

INCH-POUND

MIL-C-44436 (GL)  
13 July 1992

## MILITARY SPECIFICATION

## CLOTH, CAMOUFLAGE PATTERN, WIND RESISTANT POPLIN, NYLON/COTTON BLEND

This specification is approved for use by the Natick Research, Development and Engineering Center, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

## 1. SCOPE

1.1 Scope. This specification covers wind resistant poplin nylon/cotton cloth, dyed and overprinted with the specified camouflage pattern.

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

- Class 1 - Woodland camouflage printed
- Class 2 - Woodland camouflage printed, quarpel treated
- Class 3 - Desert camouflage printed (3 color)
- Class 4 - Desert camouflage printed (3 color), permethrin treated

## 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

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SPECIFICATIONS

FEDERAL

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

MILITARY

MIL-I-44411 - Insect Repellent, Permethrin

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  
2-1-2240 - 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-UXD, 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.)

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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 (AATOC)

## 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 27709-2115.)

## ASTM

- D 1424 - Tear Resistance of Woven Fabrics by Falling-Pendulum (Elmendorf) Apparatus
- D 5034 - Breaking Force and Elongation of Textile Fabrics (Grab Test)

(Application for copies should be addressed to the ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.)

(Non-Government standards and other publications are normally available from the organizations that prepare or 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. The cotton shall be carded and combed.

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3.3.2 Nylon. The nylon shall be first quality, high tenacity, semi-dull staple having a nominal cut length of 1-1/2 inches and a round cross-section with a nominal denier of 1.8. The use of any form of nylon waste is prohibited, such as undrawn fiber, mixtures of deniers, lusters or cross-sections, and waste from any stage of fiber production: whether drawn, undrawn, or mixed or garnetted fiber. The contractor shall submit the fiber producer's certification that each lot of nylon staple used conforms to the requirements specified herein.

3.3.3 Yarn. The warp and filling yarn shall be made from a blend of  $50 \pm 5$  percent nylon with the remaining percentage cotton, based on the dry weight of the desized cloth. The warp yarn shall be 2-ply and the filling yarn shall be 2-ply or singles.

#### 3.4 Color.

3.4.1 Color, classes 1 and 2. The color shall be the Woodland Camouflage Pattern (see 6.8.1). The cloth shall be dyed to a ground shade either matching or approximating Light Green 354 and then overprinted with the camouflage pattern by roller or screen printing. When the ground shade is dyed to match Light Green 354, the remaining colors shall be obtained by subsequent printing using three rollers or screens as appropriate for the Dark Green 355, Brown 356, and Black 357 areas of the pattern. When the ground shade is dyed to approximate Light Green 354, all four colors of the camouflage pattern shall be obtained by subsequent printing using four rollers or screens to match all four colors. Resin bonded pigments are not permitted.

3.4.2 Color, classes 3 and 4. The color shall be the Desert Camouflage Pattern (see 6.8.2). 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 remaining colors shall be obtained by subsequent printing using two rollers or screens as appropriate for 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. Resin bonded pigments are not permitted.

3.4.3 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.

3.4.4 Visual matching (classes 2, 3 and 4 only). 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

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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.

3.4.4.1 Instrumental matching (class 1). The finished cloth printed with the Woodland Camouflage Pattern shall be examined by using a spectrophotometer (see 6.5) to compare each color in the pattern with the standard sample in the visible wavelength range 400 to 700 nanometers (nm) of the electromagnetic spectrum. Each of the four colors in the pattern shall be no greater than the maximum numerical tolerance for acceptability ( $\Delta A$ ) listed below when measured as specified in 4.5.1.

<u>Color</u>	<u>Maximum numerical tolerance for acceptability (<math>\Delta A</math>)</u>
Light Green 354	1.60
Dark Green 355	1.60
Brown 356	1.30
Black 357	1.00

3.4.5 Colorfastness, classes 1 and 2. The Woodland Camouflage printed finished cloth shall show fastness to laundering (after 3 cycles), light (after 40 standard fading hours), and perspiration equal to or better than the standard sample or equal to or better than a rating of "good" for each of the pattern areas, except for Black 357 which shall be equal to or better than a rating of "fair" for laundering, and for Light Green 354, fastness to light shall be equal to or better than a rating of "fair". The finished cloth shall show fastness to crocking equal to or better than the standard sample or shall have an AATOC Chromatic Transference Scale rating of not lower than 3.5 for all the pattern areas, except for Black 357 which shall have an AATOC Chromatic Transference Scale rating of not lower than 1.0. Testing shall be as specified in 4.4.3.

