

**PURCHASE DESCRIPTION**

**UNIFORM, ENHANCED FLAME RESISTANT COMBAT ENSEMBLE (EFRCE)  
BLOUSE AND TROUSER**

**1. SCOPE**

1.1 Scope. This document covers the requirements for the enhanced flame resistant combat ensemble (EFRCE), blouse and trouser. The uniform is used to provide flame resistance protection needed for wear in field and combat operations.

1.2 Classification

1.2.1 Cloth. The cloth shall be of the following types as specified (see 6.2).

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|-----------------|--|
| Cloth, Type I   | - Woven, Woodland, Marine Corps Pattern (MARPAT)<br>Camouflage Printed       |
| Cloth, Type II  | - Woven, Desert, MARPAT Camouflage Printed                                   |
| Cloth, Type III | - Woven, Navy Working Uniform (NWU) II, Desert Digital<br>Camouflage Printed |
| Cloth, Type IV  | - Woven, NWU III, Woodland Digital Camouflage Printed                        |
| Cloth, Type V   | - Knit, Coyote, Solid (All Uniform Types)                                    |

Comment, suggestions, or questions on this document should be addressed to: Marine Corps Systems Command, Program Manager Marine – 113, Product Manager – Infantry Combat Equipment, Clothing Team, 2200 Lester Street, Quantico, VA 22134

AMSC N/A

FSC 8415

**GOVERNMENT INTELLECTUAL PROPERTY AND TRADEMARK RIGHTS NOTIFICATION:**

This notice is to advise you that the Government possesses intellectual property/trademark rights in the following Marine Corps patterns and logos (hereafter collectively referred to as “intellectual property”): The Eagle, Globe and Anchor (EGA) logo, including the EGA logo as it appears embedded in the fabric pattern. The Government further has title to the invention disclosed and claimed in United States Design Patent No. D491,372 issued on 15 June 2004 for “Camouflage Pattern for Sheet Material and Uniforms.” The Government claims exclusive ownership of the above mentioned intellectual property. Therefore, no entity other than the Government, or those contracted by or having obtained proper permission or licenses from the Government to do so, are permitted to produce, sell, or transfer in any manner any items (clothing or non-clothing) containing or copying, in whole or in part, the intellectual property. Doing so will be considered an infringement on the Government’s intellectual property rights and will be subject to legal action.

1.2.2 Garment Classification. The blouse and trouser shall be of the following types and sizes as specified (see 6.2).

Class 1, Type I	EFRCE Blouse and Trouser, Woodland MARPAT, with Durable Insect Protection
Class 1, Type II	EFRCE Blouse and Trouser, Desert MARPAT, with Durable Insect Protection
Class 2, Type III	EFRCE Blouse and Trouser, NWU II Desert Digital Camouflage Printed, with Durable Insect Protection
Class 2, Type IV	EFRCE Blouse and Trouser, NWU III Woodland Digital Camouflage Printed, with Durable Insect Protection

1.2.2.1 Schedule of Sizes. The blouse and trousers shall be constructed in the following sizes (see 6.2)

**SCHEDULE OF SIZES – BLOUSE**

X-Small	Small	Medium	Large	X-Large	XX-Large
	XX-Short	XX-Short			
X-Short	X-Short	X-Short	X-Short		
Short	Short	Short	Short	Short	
Regular	Regular	Regular	Regular	Regular	Regular
	Long	Long	Long	Long	Long
	X-Long	X-Long	X-Long	X-Long	X-Long
		XX-Long	XX-Long		XX-Long

**SCHEDULE OF SIZES – TROUSERS**

X-Small	Small	Medium	Large	X-Large	XX-Large
X-Short	X-Short	X-Short			

Short Regular Long	Short Regular Long X-Long	Short Regular Long X-Long XX-Long	Regular Long X-Long XX-Long	Regular Long X-Long	Regular Long X-Long XX-Long
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## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4 or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4 and 5 of this specification, whether or not they are listed.

### 2.2 Government documents.

2.2.1 Government 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 cited in the solicitation or contract.

#### FEDERAL STANDARDS

FED-STD -4B	Glossary of Fabric Imperfections
FED-STD-595C	Colors Used in Government Procurement

#### COMMERCIAL ITEM DESCRIPTIONS

A-A-55126	Fastener Tapes, Hook and Loop, Synthetic
A-A-55195	Thread: Para-Aramid, Spun, Intermediate Modulus
A-A-55217B	Thread, Aramid, Spun Staple
A-A-55634	Zippers (Fasteners, Slide Interlocking)

#### DEPARTMENT OF DEFENSE SPECIFICATIONS

DPSCM 4155.3	Quality Systems Requirements
MIL-DTL-44411	Insect Repellent, Permethrin
MIL-W-5664D	Webbing, Textile, Elastic

(Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Bldg. 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent

specified herein. Unless otherwise specified, the issues are those specified in the solicitation or contract.

<b>Drawing Number</b>	<b>Drawing Description</b>	<b>Drawing Date</b>
2-1-2525	Woodland MARPAT- 4 color (Coyote 476)	12-Jul-2004
2-1-2526	Woodland MARPAT- 4 color (Green 474 with EGA symbol)	12-Jul-2004
2-1-2527	Woodland MARPAT- 4 color (Black 477)	12-Jul-2004
2-1-2528	Woodland MARPAT- 4 color (Khaki 475)	12-Jul-2004
2-1-2529	Desert MARPAT- 4 color (Light Tan 479)	12-Jul-2004
2-1-2530	Desert MARPAT- 4 color (Urban Tan 478)	12-Jul-2004
2-1-2531	Desert MARPAT- 4 color (Light Coyote 481 with EGA symbol)	12-Jul-2004
2-1-2532	Desert MARPAT- 4 color (Highland 480)	12-Jul-2004
2-1-2533	Woodland MARPAT- 3 color (Coyote 476)	12-Jul-2004
2-1-2534	Woodland MARPAT- 3 color (Green 474)	12-Jul-2004
2-1-2535	Woodland MARPAT- 3 color (Khaki 476)	12-Jul-2004

(Copies of drawings are available from the U.S. Army Research, Development & Engineering Command, Natick Soldier Center, Natick, MA 01760)

Commercial US Governmentally Controlled Performance Specification Camouflage Print Performance Specification for AOR 1, AOR 2, NWU II, and NWU III.

(Copies are available from Program Manager – Special Operations Forces (SOF) Survival, Support and Equipment Systems, Natick Soldier Center, Natick, MA 01760.)

#### CODE OF FEDERAL REGULATIONS

- Title 40, part 798.4500 (Primary Eye Irritation)
- Title 40, part 798.4100 (Dermal Sensitization)
- Title 40, part 798.4470 (Primary Dermal Irritation)

#### TEXTILE FIBER PRODUCTS IDENTIFICATION ACT

(Applications for copies should be addressed to U.S. Government Printing Office, Superintendent of Documents, Mail stop: SSOP, Washington, DC 20402-9328, or this reference may be found on the Internet at [www.access.gpo.gov/nara/cfr/cfr-table-search.html](http://www.access.gpo.gov/nara/cfr/cfr-table-search.html).)

#### ENVIRONMENTAL PROTECTION AGENCY (EPA):

FEDERAL INSECTICIDE, FUNGICIDE AND RODENTICIDE ACT (FIFRA)  
 FIFRA as amended by the Food Quality Protection Act of 1996 and the Pesticide Registration Improvement Act of 2003.

EPA Product Performance Test Guidelines OPPTS 810.370  
 Insect Repellents for Human Skin and Outdoor Premises

(Copies of these documents are available online at <http://www.epa.gov> or from the U.S. Government Printing Office, Washington, DC 20402, telephone (202)-512-0132)

## US DEPARTMENT OF AGRICULTURE (USDA)

### Bite Protection Test Methodology, Enhanced Flame Resistant Combat Ensemble

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those specified in the solicitation or contract (see 6.2).

## AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS

AATCC 8	Colorfastness to Crocking: AATCC Crockmeter Method
AATCC 15	Colorfastness to Perspiration
AATCC 16.2	Colorfastness to Light: Carbon-Arc
AATCC 16.3	Colorfastness to Light: Xenon-Arc
AATCC 20A	Fiber Analysis: Quantitative
AATCC 61	Colorfastness to Laundering, Home and Commercial: Accelerated
AATCC 81	pH of the Water Extracted from Wet Processed Textiles
AATCC 96	Dimensional Changes in Commercial Laundering of Woven and Knitted Fabrics Except Wool
AATCC 100	Antibacterial Finishes on Textile Materials: Assessment of
AATCC 135	Dimensional Changes of Fabrics after Home Laundering Evaluation Procedure 9 Visual Assessment of Color Difference of Textiles

(Copies should be obtained from the American Association of Textile Chemists and Colorists, PO Box 12215, Research Triangle Park, NC 27709-2215.)

## AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM D76	Standard Specification for Tensile Testing Machines for Textiles
ASTM D737	Standard Test Method for Air Permeability of Textile Fabrics
ASTM D1424	Standard Test Method for Tearing Strength of Fabrics by Falling Pendulum Type (Elmendorf) Apparatus
ASTM D2256	Standard Test Method for Tensile Properties of Yarns by the Single-Strand Method
ASTM D3511	Standard Test Method for Pilling Resistance and Other Related Surface Changes of Textile Fabrics: Brush Pilling Tester
ASTM D3776	Standard Test Method for Mass Per Unit Area (Weight) of Fabric
ASTM D3787	Standard Test Method for Bursting Strength of Textiles Constant Rate of Travers (CRT) Ball Burst Test
ASTM D5034	Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)

<b>ASTM D6193</b>	<b>Standard Practice for Stitches and Seams</b>
ASTM D6413	Standard Test Method for Flame Resistance of Textiles (Vertical Test)
ASTM E96	Standard Test Methods for Water Vapor Transmission of Materials
ASTM F1930	Standard Test Method for Evaluation of Flame Resistant Clothing for Protection Against Fire Simulations Using an Instrumented Manikin

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

#### MISCELLANEOUS

NFPA 1971	Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting
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(Copies should be obtained from **Customer Sales/Member Services**, [custserv@nfpa.org](mailto:custserv@nfpa.org), 1-800-344-3555 or 1-617-770-3000).

ANSI/ASCQ Z1.4	Sampling Procedures and Tables for Inspection of Attributes
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(Copies should be obtained from [www.ansi.org](http://www.ansi.org) or from the American National Standards Institute, 1819 L Street, 6<sup>th</sup> floor, Washington, DC.)

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

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

Marzulli, F. and H. Maibach, "Contact Allergy: Predictive Testing in Humans,"  
Advances in Modern Toxicology, Volume 4, pp 353-372, 1977.

(Applications for copies should be addressed to U.S. Army Center for Health Promotion and Preventative Medicine, Attn: MCHB-DC-TTE, Bldg. E-2100, Aberdeen Proving Grounds, MD 21010-5422.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, 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 4.2.

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

3.3 Material.

3.3.1 Basic material.

3.3.1.1 Basic material, woven. The base material for construction of the blouse sleeves/chest and trouser shall consist of a flame resistant cotton/nylon/meta-aramid twill cloth conforming to Milliken style ResQ II 6.7 oz/sq yd or equal (see 6.4). The weave shall be twill. Fabric shall be printed with the appropriate camouflage pattern (as specified in the solicitation), and conform to the requirements as specified Table 1.

