

INCH-POUND

MIL-C-43842C  
11 June 1992  
SUPERSEDING  
MIL-C-43842B  
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## MILITARY SPECIFICATION

CLOTH, OXFORD, ARAMID

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

## 1. SCOPE

1.1 Scope. This specification covers flame resistant aramid oxford cloth.

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

Class 1 - Colored, aramid blend

Class 2 - Woodland camouflage printed, aramid blend

Class 3 - Desert camouflage printed (3 color), aramid blend

## 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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MIL-C-43842C

SPECIFICATIONS

MILITARY

MIL-T-44100 - Thread, Para-Aramid, Spun, Intermediate Modulus

STANDARDS

FEDERAL

FED-STD-4 - Glossary of Fabric Imperfections  
FED-STD-191 - Textile Test Methods  
FED-STD-802 - Packaging of Synthetic Fiber 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  
2-2-2240 - 3 Color Desert Pattern 48 & 60 inch pattern

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

FEDERAL TRADE COMMISSION

Rules and Regulations Under the Textile Fiber Products Identification Act

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

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the

MIL-C-43842C

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)

AATCC Method 16 - Colorfastness to Light: Option E - Water-Cooled Xenon-Arc Lamp, Continuous Light

Chromatic Transference Scale

(Application for copies should be addressed to the American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709-2215.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 5034 - Breaking Force and Elongation of Textile Fabrics (Grab Test)

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

3.3.1 Aramid fiber blend. The blend shall consist of 95 percent meta-aramid fiber and 5 percent para-aramid fiber. The fiber shall be 1.5

## MIL-C-43842C

denier per filament, and 1-1/2 to 2 inches in staple length. The fiber shall not char at a temperature less than 675°F. The fiber shall be spun into singles yarn for both the warp and the filling (see 6.5).

3.3.2 Conductive fiber. An approved conductive fiber (see 6.6) may be added to the aramid fiber blend to assist in meeting the electrostatic decay requirement specified in 3.8.1.

### 3.4 Color.

3.4.1 Class 1. The color of the finished cloth shall be Olive Green 106, Sage Green 1590, Tan 380, or other color as specified (see 6.2) and shall match the standard sample. The color shall be obtained by the use of producer colored fiber (see 6.8).

3.4.2 Class 2. The cloth shall be colored to a ground shade either matching or approximating Light Green 354, and subsequently overprinted with the applicable camouflage pattern. When the ground shade is colored to match the Light Green 354, the Woodland camouflage pattern shall be obtained by roller or screen printing using three rollers or screens, as appropriate for the Dark Green 355, Brown 356 and Black 357 areas of the pattern. If the ground shade is colored to approximate Light Green 354, four rollers or screens shall be used to match the required pattern. Resin bonded pigments are not permitted.

3.4.3 Class 3. The cloth shall be colored to a ground shade either matching or approximating Light Tan 492 and subsequently overprinted with the applicable Desert camouflage colors. When the ground shade is colored to match the Light Tan 492, the Desert Camouflage pattern shall be obtained by roller or automatic screen printing using two rollers or screens, as appropriate for the Light Brown 493 and Light Khaki 494 areas of the pattern. If the ground shade is colored to approximate the Light Tan 492 ground shade, three rollers or screens shall be used to match the required pattern. Resin bonded pigments are not permitted.

3.4.4 Visual matching. The color 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 (class 2 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 6.9) 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 ( $\Delta A$ ) listed below when measured as specified in 4.5.2.

## MIL-C-43842C

| <u>Color</u>    | <u><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.

3.4.5.1 Class 1. The finished cloth shall show fastness to laundering (after 3 cycles), light (after 6 standard fading hours when carbon arc is used and after 20 kilojoules per square meter when xenon is used) and perspiration equal to or better than the standard sample or equal to or better than a rating of "good". Testing shall be as specified in 4.4.3.