3.4.6 Colorfastness, classes 3 and 4. The Desert Camouflage printed finished cloth shall show fastness to laundering (after 3 cycles), light (after 40 standard fading hours), and perspiration equal to or better than the standard sample or equal to or better than a rating of "good" for each of the pattern areas, except fastness to light shall be equal to or better than "fair". The finished cloth shall show fastness to crocking equal to or better than the standard sample or shall have an AATOC 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 Pattern execution. The pattern on the finished cloth shall match the standard sample with respect to design, colors and registration of the respective areas. Each pattern area shall show solid coverage. Skitteriness exceeding that shown by the standard sample will not be acceptable. The warpwise pattern repeat of the classes 1 and 2 printed finished cloth shall

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be 27.25 +1.25 -2.50 inches. The warpwise pattern repeat of the classes 3 and 4 printed finished cloth shall be 16.75 +1.25 -2.25 inches. When the standard sample is not referenced for pattern execution, a pattern drawing shall be provided and the pattern on the finished cloth for classes 1 and 2 shall match that of Drawing 2-1-1516 for 48-inch width and Drawing 2-1-1516B for 60-inch width cloths; the pattern on the finished cloth for classes 3 and 4 shall match that of Drawing 2-1-2240 (see 2.1.2, 6.2, and 6.4).

### 3.6 Spectral reflectance.

3.6.1 Spectral reflectance, classes 1 and 2. The spectral reflectance values for each color in the Woodland Camouflage printed cloth shall conform to the requirements specified in table I when tested as specified in 4.4.3.

TABLE I. Spectral reflectance requirements, classes 1 and 2

Wavelength, Nanometers (nm)	Reflectance values (percent)					
	Light Green 354		Dark Green 355 and Brown 356		Black 357	
	Min.	Max.	Min.	Max.	Min.	Max.
600	8	18	3	9	-	10
620	8	18	3	9	-	10
640	8	18	3	9	-	10
660	8	18	3	12	-	10
680	10	22	3	14	-	10
700	18	33	5	18	-	10
720	22	45	7	20	-	10
740	30	55	12	28	-	10
760	35	65	18	36	-	10
780	40	75	26	44	-	10
800	45	80	34	52	-	10
820	50	86	42	60	-	10
840	55	88	50	68	-	10
860	60	90	56	74	-	10

3.6.2 Spectral reflectance, classes 3 and 4. The spectral reflectance values for each color in the Desert Camouflage printed cloth shall conform to the requirements specified in table II when tested as specified in 4.4.3.

TABLE II. Spectral reflectance requirements, classes 3 and 4

Wavelength, 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

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TABLE II. Spectral reflectance requirements, classes 3 and 4 (cont'd)

Wavelength, Nanometers (nm)	Reflectance values (percent)					
	Light Tan 492		Light Brown 493		Light Khaki 494	
	Min.	Max.	Min.	Max.	Min.	Max.
740	39	55	20	42	25	46
760	40	56	21	42	26	47
780	41	57	21	42	27	48
800	43	58	22	43	28	50
820	45	59	23	45	30	52
840	48	62	24	46	33	55
860	50	65	25	48	36	58

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

TABLE III. Physical requirements

Characteristic	Classes 1, 3 and 4	Class 2
Weight, oz./sq.yd.		
Minimum	6.0	6.0
Maximum	7.0	7.0
Yarns per inch, (min)		
Warp	104	104
Filling	52	52
Breaking strength, (pounds) min.		
Warp	200	200
Filling	90	90
Tearing strength, (pounds) min.		
Warp	7.0	7.0
Filling	5.0	5.0
Air permeability, (ft. <sup>3</sup> /min./ft. <sup>2</sup> ) max.	15.0	10.0

3.7.1 Weave. The weave shall be a plain weave with reinforcement ribs in both the warp and filling directions forming a uniform pattern. The ribs shall be formed by having every twenty-fourth warp end contain two ends weaving as one and every thirteenth filling contain two picks weaving as one. Testing shall be as specified in 4.4.3.



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3.7.2 Width. The width of the finished 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).

3.8 Finish. The cloth shall be thoroughly prepared, including singeing and mercerizing. The class 2 cloth shall be given a water repellent treatment as specified in 3.8.1 and the class 4 cloth shall be given an insect repellent treatment as specified in 3.8.2.