**TABLE I. Material Requirements for Cloth, Woven**

<b>CHARACTERISTIC</b>	<b>REQUIREMENT</b>	<b>TEST METHOD</b>
Weight, ounces per square yard	6.4 – 7.1	ASTM D3776
Fiber content	See 3.3.1.1	AATCC 20A
Weave	See 3.3.1.1	Visual
Breaking Strength, pounds (min), Initial (no laundering) Dry Warp Fill Wet Warp Fill	  165 150  140 125	  ASTM D5034
Breaking Strength, pounds (min), After 25 Laundering Cycles Dry Warp Fill Wet Warp Fill	  150 150  140 125	  ASTM D5034, AATCC 135 <u>1</u> /
Tear Strength, pounds (min) Initial (no laundering) and after 25 Laundering Cycles Dry Warp Fill Wet Warp	  12 16  12	  ASTM D1424, AATCC 135 <u>1</u> /

CHARACTERISTIC	REQUIREMENT	TEST METHOD
Fill	16	
Air Permeability, cfm (min)	20	ASTM D737
Colorfastness (min) Laundering (after 4 cycles) Light (40 hours or 170 kilojoules)	4-5 4	AATCC 61 Test 1A AATCC 16.2 Option 1 or AATCC 16.3 Option 2
Perspiration (acid and alkaline)	4-5 (color change) 4-5 (staining)	AATCC 15
Crocking	4 (dry) <u>3/</u> 3 (wet) <u>3/</u>	AATCC 8
Dimensional Stability, Commercial Laundering 5 cycles (max) Warp Fill	5.0% 5.0%	AATCC 96
Drying Time, minutes (max)	90	Internal Method <u>2/</u>
Moisture Vapor Transmission, per square meter per 24 hours (min)	1000	ASTM E96 Test B
Pilling Appearance after 5 Laundering Cycles (min)	3	ASTM D3511, AATCC 96 <u>4/</u>
Thermal Protective Performance, cal/cm <sup>2</sup> (min) with spacer	10	NFPA 1971
Thermal Shrinkage (max) (warp and fill)	10%	NFPA 1971
Vertical Flame, Initial After Flame, seconds (max) Char Length, inches (max) Melt/Drip	2 5 None	ASTM D6413
Vertical Flame, After 25 Laundering Cycles After Flame, seconds (max) Char Length, inches (max) Melt/Drip	2 5 None	ASTM D6413 AATCC 135 <u>1/</u>

1/ Launder according to AATCC 135, 3, V, Aiii.

2/ See 4.4.5.7

3/ Finished cloth shall show fastness to crocking equal to or better than 4 (dry) and 3 (wet) for all colors, except Black which shall have a rating not lower than 1.5.

4/ Launder according to AATCC 96 Vic, Drying: A, except no pressing is performed after drying.

3.3.1.2 Basic material, knit. The basic material for the blouse torso shall be a meta-aramid/flame resistant rayon/nylon/para-aramid knit fabric conforming to SSM Industries Sigma 4 Star Knit Style SD-1883.00 or equal (see 6.4). The knit shall be a jersey knit and dyed to coyote color 498, and conform to the requirements as specified in Table II.

**TABLE II. Material requirements for Cloth, Knit**

CHARACTERISTIC	REQUIREMENT	TEST METHOD
Weight, ounces per square yard	5.3 – 6.3	ASTM D3776

CHARACTERISTIC	REQUIREMENT	TEST METHOD
Fiber content	See 3.3.1.2	AATCC 20A
Knit construction	See 3.3.1.2	Visual
Bursting Strength, pounds (min) Initial (no laundering) and after 25 Laundering Cycles Dry Wet	100 75	ASTM D3787, AATCC 135 <u>1/</u>
Air Permeability, cfm (min)	200	ASTM D737
Antimicrobial properties Initial (no laundering) and after 25 Laundering Cycles	1-log reduction	AATCC 100 <u>1/</u> & <u>2/</u>
Dimensional Stability, Commercial Laundering 5 cycles (max) Warp Fill	8.0% 8.0%	AATCC 96
Drying Time, minutes (max)	90	Internal Method <u>3/</u>
Colorfastness Laundering (after 4 cycles) Light (40 hours or 170 kilojoules)  Perspiration (acid and alkaline)  Crocking	4 4  4-5 (color change) 4-5 (staining) 4 (dry) 4 (wet)	AATCC 61 Test 1A AATCC 16.2 Option 1or AATCC 16.3 Option 2  AATCC 15  AATCC 8
Moisture Vapor Transmission, per square meter per 24 hours (min)	1800	ASTM E96 Test B
Pilling Appearance after 5 Laundering Cycles (min)	3	ASTM D3511, AATCC 96 <u>4/</u>
Thermal Protective Performance, cal/cm <sup>2</sup> (min) with spacer	8	NFPA 1971
Vertical Flame After Flame, seconds (max) Char Length, inches (max) Melt/Drip	2 5 None	ASTM D6413
Vertical Flame, After 25 Laundering Cycles After Flame, seconds (max) Char Length, inches (max) Melt/Drip	2 5 None	ASTM D6413, AATCC 135 <u>1/</u>

1/ Launder according to AATCC 135, 3, V, Aiii.

2/ See 3.3.15 and clarification in 4.4.5.9.4

3/ See 4.4.5.7

4/ Launder according to AATCC 96 Vic, Drying: A, except no pressing is performed after drying.

3.3.1.3 **Fiber Content (all types).** The fibers for all fabric types shall be made of virgin material and the use of recycled or recovered materials is prohibited. The contractor shall keep this information on file for the duration of the contract.

3.3.1.4 Fiber and fabric identification. Each roll of finished cloth shall be labeled or ticketed for fiber content in accordance with the Rules and Regulations under the Textile Fiber Products Identification Act. Each roll shall indicate cloth type and class.

3.3.1.5 Physical requirements (all classes). The cloth shall conform to the requirements in Tables I and II when tested as specified in paragraphs 3.3.1 and 3.3.2.

3.3.1.6 Seam Strength. Finished garments shall conform to the following minimum seam strength requirements when tested according to ASTM D5034. For seams joining woven fabric to woven fabric, the minimum seam strength shall be 90 pounds. For seams joining woven fabric to knit fabric, the minimum seam strength shall be 30 pounds. For seams joining knit fabric to knit fabric, the minimum seam strength shall be 30 pounds.

### 3.3.2 Color.

3.3.2.1 Cloth Type I. The cloth shall be dyed and printed with the warp effect side as the face. The cloth shall be dyed to a ground shade approximating Khaki 475. The Woodland camouflage pattern shall be obtained by roller or screen-printing using either three or four rollers or screens, as appropriate for the Green 474, Khaki 475, Coyote 476 and Black 477 areas of the pattern. Resin bonded pigments are not permitted except for a small amount of carbon black pigment may be used to meet the black shade providing all other requirements are met.

3.3.2.2 Cloth Type II. The cloth shall be dyed and printed with the warp effect side as the face. The cloth shall be dyed to a ground shade approximating Light Tan 479. The Desert camouflage pattern shall be obtained by roller or screen-printing using either three or four rollers or screens, as appropriate for the Urban Tan 478, Light Tan 479, Highland 480 and Light Coyote 481 areas of the pattern. Resin bonded pigments are not permitted.

3.3.2.3 Cloth Type III. The cloth shall be dyed and printed with the warp effect side as the face. The cloth shall be dyed to NWU II as specified in "Commercial US Governmentally Controlled Performance Specification Camouflage Print Performance Specification for AOR 1, AOR 2, NWU II, and NWU III."

3.3.2.4 Cloth Type IV. The cloth shall be dyed and printed with the warp effect side as the face. The cloth shall be dyed to NWU III as specified in "Commercial US Governmentally Controlled Performance Specification Camouflage Print Performance Specification for AOR 1, AOR 2, NWU II, and NWU III."

3.3.2.5 Cloth Type V. The cloth shall be dyed Coyote 498.

3.3.3 Labile sulfur (all types and classes). If the use of dyes and compounds containing sulfur capable of oxidation to sulfuric acid is chosen, then they shall be applied such that the dyed cloth shall contain no more labile sulfur than shown by the standard sample when tested as specified in 4.4.5. When no standard sample is available, the dyed cloth shall show no more than a slight trace of labile sulfur when tested as specified in 4.4.5.

3.3.4. Color matching (all types and classes).

3.3.4.1. Visual matching (all types and classes). The color and appearance of the camouflage printed cloth and dyed knit cloth, and permethrin treated garments shall match the standard sample when viewed using AATCC Evaluation Procedure 9, Option A, under filtered tungsten lamps that approximate artificial daylight D75 illuminant with a color temperature of  $7500 \pm 200$  K with illumination of  $100 \pm 20$  foot candles, and shall be a good match to the standard sample under horizon lamplight at  $2300 \pm 200$  K.

3.3.4.2 Instrumental color matching (all types and classes). Instrumental color matching is used as a tool to quantify shade evaluation if visually shade is rated unacceptable. All the colors in the Woodland MARPAT shall be instrumentally measured except for Khaki and all the colors in the Desert MARPAT shall be measured except for Highland given the areas of these exempted colors are too small for accurate instrumental readings. Each measured color shall match the standard sample. See 4.4.5.2.2 for evaluation procedure and acceptance requirements.

3.3.5. Colorfastness (All types and classes). The finished camouflage printed cloth and dyed cloth shall show fastness to: light (after 40 AATCC standard fading hours or 170 Kilojoules); laundering (after 4 cycles); and perspiration (acid and alkaline) and crocking (wet and dry). The colorfastness of the cloth shall be equal to or better than the standard sample, or equal to or better than the ratings specified in Tables I and II.

3.3.6. Pattern execution (Cloth Type I-IV).

3.3.6.1 Pattern execution (Cloth Types I-II). The pattern for woodland and desert MARPAT shall reproduce the standard sample in respect to design, colors, and registration of the respective areas. The pattern repeat of the camouflage printed finished cloth shall be  $35 \pm 1 \frac{1}{2}$  inches. Each pattern area shall show solid coverage; skitteriness exceeding that shown on 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 will be provided, and the pattern of the finished cloth shall match that of the drawing.

3.3.6.2 Pattern execution (Cloth Types III-IV). The pattern for NWU II and NWU III shall be executed as specified in “Commercial US Governmentally Controlled Performance Specification Camouflage Print Performance Specification for AOR 1, AOR 2, NWU II, and NWU III.”

3.3.7 Spectral reflectance (Cloth Types I-V).

3.3.7.1 Cloth Type I. The finished cloth shall meet the spectral reflectance values (in percent) for the visible/near infrared wavelength range, 600 to 860 nanometers (nm) for the colors specified in Table IV as applicable when tested as specified in 4.4.5.1.

**TABLE III. Cloth Type I Spectral reflectance requirements**

	<b>Reflectance values (percent)</b>
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Wavelengths Nanometers	Black 477		Coyote 476 & Khaki 475		Green 474	
	Min.	Max.	Min.	Max.	Min.	Max.
600	--	10	8	18	3	10
620	--	10	8	18	3	10
640	--	10	8	18	3	9
660	--	10	8	18	3	12
680	--	10	10	22	3	14
700	--	10	18	33	5	18
720	--	10	22	45	7	20
740	--	10	30	55	12	28
760	--	10	35	65	18	36
780	--	10	40	75	26	44
800	--	10	45	80	34	52
820	--	10	50	86	42	60
840	--	10	55	88	53	68
860	--	10	60	90	56	74

3.3.7.2 Cloth Type II. The finished cloth shall meet the spectral reflectance values (in percent) for the visible/near infrared wavelength range, 700 to 860 nanometers (nm) for the colors specified in Table IV, when tested as specified in 4.4.5.1.

**TABLE IV. Cloth Type II Spectral reflectance requirements**

Wavelengths Nanometers	Reflectance values (percent)					
	Lt. Tan 479		Lt. Coyote 481 & Highland 480		Urban Tan 478	
	Min.	Max.	Min.	Max.	Min.	Max.
700	38	53	19	41	25	44
720	38	54	20	41	25	45
740	39	55	20	42	25	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

3.3.7.3 Cloth Type III-IV. The finished cloth shall meet the spectral reflectance values (in percent) for the visible/near infrared wavelength range, for the colors specified in “Commercial US Governmentally Controlled Performance Specification Camouflage Print Performance Specification for AOR 1, AOR 2, NWU II, and NWU III.”

