INCH-POUND

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MILITARY SPECIFICATION

CLOTH, OXFORD, COTTON WARP AND NYLON FILLING, QUARPEL TREATED

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

1. SCOPE

1.1 Scope. This specification covers oxford cloth made of cotton warp and nylon filling yarn, treated with a Quarpel-type water repellent (see 6.7).

1.2 Classification. The cloth shall be of the following classes as specified (see 6.2).

Class 1 - Bleached white
Class 2 - Dyed
Class 3 - Woodland camouflage printed
Class 4 - Desert camouflage printed (6 color)
Class 5 - Desert camouflage printed (3 color)

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 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).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be used in improving this document should be addressed to: U.S. Army Natick Research, Development, and Engineering Center, Natick, MA 01760-5019 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

SPECIFICATIONS

FEDERAL

A-A-50199 - Thread, Polyester Core, Cotton- or Polyester-Covered

STANDARDS

FEDERAL

FED-STD-4 - Glossary of Fabric Imperfections
FED-STD-191 - Textile Test Methods
FED-STD-803 - Packaging of Cotton and Cotton-Synthetic Fiber Blend Fabrics (Excluding Duck Fabrics)

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

2.1.2 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.

DRAWINGS

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

2-1-1516 - Woodland Pattern - 48 inches
2-1-1516B - Woodland Pattern - 60 inches
2-1-1884 - 6 Color Desert Pattern 48 & 60 inch pattern
2-1-2240 - 3 Color Desert Pattern 48 & 60 inch pattern

(Copies of drawings are available from the U.S. Army Natick Research, Development, and Engineering Center, ATTN: STRNC-UX, Natick, MA 01760-5017.)

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.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted 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 ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

Chromatic Transference Scale

(Application for copies should be addressed to 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 5034 - Breaking Force and Elongation of Textile Fabrics (Grab)

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187.)

(Non-Government standards and other publications are normally available from 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 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 6.3), in accordance with 4.3.

3.2 Standard sample. The finished cloth shall match the standard sample for shade and appearance and shall, unless otherwise indicated, be equal to or better than the standard sample with respect to all characteristics for which the standard sample is referenced (see 6.4).

3.3 Material. It is encouraged that recycled material be used when practical as long as it meets the requirements of this specification.

3.3.1 Cotton (warp). The cotton shall be carded, combed, drawn, spun, and twisted into two-ply yarns (see 6.6).

3.3.2 Nylon (filling). The nylon shall be semi-dull continuous multifilament.

3.4 Color.

3.4.1 Color class 1. The color of class 1 cloth shall be bleached white to match the standard sample (see 6.4) and shall be produced by chemical bleaching using a peroxygen-type agent and a fluorescence optical brightener with a resulting peak emission in the blue violet. The hue of fluorescence shall be the same as that of the standard sample when tested as specified in 4.4.3.

3.4.2 Color class 2. The cloth shall be dyed as specified (see 6.2) and shall match the standard sample (see 6.5.1).

3.4.3 Color class 3. The color shall be the Woodland Camouflage Pattern (see 6.5.2). The cloth shall be dyed to a ground shade approximating Light Green 354 and then overprinted with the camouflage pattern using four rollers or screens, as appropriate, to match the Light Green 354, Dark Green 355, Brown 356, and Black 357 areas of the pattern.

3.4.3.1 Pattern execution, class 3. The pattern shall match the standard sample in respect to design, colors, and registration of the respective areas. The warpwise pattern repeat of the Woodland camouflage pattern shall be 27.25 inches + 1.25 inches, - 2.50 inches. The various areas of the pattern shall be properly registered in relation to each other and 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 will not be acceptable. When the standard sample is not referenced for pattern execution, a pattern drawing shall be provided, and the pattern on the finished cloth shall match that of Drawing 2-1-1516 or 2-1-1516B as specified (see 2.1.2, 6.2, and 6.4).

3.4.3.2 Spectral reflectance, class 3. The spectral reflectance values for the visible/near infrared wavelength range 600 to 860 nanometers of the camouflage printed finished cloth shall conform to the requirements specified in table I when tested as specified in 4.4.3.