3.8.1 Water repellency (class 2). The class 2 cloth shall be given an approved quarpel-type water repellent treatment (see 6.7) and shall conform to the requirements specified in table IV. The use of materials other than approved water repellents is prohibited. The cured fabric shall be after-washed to remove all unreacted reagents. Testing shall be as specified in 4.4.3.

TABLE IV. Water repellency (class 2)

	<u>Dynamic absorption (percent)</u>		<u>Spray rating 2/</u>
	<u>Max. lot avg.</u>	<u>Max. 1/</u>	
Initial	25	30	90, 90, 80
After 15 laundering	25	30	-

1/ No individual specimen shall exceed the specified maximum.

2/ The results of the three individual determinations on the sample unit for spray rating shall be equal to or better than the specified ratings when tested as specified in 4.4.3.

3.8.2 Insect repellency (class 4). The class 4 cloth shall be given a permethrin insect repellent treatment in accordance with the Industrial fabric application method specified in MIL-I-44411. The finished treated cloth shall contain 0.100 to 0.125 mg/cm<sup>2</sup> permethrin. The use of a treatment other than the one specified herein is prohibited. Testing shall be as specified in 4.4.3.

3.8.3 Nonfibrous material. The starch and protein content including chloroform-soluble and water-soluble material of the printed cloth (prior to treatment) shall not exceed 2.0 percent when tested as specified in 4.4.1.2 or 4.4.3.

3.8.4 pH. The pH of the water extract of the finished cloth shall be not lower than 5.0 nor higher than 8.5 when tested as specified in 4.4.3.



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3.8.5 Resistance to organic liquid. The class 2 finished cloth shall show no wetting by n-tetradecane either initially or after 15 launderings when tested as specified in 4.4.3.

3.8.6 Preshrinking. The cloth shall be preshrunk. The preshrinking process used shall not be identified by name or trademark on the cloth, ticket or package.

3.9 Dimensional stability. The shrinkage or elongation both in the warp and filling of the finished cloth shall not be greater than 3.5 percent for the individual sample unit and not greater than 3.0 percent for the lot average when tested as specified in 4.4.3.

3.10 Seam efficiency. The finished cloth shall have a seam efficiency of not less than 80 percent when tested as specified in 4.4.3.

3.11 Length and put-up. For Government procurements only, 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 full width on a roll as specified in 5.1.

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

3.13 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 Responsibility 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

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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. Where 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 tested for the characteristics as specified in table V.

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.

4.4.1.1 Component and material certification. A certificate of compliance may be acceptable as evidence that the characteristics listed below conform to the specified requirements.

<u>Characteristic</u>	<u>Requirement paragraph</u>	<u>Test method</u>
Resin bonded pigment prohibition	3.4.1 and 3.4.2	----
Starch and protein content prior to water or insect repellent treatment (classes 2 and 4)	3.8.3	2611 of FED-STD-191

4.4.2 End item examination.

4.4.2.1 Yard-by-yard examination. Each roll in the sample shall be examined on the printed 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, that are clearly noticeable at normal inspection distance (3 feet) shall be scored and

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assigned demerit points as listed in 4.4.2.1.1 except that only those slubs and knots which exceed the limits shown on the Sears Fabric Defect Scale (see 6.9), "D" or "3-1/2" as applicable for slubs and "C" for knots, shall be scored and coarse yarn shall only be scored as a defect when the coarse yarn is twice the diameter of the normal yarn used in the fabric. No linear yard (increments of 1 yard on the measuring device of the inspection machine) from any one roll 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 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 in the sample 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/
- Overall uncleanness
- Uneven weaving throughout
- Pattern design not equal to the standard sample
- Incorrect color in any part of the pattern
- Pattern repeat not equal to the standard sample
- Pattern repeat less than 24.75 inches or more than 28.50 inches (classes 1 and 2)
- Pattern repeat less than 14.50 inches or more than 18.00 inches (classes 3 and 4)

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Skitteriness (mottled, uneven color) of pattern exceeds that shown by the standard sample

Excessive feathering or spew (fuzziness at color boundaries) of pattern as compared to the standard sample

Excessive grinning (off register, gap where ground shade shows through) of pattern as compared to the standard sample

Excessive haloing or trapping (overlapping of colors) of pattern as compared to the standard sample

- 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 causing significant waviness or ripples within the body of the cloth 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 the rolls in the sample is less than the total of 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 printed side. Any roll that fails to meet the requirement for shade and appearance match with respect to all areas of the pattern shall be cause for rejection of the entire lot represented by the sample.