3.3.7.4 Cloth Type V. The finished cloth shall meet the spectral reflectance values (in percent) for the visible/near infrared wavelength range, 600 to 860 nanometers (nm) for Coyote 498 specified in Table V, when tested as specified in 4.4.5.1.

**Table V. Cloth Type V Spectral reflectance requirements**

	<b>Reflectance values (percent)</b>	
<b>Wavelengths Nanometers</b>	<b>Coyote 498</b>	
	<b>Min.</b>	<b>Max.</b>
600	8	18
620	8	18
640	8	18
660	8	18
680	10	22
700	18	33
720	22	45
740	30	55
760	35	65
780	40	75
800	45	80
820	50	86
840	55	88
860	60	90

3.3.8 Dimensional stability.

3.3.8.1 Dimensional stability (Cloth Type I-IV). The shrinkage in warp and filling direction of the untreated finished cloth shall be not greater than 5.0 percent for individual sample unit and not greater than 5.0 percent for the lot average when tested as specified in 3.3.1 and 4.4.5. The fabric shall not elongate. Manufacturers must compensate for actual fabric shrinkage in order to deliver finished, treated garments complying with the dimension requirements specified in 4.4.8.

3.3.8.2 Dimensional stability (Cloth Type V). The shrinkage in course and wale direction of the untreated finished cloth shall be not greater than 10.0 percent for individual sample unit and not greater than 8.0 percent for the lot average when tested as specified in 3.3.1 and 4.4.5. Manufacturers must compensate for actual fabric shrinkage in order to deliver finished, treated garments complying with the dimension requirements specified in 4.4.8.

3.3.9 Permethrin Content and Insect Bite Protection. The finished garments with bite protection treatment shall be strictly limited to the level specified in 3.3.9.1 and provide the minimum insect bite protection specified in 3.3.9.2 when tested as specified in 4.4.5.

3.3.9.1 Permethrin Treatment. Permethrin treatment process and garment treatment shall comply with Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) as amended (see 2.2.2). Permethrin concentration in garments shall comply with EPA Toxicological Category IV. The

garments shall be treated using an EPA registered (See 6.10) permethrin insect protection treatment which shall use permethrin in accordance with Type II specified in MIL-DTL-44411 except that the application for Type II specified in paragraph 3.4 of MIL-DTL-44411 shall also be applicable to finished garment. The garments shall be labeled in accordance with 3.4.3. The permethrin finish shall be uniformly applied across the fabric or garments at a target level of 0.119 mg/cm<sup>2</sup> for blouse sleeves and collar fabric and trouser fabric and **strictly** controlled to fall within the minimum to maximum permethrin levels specified below. The permethrin finish shall be uniformly applied across the fabric or garments at a target level of 0.102 mg/cm<sup>2</sup> for blouse torso fabric and **strictly** controlled to fall within the minimum to maximum permethrin levels specified below. The treatment level shall provide the percent (%) bite protection specified in 3.3.9.2. The permethrin treatment shall be durable to repeated laundering to provide the minimum permethrin level after 20 launderings specified below. The permethrin level will be measured as specified in paragraph 4.4.5. The finished permethrin treatment shall not degrade any performance characteristics or present any latent defects to the cloth or garment.

	Min: mg/cm <sup>2</sup>	to	Max: mg/cm <sup>2</sup>
<b>INITIAL</b>			
Blouse torso knit fabric	0.084	to	0.122
Blouse sleeve & collar woven fabric	0.102	to	0.138
Trousers woven fabric	0.102	to	0.138
<b>AFTER 20 Launderings</b>			
Blouse torso knit fabric	0.042		
Trousers and Blouse sleeves & collar	0.051		

3.3.9.2 Percent (%) Bite Protection. Finished permethrin treated trousers shall provide bite protection specified below when assessed by the bite protection testing specified in 4.4.6.6. Government approval is required initially, and any time there is a change in the permethrin treatment formulation or processing conditions (see 4.4.5.3.1).

Condition	% Bite Protection
Initial	>/= 85%
After 20 launderings	>/= 80%
After 50 launderings	>/= 75%

3.3.10 pH (all types and classes). The pH value of the water extract of all the finished cloth and garments shall be no lower than 5.0 or higher than 8.5 when tested as specified in 4.4.5.

3.3.11 Toxicity (all types and classes). All the finished cloth and garments shall not present a dermal health hazard when used as intended when tested as specified in 4.4.5.

3.3.12 Ground shade/printed seconds/dyed seconds/mill seconds. Ground shade cloth shall be dyed in conformance with the specified basic material and shall meet the physical, mechanical, and dimensional requirements of the respective finished fabric. Printed seconds shall be defined as cloth that has been rejected only for defects pertaining to color, infrared reflectance, or

camouflage print patterns, which are cited in the specified basic material requirements. Dyed seconds shall be defined as cloth that has been rejected only for defects pertaining to color or infrared reflectance, which are cited in the specified basic material requirements. Mill seconds shall be cloth that has been rejected for visual defects only, and dyed to match ground shade (see 3.5.3). Mill seconds finished firsts may contain slubs and knots (see 4.4.6 and FED-STD-4B for all other fabric defects which constitute seconds).

3.3.13 Disposal of ground shade/printed seconds/dyed seconds/mill seconds/rejected garments. All scraps, irregulars, extra material, and garments containing the aforementioned intellectual property/trademarks which are not utilized for Government contracts or a purpose authorized in writing by the Government, shall be destroyed and not sold or transferred in any manner. This restriction applies to the prime contractor, as well as all subcontractors. Contractor shall be prepared to certify as to the method and execution of the destruction of all scraps, seconds, irregulars, extra material, and garments containing the aforementioned intellectual property/trademarks.

3.3.14 Instrumented Manikin Test. The EFRCE shall provide FR flash fire protection in accordance with ASTM F1930 test method and shall have no more than 25% burn injury prediction including 2d and 3d degree during a four (4) second exposure at a 2.0 cal/cm<sup>2</sup>/sec heat flux.

3.3.15 Antibacterial properties testing. The Type V fabric shall contain odor reducing properties showing a 1-log reduction of bacteria when tested against staphylococcus aureus and pseudomonas aeruginosa bacteria per AATCC 100 with clarifications specified in 4.4.5.9.

### 3.4 Design and construction.

#### 3.4.1 Design.

3.4.1.1 Blouse. The blouse shall be a multi-fabric design using two separate cloths for the main garment construction; a knit fabric for the torso and a woven fabric for the sleeves and collar. The blouse uses a pullover shirt design with long sleeves. Both sleeve and collar are constructed of woven fabric; the torso is a knit fabric. The collar converts to a mock turtle neck for additional protection in a flame environment. The slide fastener front opening extends from the top of collar to the mid-chest, with a padded placket beneath the slide fastener, which improves comfort when the blouse is worn under the ballistic vest. There are two upper sleeve pockets with bottom bellows, a drainage hole located in the bottom bellow of each pocket, with a tapered flap and concealed two-button closure. Sleeves are one-piece, single layer with adjustable wrist tabs at sleeve hem for wrist closure adjustment. The blouse has external single layer reinforcement patches at the elbow.

3.4.1.2 Trousers. The trousers have a concealed button and buttonhole fly, front panels with a centered single stitched pleat (the fold of the pleat faces the outseam), hemmed legs, seven (7) evenly spaced  $1 \pm 1/8$  inch wide belt loops with a 3 inch belt loop opening and side waist elastic adjustments. The elasticized portion of the waist starts at the front of the pocket bearer and extends past the outseam onto the back of the trousers to achieve the finished four inches of the

waist circumference for each size. The trousers have two side hanging pockets and two welt opening hip pockets. There are two pleated cargo type pockets (the pleats face the back of the trousers). The larger pocket has a flap that is bartacked at forward lower corner and one rear button closure, a bottom bellow and elasticized pocket upper edge creating an adjustable opening to secure the contents when the flap is not buttoned. The elastic cargo pocket edge requires elongation/extension when the hand is inserted into the pocket yet does not distort the trouser leg when lying in the gathered/relaxed closed position. The smaller cargo pocket has a flap with two button closures and is not elasticized. Drainage holes are positioned in the cargo pocket bellow (positioned near the back of the pocket). There are two calf pockets (the pleats face the back of the trousers) with a flap bartacked at forward lower corner and a two button closure, to secure the contents when the flap is buttoned. The calf pocket must not distort the trouser leg when lying in the relaxed closed position. All pockets, except for the side hanging ones have a flap with fusible interlining and closure with concealed buttons. The trousers have single layer external reinforcement patches at the seat and knees.

### 3.4.2 Components.

3.4.2.1 Thread. The thread for the bobbin/looper/**needle** shall be aramid, Tex Size 40 conforming to A-A-55217 or as an alternate, para-aramid spun staple thread, Tex Size 40 conforming to A-A-55195, Type I, may be used.

3.4.2.1.1 Thread colorfastness and color. All thread shall be non-staining and show good colorfastness to laundering when tested as specified in 4.4.2. The thread color shall be Khaki P-1 (C.A. 66019 or approximating color chip 30277 or FED STD-595) **for Cloth Type II and III** and Camouflage Green 483 (approximating color chip 34094 of FED-STD-595) **for Cloth Type I and IV.**

3.4.2.2 Button Attachment Thread. All buttons shall be attached using aramid, Tex Size 40 conforming to A-A-55217.

3.4.2.3 Elastic Webbing. The elastic webbing for the trouser waistband and cargo pockets shall be 1 inch wide and conform to equal to or better performance of Type II, class 1 of MIL-W-5664D or QST style 150-43171RA,  $1\frac{1}{2} \pm 1/16$  inches or equal. Elastic ends shall be heat cut to prevent raveling. When 1- $\frac{1}{2}$  inch elastic is used, the manufacturer will adjust patterns to accommodate the wider elastic without altering finished dimensions created by GFM patterns and stitching. The color shall be natural for either class, or Camouflage Green 483 or black for Class 1 Type I and Class 2 Type IV, or tan for Class 1 Type II or Class 2 Type III. The elastic for the waistband shall be cut to the length needed to achieve both the trouser 1/2 waist finished relaxed and finished stretched measurements (for each size) as specified in paragraph 4.4.8, and the elongation force specified below. The elastic in the cargo pocket opening shall extend the full width to achieve a 6  $\frac{3}{4}$  to 7  $\frac{1}{2}$  inches relaxed opening. The elastic will retreat to its relaxed opening position when the hand is removed. The encased elastic webbing for the cargo pocket shall lie flat in the relaxed state and not distort the trouser leg. The cargo pocket opening shall retain its elongation/recovery characteristic for the life of the garment. The finished elasticized waistband and cargo pocket features shall conform to the requirements listed in Table VI below.

**Table VI. Elastic Elongation**

Feature	Elongation (inches) ± 1/16"	Force (pounds) Minimum to Maximum	Test Method
Cargo Pocket	1 ½	2.5 to 3.3	See 4.4.5.4
Waistband	¾	0.5 to 1.5	See 4.4.5.4
Waistband	1 ½	1.5 to 4.0	See 4.4.5.4

3.4.2.4 Fastener Tape, Loop, IR Tab. The loop fastener tapes for the left and right sleeve pocket flap IR tab shall be 2 inches wide and 2 inches long, CG 483 (approximating color chip 34094 FED-STD-595) for Cloth Type I and IV and Khaki P-1 C.A.66019 (or approximating color chip 30277 of FED STD-595) for Cloth Type II and III and shall conform to type II, class 1 of A-A-55126. Cut edges shall be finished so that they do not ravel for the life of the garment.

