1 lb.) has been applied to the specimen. The load shall be held for 30 seconds and then released allowing the specimen to relax. The specimen shall be released from the clamps and the loading procedure repeated on the specimen with the load applied in the direction perpendicular to that of the first loading. At least five specimens from the sample of material shall be tested. Results of tests shall be the average of the measure of hydrostatic resistance of the five test specimens. The specimens shall then be tested for hydrostatic resistance in accordance with 4.4.2.1 for Type I, II and IV and 4.4.2.2 for Type III.

* 4.4.2.4 After abrasion. ASTM-D-3886 except that the test shall be conducted in the multidirectional mode as described below. The specimens shall then be tested for hydrostatic resistance in accordance with 4.4.2.1 for Type I and IV cloth and 4.4.2.2 for Type III.

a. Type I The back side of the cloth shall be abraded for 1,000 cycles using the back side of the test material as the abradant.

* b. Types III & IV. The face side of the cloth shall be abraded for 10,000 cycles using the face side of the test material as the abradant and a load of six (6) pounds.

* 4.4.2.5 After high humidity (Types I II & III) Three 4 by 4 inch specimens shall be laid flat, face side up, on a supporting plate and the assembly placed in a desiccator containing water in the lower portion. The water level shall be approximately 1 inch below the specimens. The lid of the desiccator shall be put in place and the desiccator placed in a circulating air oven having a temperature of 125 $\pm$ 2^{O}F for a period of 7 days. At the end of the aging period, each specimen shall be removed from the desiccator and then immediately examined for colorfastness and tested for hydrostatic resistance. The specimens shall then be tested for hydrostatic resistance in accordance with 4.4.2.1 for Type I and II cloths and 4.4.2.2 for Type III cloth.

* 4.4.2.6 After diethytoluamide (Types I, II, & IV). Five specimens shall be laid flat, face side up, on a glass plate 4 by 4 inches by 1/4 inch thick. Three drops of diethyltoluamide containing 75% diethyltoluamide and 25% ethanol (see 6.6) shall be applied to the center of each specimen. A glass plate of the same dimensions shall be placed on the specimen (or specimen area) and a pressure of 0.25 pounds per square inch of glass plate contact area be applied to the assembly. After 16 hours, the specimens shall be removed from between the glass plates and tested immediately for hydrostatic resistance in accordance with 4.4.2.1.

4.4.3 Stiffness.

4.4.3.1 At 70°F. TAPPI Method T-451, Preferred Procedure (1) except that five test specimens with the long dimension parallel to the warp direction of the cloth shall be tested and that the standard textile test conditions as specified in ASTM D-1776 shall be used.

4.4.3.2 At 32° ± 2°F for Type II only. The stiffness test shall be conducted as specified in 4.4.3.1 except that the apparatus and test specimens shall be subjected to a temperature of 32° ± 2°F for a period of 4 hours and the test shall be performed in a still atmosphere at that temperature.

4.4.3.3 At 0° ± 2°F for Type I only. The stiffness test shall be conducted as specified in 4.4.3.1 except that the apparatus and test specimens shall be subjected to a temperature of 0° ± 2°F for a period of 4 hours and the test shall be performed in a still atmosphere at that temperature

4.4.4 Physical surface appearance. Conduct 5 laundering and drying cycles (Types I & II) or 20 laundering and drying cycles (Types III & IV) in accordance with 4.4.15. Each sample, 48 inches in length by full width shall be cut in half across the width of the cloth. One half of the sample (24 inches in length) shall be laundered and the remaining half retained as the unlaundered portion for the final evaluation, as necessary. After each drying cycle, examine both sides of the cloth for changes in physical surface appearance when compared to the unlaundered sample.

* 4.4.5 Blocking. ASTM D751, Blocking Resistance at Elevated Temperatures except that the tests shall be performed at a temperature of 180±2°F for 30 minutes. Evaluate the resistance of the specimen to blocking by the scale given below:

1 -- *No Blocking.* Cloth surfaces are free and separate without any evidence of cohesion or adhesion.
2 -- *Trace Blocking.* Cloth surfaces show slight cohesion or adhesion.
3 -- *Slight Blocking.* Cloth surfaces must be lightly peeled to separate.
4 -- *Blocking.* Cloth surfaces separate with difficulty or coating is removed during separation.

Only one specimen shall be tested.

4.4.6 Adhesion of coating.

4.4.6.1 Dry Adhesion ASTM D-751 Adhesion of Coating except with 2 inch wide reinforced coating adhesion specimens, cyanoacrylate (solventless) adhesive, and pulling clamp

speed of 5 mm/s. Three specimens shall be tested by adhering the film/coating sides of the cloth to itself.