3.4.5.2 Classes 2 and 3. The finished cloth shall show fastness to laundering (after 3 cycles), light (after 6 standard fading hours when carbon arc is used and after 20 kilojoules per square meter when xenon is used) 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. The finished cloth shall show fastness to crocking equal to or better than the standard sample or shall show an AATOC Chromatic Transference Scale rating not lower than 3.5 for all the pattern areas except Black 357 (class 2) which shall show an AATOC Chromatic Transference Scale rating not lower than 1.5. Testing shall be as specified in 4.4.3.

3.5 Pattern execution, classes 2 and 3. The pattern 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 will not be acceptable. The pattern repeat of the class 2 Woodland camouflage printed finished cloth shall be 27.25 +1.25 -2.5 inches. The pattern repeat for class 3, 3 color Desert Camouflage printed finished cloth shall be 16.75 +1.25 -1.75 inches. When the standard sample is not available for pattern execution, a pattern drawing shall be provided, and the pattern on the finished cloth shall match that of the drawing (see 2.1.2 and 6.2).

3.6 Spectral reflectance.

3.6.1 Spectral reflectance, class 1, Sage Green 1590 and Tan 380. The spectral reflectance values for the visible/near infrared wavelength range 600 to 860 nanometers of the Sage Green 1590 and Tan 380 finished cloth shall conform to the requirements specified in table I when tested as specified in 4.4.3.

## MIL-C-43842C

TABLE I. Spectral reflectance requirements, class 1, Sage Green 1590 and Tan 380

| Wavelength,<br>Nanometers (nm) | Reflectance values (percent) |     |         |     |
|--------------------------------|------------------------------|-----|---------|-----|
|                                | Sage Green 1590              |     | Tan 380 |     |
|                                | Min                          | Max | Min     | Max |
| 600                            | 8                            | 13  | -       | -   |
| 620                            | 8                            | 13  | -       | -   |
| 640                            | 8                            | 13  | -       | -   |
| 660                            | 8                            | 13  | -       | -   |
| 680                            | 10                           | 18  | -       | -   |
| 700                            | 16                           | 28  | 25      | 53  |
| 720                            | 22                           | 40  | 25      | 54  |
| 740                            | 30                           | 51  | 25      | 55  |
| 760                            | 35                           | 61  | 26      | 56  |
| 780                            | 40                           | 70  | 27      | 57  |
| 800                            | 45                           | 77  | 28      | 58  |
| 820                            | 50                           | 81  | 30      | 59  |
| 840                            | 55                           | 82  | 33      | 62  |
| 860                            | 60                           | 82  | 36      | 65  |

3.6.2 Spectral reflectance, class 2. The spectral reflectance values for the visible/near infrared wavelength range 600 to 860 nanometers of the Woodland camouflage printed finished cloth shall conform to the requirements specified in table II when tested as specified in 4.4.3.

TABLE II. Spectral reflectance requirements, class 2

| Wavelength,<br>Nanometers (nm) | Reflectance values (percent) |     |                 |     |                                 |     |
|--------------------------------|------------------------------|-----|-----------------|-----|---------------------------------|-----|
|                                | Black 357                    |     | Light Green 354 |     | Dark Green 355<br>and Brown 356 |     |
|                                | Min                          | Max | Min             | Max | Min                             | Max |
| 600                            | -                            | 20  | 8               | 18  | 3                               | 10  |
| 620                            | -                            | 20  | 8               | 18  | 3                               | 10  |
| 640                            | -                            | 20  | 8               | 18  | 3                               | 10  |
| 660                            | -                            | 20  | 8               | 18  | 3                               | 12  |
| 680                            | -                            | 20  | 10              | 22  | 3                               | 14  |
| 700                            | -                            | 20  | 18              | 33  | 5                               | 18  |
| 720                            | -                            | 20  | 22              | 45  | 5                               | 25  |
| 740                            | -                            | 20  | 30              | 55  | 12                              | 28  |