3.4.2.5 Zippers. The blouse front zipper shall finish 8-1/2 inches long and shall conform to A-A-55634, and shall be Coyote 498 in color. Zipper shall be Type I, Style 4, Size 3 continuous element fastener according to A-A-55634.

3.4.2.6 Foam. The flame resistant (FR) foam padding stitched into the zipper flap shall conform to PacFoam style 2LB UL94, Polyester Charcoal, 1/4 inch thick, or equal (see 6.4).

3.4.3 Labels.

3.4.3.1 Blouse labels. The blouse shall contain 3 permanent labels as specified below. All permanent label inscription, legibility, label material, and label attachment method shall last the expected life of the uniform.

3.4.3.1.1 Flame Resistant Organizational Gear (FROG) label. Each blouse shall have a woven FROG label, 63 mm x 63 mm, cut single, fused edge, manufactured by IbisTek Bell Label or equal in the following configuration:



Garment Class 1 label



Garment Class 2 label

The woven FROG label must be sewn on each blouse at the right lower front (as worn), to the left of the blouse combination label and 1 ½" above the hem.

3.4.3.1.2 Blouse combination label. A separate combination label (see 6.7 for example) shall contain size, body measurement, identification, and care information as specified below. The information needed to designate size and body measurement in the top portion of the combination label is specified in the Table VII “Size and Body Measurement.” The label color shall be Coyote 498. The inscription shall have a minimum font size of 10 points. The inscription legibility, label, and label attachment method shall last the expected life of the uniform. The combination label shall be sewn on the right lower front (as worn), <sup>3</sup>/<sub>4</sub>” to the left of the side seam and 1 <sup>1</sup>/<sub>2</sub>” above the bottom hem. Label size shall be no longer than 4” and no wider than 2”.

**Size:** The size – length designation (with abbreviation), body measurements, and stock number shall be included on the combination label. Information for each size is specified in Table VII “Size and Body Measurement” and shall be centered at the top of the label.

**Identification:** List one corresponding to blouse type ordered and delivered:

Class 1, Type I      Enhanced Flame Resistant Combat Ensemble (EFRCE) Blouse  
Woodland MARPAT, with Durable Insect Protection  
Type I cloth fiber content  
Type V cloth fiber content

Or

Class 1, Type II      Enhanced Flame Resistant Combat Ensemble (EFRCE) Blouse  
Desert MARPAT, with Durable Insect Protection  
Type II cloth fiber content  
Type V cloth fiber content

Or

Class 2, Type III      Enhanced Flame Resistant Combat Ensemble (EFRCE) Blouse  
NWU II Desert Digital Camouflage Printed, with Durable Insect  
Protection  
Type I cloth fiber content  
Type V cloth fiber content

Or

Class 2, Type IV      Enhanced Flame Resistant Combat Ensemble (EFRCE) Blouse  
NWU III Woodland Digital Camouflage Printed, with Durable  
Insect Protection  
Type II cloth fiber content  
Type V cloth fiber content

**Contract Information:**

Contract Number

**Care Information:**

**DO NOT BLEACH, STARCH, DRY CLEAN, OR PRESS**

1. Washing. Machine wash using Permanent Press Cycle or hand wash in warm water using mild detergent that does NOT contain optical brighteners. Rinse completely. Do not overload the machine.
2. Drying. Tumble dry on low heat. Do not overload the dryer.
3. Fabric softener. The use of fabric softeners is not recommended due to potential to adversely affect the flame protection.

3.4.3.1.3 Blouse insect protection label. Finished blouses shall include a permanent insect protection label complying with an approved EPA registration (see 6.9). The label shall be heat sealed or stitched on all four sides and attached to left lower front (as worn). Labeling information, characteristics and location of labels are subject to Government approval prior to production. See paragraph 3.4.3.5.2 for additional EPA hang tag information requirement.

3.4.3.1.4 Blouse insect protection brand label. Finished blouses shall contain brand identification in accordance with the treatment's EPA registration. Brand identification may be included in an expanded permanent insect protection label (see 3.4.3.1.3) or as a separate brand label stitched directly above the insect protection label. The contractor's labeling is subject to Government approval prior to production.

3.4.3.2 Trouser labels. The pair of trousers shall contain 3 permanent labels as specified below. All permanent label inscription, legibility, label material, and label attachment method shall last the expected life of the uniform.

3.4.3.2.1 FROG label. Each pair of trousers shall have a woven FROG label, 63 mm x 63 mm, cut single, fused edge, manufactured by IbisTek Bell Label or equal in the configuration shown in 3.4.3.1.1. A woven FROG label must be sewn on each pair of trousers on the left back pocket (as worn) so that on the finished trousers the label shall face the wearer. The FROG label shall be positioned to the left (as worn) of the trouser combination label.

3.4.3.2.2 Trouser combination label. A separate combination label (see 6.8 for example) shall contain size, body measurement, identification, and care information as specified below. The information needed to designate size and body measurement in the top portion of the combination label is specified in the Table VII "Size and Body Measurement." The label color shall be Coyote 498. The inscription shall have a minimum font size of 10 points. The inscription legibility, label, and label attachment method shall last the expected life of the uniform. The combination label shall be stitched on all four sides and attached to the underside of the left back pocket with the writing facing out as worn, parallel to the FROG label. The attachment of this label will not be visible on the outside of the garment. Label size shall be no longer than 4" and no wider than 2".

**Size:** The size – length designation (with abbreviation), body measurements, and stock number shall be included on the combination label. Information for each size is specified in Table VII “Size and Body Measurement” and shall be centered at the top of the label.

**Identification:** List one corresponding to trouser type ordered and delivered:

Class 1, Type I      Enhanced Flame Resistant Combat Ensemble (EFRCE) Trouser  
Woodland MARPAT, with Durable Insect Protection  
Type I cloth fiber content  
Type V cloth fiber content

Or

Class 1, Type II      Enhanced Flame Resistant Combat Ensemble (EFRCE) Trouser  
Desert MARPAT, with Durable Insect Protection  
Type II cloth fiber content  
Type V cloth fiber content

Or

Class 2, Type III      Enhanced Flame Resistant Combat Ensemble (EFRCE) Trouser  
NWU II Desert Digital Camouflage Printed, with Durable Insect  
Protection  
Type III cloth fiber content  
Type V cloth fiber content

Or

Class 2, Type IV      Enhanced Flame Resistant Combat Ensemble (EFRCE) Trouser  
NWU III Woodland Digital Camouflage Printed, with Durable  
Insect Protection  
Type IV cloth fiber content  
Type V cloth fiber content

**Contract Information:**

Contract Number  
Contractor Name

---

**Care Information:**

DO NOT BLEACH, STARCH, DRY CLEAN, OR PRESS

1. Washing. Machine wash using Permanent Press Cycle or hand wash in warm water using mild detergent that does NOT contain optical brighteners. Rinse completely. Do not overload the machine.
2. Drying. Tumble dry on low heat. Do not overload the dryer.
3. Fabric softener. The use of fabric softeners is not recommended due to potential to adversely affect the flame protection.

**3.4.3.2.3 Trouser insect protection label.** Finished trousers shall include a permanent insect protection label complying with an approved EPA registration (see 6.9). The label shall be heat

sealed or be stitched on all four sides and attached to the underside of the right back pocket (see Figure 6) with the writing facing out as worn. The attachment of this label will not be visible on the outside of the garment. Labeling information, characteristics and location of labels are subject to Government approval prior to production. See paragraph 3.4.3.5.2 for additional EPA hang tag information requirement.

3.4.3.2.4 Trouser insect protection brand label. Each trouser shall contain brand identification in accordance with the treatment’s EPA registration. Brand identification may be include in an expanded permanent insect protection label (see 3.4.3.2.3) or as a separate label stitched directly above the insect protection label which shall not be visible on the outside of the garment. The contractors labeling is subject to Government approval prior to production (see Figure 6).

3.4.3.3 Size and body measurements table.

**Table VII. Size and Body Measurements**

Location	Size	Measurement
Chest (Size of Blouse)	X-Small	Up to 33 inches
	Small	33 to 37 inches
	Medium	37 to 41 inches
	Large	41 to 45 inches
	X-Large	45 to 49 inches
	XX-Large	49 to 53 inches
Height (Length of Blouse)	XX-Short	55 to 59 inches
	X-Short	59 to 63 inches
	Short	63 to 67 inches
	Regular	67 to 71 inches
	Long	71 to 75 inches
	X-Long	75 to 79 inches
	XX-Long	Above 79 inches
Waist (Size of Trouser)	X-Small	Up to 27 inches
	Small	27 to 31 inches
	Medium	31 to 35 inches
	Large	35 to 39 inches
	X-Large	39 to 43 inches
	XX-Large	Over 43 inches
Inseam (Length of Trousers)	X-Short	Up to 26 ½ inches
	Short	26 ½ to 29 ½ inches
	Regular	29 ½ to 32 ½ inches
	Long	32 ½ to 35 ½ inches
	X-Long	35 ½ to 38 ½ inches
	XX-Long	Over 38 ½ inches

3.4.3.4 Garment Lot Designation. For garment manufacturing traceability, each blouse and trouser garment shall have a lot designation in accordance with lot Numbering procedure as specified in DPSCM 4155.3, Quality Systems Requirements. The lot number for the blouse shall be placed inside the sleeve behind the elbow patch reinforcement. The lot number for the trouser

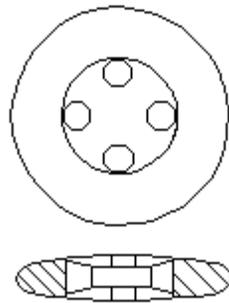
shall be placed next to or above the combination identification / care label on the trouser. Batch designation is not acceptable.

### 3.4.3.5 Hang Tag Labels.

3.4.3.5.1 Bar Code Label. Each blouse and trouser shall have an individual bar code placed on a paper tag for personal clothing items. The paper tag shall be standard bleached sulfate having a basis weight of 100 pounds. The paper used for the tags shall have a smooth finish to accept thermal transfer and direct printing. The tags shall have a hole and shall be attached to each item by a fastener. The tags shall be clearly legible and readable by a scanner. The bar-coding element shall be a 13 digit national stock number (NSN). There shall be a 12 digit UPC number assigned for each NSN by the contracting activity. UPC will be provided as Government Furnished Information. The initials "UPC" must appear beneath the code. The bar-code for NSN and UPC printing shall be a medium to high code density and shall be located so that it is completely visible on the item when it is folded and/or packaged as specified and shall cause no damage to the item. The UPC code must also be placed on all shipping cartons on which the NSN appears.

3.4.3.5.2 Insect protection label. Each garment shall have an individual paper tag attached that provides additional insect protection information required by EPA registration and subject to Government approval (see Figure 7).

3.4.4 Buttons. The buttons shall be dull finish, 4-hole, 3ligne, and shall be in accordance with the following button style:



The color of the buttons shall be a good match to Coyote 498. The buttons shall not exhibit chalking when tested as specified in 4.4.3.1. The buttons shall show a minimum compressive strength of 1800 lb. when tested as specified in 4.4.3.2. When attached to the blouse and the trouser, the button and thread shall withstand a pull test of 40 lb. (min.), when tested as specified in 4.4.3.3.

3.5 List of pattern parts. The Government shall furnish a complete set of patterns which show directional line markings for proper assembly. The Government patterns are to be used as a guide for cutting contractor's working patterns. Minor modifications are permitted to accommodate manufacturing procedures; however, the design and finished measurements must be maintained.

3.5.1 List of blouse pattern parts. Standard patterns provide a seam allowance of 3/8 inch for single needle seams and 1/2 inch for double needle seams. Buttonholes, pockets and pocket flaps shall be located in accordance with marks on patterns and figures. The pattern parts list in Table VIII is provided for first quality fabrics and to ensure that the pattern set is complete.