4.4.6.2 Wet Adhesion The test specimens of 4.4.6.1, after dry adhesion testing, shall be immersed in distilled water at 70°F for 16 hours, removed from the water and blotted dry and then immediately tested for wet adhesion in accordance with 4.4.6.1 using the remainder of the specimen.

4.4.7 Water permeability. ASTM D-751, Hydrostatic Resistance, Procedure B, Procedure 2 with a fixed hydrostatic head of 50 centimeters applied to the face side of the test specimen for 10 minutes. Five specimens shall be tested. The report shall only include measurement for the appearance of water droplets. For Types I, III and IV cloths leakage is defined as the appearance of one (1) or more droplets of water within the 4-1/2 inch diameter test area. For Type II cloth, leakage is defined as the appearance of water at three or more different places or the continuous flow of water through the cloth at one or more different places within the 4 1/2 inch diameter test area.

4.4.7.1 Water permeability after Flex at 70°F. One specimen, 8-inches by 12-inches 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 ASTM F-392, except that 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 flex cycles. Two six (6) inch by eight (8) inch specimens shall be cut from the 8-inch by 12-inch flexed specimen and tested for water permeability in accordance with 4.4.7.

* 4.4.7.2 Water permeability after cold flex at -25°F and -40°F. 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 ASTM F-392 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. The 8 inch by 12 inch specimen shall be mounted on the flex test apparatus, placed in a test chamber at the specified temperature (±5°F) for 1 hour, and then flexed in the test chamber at the specified temperature. At the end of the flexing cycle, two 6 inch by 8 inch specimens shall be cut from the 8 inch by 12 inch flexed specimen and conditioned prior to testing for water permeability in accordance with 4.4.7.

4.4.8 Moisture vapor transmission rate. ASTM E-96 with exceptions as follows: The back side of the cloth shall face the water. The free stream air velocity shall be 550 ± 50 FPM as measured 2 inches above the fabric specimen, for Procedure B tests, and 2 inches below the fabric specimen for Procedure BW tests. The airflow shall be measured at least 2 inches from any other surface.

4.4.8.1 Procedure B The air gap between the water surface and the back of the specimen shall be 3/4 ± 1/16 inch. Five initial and, when applicable, three after synthetic perspiration tests shall be performed.

4.4.8.2 Procedure BW The test shall be run for 2 hours and weight measurements shall be taken at only the start and completion of the test. Five initial and, when applicable, three after synthetic perspiration tests shall be performed. The specimen shall be sealed in any manner which prevents wicking and/or leakage of water out of the cup.

4.4.9 Spray rating.

4.4.9.1 Initial. Testing shall be conducted in accordance with AATCC 22.

4.4.9.2 After 3 launderings. Testing shall be conducted in accordance with 4.4.14 and 4.4.9.1.

4.4.10 Resistance to organic liquids.

4.4.10.1 Initial. Place a small specimen of the cloth on a smooth horizontal surface, face side 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.

* 4.4.10.2 After 3 launderings. After 3 launderings in accordance with 4.4.11.1, test in accordance with 4.4.10.1.

4.4.11 Colorfastness.

4.4.11.1 Laundering. AATCC No. 61, Test 1A (4 cycles) except that 1993 AATCC Standard Reference Detergent (non-phospate) without optical brighteners shall be used.

4.4.11.2 Accelerated laundering (Black 357 only). The test procedure shall be as follows using the test equipment cited in AATCC No. 61.

Five specimens containing predominantly black print, each 4 1/2 inches by 3 inches, shall be cut from the test fabric and then folded in half, with the face side out, to form a bag 2-1/4 by 3 inches. Machine stitch the open edges together (seam allowance no more than 1/4 inch), to form a bag leaving an opening approximately 1 inch in length. Through the opening add thirty five (35) stainless steel spheres.

Close the bag by stitching. Place the bag in a stainless steel cylinder (one (1) bag per cylinder) without the color transfer cloth, add 50 ml of 1993 AATCC Standard Reference Detergent (non-phospate) without optical brighteners solution (0.5 percent by weight) 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 $\pm$ 5^{o}F. Agitate cylinder for one 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 $\pm$ 5^{o}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, (150-160 ^{o}F) for fifteen (15) minutes (more than one (1) bag can be dried together). If the bag breaks open to 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 unlaundered sample 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 shall be considered a test failure.