## MIL-C-43842C

TABLE II. Spectral reflectance requirements, class 2 (cont'd)

| Wavelength,<br>Nanometers (nm) | Reflectance values (percent) |     |                 |     |                                 |     |
|--------------------------------|------------------------------|-----|-----------------|-----|---------------------------------|-----|
|                                | Black 357                    |     | Light Green 354 |     | Dark Green 355<br>and Brown 356 |     |
|                                | Min                          | Max | Min             | Max | Min                             | Max |
| 760                            | -                            | 20  | 35              | 65  | 18                              | 36  |
| 780                            | -                            | 20  | 40              | 75  | 26                              | 44  |
| 800                            | -                            | 25  | 43              | 80  | 34                              | 52  |
| 820                            | -                            | 25  | 45              | 86  | 36                              | 60  |
| 840                            | -                            | 25  | 45              | 88  | 36                              | 68  |
| 860                            | -                            | 25  | 45              | 90  | 36                              | 74  |

3.6.3 Spectral reflectance, class 3. The spectral reflectance of each color for the 3 color Desert Camouflage printed finished cloth shall conform to the requirements specified in table III, when tested as specified in 4.4.3.

TABLE III. Spectral reflectance requirements, class 3

| Wavelengths<br>nanometers | Reflectance values (percent) |       |                 |       |                 |       |
|---------------------------|------------------------------|-------|-----------------|-------|-----------------|-------|
|                           | Light Tan 492                |       | Light Brown 493 |       | Light Khaki 494 |       |
|                           | (min)                        | (max) | (min)           | (max) | (min)           | (max) |
| 700                       | 38                           | 65    | 19              | 53    | 25              | 62    |
| 720                       | 38                           | 66    | 20              | 58    | 25              | 64    |
| 740                       | 39                           | 67    | 20              | 62    | 25              | 66    |
| 760                       | 40                           | 67    | 21              | 64    | 26              | 67    |
| 780                       | 41                           | 67    | 21              | 65    | 27              | 67    |
| 800                       | 43                           | 67    | 22              | 65    | 28              | 67    |
| 820                       | 45                           | 67    | 23              | 66    | 30              | 68    |
| 840                       | 48                           | 68    | 24              | 67    | 33              | 68    |
| 860                       | 50                           | 70    | 25              | 68    | 36              | 69    |

3.7 Physical requirements. The physical requirements of the finished cloth shall be as specified in table IV when tested as specified in 4.4.3.

## MIL-C-43842C

TABLE IV. Physical requirements

| Characteristics   | Requirements |                 |
|---|--------------|-----------------|
|   | class 1      | classes 2 and 3 |
| Weight, oz./sq.yd.  | 5.6 - 6.0    | 6.0 - 6.6       |
| /   |              |                 |
| Yarns per inch (min.):  |              |                 |
| Warp  | 124          | 120             |
| Filling   | 46           | 45              |
| Breaking strength, lbs. (min.):                                   |              |                 |
| Warp  | 300          | 250             |
| Filling   | 100          | 90              |
| Air permeability, ft. <sup>3</sup> /min./ft. <sup>2</sup> (max.): |              |                 |
| Initial   | 15           | 40              |
| After 15 launderings  | 20           | 30              |
| Flame resistance, (max.):   |              |                 |
| After flame, seconds:   |              |                 |
| Initial   | 2.0          | 2.0             |
| After five launderings  |              | 2.0             |
| After glow, seconds:  |              |                 |
| Initial   | 25.0         | 25.0            |
| After five launderings  |              | 25.0            |
| Char length, inches:  |              |                 |
| Initial   | 3.5          | 3.5             |
| After five launderings  |              | 3.5             |

3.7.1 Weave. The weave shall be oxford (two ends weaving as one in the warp and a single pick in a shed).

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 looms with a tuck-in selvage 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).

3.7.3 Fabric break open. The flame from a meker burner shall not pass from the flame contact side to the other side of the fabric due to the fabric breaking open when tested as specified in 4.4.3.

3.8 Finishing. The cloth shall be desized, scoured, calendered on the back side and autoclaved. An approved antistatic finish (see 6.6) may be used to meet the electrostatic decay requirements specified in 3.8.1.