**TABLE VIII. List of blouse pattern parts – First Quality**

<b>Material</b>	<b>Pattern Abbreviation</b>	<b>Nomenclature</b>
Woven Cloth	FRONT_YOKE	Front Yoke
	SLEEVE	Sleeve
	COLLAR	Collar
	PLACKET	Placket
	ZIPPER_FLAP	Zipper Flap
	SLEEVE_PCKT	Sleeve Pocket
	SLV_PK_FL_TB	Sleeve Pocket Flap Tab
	ELBOW_PATCH	Elbow Patch
	CUFF_TAB	Cuff Tab
LWR_SLV_PKT	Lower Sleeve Pocket	
Knit Cloth	FRONT	Front
	BACK	Back
	SLVE_GUSSET	Sleeve Gusset
FR FOAM	ZIP_FLAP_REI	Zipper Flap Reinforcement

3.5.2 List of trouser pattern parts. Standard patterns provide a seam allowance of 3/8 inch for single needle seams and 1/2 inch for double needle seams. Buttonholes, pockets and pocket flaps shall be located in accordance with marks on patterns. The pattern list in Table IX is provided for first quality fabrics and to insure that the pattern set is complete.

**TABLE IX. List of trouser pattern parts – First Quality.**

<b>Pattern Abbreviation</b>	<b>Nomenclature</b>
FRONT	Front
BACK	Back
CARGO_POCKET	Cargo Pocket
CARG_PKT_FAC	Cargo Pocket Facing
CRG_PKT_FLTB	Cargo Pocket Flap Tab
THIGHT_CRG_PK	Thigh Cargo Pocket
THG_CG_FL_TB	Thigh Cargo Pocket Flap Tab
SD_HANG_PCKT	Side Hanging Pocket
SD_HNG_PK_BR	Side Hanging Pocket Bearer
SD_HG_PK_FAC	Side Hanging Pocket Facing
HIP_POCKET	Hip Pocket
HIP_POCKET_BR	Hip Pocket Bearer
HIP_PCKT_FAC	Hip Pocket Facing
HIP_PKT_FLTB	Hip Pocket Flap Tab
LWR_LEG_PKT	Lower Leg Pocket

LWR_LEG_FLAP	Lower Leg Pocket Flap
GUSSET	Gusset
LEFT_FLY	Left Fly
RIGHT_FLY_LIN	Right Fly Lining
SEAT_PATCH	Seat Patch
KNEE_PATCH	Knee Patch

3.5.3 Parts cut from ends and from ground shade. Use of ground shade and/or print second quality is restricted to: hip pocket, side hanging pocket, cargo pocket facing pattern parts and waistband lining. Printed seconds shall be defined as cloth that has been rejected only for defects pertaining to color, infrared reflectance, or camouflage print patterns, which are cited in the specified basic material requirements.

3.6 Configuration. The following specifications are needed to provide uniform appearance, comfort and durability in combat operations. End item blouse and trouser construction and appearance shall conform to the requirements of this document and the finished dimensions in Tables XIV and XV (see 4.4.8) and figures 1 – 7 to maintain item configuration and compliance to component and end item tests (see 4.4).

3.6.1 Seaming and stitching. Seaming shall be consistent, exhibit a uniform appearance and shall conform to the ASTM D-6193 stitch types listed in Table X below. The backside of all seams (inside garment) shall be flat with no protruding seam allowance or raw edges to create irritation, discomfort or poor appearance. To maintain durability and functionality, the seams shall be sewn with 10-14 stitches per inch for all outside visible stitching. Thread ends shall be secured by a minimum of ¼” backstitched or ½” overlap when broken stitches are repaired. Overedge or pre-hemming shall be 6 – 10 stitches per inch. All bartacks, except for the waistband and cargo pocket elastic bartacks, shall be 3/8 to 5/8 inch in length with approximately 27 stitches each. The waistband and cargo pocket elastic bartacks shall be 1 – 1 1/8” with 55 – 65 total stitches, and placed at each end of the elastic when the elastic floats within the casing. Bartacks are required at the specified reinforcement points (see figures 1-4) and centered on belt loop for attachment. The pocket drainage eyelets shall have a minimum of 19 stitches each, with the purling on the outside. Material edges must not ravel. Raw edges may be turned-in, turned-under or serged to prevent raveling. No raw edges are allowed.

**TABLE X. Seam types**

<b>Seam Placement</b>	<b>Seam Type</b>	<b>Gage</b>	<b>Stitch Type</b>
Blouse sleeve/side seams	SSa-2	3/16 to 9/32 inch	301 or 401 and 504
Shoulder/underarm seams, yoke seams	LSbm-3	3/16-1/4 inch	301 or 401 and 504
Outseams, seat seam and inseams	LSc-2	3/16 to 9/32 inch gage	301 or 401 and 504
Waistband	LSk-2	1 ½ inch	301 or 401
Alternate Waistband- metered elastic	LSbc-4	<u>1/</u>	<u>1/</u>

Top stitching for pocket flaps, collar, cuff tab, flies, tabs, and front edges.	SSe-1	1/8 to 1/4 inch from the edge (uniform throughout the garment)	301
Closing of side hanging and hip pockets leaving 1/2" chain	SSe-2 and OSf-1 Or SSa-2	3/16 to 1/4 inch from edges	301 or 515,516, or 519
Hip pocket	SSa or SSbe-2	Hip pocket welt width 1/4 - 3/8 inch:	301
Attachment of patch pockets and attachment of side and hip pocket bearers and facings	LSd-1	one row 1/16 to 1/8 inch apart	301
Double needle flap stitching 2/	LSd-2	two rows 3/16 to 1/4 inch apart	301
Belt loop construction	Efh-1	1/16 to 1/8 inch from edges	301
Attachment of elbow, seat and knee patches	LSd-2	two rows 3/16 to 1/4 inch apart	301
Label attachment	LSbj-1	1/8 to 3/16 inch from edges	301
All hems: Trouser legs and Sleeves	EFb-1	1/16 to 1/8 inch from edge	301
Blouse hem	EFa-2	1/8-3/16 inch gage	602

1/ An alternate waistband construction shall use 1-1/2 + 1/16 inch elastic metered its entire length using seam type LSbc-4 with the elastic inserted within the seam construction along opposite sides of the waistband per pattern placement. A total of 4 stitch lines shall be correctly tensioned or balanced such that the stitch lines do not impede stretch whereby stitches cold break open. The alternate waistband shall meet elastic webbing, elongation, and force specified in 3.4.2.6 and finished dimensions specified in 4.4.9.

2/ An alternate for all pocket flaps shall be a single needle stitch attachment in accordance with the pattern then turned and topstitched 3/16" to 1/4" with backtacking at each end. The top flap edge, raw or overedged, shall not be visible when the flap is raised.

**TABLE XI. Bartacks**

Size (Inches)	Stitches/bartack	Location
<b>BLOUSE</b>		
3/8	20-27	Top of slide fastener
3/8	20-27	Top corners of sleeve pockets
3/8	20-27	Sleeve pocket flaps
3/8	20-27	Top corners of pen pocket
3/8	20-27	Top of pen pocket divider
3/8	20-27	Vertically at each end of cuff tab along vertical stitching
3/8	20-27	End of each sleeve inseam at cuff edge

<b>TROUSER</b>		
1	52-56	Across top and bottom of belt loops
5/8	35-40	Each end of hip pocket opening
5/8	35-40	Each end of back pocket welt openings
1/2	28-34	Top corners of cargo, thigh, and calf pockets
1/2	28-34	Top corners of cargo, thigh, and calf pocket flaps
1/2	28-34	Bottom front corner of cargo pocket flap
1/2	28-34	Bottom corners of cargo and thigh pocket and bottom at shared seam
3/8	20-27	Across pleat placements below lower edge of elastic on top of cargo pockets.
3/8	20-27	Across pleat placements on top of thigh and calf pockets
3/8	20-27	Bottom of fly, Superimposed on "J" stitching
3/8	20-27	Top and bottom of crotch gusset

3.7 Toxicity Statement. The blouse and trousers shall show no toxicity (see 4.4.4).

#### 4. VERIFICATION

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

1. First article inspection (see 4.2)
2. Quality conformance inspection (see 4.3)

4.2 First article inspection. The first article, submitted in accordance with 3.1, shall be inspected for compliance with design, configuration, workmanship, and dimensional requirements. The presence of excessive defects, as defined by contract, (see 4.1) or failure to pass any test shall be cause for rejection of the first article.

4.3 Quality conformance inspection. Sampling for inspection shall be performed in accordance with ANZI/ASQC Z1.4, as defined by contract, except where otherwise indicated.

4.4 Component and end item inspection. The components and end items shall be tested in accordance with all the requirements of referenced documents unless otherwise excluded, amended, modified, or qualified in this document or applicable procurement documents. The government reserves the right to inspect all components and end items to determine conformance to requirements. A certification of compliance may be acceptable as evidence that the permethrin treatment meets the requirements of paragraph 3.3.9. When Certificate of Compliance are submitted, the QAR will conduct in-process inspections and review records to audit compliance to the treatment process approved by the government in production verification and EPA registration. The Government reserves the right to periodically inspect such items to determine the validity of the certification in accordance with MIL-DTL-44411C and the performance requirements of this specification.

4.4.1 Breaking strength and elongation test. The thread shall meet the requirement stated in 3.4.2.1 when tested according to ASTM-D-2256, except testing speed shall be  $12 \pm 0.5$  in./min and a 10 inch gauge shall be used.

4.4.2 Thread colorfastness test. The thread shall meet the requirements stated in 3.4.2.1.1 when tested according to AATCC-61, Test 3A (4 cycles).

4.4.3 Button tests.

4.4.3.1 Chalking test. The buttons shall meet the requirements stated in 3.4.4 when tested for chalking by immersion in a boiling solution of 0.8 percent by weight sulfuric acid for 10 minutes, immediately thereafter dried and examined by holding the button at arm's length under a strong white light.

4.4.3.2 Compressive strength test. The buttons shall meet the requirements stated in 3.4.4 when tested for compressive strength using an apparatus that permits gradual application of the load either by a manual or automatic hydraulic mechanism. Buttons shall be placed face down one at a time between flat blocks of steel, and tested to failure. Failure is defined as the first sign of a crack in the button visible to the naked eye (a visible crack in the button will usually be found at the first audible sound of cracking).

4.4.3.3 Button pull test. The buttons attached to the blouse and trouser shall meet the requirements stated in 3.4.4 when tested according to ASTM D-5034, except slide button on top of 1 inch wide grips separated at least 3/8 inch so that button loosely rests evenly on top of grips. Use manually adjusted grips only, not pneumatic. Place button attachment stitching in middle of bottom grips and adjust an additional 3/8-inch down so that the grips grab fabric just below stitching, not on the stitching. Run tensile machine per test method and record force required to pull button from sewn garment.

4.4.4 Toxicity test. The finished blouse and trouser shall be tested for dermal toxicity as follows:

- a. Title, Code of Federal Regulations, 1994 Edition;  
Part 798.4100 – Dermal Sensitization  
Part 798.4470 – Primary Dermal Irritation  
Part 798.4500 – Primary Eye Irritation  
Marzulli, F. and H. Maibach, “Contact Allergy: Predictive Testing in Humans,”  
Advances in Modern Toxicology, Volume 4, pp 353-372, 1977.
- b. As an alternative to animal and human testing, the contractor may provide information, which certifies that the treated cloth is composed of chemicals and/or materials, which have been safely used commercially where prolonged, repeated skin contact has occurred.

4.4.5 Material and Garment Testing. The cloth and/or garment shall be tested for characteristics listed in Tables I-IV. The testing shall be performed using the test methods as specified in Table XII. All test reports shall contain the individual values utilized in expressing the final results.