TABLE I. Spectral reflectance requirements, class 3

Wavelengths nanometers (nm)	Reflectance values (percent)					
	Black 357		Light Green 354		Dark Green 355 and Brown 356	
	Min.	Max.	Min.	Max.	Min.	Max.
600	--	10	8	21	3	10
620	--	10	8	21	3	10
640	--	10	8	21	3	10
660	--	10	8	22	3	12
680	--	10	10	27	3	16
700	--	10	13	40	4	18
720	--	10	16	53	5	20

TABLE I. Spectral reflectance requirements, class 3 (cont'd)

Wavelengths nanometers (nm)	Reflectance values (percent)					
	Black 357		Light Green 354		Dark Green 355 and Brown 356	
	Min.	Max.	Min.	Max.	Min.	Max.
740	--	10	21	64	7	28
760	--	10	27	73	11	36
780	--	10	34	80	17	44
800	--	10	41	85	24	52
820	--	10	48	88	32	60
840	--	10	50	90	39	68
860	--	10	52	91	46	74

3.4.4 Color class 4. The cloth shall be dyed to a ground shade approximating Light Tan 379. The Desert camouflage pattern shall be obtained by roller or screen printing using the five remaining rollers or screens, as appropriate, for Tan 380, Light Brown 381, Dark Brown 382, Black 383, and Khaki 384 (see 6.5.3).

3.4.4.1 Pattern execution, classes 4 and 5. The pattern shall reproduce the standard sample in respect to design, colors, and registration of the respective areas. The warpwise pattern repeat of the dyed, printed, and finished cloth shall be 16.75, +1.25 -1.75 inches. 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, a pattern drawing shall be provided and the pattern on the finished cloth shall match that of Drawing 2-1-1884 for class 4 and 2-1-2240 for class 5 (see 2.1.2, 6.2 and 6.4).

3.4.4.2 Spectral reflectance, class 4. The spectral reflectance values for the 6 color Desert camouflage printed finished cloth shall conform to the requirements specified in table II when tested as specified in 4.4.3.

TABLE II. Spectral reflectance requirements, class 4

Wavelengths nanometers (nm)	Reflectance values (percent)					
	Light Tan 379		Tan 380 and Khaki 384		Light Brown 381 and Dark Brown 382	
	Min.	Max.	Min.	Max.	Min.	Max.
700	38	53	25	44	19	41
720	38	54	25	45	20	41
740	39	55	25	46	20	42
760	40	56	26	47	21	42
780	41	57	27	48	21	42
800	43	58	28	50	22	43

TABLE II. Spectral reflectance requirements, class 4 (cont'd)

Wavelengths nanometers (nm)	Reflectance values (percent)					
	Light Tan 379		Tan 380 and Khaki 384		Light Brown 381 and Dark Brown 382	
	Min.	Max.	Min.	Max.	Min.	Max.
820	45	59	30	52	23	45
840	48	62	33	55	24	46
860	50	65	36	58	25	48

3.4.5 Color class 5. The color shall be the three-color Desert Camouflage Pattern (see 6.5.4). The cloth shall be dyed to a ground shade either matching or approximating Light Tan 492 and then overprinted with the camouflage pattern by roller or automatic screen printing. When the ground shade is dyed to match Light Tan 492, the two remaining colors shall be obtained by subsequent printing using two rollers or screens, as appropriate, to match the Light Brown 493 and Light Khaki 494 areas of the pattern. When the ground shade is dyed to approximate Light Tan 492, all three colors of the camouflage pattern shall be obtained by subsequent printing using three rollers or screens to match all three colors. The ground shade dying and the overprinting shall be accomplished using organic colorants.

3.4.5.1 Spectral reflectance, class 5. The spectral reflectance values for the 3 color Desert camouflage printed finished cloth shall conform to the requirements specified in table III when tested as specified in 4.4.3.

TABLE III. Spectral reflectance requirements, class 5

Wavelengths nanometers (nm)	Reflectance values (percent)					
	Light Tan 492		Light Brown 493		Light Khaki 494	
	Min.	Max.	Min.	Max.	Min.	Max.
700	38	53	19	41	25	44
720	38	54	20	41	25	45
740	39	55	20	42	25	48
760	40	56	21	42	26	50
780	41	57	21	42	27	52
800	43	58	22	43	28	54
820	45	59	23	45	30	56
840	48	62	24	46	33	59
860	50	65	25	48	36	62

3.4.6 Labile sulfur. When dyes and compounds containing elementary sulfur capable of oxidation to sulfuric acid are used, they shall be chosen and applied so that the dyed cloth shall contain no more labile sulfur than shown

by the standard sample. When a standard sample is not available, the dyed cloth shall show a rating of "slight" or better for labile sulfur. Testing shall be as specified in 4.4.3.

3.4.7 Visual matching. All colors of the finished 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 ± 200K, with illumination of 100 ± 20 foot candles, and shall be a good match to the standard sample under incandescent lamplight at 2300 ± 200K.