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

Preshrinking 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 V. The methods of testing as specified in FED-STD-191 wherever applicable and as listed in table V shall be followed. All test reports shall contain the individual values utilized in expressing the final results. The sample unit shall be 1/4 yard full width of printed cloth (prior to treatment) for determination of nonfibrous material, and 5 continuous yards full width of finished cloth for all other physical and chemical tests except dimensional stability (see 4.4.3.1). The lot shall be

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unacceptable if one or more sample units or the lot average for dimensional stability fail to meet any requirement specified. The sample size, except for dimensional stability, shall be in accordance with the following:

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

TABLE V. End item tests

<u>Characteristic</u>	<u>Requirement paragraph</u>	<u>Test method</u>
Material:		
Cotton:		
Identification	3.3.1	1200 <u>1</u> /
Combed cotton	3.3.1	<u>1</u> /
Nylon:		
Identification	3.3.2	1530 <u>1</u> /
Luster	3.3.2	<u>1</u> /
Denier	3.3.2	<u>1</u> /
Absence of nylon waste	3.3.2	<u>1</u> /
Fiber content:		
Cotton content	3.3.3	2530 <u>1</u> / <u>2</u> /
Nylon content	3.3.3	2530 <u>1</u> /
Yarn ply	3.3.3	Visual <u>3</u> /
Presence of labile sulfur	3.4.3	2020 <u>1</u> /
Colorfastness to:		
Laundering (after 3 cycles)	3.4.5 and 3.4.6	5610 and 4.5.2 <u>4</u> /
Perspiration	3.4.5 and 3.4.6	5680 and 4.5.2
Crocking	3.4.5 and 3.4.6	5651 and 4.5.3
Light (after 40 standard fading hours)	3.4.5 and 3.4.6	5660
Spectral reflectance:		
Classes 1 and 2	3.6.1	4.5.4
Classes 3 and 4	3.6.2	4.5.4
Weight	3.7	5041
Yarns per inch	3.7	5050
Breaking strength	3.7	ASTIM D 5034
Tearing strength	3.7	ASTIM D 1424
Air permeability	3.7	5450
Weave	3.7.1	Visual
Singeing	3.8	<u>1</u> /
Mercerization	3.8	Microscopic examination <u>1</u> /
Water repellent treatment (class 2)	3.8.1	<u>5</u> /

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TABLE V. End item tests (cont'd)

Characteristic	Requirement paragraph	Test method
Dynamic absorption (class 2):		
Initial	3.8.1	5500
After 15 launderings (cotton method)	3.8.1	5556 and 5500 <u>6/</u>
Spray rating (class 2):		
Initial	3.8.1	5526
Insect repellent treatment (class 4)	3.8.2	4.5.5
Nonfibrous material (classes 1 & 3)	3.8.3	2611 <u>1/</u>
pH	3.8.4	2811
Resistance to organic liquid (class 2):		
Initial	3.8.5	4.5.6
After 15 launderings (cotton method)	3.8.5	4.5.6 and 5556 <u>6/</u>
Dimensional stability	3.9	5556 and 4.4.3.1
Seam efficiency	3.10	5110 <u>7/</u>

- 1/ A certificate of compliance shall be submitted and will be acceptable for the stated requirement.
- 2/ The cotton content shall be calculated as follows:
- $$\text{Cotton content, percent} = \frac{R}{S} \times 100$$
- R = Weight of residual fibers  
S = Weight of dry desized specimen
- 3/ One determination shall be made from each sample unit and the result reported as "pass or fail".
- 4/ Only the stain on the nylon and cotton fibers of the color transfer cloth shall be evaluated and the stain shall be equal to or better than a rating of "fair".
- 5/ The contractor shall report the approved water repellent used, and certify that no other material (except the specified buffer and acetic acid) has been added.
- 6/ Specimens shall be subjected to 15 complete cycles (wash and dry) prior to determination of dynamic absorption and resistance to organic liquid after laundering.

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- 7/ The needle shall measure  $0.040 \pm 0.001$  inch across the blade at the eye. The thread for all types shall be cotton- or polyester-covered in accordance with A-A-50199, ticket no. 50, 2 or 3 ply for the needle and ticket no. 70, 2 or 3 ply for the looper.