4.4.11.3 Light. AATCC No. 16, Option A (after 40 fading units) or E (after 75 kilojoules).

4.4.11.4 Abrasion (Black 357 only). AATCC 119 except that the number of abrasion cycles shall be 300.

4.4.12 Synthetic perspiration test. The specimen, 8 inches by 8 inches, shall be cut and exposed to synthetic perspiration as follows: the synthetic perspiration solution shall be made by combining 3.0 grams sodium chloride, 1.0 gram trypticase soy broth powder, 1.0 gram normal propyl propionate, 0.5 gram of liquid lecithin and 500 ml of distilled water. Cover the solution and stir while heating to 50°C until all ingredients are dissolved. Then, cool the solution to 35°C, remove cover and dispense it immediately with a pipette or other suitable measuring device. Dispense 2 ml of perspiration solution at 35°C, onto the center of an 8 inch by 8 inch by 1/4 inch glass plate. Place the specimen on the glass plate with the back side contacting the glass. Dispense an additional 2 ml of the synthetic perspiration solution onto the center of the specimen. Place a second 8 inch by 8 inch by 1/4 inch glass plate on top of the specimen and then place a 4 pound weight on top of and in the center of the assembly. After 16 hours, remove the specimen (do not rinse) and air dry the specimen before testing.

4.4.13 Contamination procedure. The specimen (or specimen area) shall be laid flat, face side up, on a glass plate. Three drops of the test liquid shall be applied to the center of the specimen (or specimen area); as applicable, the test liquid shall be diethyltoluamide (see 6.6), diesel fuel (ASTM D-975, Grade 1-D), weapons lubricant (MIL-L-63460, see 6.7), motor oil (ASTM D-4485, Grade CD-II), and JP-8 fuel (MIL-T-83133). A glass plate of the same dimensions shall be placed on the specimen (or specimen area) and a pressure of 0.0625 pounds per square inch of glass plate contact area be applied to the assembly. After 16 hours, remove the specimen (or specimen area) from the assembly and test immediately for the required performance property in the center of specimen (or specimen area). For testing the "initial" condition, the test specimen shall be as specified by the applicable test method. For testing the "After laundering" condition the laundering test shall be conducted in accordance with 4.4.15 for one laundering and drying cycle and one laundering sample, 48 inches by the full width of the cloth, for each test liquid shall be marked on the face side (using a laundry marker pen) for the specimen areas for hydrostatic resistance and for leakage; after laundering, the specimen areas may be cut from the laundering sample to facilitate performance property testing. Five (5) specimens (minimum) shall be tested for each of the Initial and the After Laundering conditions.

4.4.14 Laundering procedure. Place 2.0 $\pm$ 0.2 pounds of the cloth and if needed, ballast in an automatic washing machine set on permanent press cycle, high water level and warm (100 + 10°F - 0°F) wash temperature. Place 0.5 ounce (14 grams) of 1993 AATCC Standard Reference Detergent (non-phosphate) without optical brighteners 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, 150-160°F and dry for approximately fifteen (15) minutes. The laundering equipment, washer and dryer, shall be in accordance with AATCC No.135..

4.4.15 Pattern execution. The pattern of the cloth shall be matched to the pattern drawing (see 6.3).

4.4.16 Spectral reflectance. Spectral reflectance data shall be determined on the face side and shall be obtained from 600 to 860 nanometers (nm) at 20 nm intervals on a spectrophotometer (see 6.4) relative to the barium sulfate standard, the preferred white standard. Other white reference materials may be used provided they are calibrated to absolute white, e.g. magnesium oxide or vitrolite tiles (see 6.5). The spectral band width shall be less than 26 nm at

860 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 source that simulates either CIE source A or CIE source D65. The specimen shall be measured as a single layer, backed with six layers of the same fabric and shade. Measurements shall be taken on a minimum of two different areas and the data averaged. The measured areas should be at least 6 inches away from the selvage. The specimen shall be viewed at an angle no greater than 10 degrees from the normal, with the specular component included. Photometric accuracy of the spectrophotometer shall be within 1 percent and wavelength accuracy 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 shall be considered a test failure.

* 4.4.16.1 Accelerated Laundering (Spectral Reflectance Durability Test). Each color, except Black 357, of the camouflage pattern cloth shall be laundered separately in accordance with AATCC-61 (Option 3A) except that a 4-gram sample size shall be used (Note: a sample size large enough to evaluate the spectral reflectance shall be used) and that the procedure shall be conducted using (10) stainless steel spheres and the 1993 AATCC Standard Reference Detergent without optical brighter. The samples shall then be evaluated for spectral reflectance in accordance with 4.4.16.

4.4.17 Color Matching. The 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 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 K.

