INCH-POUND

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SUPERSEDING
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MILITARY SPECIFICATION

CLOTH, CAMOUFLAGE PATTERN, WIND RESISTANT POPLIN, COTTON

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

1. SCOPE

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

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

Type III - Woodland Camouflage Pattern
Type IV - Woodland Camouflage Pattern, quarpel treated
Type V - Desert Camouflage Pattern (3 color)
Type VI - Desert Camouflage Pattern (3 color), permethrin treated
Type VII - Desert Camouflage Pattern (3 color), quarpel 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

Beneficial comments (recommendations, additions and 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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are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

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 and 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 1424 - Tear Resistance of Woven Fabrics by Falling-Pendulum (Elmendorf) Apparatus
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 unless otherwise indicated (see 3.4.3), shall 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, combed, drawn, spun, and twisted into 2-ply yarn for the warp and 2-ply or single yarn for the filling. Testing shall be as specified in 4.4.3.

3.4 Color.

3.4.1 Color, types III and IV. 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 three 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 (see 4.4.1.1).

3.4.2 Color, types V, VI, and VII. 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 two 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 (see 4.4.1.1).

3.4.3 Labile sulfur. The use of dyes and compounds containing elementary sulfur capable of oxidation to sulfuric acid is prohibited. The dyestuff shall be chosen and applied so that the dyed and printed finished cloth shall contain no more labile sulfur than shown by the standard sample when tested as specified in 4.4.3. When no standard sample is available, the finished cloth shall show no more than a slight trace of labile sulfur when tested as specified in 4.4.3.

3.4.4 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 ± 200 K, with illumination of 100 ± 20 foot candles, and shall be a good match to the standard sample under incandescent lamplight at 2300 ± 200 K.

3.4.4.1 Instrumental matching, types III and IV 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 6.5)

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 4.5.1.

Color	Maximum numerical tolerance for acceptability ΔA
Light Green 354	1.60
Dark Green 355	1.60
Brown 356	1.30
Black 357	1.00

3.4.5 Colorfastness, types III and IV. The Woodland Camouflage printed finished cloth shall meet the colorfastness requirements listed below when tested as specified in 4.4.3.

Colorfastness to:	Requirement, equal to or better than:
Laundering (after 3 cycles)	Standard sample or "good" 1/
Perspiration	Standard sample or "good"
Crocking	Standard sample 2/
Light (after 40 hours)	Standard sample or "good" 3/

1/ Except the fastness for Black 357 shall be not less than "fair".

2/ Or AATCC Chromatic Scale Ratings of not less than 3.5 for Light Green 354, Dark Green 355, and Brown 356, and not less than 1.0 for Black 357.

3/ Except the fastness for Light Green 354 shall be not less than "fair".

3.4.6 Colorfastness, types V, VI, and VII. The Desert Camouflage printed finished cloth shall meet the colorfastness requirements listed below when tested as specified in 4.4.3.

Colorfastness to:	Requirement, equal to or better than:
Laundering (after 3 cycles)	Standard sample or "good"
Perspiration	Standard sample or "good"
Crocking	Standard sample 1/

Colorfastness to:	Requirement, equal to or better than:
Light (after 40 hours)	Standard sample or "good"

1/ Or an AATCC Chromatic Scale Rating of not less than 3.5.

3.5 Pattern execution.

3.5.1 Pattern execution, types III and IV. 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 in any of the printed areas shall not be acceptable. The pattern repeat of the types III and IV printed finished cloth shall be 27.25 +1.25 -2.5 inches. When the standard sample is not referenced for pattern execution of types III and IV, a pattern drawing shall be provided and the pattern on the finished cloth shall match that of the drawing (see 6.2).

3.5.1.1 Printing screens or rollers, types III and IV. Screens or rollers shall conform to the required pattern Drawing 2-1-1516 for 48-inch width, and Drawing 2-1-1516B for 60-inch width fabric.

3.5.2 Pattern execution, types V, VI, and VII. The pattern shall reproduce the standard sample with 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 -2.25 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 2-1-2240 for types V, VI, and VII (see 2.1.2, 6.2, and 6.4).