4.4.3.1 Dimensional stability testing. In addition to the testing specified in 4.4.3, Method 5556 of FED-STD-191, the cloth shall not be pressed after tumble drying prior to measurement. The sample unit for testing dimensional stability shall be 2 continuous yards full width of the finished cloth. The sample size shall be in accordance with the following:

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

The lot average shall be determined by averaging the results of the sample units tested.

4.4.4 Packaging inspection. The inspection shall be in accordance with the quality assurance provisions of FED-STD-803.

#### 4.5 Methods of inspection.

4.5.1 Colorimetric measurements for the acceptability equation. Each of the four colors from the Woodland pattern cited in 3.4.4.1 for both the standard sample and the test specimen shall be measured as specified in 4.5.4, except the spectral reflectance factor data shall be obtained in the visible wavelength range 400 to 700 nanometers (nm) only, and at 20 nm (or less) intervals. When the spectrophotometer is operated in the polychromatic mode, a source simulating CIE illuminant source D65 should be used. Colorimetric data (see 6.10), computed from the resulting spectral reflectance data, shall be incorporated in the equation for acceptability (see 6.11) and the  $\Delta A$  values for each color shall be calculated. Specimens recording  $\Delta A$  values equal to or less than those specified for each color in 3.4.4.1 represent acceptable color matches to the standard. Any color having a  $\Delta A$  value greater than that specified in 3.4.4.1 shall be considered a shade matching failure.

4.5.2 Colorfastness evaluation test. When testing for colorfastness to laundering and perspiration, identical portions of the pattern in the submitted specimen and standard sample shall be selected for the test. Each individual shade in the pattern shall be evaluated and reported separately in accordance with the provisions of the applicable test method.

4.5.3 Colorfastness to crocking evaluation test. When testing for colorfastness to crocking, the individual section of the pattern shall be so



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selected that only the specific shade being evaluated is included in the test area of the submitted specimen as well as the standard. Individual shades in the pattern shall be evaluated and reported separately.

**4.5.4 Spectral reflectance test.** Spectral reflectance data shall be obtained from 600 to 860 nanometers (nm) for classes 1 and 2 and 700 to 860 nm for classes 3 and 4, on a spectrophotometer (see 6.5) 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 6.6). The spectral band width shall be less than 26 nm at 860 nm. Reflectance measurements shall be made by either the monochromatic or polychromatic mode of operation. When the polychromatic mode of operation is used, the spectrophotometer shall operate with the specimen diffusely illuminated with the full emission of a continuous source that simulates either CIE Source A or CIE Source D65. The specimen shall be viewed at an angle no greater than  $10^\circ$  from 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. 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 the selvage. The specimen shall be measured as a single layer backed with layers of the same fabric and shade. For classes 1 and 2 Woodland pattern cloth, three backing layers shall be used for Light Green 354, Dark Green 355 and Brown 356 colors. Two backing layers shall be used for Black 357. For classes 3 and 4 Desert pattern, the specimen shall be measured as a single layer backed with four layers of the same shade cut from the standard. When presented to the sample port, the specimen shall be oriented so that the reinforcement ribs in the filling direction are parallel with the horizontal plane. Measurements shall be taken on a minimum of two different areas 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 (classes 1 and 2) in table I, or the 3 color Desert pattern (classes 3 and 4) in table II, it shall be considered a test failure.

**4.5.5 Permethrin content analysis.** The permethrin content of treated fabric shall be determined by a gas chromatographic procedure and directly compared to an external standard containing a known permethrin content.

**4.5.5.1 Apparatus.**

**4.5.5.1.1 Gas chromatograph.** The gas chromatograph shall be equipped with an electron capture detector.

**4.5.5.1.1.1 Gas tank.** The gas tank shall contain an Argon/Methane (95 percent/5 percent) mixture and be equipped with an appropriate gas regulator.

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4.5.5.1.1.2 Glass column. The glass column shall be 6 feet by 1/8 inch inside diameter.

4.5.5.1.1.3 Column packing. The packing shall be 3.0 percent OV-225 on 10/120 mesh Gas Chrom Q (or equivalent).

4.5.5.1.1.4 GC septa.

4.5.5.1.2 10 microliter syringe.

4.5.5.1.3 Analytical balance.

4.5.5.1.4 Electrical heater with variable control.

4.5.5.1.5 Heat resistant glass flask. The glass flask shall be a 250 mL, flat bottom, single neck, heat resistant glass flask.