3.4.7.1 Instrumental matching (class 3 only). As an alternative to visual color matching, the finished cloth printed with the Woodland Camouflage Pattern shall be examined by using a spectrophotometer (see 6.8) to compare each color in the pattern with the standard sample in the visible wavelength range (400 to 700 nanometers) of the electromagnetic spectrum. Each of the four colors in the pattern shall conform to the applicable maximum numerical tolerance for acceptability (ΔA) listed below when measured as specified in 4.5.2.

Color	ΔA
Light Green 354	1.60
Dark Green 355	1.60
Brown 356	1.30
Black 357	1.00

3.4.8 Colorfastness.

3.4.8.1 Classes 1 and 2. Class 1 cloth shall show fastness to laundering (after 3 cycles), perspiration, and light (after 20 standard fading hours) equal to or better than the standard sample or equal to or better than a rating of "good". Class 2 cloth shall show fastness to laundering (after 3 cycles), perspiration, and light after 40 hours equal to or better than the standard sample or equal to or better than a rating of "good". Class 2 cloth shall show fastness to crocking equal to or better than the standard sample or shall have an AATCC Chromatic Transference Scale rating of not lower than 3.5. Testing shall be as specified in 4.4.3.

3.4.8.2 Class 3. Class 3 dyed and camouflage printed cloth shall show fastness to laundering (after 3 cycles), perspiration, and light after 40 hours equal to or better than the standard sample or equal to or better than the rating of "good" for each of the pattern areas, except Black 357 which shall be equal to or better than a rating of "fair". Fastness to crocking shall be equal to or better than the standard sample or shall have an AATCC Chromatic Transference Scale rating not lower than 3.5 for all the pattern areas, except Black 357 which shall have an AATCC Chromatic Transference Scale rating not lower than 1.0. Testing shall be as specified in 4.4.3.

3.4.8.3 Classes 4 and 5. The dyed and Desert camouflage printed cloth shall show fastness to laundering (after 3 cycles), perspiration and light after 40 hours equal to or better than the standard sample or equal to or better than a rating of "good" for each of the pattern areas. The class 4 cloth shall show fastness to crocking equal to or better than the standard sample or shall have an AATCC Chromatic Transference Scale rating of not lower than 3.5 for all the pattern areas, except Black 383 which shall have an AATCC Chromatic Transference Scale rating of not lower than 1.5. The class 5 cloth shall show fastness to crocking equal to or better than the standard sample or shall have an AATCC Chromatic Transference Scale rating of not lower than 3.5 for all the pattern areas. Testing shall be as specified in 4.4.3.

3.5 Physical requirements. The finished cloth shall conform to the requirements specified in table IV when tested as specified in 4.4.3.

TABLE IV. Physical requirements

Class	Weight per square yard ounces (min)	(max)	Yarns per inch (minimum) Warp	Filling	Breaking strength pounds (minimum) Warp	Filling
1	4.8	5.8	160	74	140	125
2	4.8	5.8	160	74	150	125
3	4.8	---	160	74	150	125
4, 5	4.8	---	160	74	150	125

3.5.1 Weave. The weave shall be oxford (2 warp ends weaving as one).

3.5.2 Width. The width of the cloth shall be as specified (see 6.2) and shall be the minimum acceptable width inclusive of the selvage when fly shuttle looms or shuttleless with tuck-in selvage looms are used. For all other shuttleless looms, the width measurement shall be made between the last warp yarn on each side excluding the protruding fringe(s).

3.6 Cloth preparation. The cloth shall be closely singed, fully desized, caustic scoured (through boil-off), and full mercerized.

3.7 Dimensional stability. The shrinkage or elongation both in the warp and in the filling of the finished cloth shall not be greater than 2.0 percent for the individual sample unit and not greater than 1.5 percent for the lot average when tested as specified in 4.4.3. The preshrinking process used shall not be identified by name or trademark either on the cloth, ticket, or package.

3.8 Finish.

3.8.1 Water repellent treatment. The cloth shall be given an approved Quarpel-type water repellent treatment (see 6.7). The use of finishing materials other than the approved water repellents is prohibited. The cured fabric shall be afterwashed to remove all unreacted compounds. The finished cloth shall meet the requirements specified in table V when tested as specified in 4.4.3.

TABLE V. Water repellency and air permeability requirements

	Spray rating 1/	Hydrostatic height, cm Min Lot avg	Min 2/	Dynamic absorption, percent Max Lot avg	Max 3/	Air permeability, cu ft/min/sq ft Max, avg
Initial	90 90 80	35	30	20	25	-
After 3 launderings	-	35	30	-	-	3.0 4/
After 15 launderings	-	-	-	20	25	-

1/ Three individual determinations shall be equal to or better than the ratings specified.

2/ No individual specimen shall fall below the specified minimum.

3/ No individual specimen shall exceed the specified maximum.