3.6 Spectral reflectance.

3.6.1 Spectral reflectance, types III and IV. The spectral reflectance of each color for the Woodland 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, types III and IV

Wavelength nanometers	Values (percent) Light Green 354 Min	Light Green 354 Max	Dark Green 355 and Brown 356 Min	Dark Green 355 and Brown 356 Max	Black 357 Max
600	8	21	3	10	10
620	8	21	3	10	10

TABLE I. Spectral reflectance requirements, types III and IV (cont'd)

Wavelength nanometers	Light Green 354 Min	Light Green 354 Max	Dark Green 355 and Brown 356 Min	Dark Green 355 and Brown 356 Max	Black 357 Max
	Values (percent)				
640	8	21	3	10	10
660	8	22	3	12	10
680	10	27	3	16	10
700	13	40	4	18	10
720	16	53	5	20	10
740	21	64	7	28	10
760	27	73	11	36	10
780	34	80	17	44	10
800	41	85	24	52	10
820	48	88	32	60	10
840	50	90	39	68	10
860	52	91	46	74	10

3.6.2 Spectral reflectance, types V, VI, and VII. The spectral reflectance factors for Light Tan 492, Light Brown 493 and Light Khaki 494 for the three color camouflage pattern shall conform to the corresponding requirements specified in table II, when tested as specified in 4.4.3.

TABLE II. Spectral reflectance requirements, types V, VI, and VII

Wavelengths nanometers	Light Tan 492 (min)	Light Tan 492 (max)	Light Brown 493 (min)	Light Brown 493 (max)	Light Khaki 494 (min)	Light Khaki 494 (max)
	Reflectance values (percent)					
700	38	53	19	41	25	44
720	38	54	20	41	25	45
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 camouflage printed finished cloth shall conform to the requirements in table III when tested as specified in 4.4.3.

TABLE III. Physical requirements

Type	Wt. per sq. yd. Min. Ounces	Wt. per sq. yd. Max. Ounces	Yarns per inch minimum Warp	Yarns per inch minimum Filling	Breaking strength minimum Warp Pounds	Breaking strength minimum Filling Pounds	Tearing strength minimum Warp Pounds	Tearing strength minimum Filling Pounds	Air permeability (cu. ft/min/sq. ft.) max. ave.
III, V and VI	5.7	7.0	104	52	110	68	4.0	4.0	18.0
IV and VII	5.7	7.2	104	52	100	60	4.0	4.0	15.0

3.7.1 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).

3.7.2 Weave. The weave shall have reinforcement ribs in both the warp and the filling directions forming a uniform pattern. The warp repeat shall be 2 ends weaving as one in a plain weave manner with 23 ends weaving plain weave. The filling repeat shall be 2 picks weaving as one in a plain manner with 12 picks weaving plain weave. Testing shall be as specified in 4.4.3.

3.8 Finish. All types of cloth shall be thoroughly prepared, including singeing and mercerizing. The type IV and VII cloth shall be given a water repellent treatment as specified in 3.8.1 and the type VI cloth shall be given an insect repellent treatment as specified in 3.8.2.

3.8.1 Water repellency (type IV and VII). The type IV and VII 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 afterwashed to remove all unreacted reagents. Testing shall be as specified in 4.4.3.

TABLE IV. Water repellency (type IV and VII)

	Dynamic absorption, (percent) Max. Lot avg.	Max. 1/	Spray rating 2/
Initial	30	35	90, 90, 80
After 15 launderings	30	35	-

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 ratings when tested as specified in 4.4.3.

3.8.2 Insect repellency (type VI). The type VI cloth shall be given a permethrin insect repellent treatment in accordance with the industrial pad roll method specified in MIL-I-44411. The finished treated cloth shall contain 0.100 to 0.125 mg/cm^2 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 no lower than 5.0 nor higher than 8.5 when tested as specified in 4.4.3.

3.8.5 Resistance to organic liquid. The type IV and VII 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 in the filling of the finished cloth shall not be greater than 3 percent for the individual sample unit and not greater than 2.5 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. 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 full width rolls as specified in 5.1.

3.12 Fiber identification. Each roll of the 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 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 shall be tested for the characteristics specified in table IV.

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 resin bonded pigments have not been used (see 3.4) for printing the camouflage pattern.

4.4.1.2 In-process inspection. Prior to the application of the water repellent treatment to type IV and type VII or the insect repellent treatment to type VI, the cloth shall be tested for starch and protein content including chloroform-soluble and water-soluble material in accordance with Method 2611 of FED-STD-191. The sample unit shall be 1/4 yard of cloth full width. The lot shall be unacceptable if any sample unit fails to meet the requirement specified in 3.8.3. The sample size shall be in accordance with the following:

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

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, 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 6.9), "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 yarn normally used in the fabric. 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 3 inches or less 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
Pattern design not equal to 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 (types III and IV)
Pattern repeat less than 14.50 inches or more than 18.00 inches (types V, VI, and VII)
Skitteriness (mottled, uneven color) of pattern exceeds that shown by standard sample
Excessive feathering or spew (fuzziness at color boundries) 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 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. 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-to-yard examination, each roll in the sample 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:

The preshrinking process is identified by name or trademark on the cloth, ticket, or package.
Not labeled or ticketed in accordance with the Textile Fiber Products Identification Act.