## MIL-C-43842C

3.8.1 Electrostatic decay. The finished cloth shall, when charged toward 5000 volts, reach a minimum level of 4000 volts and shall dissipate 90 percent of this charge within 1/2 second (decay time less than 1/2 second). The average warp results and the average filling results shall meet these requirements before and after five launderings when tested as specified in 4.4.3.

3.8.2 Nonfibrous material. Prior to the application of the finish, the cloth shall contain no more than 2.0 percent starch and protein including chloroform-soluble and water-soluble material when tested as specified in 4.4.3.

3.9 Quiling. The finished cloth shall lie flat, without distortion, and show no evidence of curling when tested as specified in 4.4.3.

3.10 pH. The pH value of the water extract of the finished cloth shall be not less than 4.0 nor more than 8.0 when tested as specified in 4.4.3.

3.11 Dimensional stability. The cloth shall not shrink more than 4.0 percent in the direction of the warp nor more than 2.0 in the direction of the filling, after 15 launderings when tested as specified in 4.4.3.

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

3.13 Length and put-up. For Government procurements only, unless otherwise specified (see 6.2), the finished cloth shall be furnished in continuous lengths each not less than 40 yards. Each length shall be put-up in full width rolls as specified in 5.1.

3.14 Face identification, class 1. The face side of the class 1 cloth shall be identified by applying a stamping on that side of the cloth with the word "Face" at each end of the roll.

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

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

## MIL-C-43842C

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

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

- a. First article inspection (see 4.3).
- b. Quality conformance inspection (see 4.4).

4.3 First article inspection. When a first article is required (see 3.1 and 6.2), it shall be examined for the defects specified in 4.4.2.1 thru 4.4.2.4 and tested for the characteristics 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.

## MIL-C-43842C

4.4.2 End item examination.

4.4.2.1 Yard-by-yard examination. Each roll in the sample shall be examined on the face side only. When the total yardage in the roll does not exceed 100 yards, the entire yardage in the roll shall be examined. When the total yardage in the roll exceeds 100 yards, only 100 yards shall be examined. All defects as defined in Section III 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 as follows:

a. Only coarse yarns that exceed twice the normal yarn diameter shall be scored.

b. Mixed filling (shade bar) shall be scored only when resulting from wrong ply, variation of twist in the yarn, or off shade yarn.

c. Only knots and slubs, which exceed limits shown on Sears Fabric Defect Scales (see 6.7) F or 2 as applicable for slubs and D for knots shall be scored.

No linear yard (increment 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 50 points. The lot shall be unacceptable if the points per 100 square yards of two or more individual rolls exceeds 75 points. If one roll exceeds 75 points per 100 square yards, a second sample of 20 rolls shall be examined only for individual roll quality. The lot shall be unacceptable if one or more rolls in the second sample exceeds 75 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  |

## MIL-C-43842C

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  
 Uneven weaving  
 Edge ravel when pulled outward  
 Slack or tight selvages <sup>1/</sup>  
 Overall uncleanness  
 Pattern design not equal to standard sample (classes 2 and 3)  
 Incorrect color in any part of the pattern (classes 2 and 3)  
 Pattern repeat not equal to the standard sample (classes 2 and 3)  
 Pattern repeat less than 24.75 inches or more than 28.5 inches  
 (class 2)  
 Pattern repeat less than 15.00 inches or more than 18.00 inches  
 (class 3)  
 Skitteriness (mottled, uneven color) of pattern exceeds that  
 shown by the standard sample (classes 2 and 3)  
 Excessive feathering or spew (fuzziness at color boundaries) of  
 pattern as compared to the standard sample (classes 2 and 3)  
 Excessive grinning (off register, gap where ground shade shows  
 through) of pattern as compared to the standard sample  
 (classes 2 and 3)  
 Excessive haloing or trapping (overlapping of colors) of pattern  
 as compared to the standard sample (classes 2 and 3)

- 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 or ripples within the body of the cloth is an indication of slack or tight selvage.