4.5.5.1.6 Soxhlet extractor.

4.5.5.1.7 Extractor condenser.

4.5.5.1.8 50 mL volumetric flask.

4.5.5.1.9 Graduated cylinder.

4.5.5.1.10 Funnel.

4.5.5.1.11 Pipettes.

4.5.5.1.12 Boiling chips.

4.5.5.2 Reagents.

4.5.5.2.1 Permethrin. The permethrin shall consist of 40 percent Technical, a minimum 35 percent (+) cis and a maximum 65 percent (+) trans.

4.5.5.2.2 Mixture. The mixture shall be of 80 percent 190 UV cutoff reagent grade acetonitrile and 20 percent reagent grade methanol.

4.5.5.3 Preparation.

4.5.5.3.1 Stock solution. Prepare a stock solution by weighing 1.250 g permethrin solution (see 4.5.5.2.1) to the nearest 1 mg into a 100 mL volumetric flask and dilute to volume with acetonitrile/methanol (80/20) (see 4.5.5.2.2). The stock solution shall then contain 500 mg permethrin.

4.5.5.3.2 Standard preparation. Place 1 mL of the stock solution into a 50 mL volumetric flask and dilute to volume with acetonitrile/methanol (80/20) (see 4.5.5.2.2). Two microliters (uL) of this standard shall then

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contain 200 ng permethrin. This amount is within the linear portion of the permethrin concentration x peak area standard curve performed under the gas chromatographic procedure described in 4.5.5.3.3 (the curve is linear from 0 - 400 ng permethrin).

4.5.5.3.3 Standard injection. Inject 2 uL of the standard solution into a gas chromatograph equipped with an electron capture detector. Use carrier gas containing 95 percent argon, 5 percent methane and a 6-foot by 1/8 inch I.D. glass column packed with 3 percent OV-225 on 100/120 mesh Gas Chrom Q or equivalent. Use the following gas chromatograph settings in the analysis:

- a. Oven temperature - 245°C
- b. Injector temperature - 255°C
- c. Detector temperature - 275°C
- d. Injection volume - 2 uL
- e. Carrier gas flow rate - 50 mL/minute
- f. Run time - 100 minutes

Repeat the standard injection three times and determine the average area for permethrin.

4.5.5.3.4 Test specimen. Three specimens, (3 inches by 4 inches (77.4 cm<sup>2</sup>)) shall be cut from the permethrin treated material.

4.5.5.3.5 Number of determinations. Unless otherwise specified in the procurement document, three specimens for each sample unit shall be tested.

4.5.5.4 Test procedure. Place each specimen into a Soxhlet extraction thimble. Add 160 mL of acetonitrile/methanol mixture and several boiling chips into a 250mL heat resistant flask. Assemble the Soxhlet extraction apparatus and extract the permethrin impregnated specimens for 6 hours. After 6 hours of extraction, concentrate the extract by heating in an electric heater to 50 mL in a volumetric flask. Inject 2 uL of the extract into a gas chromatograph using the conditions outlined in 4.5.5.3.3.

4.5.5.5 Calculations. The mg permethrin/cm<sup>2</sup> shall be calculated from the peak area of the gas chromatographic curve as follows:

$$\text{mg Permethrin/cm}^2 = \frac{W_s \times A_t \times V_E}{V_s \times A_s \times A_m}$$

Where:  $W_s$  = weight of injected standard in mg  
 $A_t$  = peak area of test specimen  
 $V_E$  = volume of specimen extract in uL  
 $V_s$  = volume of injected test specimen in uL  
 $A_s$  = peak area of standard  
 $A_m$  = test specimen area in cm<sup>2</sup>

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4.5.5.6 Report. The mg permethrin/cm<sup>2</sup> shall be reported as the mean of the values obtained for the sample and reported to the nearest 0.001 mg. The individual values of each specimen used to calculate the mean shall be reported to the nearest 0.001 mg.

NOTE: The conditions described in this method are optimum for the gas chromatograph employed. These conditions may vary depending on the gas chromatograph used.