4/ For classes 3, 4 and 5 fabric, the air permeability requirement shall be not greater than 4.0 cu. ft/min/sq. ft.

3.8.2 Resistance to organic liquid. The finished cloth shall show no wetting by n-tetradecane either initially or after 15 launderings when tested as specified in 4.4.3.

3.8.3 Nonfibrous material. Prior to the application of the water repellent treatment, the cloth shall have no more than 2.0 percent starch and protein content (including chloroform-soluble and water-soluble material) when tested as specified in 4.4.3.

3.9 pH. The pH value of the water extract of the finished cloth shall be not less than 5.0 nor more than 8.5 when tested as specified in 4.4.3.

3.10 Seam efficiency. The finished cloth shall show a seam efficiency of not less than 70 percent when tested as specified in 4.4.3.

3.11 Length and put-up. Unless otherwise specified (see 6.2), the cloth shall be furnished in continuous lengths, each not less than 40 yards. Each length shall be put up on a roll as specified in 5.1.

3.12 Fiber identification. Each roll shall be labeled or ticketed for fiber content in accordance with the Rules and Regulations Under the Textile Fiber Products Identification Act.

3.13 Face identification (classes 1 and 2). The face side of the classes 1 and 2 cloths shall be identified by stamping one side with the word "FACE" at each end of the roll.

3.14 Workmanship. The finished cloth shall conform to the quality of product established by this specification. The demerit points per 100 square yards when calculated as specified in section 4 shall not exceed the applicable established maximum point values.

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 (examinations and tests) 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 specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsiblity for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.1.2 Certificates 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 inspections. 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 3.1 and 6.2), it shall be examined for appearance, color, and finish defects and shall be tested for the characteristics specified in table VI.

4.4 Quality conformance inspection.

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 specification or applicable purchase document.

4.4.2 End item examination.

4.4.2.1 Yard-by-yard examination. Each roll in the sample shall be examined on the face side only. When the total yardage in the roll does not exceed 100 yards, the entire yardage in the roll shall be examined. When the total yardage in the roll exceeds 100 yards, only 100 yards shall be examined. All defects, as defined in section I of FED-STD-4, which are clearly noticeable at normal inspection distance (3 feet) shall be scored and assigned demerit points as listed in 4.4.2.1.1 except that only those slubs and knots which exceed the limits shown on Sears Fabric Defect Scale (see 6.10), "D" or 3 1/2 as applicable for slubs and "C" for knots, shall be scored. No linear yard (increments of 1 yard on the measuring device of the inspection machine) from any one roll within the sample shall be penalized more than four points. The sample size shall be 20 rolls selected from 20 containers. The lot shall be unacceptable if the points per 100 square yards of the total yardage examined exceeds 30.0 points. The lot shall be unacceptable if the points per 100 square yards of two or more individual rolls exceeds 45.0 points. If one roll exceeds 45.0 points per 100 square yards, a second sample of 20 rolls shall be examined for individual roll quality only. The lot shall be unacceptable if one or more rolls in the second sample exceeds 45.0 points per 100 square yards. Point computation for lot quality and individual roll quality shall be as follows:

$$\frac{\text{Total points scored in sample} \times 3600}{\text{Contracted width of cloth (inches)} \times \text{Total yards inspected}} = \text{Points per 100 square yards}$$

4.4.2.1.1 Demerit points. Demerit points shall be assigned as follows:

For defects up to 3 inches in any dimension	- one point
For defects exceeding 3 inches but not exceeding 6 inches in any dimension	- two points
For defects exceeding 6 inches but not exceeding 9 inches in any dimension	- three points
For defects exceeding 9 inches in any dimension	- four points

The following defects, when present shall be scored four points for each yard in which they occur:

Objectionable odor
Baggy, ridgy, or wavy cloth
Width less than specified
Edge ravels when pulled outward
Slack or tight selvages 1/
Excessive neppiness
Not singed
Not finished as specified
Poor dye penetration, mottled, streaky, or cloudy (class 2)
Overall uncleanness
Pattern design not equal to the standard sample (classes 3, 4 and 5)
Incorrect color in any part of the pattern (classes 3, 4 and 5)
Pattern repeat not equal to the standard sample (classes 3, 4 and 5)
Pattern repeat less than 24.75 inches or more than 28.50 inches (class 3)
Pattern repeat less than 15.00 inches or more than 18.00 inches (classes 4 and 5)
Skitteriness (mottled, uneven color) or pattern exceeds that shown by standard sample (classes 3, 4 and 5)
Excessive feathering or spew (fuzziness at color boundaries of pattern as compared to the standard sample (classes 3, 4 and 5)
Excessive grinning (off register, gap where ground shade shows through) of pattern as compared to the standard sample (classes 3, 4 and 5)
Excessive haloing or trapping (overlapping of colors) of pattern as compared to the standard sample (classes 3, 4 and 5)

1/ To determine the presence of unacceptable selvage conditions, the following procedure shall be observed: During the visual examination, the perch shall be stopped a minimum of three times for each roll in the sample, the tension removed and the finished cloth examined for the selvage conditions. A waviness in the selvage or significant ripples diagonally across the width of the fabric is an indication of slack or tight selvages.