For material testing, the sample unit shall be five (5) continuous yards full width of the finished cloth, for all physical and chemical tests. For garment testing, the sample unit shall be one blouse and one trouser per treated lot. The lot shall be considered unacceptable if one or more sample units fail to meet any requirements specified.

**TABLE XII. Material and Garment Testing Requirements**

Characteristic	Requirement Paragraph	Test Method
<b>Garment Testing:</b>		
Dimensional stability	3.3.8	AATCC 96
pH	3.3.10	AATCC 81
Toxicity	3.3.11	4.4.5.3, 4.4.5.3.1 <u>1/</u>
Elastic Force vs Elongation Cargo Pocket Waistband	3.4.2.3	4.4.5.4 4.4.5.4.1 4.4.5.4.2
Seam Strength (min)	3.3.1.6	ASTM D 5034
Permethrin Content	3.3.9.1	4.4.5.5
% Bite Protection	3.3.9.2	4.4.5.6 <u>1/</u>
Flammability (After 1 and 25 laundering W/D cycles) Instrumented Manikin Test (4 second flame exposure)	3.3.14	ASTM F1930 <u>1/</u> 4.4.5.8 <u>1/</u>
<b>Material Testing:</b>		
Weight, ounces per square yard (max)	3.3.1	ASTM D 3776
Fiber content	3.3.1	AATCC 20 <u>1/</u>
Weave	3.3.1	Visual <u>1/</u>
Breaking Strength, pounds (min)	3.3.1	ASTM D 5034
Tear Strength, pounds (min)	3.3.1	ASTM D1424
Knit construction	3.3.1	Visual <u>1/</u>
Antimicrobial properties Initial (no laundering) and after 25 Laundering Cycles	3.3.1	AATCC 100 <u>1/</u>
Bursting Strength, pounds (min)	3.3.1	ASTM D 3787
Air Permeability, cfm (min)	3.3.1	ASTM D 737
Dimensional Stability, Commercial Laundering	3.3.8	AATCC 96
Drying Time, minutes (max)	3.3.1	Internal Method
Colorfastness	3.3.1	AATCC 61 Test 1A AATCC 16.2 or 16.3 AATCC 15 AATCC 8
Laundering (after 4 cycles)	3.3.5	
Light (40 hours or 17 kilojoules)		
Perspiration (acid and alkaline)		
Crocking		
Visual Color Matching	3.3.4.1	AATCC Evaluation Procedure 9, Option A,

Characteristic	Requirement Paragraph	Test Method
		4.4.5.2.1
Instrumental Color Matching	3.3.4.2	AATCC Evaluation Procedure 6, 4.4.5.2.2
Moisture Vapor Transmission, per square meter per 24 hours (min)	3.3.1	ASTM E 96 Test B
Pilling	3.3.1	ASTM D3511, AATCC 96
Spectral Reflectance	3.3.7	4.4.5.1
Thermal Protective Performance, cal/cm <sup>2</sup> (min)	3.3.1	NFPA 1971 1/
Thermal Shrinkage (warp and fill)	3.3.1	NFPA 1971 1/
Vertical Flame After Flame, seconds (max) Char Length, inches (max) Melt/Drip	3.3.1	ASTM D 6413
Presence of labile sulfur	3.3.3	1/

1/. Unless otherwise specified, a certificate of compliance shall be submitted and will be acceptable for the stated requirement. When Certificates of Compliance (COC) are submitted the Government reserves the right to inspect such items to determine the validity of the certification. If a significant change is made to the garment design or materials (as determined by the Marine Corps Systems Command (MARCORSYSCOM)) COC verification testing may be conducted.

4.4.5.1 Spectral Reflectance. Initial and permethrin treated cloth shall meet requirements specified in 3.3.7. Spectral reflectance shall be measured and reported on the initial cloth. Certificate of compliance will be accepted on finished uniforms and subject to Government verification. If finished garments are rejected for shade, spectral reflectance will be measured on cloth in the finished garments. Spectral reflectance data shall be determined on the face side and shall be obtained from 600 to 860 nanometers (nm) at 20 nm intervals on a spectrophotometer relative to the barium sulfate standard, the preferred white standard. Other white reference materials may be used provided they are calibrated to absolute white, e.g. magnesium oxide or vitrolite tiles. 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 the polychromatic mode is used, the spectrophotometer shall operate with the specimen diffusely illuminated with the full emission of a source that simulates either CIE source A or CIE source D65. The specimen shall be measured as a single layer, backed with six layers of the same fabric and shade. Measurements shall be taken on a minimum of two different areas and the data averaged. The measured areas should be taken at least 6 inches away from the selvage. The specimen shall be viewed at an angle no greater than 10 degrees from the normal, with the specular component included. Photometric accuracy of the spectrophotometer shall be within 1 percent and the wavelength accuracy within 2 nm. The standard aperture size used in the color measurement device shall be 0.3725 inches in diameter. Any color having spectral reflectance values outside the limits at four or more of the wavelengths specified shall be considered a test failure.

#### 4.4.5.2 Color Matching.

4.4.5.2.1 Visual color matching (all types and classes). The color and appearance of the Type I, Type II, Type III, and Type IV camouflage printed and permethrin treated cloth and Type V dyed cloth shall match the standard sample when viewed using AATCC Evaluation Procedure 9, Option A, under filtered tungsten lamps that approximate artificial daylight D75 illuminant with a color temperature of  $7500 \pm 200$  K with illumination of  $100 \pm 20$  foot candles, and shall be a good match to the standard sample under horizon lamplight at  $2300 \pm 200$  K.

4.4.5.2.2 Instrumental color matching (all types and classes). Instrumental color matching is used as a tool to quantify shade evaluation if visually shade is rated unacceptable. All the colors in the Woodland MARPAT shall be instrumentally measured except for Khaki and all the colors in the Desert MARPAT shall be measured except for Highland given the areas of these exempted colors are too small for accurate instrumental readings. The solid colored knit fabric shall be instrumentally measured. Each measured color shall match the standard sample using AATCC Evaluation Procedure 6. A color difference greater than a  $\Delta E_{CMC} = 1.5$ , when using a  $\Delta E_{CMC}$  (2:1) ratio (D65 /  $10^\circ$ ) units as compared to the standard sample, shall be basis for rejection.

4.4.5.3 Toxicity assessment. The contractor must furnish information (see 4.4.5.3.1) certifying that the finished product is composed of materials which have been safely used commercially OR which provide sufficient toxicity data to show compatibility with prolonged, direct skin contact. At a minimum, toxicity data should include results from a primary dermal irritation study in laboratory animals and a repeated insult human patch test (Modified Draize Procedure). The latter must be conducted under the supervision of a qualified dermatologist using at least 100 free-living individuals.

4.4.5.3.1 Toxicity Documents. All finishes/chemicals used to process the garment shall be identified and accompanied by the appropriate Material Safety Data Sheet (MSDS) information. The use of chemicals recognized by the Environmental Protection Agency (EPA) as known human carcinogens is prohibited.

4.4.5.4 Force versus elongation of elasticized features. Cargo pocket and waistband samples shall be samples from garments that are constructed to duplicate the configuration on the finished garment where the elastic webbing is set on or within the trouser fabric. The cargo pocket length (relaxed) is the finished opening length of six inches in length. The waistband shall consist of one side of the elasticized waistband which is approximately four inches in length (relaxed). Both cargo pocket and waistband samples are laundered 5 times as per AATCC 135, 3, V, iii and stitching which sets the elastic must stay secured through the washings. Tensile properties are evaluated by conducting tensile tests utilizing equipment, which conform to ASTM D-76, Standard Specification of Tensile Testing Machines for Textiles. Samples are conditioned in a 70 degree F, 65% RH laboratory for a minimum of 24 hours. The specimens are clamped in pneumatic jaws in a relaxed state (no force on read out) where the jaws are spaced 4.0 inches apart.

4.4.5.4.1 Cargo Pocket. The cargo pocket sample shall be centered between the jaws so that the set elastic webbing is clamped into each jaw. A Constant Rate of Extension (CRE) with a loading rate of 20.0 inches per minute is used. The crosshead is moved 1.5” for a total of 5.5”. The resulting force is recorded at a rate of 10 points per second. One cycle consists of this elongation as well as the return to the initial 4.0” separation position. The cycle is repeated 100 times for each sample. The graph shall be evaluated and the sample will meet the requirement when no peak is greater than 3.5 lbs. nor less than 2.5 lbs.

4.4.5.4.2 Waistband. A Constant Rate of Extension (CRE) with a loading rate of 2.0 inches per minute is used. The crosshead is moved 1.5” for a total of 5.5”. The resulting force is recorded at a rate of 10 points per second. The graph shall be evaluated to record the force separately at  $\frac{3}{4}$  inch and 1  $\frac{1}{2}$  inch extension. The sample meets requirements when the  $\frac{3}{4}$  inch extension does not exceed 1.5 lbs nor is less than 0.5 lbs, and the 1  $\frac{1}{2}$  inch extension does not exceed 4 lbs nor less than 1  $\frac{1}{2}$  lbs. The sample must demonstrate acceptable performance at both extensions to pass the requirement.

4.4.5.5 Permethrin content analysis. The permethrin content of treated fabric shall be determined by gas chromatographic procedure and directly compared to an external standard containing known permethrin content (see 4.4.5.5.2.1). Alternate method(s) of extraction and analysis, and specimen size are subject to government approval and laboratory cross correlation prior to implementation. The conditions described in this method are optimum for the gas chromatograph employed. These conditions may vary based on the gas chromatograph used. The carrier gas flow rate shall be adjusted so the elution of the first permethrin isomer is greater than 5 minutes. Alternate methods of extraction and analysis are subject to government approval and laboratory cross correlation prior to implementation.

4.4.5.5.1 Apparatus.

4.4.5.5.1.1 Analytical Balance. 0.0001g sensitivity, Mettler Toledo, or equal

4.4.5.5.1.2 Analytical Balance. 0.000001g sensitivity, Mettler Toledo, or equal

4.4.5.5.1.3 Glassware.

- a. 10-100mL volumetric flasks
- b. Funnel
- c. Pipettes

4.4.5.5.1.4 Automatic Die Cutter. Freeman Atom, or equal

4.4.5.5.1.4.1 Three Inch Cutting Die. 3 inch diameter circular steel die cutter

4.4.5.5.1.5 Extraction Apparatus.

4.4.5.5.1.5.1 Accelerated Solvent Extractor (ASE). Dionex Corporation or equal

- a. Liquid Nitrogen Cylinder to Deliver High Pressure Gas, 230psi32
- b. Complete Extraction Cells, 22mL

- c. Cellulose filters, 1.98cm
- d. 40mL Amber Glass Collection Vials
- e. Solvent Resistant Teflon-Silicone Coated Septa
- f. 3mm-4mm borosilicate glass beads

4.4.5.5.1.5.2 Soxhlet.

- a. Electric heater with variable control
- b. Heat resistant glass flask when using Soxhlet extractor. The flask shall be a 250mL, flat or round bottom, and single neck.
- c. Extractor condenser
- d. Boiling condenser
- e. Cellulose extraction thimbles

4.4.5.5.1.6 Agilent 6890N (G1530N) Series Gas Chromatograph. Gas Chromatograph equipped with ChemStation software, or equal

- a. Carrier Gas Cylinder, Appropriate Regulator Set at 80psi
- b. Hewlett-Packard Capillary Column, 5% Phenyl Methyl Siloxane/30.0m x 250µm x 0.25µm nominal, 325oC Max, or equal.
- c. Split Inlet Liner, Packed with Silanized Glass Wool/5mm
- d. Injector Microliter Syringe, Capable of Delivering 1µL
- e. GC Amber Injection Vials and Rinse Vials

4.4.5.5.1.7 Agilent Series 5973N (G2579A) Mass Spectrometer, or equal.

- a. Performance Turbo Pump MSD (EI Mode), or equal

4.4.5.5.1.8 Ultrasonic Cleaner. Branson, or equal

4.4.5.5.1.9 High Temperature Convection Oven. 500°C Max

4.4.5.5.1.10 Refrigerator Storage. 4°C

4.4.5.5.2 Reagents.

4.4.5.5.2.1 Permethrin Analytical Standard. Permethrin standard shall be  $\geq 97\%$ , mixture of Cis/Trans Isomers. Permethrin standards are available from FMC Agricultural Products; Princeton, New Jersey 08543; FMC reference #33297; 97% purity/specified technical, or equal

4.4.5.5.2.2 Solvent Mixture. Solvent mixture shall be 80% Acetonitrile/Analytical Grade and 20% Methanol/Analytical Grade

4.4.5.5.2.3 High Purity Helium Carrier Gas. Carrier gas shall be  $\geq 99.999\%$

4.4.5.5.2.4 Cleaning Solutions. Cleaning solutions shall be as follows:

- a. Micro-90 Ultra Cleaning Solution, or equal
- b. Reversed Osmosis Water, 98% Rejection Rate

4.4.5.5.3 Calibration of Apparatus.

#### 4.4.5.5.3.1 Analytical Balance.

4.4.5.5.3.1.1 Pre-Weighing Procedures. Prior to weighing, initiate the internal weight calibration function or use an external certified weight set to verify that the balance is operating properly.