4.5.6 Resistance to organic liquid test. Place a small specimen of the cloth on a smooth horizontal surface, face up. Using a pipette or eye dropper, gently deposit one drop of n-tetradecane on the surface of the specimen. After 1 minute, examine the specimen under light at an angle. Absence of light reflectance at the fabric-drop interface shall be taken as evidence of wetting. Three specimens (or areas) taken at various locations across the sample 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 in the contract or purchase order, shipments shall be marked in accordance with the 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 for use in woodland and desert camouflage pattern clothing.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Class of cloth required (see 1.2)

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- 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. Woodland or desert camouflage pattern drawing if required (see 3.5.).
- f. Width of cloth required (see 3.7.2).
- g. Length required if other than specified (see 3.11).
- h. 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 furnished. The contracting officer should also include specific instructions in all acquisition documents regarding arrangements for selection, inspection, and approval of the first article.

6.4 Sample. For access to samples, address the contracting activity issuing the invitation for bids or request for proposal.

6.5 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 D54P-IR, Applied Color Systems Spectro Sensor I & II and CS-5, Hunter VIS/NIR Spectrocolorimeter and Macbeth 1500 with IR options.

6.6 White standard. Barium sulfate of suitable quality for use as a white reference material 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.

6.7 Quarapel water repellent. The "Quarapel-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 responsibility of the U.S. Army Natick Research, Development and Engineering Center, Natick, MA 01760-5019, and is based on 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 Dye combinations.

6.8.1 Classes 1 and 2. Satisfactory printing on the 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

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combination of vat and sulfur dyes and with a combination of vat dyes. The areas of the woodland camouflage pattern have been found to be satisfactory when dyed or printed by the selection from among the following colorants:

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

6.8.2 Classes 3 and 4. The areas of the desert camouflage 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 Tan 492

Vat Green 8  
Vat Green 8 \* similar  
Vat Brown 1  
Vat Black 25  
Vat Brown 57  
Vat Yellow 2

Light Brown 493

Vat Green 8  
Vat Green 8 \* similar  
Vat Brown 1  
Vat Black 25  
Vat Brown 57  
Vat Yellow 2

Light Khaki 494

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

6.9 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.

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6.10 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<sub>65</sub> and the 1964 CIE 10° Supplementary Standard Colorimetric Observer. The tristimulus values are converted to CIE L\*a\*b\* for use in the acceptability equation (see 6.11). 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).

6.11 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  $\Delta A$  is an acceptability figure, scaled according to color (see 3.4.4.1); and the quantities  $\Delta a^*$ ,  $\Delta b^*$ ,  $\Delta L^*$  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  $a^*_0$  and  $b^*_0$  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:

$$\theta = \tan^{-1} (b^*_0/a^*_0)$$

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

$$2g_{12} = 2 \sin \theta \cos \theta [(1/c^2) - (1/h^2)]$$

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

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

Hue, Chroma and Lightness Tolerances for the  
Woodland Pattern, Nylon/Cotton, Poplin

	<u>Lightness (v)</u>	<u>Chroma (c)</u>	<u>Hue (h)</u>
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



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Specimens recording  $\Delta A$  values less than those listed for each color in 3.4.4.1 represent acceptable matches for color to the standard; those specimens with higher  $\Delta A$  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.

#### 6.12 Subject term (key word) listing.

Clothing  
Desert  
Insect repellent treated  
Permethrin  
Printed cloth  
Quarrel  
Water repellent treated  
Woodland

#### Custodian:

Army - GL

#### Preparing activity:

Army - GL

#### Review activities:

Army - MD  
DLA - CT

(Project 8305-A461)

# STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

## INSTRUCTIONS

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

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

<b>1. RECOMMEND A CHANGE:</b>	<b>1. DOCUMENT NUMBER</b> MIL-C-44436 (GL)	<b>2. DOCUMENT DATE (YYMMDD)</b> 1992 July 13
	<b>3. DOCUMENT TITLE</b> CLOTH, CAMOUFLAGE PATTERN, WIND RESISTANT POPLIN, NYLON/COTTON BLEND	
<b>4. NATURE OF CHANGE</b> (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)		

## 5. REASON FOR RECOMMENDATION

<b>6. PREPARING ACTIVITY</b>	<b>7. ORGANIZATION</b>
<b>a. NAME</b> U.S. Army Natick RD&E Center	<b>b. TELEPHONE (Include Area Code)</b> (1) Commercial 508-651-4532 (2) AUTOVON/DSN 256-4532

<b>c. ADDRESS (Include Zip Code)</b> Commander, U.S. Army Natick RD&E Center ATTN: STRNC-IRT Natick, MA 01760-5019	<b>IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT.</b> Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340
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