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 with 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 on the face side. The lot (classes 1 or 2) shall be unacceptable if any roll is off shade, shaded side to side, shaded side to center, or shaded end to end, or if any roll does not have the same appearance as the standard sample. The lot (classes 3, 4, or 5) shall be unacceptable if any roll fails to match the standard sample with respect to color for all pattern areas, or if any roll does not have the same appearance as the standard sample.

4.4.2.4 Roll identification examination. During the yard-by-yard examination, each roll in the sample shall be examined for defects listed below. The lot shall be unacceptable if two or more rolls have any of the following defects:

Face identification for classes 1 and 2 cloths missing from either or both ends.

Preshrinkage process identified by name or trademark on cloth or ticket.

Not labeled or ticketed in accordance with the Rules and Regulations Under the Textile Fiber Products Identification Act.

4.4.3 End item testing. The cloth shall be tested for the characteristics listed in table VI. The methods of testing specified in FED-STD-191, wherever applicable, and as listed in table VI shall be followed. The sample unit shall be 1/2 yard full width of the dyed cloth (prior to treatment) for determination of non-fibrous material content and 5 continuous yards full width for all other physical and chemical tests. The lot shall be unacceptable if one or more units or the lot average for dynamic absorption or dimensional stability fail to meet any test requirement specified. 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 VI. End item tests

Characteristic	Requirement paragraph	Test method
Material:		
Cotton (warp)	3.3.1	1200 1/
Nylon (filling)	3.3.2	1530 1/
Luster	3.3.2	1/
Fluorescence (class 1)	3.4.1	4.5.1

TABLE VI. End item tests (cont'd)

Characteristic	Requirement paragraph	Test method
Spectral reflectance		
Class 3	3.4.3.2	4.5.3
Class 4	3.4.4.2	4.5.3
Class 5	3.4.5.1	4.5.3
Presence of labile sulfur	3.4.6	2020 1/
Colorfastness (classes 1 and 2):		
Laundering (after 3 cycles)	3.4.8.1	5610 2/ 3/
Crocking (class 2 only)	3.4.8.1	5651
Perspiration	3.4.8.1	5680
Light	3.4.8.1	5660
Colorfastness (classes 3, 4 and 5):		
Laundering (after 3 cycles)	3.4.8.2 and 3.4.8.3	5610 2/ 3/
Perspiration	3.4.8.2 and 3.4.8.3	5680
Crocking	3.4.8.2 and 3.4.8.3	5651
Light	3.4.8.2 and 3.4.8.3	5660
Weight	3.5	5041
Yarns per inch	3.5	5050
Breaking strength	3.5	ASTM D 5034
Weave	3.5.1	Visual 4/
Mercerization	3.6	Visual 1/
Dimensional stability	3.7	5550
Spray rating	3.8.1	5526
Hydrostatic height:		
Initial	3.8.1	5514
After 3 launderings	3.8.1	5556 5/ and 5514
Dynamic absorption:		
Initial	3.8.1	5500
After 15 launderings	3.8.1	5556 5/ and 5500
Air permeability:		
After 3 launderings	3.8	5556 5/ and 5450
Use of approved finish materials only	3.8	1/
Resistance to organic liquid:		
Initial	3.8.2	4.5.4
After 15 launderings	3.8.2	5556 5/ and 4.5.4
Nonfibrous material	3.8.3	2611
pH	3.9	2811
Seam efficiency	3.10	5110 6/

1/ A certificate of compliance shall be submitted and will be acceptable for the stated requirements.

2/ The specimens must be dried after each of the 3 laundering cycles.

3/ Only the stain on the nylon and cotton fiber of the color transfer cloth shall be evaluated, and stain shall be equal to or better than a rating of "fair".

4/ One determination shall be made on each sample unit and the result reported as "pass" or "fail".

5/ Laundering shall be in accordance with Method 5556 (cotton laundering procedure) except that the specimens shall be tumble dried at a stack temperature of 180° to 210°F for 30 to 40 minutes and the specimens shall not be pressed. Launderings shall be the specified number of complete cycles (3 or 15 as applicable).