4.4.3 End item testing. The cloth shall be tested for the characteristics listed in table V. The methods of testing specified in FED-STD-191 whenever 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 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:

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

TABLE V. End item tests

Characteristic	Requirement paragraph	Test method
Cotton identification	3.3.1	1200 1/
Combed cotton yarn	3.3.1	1/
Yarn ply	3.3.1	Visual 2/
Presence of labile sulfur	3.4.3	2020 1/
Colorfastness to:		
Laundering (after 3 cycles)	3.4.5 and 3.4.6	5610 and 4.5.2
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

TABLE V. End item tests (cont'd)

Characteristic	Requirement paragraph	Test method
Spectral reflectance:		
types III and IV	3.6.1	4.5.4
types V, VI, and VII	3.6.2	4.5.4
Weight	3.7	5041
Yarns per inch	3.7	5050
Breaking strength	3.7	ASTM D 5034
Tearing strength	3.7	ASTM D 1424
Air permeability	3.7	5450
Weave	3.7.2	Visual
Singeing	3.8	1/
Mercerization	3.8	Microscopic examination 1/
Water repellent treatment (types IV and VII)	3.8.1	3/
Dynamic absorption (types IV and VII):		
Initial	3.8.1	5500
After 15 launderings (cotton method)	3.8.1	5556 and 5500 4/
Spray rating (types IV and VII) (initial)	3.8.1	5526
Insect repellent treatment (type VI)	3.8.2	4.5.5
Nonfibrous material	3.8.3	2611 1/
pH	3.8.4	2811
Resistance to organic liquid (types IV and VII):		
Initial	3.8.5	4.5.6
After 15 launderings (cotton method)	3.8.5	4.5.6 and 5556 4/
Dimensional stability	3.9	4.4.3.1
Seam efficiency	3.10	5110 5/

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

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

3/ The contractor shall report the approved water repellent treatment used, and certify that no other material (except the specified buffer and acetic acid) has been added.

4/ Specimens shall be subjected to 15 complete cycles (wash and dry) prior to determination of dynamic absorption and resistance to organic liquid after laundering.

5/ The needle shall measure 0.040 ± 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, the cloth shall be tested for dimensional stability in accordance with Method 5550 of FED-STD-191. The sample unit shall be 2 continuous yards full width of the finished cloth. The sample size shall be in accordance with the following:

Lot size (yards)	Sample size (number of sample units)
10,000 or less	5
10,001 up to and including 35,000	8
35,001 and over	13

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 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 data, shall be incorporated in the equation of acceptability (see 6.11) and the A for each color shall be calculated. Specimens recording 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 A value greater than that specified in 3.4.4.1 shall be considered a test 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 shades of the pattern shall be so selected that only the specific shade being evaluated is included in the test area of the submitted specimen as well as of 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 types III and IV and 700 to 860 nm for types V, VI, and VII, on a spectrophotometer (see 6.5) relative to a barium sulfate standard, the prefered 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° 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 types III and IV 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 types V, VI, and VII 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 fill direction are parallel with the horizontal plane. Measurements shall be taken on a minimum of three 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 (types III and IV) in table I, and 3 color Desert pattern (types V, VI, and VII) 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.

4.5.5.1.1.2 Glass column. The glass column shall be 6 feet by 1/8 inch I.D.

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 of this standard shall then 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 microliters 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 microliters
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^2)) 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 250 mL 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^2 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^2

4.5.5.6 Report. The mg permethrin/cm^2 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 and 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, the 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 clothing.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of this specification.
b. Type of cloth 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 a first article is required (see 3.1, 4.3, and 6.3).
e. Woodland or desert camouflage pattern drawing if required (see 3.5.1 and 3.5.2).
f. Width required (see 3.7.1).
g. Minimum length 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 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 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 and 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 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.

6.7 Quarpel 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 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 a 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 Types III and IV. 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

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

Vat Orange 2
Vat Green 1
Vat Yellow 2

6.8.2 Types V, VI, and VII. 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.

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_{65} 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 ΔA is an acceptability figure, scaled according to color (see 3.4.4.1); 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^*_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:

$$0 = \tan^{-1}(b^*_0/a^*_0)$$

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

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

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

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

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

		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 3.4.4.1 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.

6.12 Subject term (key word) listing.

Clothing
Desert
Insect repellent, treated
Permethrin
Printed cloth
Quarpel
Water repellent treated
Woodland

6.13 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, GS

User activity:

Air Force - 45

Preparing activity:

Army - GL

(Project 8305-0447)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

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RECOMMEND A CHANGE:	1. DOCUMENT NUMBER	2. DOCUMENT DATE (YYMMDD)
	MIL-C-43468H	1992 March 31

3. DOCUMENT TITLE
CLOTH, CAMOUFLAGE PATTERN, WIND RESISTANT POPLIN, COTTON

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
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