4.4.2.2 Length examination. During the yard-by-yard examination, each roll in the sample shall be examined for length. Any length found to be less than the minimum specified or more than 2 yards less than the length marked on the ticket shall be considered a defect with respect to length. The lot shall be unacceptable if two or more rolls in the sample are defective with respect to length or if the total of the actual lengths of rolls in the sample is less than the total of the lengths marked on the tickets.

4.4.2.3 Shade and appearance examination. During the yard-by-yard examination, each roll in the sample shall be examined for shade and appearance on the face side. The lot shall be unacceptable if two or more rolls (class 1) are off shade, shaded side to side, shaded side to center, or shaded end to end; if any roll (classes 2 and 3) fails to match the standard

## MIL-C-43842C

sample with respect to color for all pattern areas; or if any roll (all classes) does not have the same appearance as the standard.

4.4.2.4 Roll identification examination. During the yard-by-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:

Face identification missing from either or both ends (class 1 only)  
 Face identification on wrong side (class 1 only)  
 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 applicable characteristics indicated in table V. The methods of testing specified in FED-STD-191, wherever applicable, and as listed in table V shall be followed. The physical and chemical values specified in section 3, except where otherwise specified, apply to the results of the determinations made on the sample unit for test purposes as specified in the applicable test method. The sample unit shall be 5 continuous yards full width of the finished cloth, 1/4 yard full width of the cloth prior to the application of the finish for determination of nonfibrous materials, and 1/2 yard of the finished cloth carefully wrapped on a tube for the air permeability test. The lot shall be unacceptable if one or more sample units fail to meet any test requirement specified. 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                                 |

TABLE V. End item tests

| <u>Characteristic</u>    | <u>Requirement paragraph</u> | <u>Test method</u> |
|--------------------------|------------------------------|--------------------|
| Material identification: |                              |                    |
| Aramid:                  |                              |                    |
| Blend                    | 3.3.1                        | <u>1/</u>          |
| Denier                   | 3.3.1                        | <u>1/</u>          |
| Staple length            | 3.3.1                        | Visual <u>2/</u>   |
| Non-charring             | 3.3.1                        | <u>1/</u>          |
| Yarn ply                 | 3.3.1                        | Visual <u>2/</u>   |
| Conductive fiber         | 3.3.2                        | <u>1/</u>          |

## MIL-C-43842C

TABLE V. End item tests (cont'd)

| Characteristic              | Requirement paragraph | Test method             |
|-----------------------------|-----------------------|-------------------------|
| Colorfastness to:           |                       |                         |
| Class 1:                    |                       |                         |
| Laundering (after 3 cycles) | 3.4.5.1               | 5610 <u>3/</u>          |
| Light                       | 3.4.5.1               | 5660 <u>4/</u> or 4.5.5 |
| Perspiration                | 3.4.5.1               | 5680                    |
| Classes 2 and 3:            |                       |                         |
| Laundering (after 3 cycles) | 3.4.5.2               | 5610                    |
| Light                       | 3.4.5.2               | 5660 <u>4/</u> or 4.5.5 |
| Perspiration                | 3.4.5.2               | 5680                    |
| Crocking                    | 3.4.5.2               | 5651                    |
| Spectral reflectance        | 3.6                   | 4.5.1                   |
| Weight                      | 3.7                   | 5041                    |
| Yarns per inch              | 3.7                   | 5050                    |
| Breaking strength           | 3.7                   | ASTM D 5034             |
| Air permeability            | 3.7                   | 5450                    |
| Flame resistance:           |                       |                         |
| Initial                     | 3.7                   | 5903                    |
| After five launderings      | 3.7                   | 5556 and 5903           |
| Weave                       | 3.7.1                 | Visual <u>2/</u>        |
| Fabric break open           | 3.7.3                 | 4.5.3                   |
| Electrostatic decay:        |                       |                         |
| Initial                     | 3.8.1                 | 5931                    |
| After five launderings      | 3.8.1                 | 5556 and 5931           |
| Nonfibrous material         | 3.8.2                 | 2611                    |
| Curling                     | 3.9                   | 4.5.4                   |
| pH                          | 3.10                  | 2811                    |
| Dimensional stability       |                       |                         |
| after 15 launderings        | 3.11                  | 5556 <u>5/</u>          |
| Seam efficiency             | 3.12                  | 5110 <u>6/</u>          |