6/ The needle shall measure 0.040 inch ± 0.001 inch across the blade at the eye. The thread shall be polyester-covered, or cotton-covered in accordance with A-A-50199, ticket No. 50 for the needle and ticket No. 70 for the looper.

4.4.4 Packaging inspection. The inspection of the preservation, packing and container marking shall be in accordance with the quality assurance provisions of FED-STD-803.

4.5 Methods of inspection.

4.5.1 Determination of fluorescence (class 1 only). A specimen of the sample unit and a specimen of the standard sample shall be compared under ultra-violet light in an otherwise completely dark room. The specimen shall be considered satisfactory if its hue of fluorescence is the same as the standard sample. One determination shall be performed on the sample unit and the results reported as "pass" or "fail".

4.5.2 Colorimetric measurements for the acceptability equation. Each of the four colors from the Woodland pattern cited in 3.4.7.1 for both the standard sample and the test specimen shall be measured as speciifed in 4.5.3, except the spectral reflectance factor data shall be obtained in the visible wavelength range 400 to 700 nm only, and at 20 nm (or less) intervals. When the spectrophotometer is operated in the polychromatic mode, a source simulating CIE illuminant source D 65 shall be used. Colorimetric data (see 6.11), computed from the resulting spectral data, shall be incorporated in the equation of acceptability (see 6.12) and the ΔA for each color shall be calculated. Specimens recording ΔA values equal to or less than those specified for each color in 3.4.7.1 represent acceptable color matches to the standard. Any color having a ΔA value greater than that specified in 3.4.7.1 shall be considered a test failure.

4.5.3 Spectral reflectance test. Reflectance data shall be obtained from 600 to 860 nanometers (nm) for class 3 and 700 nm to 860 nm for classes 4 and 5, for each color on a spectrophotometer (see 6.8) relative to a barium sulfate standard, the preferred white reference standard. Other white

reference materials may be used, provided they are calibrated to absolute white; e.g. Halon, magnesium oxide, or vitrolite tiles (see 6.9). The spectral band width shall be less than 25 nm at 860 nm. Reflectance measurements shall be made by either the monochromatic or polychromatic mode of operation. When the polychromatic mode is used, the spectrophotometer shall operate with the specimen diffusely illuminated with the full emission of a continuous source that simulates in the visible spectrum either CIE Source A or CIE Source D65. The specimen shall be viewed at an angle no greater than 10^{o} from normal, with the specular component included. Photometric accuracy of the spectrophotometer shall be within one 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. Areas to be measured for each color shall be lightly marked with a circle at least 1.50 inches in diameter, on the reverse side of the fabric, and at least 6 inches from either selvage. When evaluating class 3, Woodland camouflage pattern, specimens shall be measured as a single layer backed with four layers of the same shade cut from the standard. For classes 4 and 5 Desert camouflage pattern, specimens shall be measured as a single layer backed with four layers of the same shade cut from the standard. Light Tan 379 shall be measured using a small area of view. Readings shall be taken on a minimum of two different areas for each color and the data averaged. When the measured reflectance values for any color at four or more wavelengths do not meet the limits for the Woodland pattern (class 3) in table I, 6 color Desert pattern (class 4) in table II, and 3 color Desert pattern (class 5) in table III, it shall be considered a test failure.

4.5.4 Resistance to organic liquid test. Place a small specimen of the cloth face up on a smooth horizontal surface. Using a pipette or eye dropper, gently deposit one drop of n-tetradecane on the surface of the specimen. After 1 minute, 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.

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 FED-STD-803.

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

5.2.1 Levels A, B, or Commercial. The cloth shall be packed in accordance with the applicable requirements of FED-STD-803.

5.3 Marking. In addition to any special marking required by the contract or purchase order, shipments shall be marked in accordance with the applicable requirements of FED-STD-803.

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 cloth is intended various hood components, caps, and the casualty evacuation bag casing.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of this specification.
b. Class required (see 1.2).
c. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
d. When first article is required (see 3.1, 4.3, and 6.3).
e. Color of cloth when class 2 is specified (see 3.4.2).
f. Woodland or applicable Desert camouflage pattern drawing if required (see 3.4.3.1 and 3.4.4.1).
g. Width of cloth required (see 3.5.2).
h. Length of roll, if required other than specified (see 3.11).
i. Levels of preservation and packing (see 5.1 and 5.2).

6.3 First article. When a first article is required, it shall be inspected and approved under the appropriate provisions of FAR 52.209-4. 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 also include specific instructions in acquisition documents regarding arrangements for selection, inspection, and approval of the first article.