4.4.5.5.3.1.2 Manufacturer Calibrations. Obtain manufacturer certifications within 12 months prior to taking measurement.

#### 4.4.5.5.3.2 Gas Chromatography equipped with Mass Selective Detector (See 4.4.5.5.1.6, 4.4.5.5.1.7)

- a. Perform the manufacturer's recommended calibration procedures prior to analyses.
- b. Before samples or required blanks can be analyzed, the instrument must meet the initial calibration acceptance criteria (see 4.4.5.5.7).

4.4.5.5.3 Cleaning Techniques. Establish cleaning techniques to ensure that no permethrin carries over from experiment to experiment. The techniques listed below have been determined to be suitable:

- a. Evaporate excess solvent from extraction glassware and wash using conventional methods. (see 4.4.5.5.2.4)
- b. Bake off residual organic substances from glassware in high temperature convection oven, 500oC, for three to six hours. (see 4.4.5.5.1.9)
- c. Sonicate A.S.E. Cells in the solvent that was used for the extraction. (see 4.4.5.5.1.8)

#### 4.4.5.5.4. Sampling and Test Specimens.

4.4.5.5.4.1 Sample size. The garment sample size to be tested shall be selected in accordance with ANSI/ASQ Z1.4, Special Inspection Levels S-1 and AQL of 1.5, OR a minimum of three (3) samples per lot to be evaluated.

#### 4.4.5.5.4.2 Test specimens.

- a. From sample garment being evaluated (unlaundered, after 20 and after 50 launderings), select three 3 inch diameter specimens (use a 3 inch circular cutting die having surface area of 45.6037cm<sup>2</sup>) for each test condition. For the blouse, three specimens should be taken from both the Types I - IV (woven) cloth and Type V (knit) cloth portions of the garment. Cut specimens from single ply areas so that no two specimens shall contain the same warp and filling yarns (Types I - IV) or same course and wale yarns (Type V). Specimens for the measurement of permethrin content after laundering shall be cut after the finished garment has been laundered according to AATCC 135, 3, V, III to the specified number of cycles. Laundered specimens shall be cut from different ply areas across the garment.
- b. Weigh each specimen to the nearest milligram (see 4.4.5.5.1.1).

#### 4.4.5.5.5 Standard Preparation.

- a. Prepare six concentrations of permethrin standards which are 20, 50, 75, 100, 150, and 200ng/μL, [1ng/μL is equal to 1 part-per-million (ppm)]

- b. Using the balance specified in 4.4.5.5.1.2, weigh 10mg ± 1mg of permethrin crystals and place into a 50mL volumetric flask and fill with 80% acetonitrile/20% methanol solvent to obtain the standard of 200ng/μL. Make all appropriate dilutions from this flask to obtain the additional standards.
- c. Calculate the actual concentrations of the standards based on the weight of the permethrin.

4.4.5.5.6 Extraction Procedure (see 4.4.5.5.1.5)

4.4.5.5.6.1 ASE.

4.4.5.5.6.1.1 Preparing Specimens. Roll each specimen and place into an ASE cell fitted with a cellulose filter. Fill the void with glass beads to conserve solvent. Place all cells onto ASE cell tray.

4.4.5.5.6.1.2 Quality Control. Extract a specimen blank for every run to detect if any carryover of permethrin is significant.

4.4.5.5.6.1.3 Accelerated Solvent Extraction Procedures.

4.4.5.5.6.1.3.1 Parameters.

Cell Size	22mL
Collection vials	60mL, light blocking/amber
Solvent	80% Acetonitrile, 20% Methanol

Approximate Gas Pressures:

System	50 psi
System Solvent	10 psi
Oven Compression	130 psi

Parameters:

Preheat	0 min
Heat	5 min @ 100°C
Static w/Solvent	10 min @ 1500 psi
Flush Volume	90%
Purge	90 sec
Cycles	2

4.4.5.5.6.1.3.2 Preparation for analyses. Dilute or concentrate each vial to 40mL and prepare a 1mL aliquot from every specimen extraction for GC analysis. Permethrin recovery must be 95% or greater (see 4.4.5.5.6.4).

4.4.5.5.6.2 Soxhlet. Place each specimen into cellulose Soxhlet extraction thimble. Add 160mL of the acetonitrile/methanol mixture and boiling chips into a 250mL flask. Assemble the Soxhlet

apparatus and extract the permethrin treated specimens for 6 hours or until and extraction recovery of 95% or greater has been achieved (see 4.4.5.5.6.4). Concentrate the extract by rotoevaporation, or equal, at 35°C to a final volume of 40mL.

4.4.5.5.6.3 Storage. After the specimens are extracted, store in light blocking amber vials in refrigerator until ready to inject (see 4.4.5.5.1.10). Specimen extractions shall be stored in a refrigerator for no longer than three months. When ready to analyze, allow the temperature of the GC vials to equilibrate in the area of evaluation before injection into GC.

4.4.5.5.6.4 Extraction Efficiency.

- a. Select three random specimens from any permethrin treated fabric sample and perform three consecutive extractions.
- b. Quantify the level of permethrin recovered from each specimen for each consecutive extraction, through GC/MS analysis.
- c. Verify that the percent recovery of permethrin for any specimen size and composition, is 95% or greater by comparing the recovery level from the first extraction, to that of subsequent extractions. Combine the permethrin levels obtained from each of the three extractions, if the initial extraction yields permethrin levels 95% or greater than the total percent of permethrin extracted three sequential times, then the extraction efficiency is 95% or greater. Note - To ensure that the extraction efficiency is being accurately calculated, the permethrin levels in the second and third extraction should be minimal, and the permethrin level by the third extraction should be trace or zero.

Note: Initial verification of extraction efficiency of this test method must be performed. Once an extraction efficiency of 95% or greater is established, no further demonstration of the extraction efficiency is needed.

4.4.5.5.7. Analytical Procedure.

4.4.5.5.7.1 Quality Control. Laboratory blanks that contain no analyte are used to ensure specimens are free of contaminants or to ensure there is no cross contamination during a run. Inject a blank containing 80% acetonitrile/20% methanol before every set of standards and before and after every ten specimens. If any blank, after multiplying concentration by five, is greater than any specimen result, the specimen data points are invalid and a system check must be run to identify the source of the carry over. After system maintenance has been performed, repeat injections of the standards for the calibration curve, new blanks, and new aliquots of the specimens affected by the previous carryover.

4.4.5.5.7.2 Standard Injection.

- a. All six permethrin standards will be injected at the beginning and at the end of each series of specimens to "bracket" the specimen injections. Check linearity of the standards for each set of injections by plotting the responses (area counts) on the x-axis vs. the calculated standard concentrations on the y-axis. A 3rd order polynomial regression line with R-squared value of 0.99 or greater is acceptable. Derive the equation of the 3rd order polynomial for sample calculations.

4.4.5.5.7.3 Specimen Injection. Run specimen injections in duplicate. Sample extracts, standards, and blanks must be analyzed within an analytical sequence such as listed below:

- a. Initial calibration (Standards)
- b. Instrument blank at the end of the initial calibration
- c. Specimen Series 1 (extracts 1-10, 1st quantitation)
- d. Instrument blank
- e. Standard Series 1
- f. Instrument blank
- g. Specimens Series 2 (extracts 1-10, 2nd quantitation)
- h. Instrument blank
- i. Standard Series 2
- j. Instrument blank
- k-r. Subsequent specimen series,( ex. 11-20, including blanks, and standard series)
- s. Final calibration (Standards)

Note: After the initial calibration, the analytical sequence may continue as long as acceptable instrument blanks and the standards are analyzed at the required frequency. If any specimen count does not fall on the standard calibration curve, the evaluator may dilute that specimen by 1:10 and re-run; calculations of the permethrin level must be adjusted using the factor of 10.

4.4.5.5.7.4 Gas Chromatograph/Mass Spectrometer Parameters. (see 4.4.5.5.1.6)

4.4.5.5.7.4.1 Injection procedures.

- a. Place all GC vials into auto sampler tray. To avoid vapor pressure differences, all vials must be at room temperature and containing identical volumes.
- b. Inject 1 $\mu$ L into the Gas Chromatograph equipped with Mass Spectrometer. Use high purity helium carrier gas (see 4.4.5.5.2.3) and appropriate column.
- c. Ensure that rinse vials in the injector port contain 80% acetonitrile/20% methanol above the minimum solvent line.

4.4.5.5.7.4.2 Instrument Settings. The following parameters will be used in the analysis:

Oven Temperature	250 °C
Injector Temperature	275 °C
Detector Temperature	280 °C
Injection volume	1 $\mu$ L
Carrier Gas Flow Rate	1.3 mL/min
GC Run Time	10 min
Split Ratio	3:1

MS Single Ion Monitoring

Scan Parameters	EM Voltage Gain Factor of 1
Real Time Plot	10 min
Resolution	Low
Solvent Delay	4 min
Start Time	4 min, 4.26 Cycles/sec



of these conditions will be measured as specified in 4.4.5.5 to correlate biological toxicity with the particular garment treatment used to meet requirements specified in 3.3.9.

4.4.5.6.1 Number of determinations. Three determinations will be run for each of the 2 insect species (see 4.4.5.6.3.3). Each determination for each insect is conducted with 4 volunteers using 3 different fabric conditions; unlaundered, 20 launderings and 50 launderings and compared to non-permethrin treated control. One set of controls will be used for the 3 determinations for each volunteer (see 4.4.5.6.3.6). The total number of specimens for the 3 determinations is outlined below. It is estimated that one trouser yields 4 specimens consisting of largely a single ply fabric area (see 4.4.5.6.2).

<u>Number of Insect tests</u>	<u>X Number of Determinations</u>	<u>X Number of Volunteers</u>	<u>X Number of Fabric Conditions</u>	<u>= Total Specimens per Garment Type</u>
Mosquitoes <u>1/</u>	3 x	4 x	3 x	= 36 <u>2/</u>
Control <u>2/</u>	1 x	4 x	3 x	= 36 <u>2/</u>

1/ one set of treated specimens will be used twice to test each mosquito species

2/ Total garments estimated, required to conduct 3 determinations are; 9 treated trousers, 3 untreated trousers

4.4.5.6.2 Specimen size. Specimens will be cut to the shape and dimensions illustrated in Figure 5. The cut specimen shall be folded in half lengthwise (right sides together) and seamed 1/8” from the raw edge. The seam shall finish 2-1/4” from the narrower end of the sample, with the completed seam measuring 9-3/4”. Specimens shall be cut from single fabric ply areas. To minimize the number of garments needed for each determination, multiple ply areas such as seam areas or hems may occur limitedly in the perimeter areas provided multiple plies of fabric in these areas shall not create a gap between subject’s arm and fabric (see 4.4.5.6.3.5). Specimens will be cut with gloved hand and placed in a plastic bag and the glove disposed of to avoid residual contamination of controls. When failure point is being quantified, the laundered samples may be used to accomplish the additional launderings needed.