4.4.18 Toxicity assessment. The contractor must furnish information which certifies that the finished product is composed of materials which have been safely used commercially or provide sufficient toxicity data to show compatibility with prolonged, direct skin contact. At a minimum, toxicity data should include results from a primary dermal irritation study in laboratory animals (see 2.2.2) and a repeated insult human patch test (Modified Draize Procedure) (see 2.3). The latter must be conducted under the supervision of a qualified dermatologist using at least 100 free living individuals.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The type I cloth is intended for use in fabricating bivy covers for the modular sleeping bag (MSB). The type II cloth is used in the fabrication of the Rainsuit. The type III cloth is intended for use in the fabrication of parkas and trousers for the Extended Cold Weather Clothing System – Second Generation (2GECWCS). The type IV cloth is used in the fabrication of the Extended Cold Weather Clothing System (ECWCS) parka and trousers and of the Air Force Cold Weather Security Police Jacket and Hood.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number and date of this specification.
b. Issue of DODISS to be cited in the solicitation and, if required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).
c. Type, and Class required.
d. When first article inspection is required, (see 3.1) the item will be tested and should be a first article sample. The contracting officer should include specific instructions in acquisition documents regarding arrangement for examinations, quantity, and testing and approval.

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

6.4 Spectrophotometer. Suitable spectrophotometers for measuring spectral reflectance in the visible/near spectral include the Diano Hardy, Diano Match Scan, Hunter D54P-IR, and the MacBeth 1500 with IR options.

6.5 White standard. Barium sulfate of suitable quality for use as a white reference standard is available from the Eastman Kodak Company. The same source has available magnesium reagent (ribbon). Suitable tiles can be obtained from the National Institute of Standards and Technology or the instrument manufacturers.

* 6.6 Diethyltoluamide (DEET Insect Repellent) reagent. The insect repellent reagent shall be a solution of 75% by weight (min) of diethyltoluamide and the remainder denatured alcohol. The diethyltoluamide component of the solution shall be a technical grade and contain N, N-diethyl-metatoluamide of not less than 95% purity and the remainder shall consist of entirely or a mixture of ortho or para isomers of N, N-diethytoluamide. The denatured alcohol component of the solution shall be ethanol, U.S.P. 94.9% by volume and denatured in accordance with The Code of Federal Regulations 27 CFR 21, Formula 40 (see 2.1). The insect repellent must be registered with the U.S. Environmental Protection Agency in accordance with the Federal Insecticide, Fungicide and Rodenticide (FIFRA) (see 2.1).

(For guidance purposes only, DEET insect repellent conforming to Type II, Concentration A of O-I-503 has been used successfully as a reagent in testing.)

6.7 Weapons lubricant. MIL-L-63460 weapons lubricant is marketed as “Break-Free CLP” and may be obtained from Break-Free, Inc., Santa Anna, CA.

6.8 Superseded documents. The MIL-DTL-31011A should be used in preference too Mil-C-44187, Cloth, Waterproof, and Moisture Vapor Preamble, and FQSE/PD 96-19 Cloth, Waterproof, and Moisture Vapor Preamble.

6.8 Subject term (key word) listing.
Cloth
Physical surface appearance
Rainsuit system
Bivy cover
Modular sleeping bag (MSB)
ECWCS (Extended Cold Weather Clothing System)
Jacket, Security Police

Custodian:
Army - GL
Navy - NU
Air Force - 99

Preparing activity:
DLA - CT

(Project No. 8305-0746)

Review Activities:
Navy - MC
Air Force – 11, 82

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.

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I RECOMMEND A CHANGE:	**1. DOCUMENT NUMBER** MIL-DTL-31011A	**2. DOCUMENT DATE (YYYYMMDD)** 20001206

3. DOCUMENT TITLE **CLOTH, WATERPROOF AND MOISTURE VAPOR PERMEABLE**

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*	b. ORGANIZATION	
c. ADDRESS *(Include Zip Code)*	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON *(if applicable)*	**7.DATE SUBMITTED** (YYYYMMDD)

8. PREPARING ACTIVITY

a. NAME DEFENSE SUPPLY CENTER, PHILADELPHIA CLOTHING AND TEXTILES DIRECTORATE	b. TELEPHONE *Include Area Code)* (1) Commercial (2) AUTOVON
c. ADDRESS *(Include Zip Code)* ATTN: DSCP-COTC 700 ROBBINS AVENUE PHILADELPHIA, PA 19111-5096	**IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:** Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman road, Suite 2533 Ft. Belvoir, VA 22060-2533 Telephone (703) 767-6888 AUTOVON 427-6888