6.4 Sample. For access to the standard sample (see 3.2) and the Woodland camouflage pattern drawing or Desert camouflage pattern drawing, if applicable (see 3.4.3.1 or 3.4.4.1), address the contracting activity issuing the invitation for bids or request for proposal.

6.4.1 Standard sample (class 1). The standard sample for class 1 was produced as follows: Singed, desized, progressive open boil-off, mercerized 42° Tw, bleached with hydrogen peroxide, water repellent treated using a quaternary pyridinium complex (Norane R) presence of Fluorescent Brightener No. 28. Because of possible aging effects, reference to the standard sample for class 1 applies only to the sample established specifically for each procurement.

6.5 Dye combinations.

6.5.1 Class 2, Olive Green 107. A suggested but not mandatory dye combination for Olive Green 107 is as follows:

Nylon:	Acid Yellow 219	Cotton:	Vat Brown 57
	Acid Blue 258		Vat Brown 3
	Acid Orange 162		Vat Green 1
			Vat Yellow 2
			Vat Orange 2
			Cibanone Olive Green NY

6.5.1.1 Class 2, Camouflage Green 483. A suggested but not mandatory dye combination for Camouflage Green 483 is as follows:

Nylon:	Acid Blue 171	Cotton:	Vat Green 1
	Acid Orange 162		Vat Brown 57
			Vat Yellow 33

6.5.2 Class 3, Woodland camouflage printed. The areas of the pattern have been found to be satisfactory when dyed or printed with the following colorants. The dyeing of the ground shade approximating Light Green 354 was accomplished using the acid and vat dyes listed below:

Light Green 354

Vat Orange 2
Vat Green 1
Vat Yellow 2

Dark Green 355

Vat Brown 3
Vat Green 1
Vat Yellow 2

Brown 356

Vat Brown 57
Vat Brown 3
Vat Yellow 2
Vat Green 1

Black 357

Sulphur Black 6
Vat Blue 20
Vat Brown 3 Vat Black 11

Ground Shade

Acid Blue 258
Tectilon Orange 4R
Vat Orange 2
Vat Green 1
Vat Yellow 2

Satisfactory printing of shades Light Green 354, Dark Green 355, and Brown 356 has been accomplished by the use of vat dyes only. Shade Black 357 has been satisfactorily printed with a combination of vat and sulfur dyes.

6.5.3 Class 4, Desert camouflage printed (6 color). The areas of the pattern have been found to be satisfactory when dyed or printed with various combinations of the following dyes for the colored areas:

Light Tan 379 (ground shade)

Vat Brown 1
Vat Black 25

Dark Brown 382

Vat Yellow 1
Vat Yellow 33
Vat Brown 1
Vat Brown 57

Tan 380

Vat Yellow 1
Vat Yellow 33
Vat Brown 1
Vat Brown 57
Vat Black 25

Black 383

Sulfur Black 6/Vat Black 14
Cibanone Black R

Light Brown 381

Vat Yellow 1
Vat Yellow 33
Vat Brown 1
Vat Brown 57

Khaki 384

Vat Yellow 1
Vat Yellow 33
Vat Brown 1
Vat Black 25

Satisfactory dyeing of the Light Tan 379, ground shade, and printing of Tan 380, Light Brown 381, Dark Brown 382 and Khaki 384 has been accomplished by the use of vat dyes only. Black 383 has been satisfactorily printed with a combination of vat and sulfur dyes.

6.5.4 Class 5, Desert camouflage printed (3 color). The areas of the pattern have been found to be satisfactory when dyed or printed with various combinations of the following dyes for the colored areas:

Ground Shade

Vat Green 8
Vat Green 8 * similar
Vat Brown 1
Vat Black 25
Vat Orange 1
Vat Yellow 2

Light Brown 493

Vat Green 8
Vat Green 8 * similar
Vat Brown 1
Vat Black 25
Vat Orange 1
Vat Yellow 2

Light Tan 492

Vat Green 8
Vat Green 8 * similar

Light Khaki 494

Vat Green 8
Vat Green 8 * similar

Vat Brown 1	Vat Brown 1
Vat Black 25	Vat Black 25
Vat Brown 57	Vat Yellow 2
Vat Yellow 2	

6.6 Warp yarn (cotton). The requirements of this specification are based on the use of nominal 60/2 warp yarns.

6.7 Quarpel-type water repellent. The "Quarpel-type" water repellent treatment consists of the co-application of an emulsified fluorocarbon and a fluorocarbon extender. Approval of such components and combinations is the responsiblity of the U.S. Army Natick Research, Development, and Engineering Center, Natick, MA 01760-5019, and is based on more extensive tests, including those for toxicity, which are not set forth in this specification. 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 proposal shall be considered acceptable for the related procurement.