- 1/ Unless otherwise specified, a certificate of compliance shall be submitted and will be acceptable for the stated requirements.
- 2/ One determination shall be made from each sample unit and the results reported as "pass" or "fail".
- 3/ Except that the specimen shall be evaluated for color change only.
- 4/ Except that the specimen shall be compared with the standard sample after 6 standard fading hours and evaluated.
- 5/ Cotton laundering procedures.

## MIL-C-43842C

6/ The needle shall measure 0.044 inch across the blade at the eye. The thread for the needle shall be size T-50 and the thread for the looper shall be size T-35 of MIL-T-44100.

4.4.4 Packaging inspection. The inspection of the preservation, packing and container marking shall be made in accordance with the quality assurance provisions of FED-STD-802.

4.5 Methods of inspection.

4.5.1 Spectral reflectance measurements in the visible/near infrared. Spectral reflectance data shall be obtained from 600 to 860 nanometers (nm) for the Woodland camouflage colors and Sage Green 1590, and from 700 to 860 (nm) for Tan 380 and for the 3 Color Desert Camouflage color at 20 nm intervals on a spectrophotometer (see 6.9) 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 6.10). The spectral bandwidth shall be less than 26 nm at 860 nm. Reflectance measurements may be made by either the monochromatic or polychromatic mode of operation. When polychromatic mode is used, the spectrophotometer shall operate with the specimen diffusely illuminated with the full emission of a source that simulates either CIE Source A or CIE Source D65. The specimen shall be 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 shall be lightly marked with a circle, at least 1.50 inches in diameter on the reverse side of the fabric, and at least 6 inches from either selvage. The specimen shall be measured as a single layer backed by layers of the same fabric and shade. Eight backing layers shall be used for Sage Green 1590 and Tan 380 and for the 3 Color Desert Camouflage colors, Light Tan 492, Light Brown 493, and Light Khaki 494. Five backing layers shall be used for Light Green 354, Dark Green 355, and Brown 356 colors. Three backing layers shall be used for Black 357. Measurements will be taken on a minimum of two different areas for all classes and shades and the values averaged. When measured spectral reflectance values for any color do not meet the requirement specified in tables I, II or III at four or more wavelengths, it shall be considered a test failure.

4.5.2 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 4.5.1 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

## MIL-C-43842C

(see 6.12), computed from the resulting spectral reflectance data, shall be incorporated in the equation for acceptability 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.

4.5.3 Fabric break open test. The specimen shall be rigidly held in a horizontal position between two metal plates with a 6-inch diameter fabric exposure. One side of the fabric shall be exposed to a meker burner in the center at a 90 degree angle using natural gas for 30 seconds with 2-inches distance between fabric and burner top. Proper flame adjustment shall be accomplished by setting the needle valve at the midpoint between the open and closed positions and adjusting the gas by means of a flow meter to 2 liters per minute. This test procedure shall not apply to natural color, undyed aramid fabric.

4.5.4 Curling. Two specimens of cloth, 1-1/2 inches wide by 6 inches long shall be cut, one having the long dimension parallel to the warp and the other with the long dimension parallel to the filling. Both specimens shall be placed on a flat surface for at least 5 minutes and then visually examined for evidence of curling.