6.8 Spectrophotometers. Suitable spectrophotometers for measuring spectral reflectance in the visible/near infrared include the Diano Hardy, Diano Match Scan, Milton Roy Match Scan 2, Hunter D-54P-IR, Applied Color Systems Spectro Sensor I and II and CS-5, Hunter VIS/NIR Spectrocolorimeter and Macbeth 1500 with IR options.

6.9 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) and Halon. Suitable tiles can be obtained from the National Institute of Standards and Technology or the instrument manufacturers.

6.10 Fabric defect scales. Fabric defect replica kits are available from Sears Roebuck Company, Department 817 (ATTN: BSC 23-29), Sears Tower, Chicago, IL 60684.

6.11 CIE Tristimulus, and CIE $L^*a^*b^*$ values. The spectral reflectance values obtained from 400 to 700 nm for a color are used to compute the tristimulus values X, Y and Z, using CIE illuminant D_{65} and the 1964 CIE 10^O Supplementary Standard Colorimetric Observer. The tristimulus values are converted to CIE $L^*a^*b^*$ for use in the acceptability equation (see 6.12). Most spectrophotometers are interfaced to computers that automatically compute CIE tristimulus values, and CIE $L^*a^*b^*$ values. Derivation of tristimulus values can be found in, "Color in Business, Science and Industry", Third Edition, D.B. Judd and G. Wyszecki, John Wiley & Sons, New York, NY. Conversion of tristimulus values to CIE $L^*a^*b^*$ values is described in CIE publication, "Recommendations of Uniform Color Spaces, Color Difference Equations, and Psychometric Color Terms", Supplement No. 2 to CIE Publication No. 15, "Colorimetry", E-1.3.1 (1971), Bureau Central de la CIE, Paris (1978).

6.12 Acceptability Equation. Color acceptability is determined by the following equation:

$$\Delta A=[g_{11}(\Delta a^*)^2+2g_{12}\Delta a^*\Delta b^*+g_{22}(\Delta b^*)^2+g_{33}(\Delta L^*)^2]^{1/2}$$

where ΔA is an acceptability figure, scaled according to color (see 3.4.7.1); and the quantities Δa^*, Δb^*, ΔL^* are sample minus standard in CIELAB coordinates. The coefficients g_{11}, $2g_{12}$, g_{22} and g_{33} are given by the following equations, where a^*_O and b^*_O represent the CIELAB a^* and b^* values of the standard, c is the chroma tolerance, h is the hue tolerance, and v (for value) is the lightness tolerance:

$$\theta = \tan^{-1}(b^*_O/a^*_O)$$

$$g_{11} = (\cos^2\theta/c^2) + (\sin^2\theta/h^2)$$

$$2g_{11} = 2 \sin\theta \cos\theta [(1/c^2) - (1/h^2)]$$

$$g_{22} = (\sin^2\theta/c^2) + (\cos^2\theta/h^2)$$

$$g_{33} = 1/v^2$$

Hue, Chroma and Lightness Tolerances for the Woodland Pattern

		Lightness (v)	Chroma (c)	Hue (h)
Light Green	354	2.26	1.32	1.16
Dark Green	355	2.20	1.30	1.11
Brown	356	1.88	1.28	0.74
Black	357	2.70	1.50	1.25

Specimens recording ΔA values less than those listed for each color in 3.4.7.1 represent acceptable matches for color to the standard; those specimens with higher ΔA values are unacceptable.

Natick TR-80/036, Investigations to Define Acceptability Tolerance Ranges in Various Regions of Color Space, E. Allen and B. Yuhas, U.S. Army Natick RD&E Center, Natick, MA 01760-5019, Sept. 1981, is available from Natick for those interested in writing a software program for the acceptability equation.

6.13 Subject term (key word) listing.

Camouflage
Clothing
Printed cloth
Water repellent treated

6.14 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians:

Army - GL
Navy - NU
Air Force - 99

Review activities:

Army - MD
Navy - MC
Air Force - 82
DLA - CT

Preparing activity:

Army - GL

(Project 8305-0427)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER	2. DOCUMENT DATE (YYMMDD)
	MIL-C-392...	1991 December 1'

3. DOCUMENT TITLE
CLOTH, OXFORD, COTTON WARP AND NYLON FILLING, QUARPEL TREATED

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 (YYMMDD)

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE (Include Area Code) (1) Commercial	(2) AUTOVON/DSN
U.S. Army Natick RD&E Center	508-651-4532	256-4532
c. ADDRESS (Include Zip Code) Commander, U.S. Army Natick RD&E Center ATTN: STRNC-IRT Natick, MA 01760-5019	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	