4.5.5 Colorfastness to light (xenon lamp exposure). The following xenon colorfastness to light test method may be used as an alternative to method 5660 of FED-STD-191. The test procedure shall be in accordance with AATCC Method 16 Option E (Water cooled, Continuous light cycle) except that the following deviations shall apply:

- a. The test apparatus shall be an Atlas ci35 or ci65 Fadeometer with either two or three-tiered (preferably a three-tiered) inclined specimen rack. The apparatus shall be equipped with an automatic light monitor and shall be capable of automatically controlling irradiance, temperature, and humidity. The apparatus shall be maintained in accordance with the manufacturer's recommendations.
- b. The irradiance level shall be  $0.55 \pm 0.01$  watt/square meter/nanometer ( $w/m^2/nm$ ) bandpass at 340 nanometers.
- c. The glass filter combination shall be a borosilicate Type "S" inner and outer filter.
- d. The relative humidity shall be  $50 \pm 5$  percent during the entire cycle.
- e. The equipment shall be operated to maintain the following tolerances:



## MIL-C-43842C

|                                   |          |
|-----------------------------------|----------|
| Black Panel                       | 63 ± 2°C |
| Conditioning water                | 50 ± 4°C |
| Dry Bulb                          | 45 ± 2°C |
| Wet Bulb depression $\frac{1}{2}$ | 10°C     |

$\frac{1}{2}$  As a guide only; adjust to achieve required relative humidity (see d. above).

f. The test specimen and the AATCC Blue Wool Lightfastness Standard shall be mounted on white cardboard. When mounted test specimen are masked, use test mask approaching zero light transmittance.

g. The test shall be continued until the energy exposure is equal to 20 kilojoules per square meter.

NOTE: Monitoring of the dry bulb temperature, wet bulb depression, irradiance, and black panel temperature is recommended through the use of chart recorders.

## 5. PACKAGING

5.1 Put-up and packaging. 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-802.

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-802.

5.3 Marking. In addition to any special marking required by the contract or purchase order, shipments shall be marked in accordance with the applicable requirements of FED-STD-802.

## 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 body armor vests, aircraft seat cushion covers, armored vehicle crewmen's cold weather coveralls, and aircrew flying jackets.

## MIL-C-43842C

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).
- c. Issue of DODISS to be cited in the solicitation, and if required, the specific issues 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. Color required when class 1 is specified (see 3.4.1)
- f. Pattern drawing if required (see 3.5).
- g. Width of cloth required (see 3.7.2).
- h. Length required if other than specified (see 3.13).
- i. Levels of preservation and packing (see 5.1 and 5.2).

6.3 First article. When a first article is required, it shall be inspected and approved under the appropriate provisions of FAR 52.209-4. The first article should be a preproduction sample. The contracting officer should specify the appropriate type of first article and the number of units to be furnished. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for selection, inspection, and approval of the first article.

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

6.5 Yarn. Cloth woven with 22/1 yarn has been found to meet the class 1 requirements of this specification.

6.6 Antistatic properties. The approval of the antistatic treatment and conductive fibers is the responsibility of the 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 and fibers already approved will be acceptable for the related procurements. Information pertaining to approval of new treatments and fibers should be obtained from the U.S. Army Natick Research, Development and Engineering Center. The list of approved treatments and conductive fibers may be obtained from the contracting activity.

6.6.1 Electrostatic decay. The requirement for electrostatic decay may be accomplished by the use of a conductive fiber, an antistatic finish or a combination of both. It should be noted that low blend levels of conductive fiber alone (such as 1.0 percent by weight) may not be sufficient to meet the electrostatic decay requirement of this specification.

## MIL-C-43842C

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

6.8 Colors. Colors available for class 1 cloth include Sage Green 1590, Olive Green 106, Navy Blue 3374, Royal Blue 3375, and Tan 380.

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

6.10 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.

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

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

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

where  $\Delta A$  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:

## MIL-C-43842C

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

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

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

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

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

## Hue, Chroma and Lightness Tolerances for the Woodland Pattern

|                 | <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           |

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.

6.13 Subject term (key word) listing.

Aircrew  
 Antistatic  
 Body armor  
 Camouflage  
 Flame resistant  
 Woodland pattern

6.14 Changes from previous issue. Due to the extensiveness of the changes, asterisks are not used in this revision to identify changes with respect to the previous issue.

MIL-C-43842C

Custodians:

Army - GL  
Navy - NU  
Air Force - 99

Preparing activity:

Army - GL  
(Project 8305-0456)

Review activities:

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

User activities:

Navy - MC