4.4.5.6.3 Procedure. The procedure to conduct biting protection assay shall follow the “EPA Product Performance Test Guidelines, OPPTS 810.3700, Insect Repellents For Human Skin and Outdoor Premises (see 2.2.2), and is described in part below, noting any exceptions to this procedure.

4.4.5.6.3.1 Applicable Protocol. Within OPPTS 810.3700 , Section 3 addresses treated fabric material and section (3)(iii) specifies that laboratory studies are conducted as described in (d)(1) of the OPPTS 810.3700 guideline.

4.4.5.6.3.2 Fastening Test Specimen. Section (3)(iii) recommends “fastening a strip of the impregnated material to the test subject’s forearm.” This will be accomplished by utilizing specimen size specified in 4.4.5.6.2 (see Figure 5) and ensure it covers the entire forearm of the test subject without gaps for insect access. With the arm in the pronated position, the fastening seam that closes the specimen on the volunteer’s arm shall be located on the top of the forearm.

Attachment of the treated specimen will be done with gloved hand, which will be disposed of prior to attaching the control to alternate arm.

4.4.5.6.3.3 Test Insects. OPPTS 810.3700 section (d) (1) addresses laboratory tests conducted with mosquitoes and stable except this test shall utilize two species of mosquito. The results of this evaluation for the mosquitoes are a contractual requirement. Insect genus, species and subspecies, colony origin and approximate age shall be used as specified below and in 4.4.5.6.3.3.1 and 4.4.5.6.3.3.2.

Mosquitoes:

Aedes (Stegomyia) aegypti

Anopheles albimanus

4.4.5.6.3.3.1 Insect Characteristics. Mosquito ages employed for these studies shall be 5-11 days old after emergence from the pupal stage. Methods should be used to preselect females for the studies. Use either a hand draw box or cold table to collect mosquitoes for the required cage density (see 4.4.5.6.3.3.3).

4.4.5.6.3.3.2 Insect Rearing. Insects for these studies shall be reared under optimal conditions for larvae, as described in OPPTS 810.3700, section (d)(1)(iii).

4.4.5.6.3.3.3 Cage Conditions. A cage density of 225 + 25 female insects per cage is required to meet the biting pressure density of at least one female mosquito per 100 cm<sup>3</sup> cage volume. (Cages shall be 20,000 cm<sup>3</sup>, with a sleeved opening for the arm of the volunteer to be inserted.) Cages shall be constructed of a lightweight clear plastic on 4 sides, with the side opposite the cloth sleeve containing a screen covered by a plastic flap. Tests shall be conducted with fluorescent lights on and under room conditions (22-27°C, and 40-80% RH). The temperature and RH during the test shall be recorded and reported.

4.4.5.6.3.4 Subjects. A minimum of 4 test volunteers shall be used in each study for each insect species at each test facility. The same 4 subjects can be used to evaluate different insect species done at the same facility. Each replicated assay with a volunteer and garment specimen shall be run on different days such that a specimen is not simply replicated under the same environment conditions and using essentially the same insect population. Due to the replication, the number of volunteers is now decreased from the 5 or more recommended in OPPTS 810.3700, section (c)(3)(i). Equivalent numbers of females and males are preferred for the study, and if not possible, at least one male and female volunteer shall be included for each insect species. Cosmetics and alcohol shall be avoided 12 hr prior and during the test. Volunteers shall read and sign the appropriate Institutional Review Board (IRB)-Human Use protocol forms, required for their consent, prior to being used in the test. IRB protocols shall be approved through the appropriate agencies' IRB mechanisms.

4.4.5.6.3.5 Volunteer's Test Area. The test area shall consist of the region from the wrist to approximately ½ inch before the elbow. Fabric material shall be secured around the forearm to eliminate gaps between the arm and material and with the fastened seam positioned on the top of the forearm as specified in 4.4.5.6.3.2. The ends of the garment, near the wrist and elbow shall

be sealed with protective tape of adequate thickness to prevent insects from biting through the tape. The hand shall be gloved with a glove of appropriate thickness to prevent biting through to the hand.

4.4.5.6.3.6 Controls. For each test condition a control shall be conducted. The control shall consist of the same fabric without the insect protection treatment and be identical size to the test swatch (see 4.4.5.6.2). Controls will be cut in clean area and stored in separate plastic bags to avoid residual permethrin contamination. Laundered controls shall be laundered separately and to the identical number of times as the treated fabric. Controls shall be worn on the arm opposite the treated specimens.

4.4.5.6.3.7 Biting Exposure. Arms containing the treated specimens shall be exposed to a cage of insects for 15 minutes. Since both arms shall contain fabric (one as the control, one as the treatment), the order of the exposure periods shall be randomized; however, effort should be made to run each period consecutively, with as little elapsed time as possible in between testing of a volunteer's arms.

4.4.5.6.3.8. Raw Data. Raw data shall consist of the insect information as described in 4.4.5.6.3.3, the number of insects used per cage, and method of selection of these insects. The number of male and female insects shall be counted and only the number of females used for purposes of identifying insects that bite compared to non-biting mosquitoes. The number of bites received for each sample (treatment or control) shall be counted and recorded.

4.4.5.6.4 Report. Calculation of the reduction in bites for the treatment, compared to the control, shall be expressed as a percentage that represents the percentage bite protection as shown below. Individual subject results for each trial (3 for each treatment type or control), shall be averaged with all trials for the other volunteer subjects in the study. An overall average % bite protection shall be calculated by Abbott's equation below and reported in this manner for each insect and for all volunteer tested. For initial and 20 wash conditions, a single average within each species trial may fall below the 85% minimum provide it is greater than or equal to 80% and the overall average of all 4 (or more) volunteer's samples results in bite protection which is greater than or equal to 85%. For the 50 wash condition, single average within each species trial may fall below the 75% minimum provide it is greater than or equal to 70% and the overall average of all 4 (or more) volunteer's samples results in bite protection which is greater than or equal to 75%.

$$\% \text{ Bite Protection} = \frac{(B_{NC}/F_C) - (B_T/F_C)}{(B_{NC}/F_C)}$$

where:

$B_{NC}$  = bites recorded on the arm covered by the negative control fabric

$F_C$  = female insects in the cage that are capable of biting at the start of the 15-minute period

$B_T$  = bites recorded on the arm that was covered by the treated fabric.

4.4.5.7 Drying time test method.

4.4.5.7.1 Apparatus.

4.4.5.7.1.1 Wringer. Motor driven, see AATCC 70 footnote 11.2.

4.4.5.7.1.2 Laboratory balance. Accurate to 0.01 grams.

4.4.5.7.2 Materials.

4.4.5.7.2.1 White AATCC blotting paper. 25 x 25 cm, see AATCC footnote 11.3.

4.4.5.7.2.2 Water, distilled.

4.4.5.7.2.3 Glass beaker, 250mL.

4.4.5.7.3 Test Specimens. The fabric samples and blotting paper should be conditioned at  $65 \pm 2\%$  RH and  $70 \pm 2^\circ\text{F}$  for a minimum of 4 hours. Three (3) 2x2 inches samples should be cut per fabric tested.

4.4.5.7.4 Procedure. Test shall be run in standard conditions,  $65 \pm 2\%$  RH and  $70 \pm 2^\circ\text{F}$ .

- a. Weigh the conditioned specimen using a laboratory balance accurate to 0.01g.
- b. Place 100 mls of distilled water into a 250 ml glass beaker.
- c. Submerge the specimen in the beaker of water for 30 minutes. Make certain that the specimen is completely submerged to insure complete wetting.
- d. Remove the specimen and sandwich it between two pieces of unused blotting paper. Pass the sandwich through the wringer with a dead weight load of  $27.7 \pm 0.5$  kg.
- e. Immediately place specimen on the balance with top door of the balance open, side doors closed and record wet weight either to the nearest 0.01 or 0.1 grams. Manually monitor weight at set intervals until dry or use an automated balance with capability to weigh specimen until dry (Suitable Automation Software for a balance, Labtronics Inc., Web: [www.labtronics.com](http://www.labtronics.com)). Record time to dry.
- f. Repeat for remaining specimens. Average the 3 specimens.

4.4.5.8 Instrumented Manikin Testing. Finished end item blouse and trousers shall be tested according to ASTM F1930 and subjected to 4 second exposure at  $2.0 \text{ cal/cm}^2/\text{sec}$  heat flux. The EFRCE (medium-regular size) shall be tested after one (1) and twenty-five (25) laundering cycles according to AATCC 135, 3, V, Aiii. Items shall be tested with cotton t-shirt and briefs underneath the EFRCE. The EFRCE shall have no more than 25% total burn injury prediction including 2<sup>nd</sup> and 3<sup>rd</sup> degree burns. The burn sensors in the torso and head sections should be excluded from the total burn injury calculation as the torso sensors would not register a burn as this area is covered and protected by a ballistic vest and the uniform does not cover the head. This test shall be conducted during First Article Testing (FAT) and when a significant change is

made to the garment design or materials. The change is determined to be significant by the Marine Corps Systems Command.

4.4.5.9 Antimicrobial properties testing and clarification for Type V cloth only. There is significant room for customization within the American Association of Textile Chemists and Colorists (AATCC) Test Method 100 (TM100). The purpose of this clarification is to decrease how much the procedure can be changed and minimize variation between labs.

4.4.5.9.1 Microbes. Antimicrobial activity will be measured using *Staphylococcus aureus* ATCC 6538 and *Pseudomonas aeruginosa* ATCC 9027.

4.4.5.9.2 Fabric samples. Testing shall be conducted on a single ply of fabric. An untreated control fabric will be run for each determination that closely approximates the characteristics of the treated fabric without anti-microbial technology.

4.4.5.9.3 Laundering procedure for preparing anti-microbial fabric testing. The laundering equipment must be cleaned and dedicated laundry ballast is prior to laundering the test fabric to avoid contaminating the test fabric.

4.4.5.9.3.1 Test fabric preparation. The test fabric may include selvages and requires pinking shears to prepare cut edges to minimize fraying in laundering. Over edged stitching is not allowed. After each laundering cycle, trim any frayed yarns from fabric so that the fabric is not distorted or bunched in subsequent wash/dry cycles.

4.4.5.9.3.2 Washing machine equipment preparation. Clean the washing machine before beginning the test fabric launderings by using - 200 ml bleach to 18 gallons of water at 120 +/-5 F, normal cycle. Use same washing machine for the 25 launderings (25X) of the test fabric without allowing a different fabric/ballast to be washed in between these cycles.

4.4.5.9.3.3 Laundry ballast preparation. Use dedicated ballast for anti-microbial testing to avoid contamination with other functional finishes. The ballast shall be laundered with 200 ml bleach to 18 gallons of water before laundering the test fabric.

4.4.5.9.3.4 Dryer equipment preparation. Wipe the inside of the dryer drum clean with isopropyl alcohol. Use the same dryer for 25X without allowing a different fabric/ballast to be washed.

4.4.5.9.3.5 Test fabric laundering procedure. After the preparation is complete, launder the fabric specimens 25 times as follows: Launder in accordance with AATCC 135 with AATCC Detergent (non-phosphate, warm water at 100 to 110 deg F for 30 minutes and tumble dry, permanent press cycle 150 to 160 deg F). The following cycles shall be run without detergent; 5, 10, 15, 20, 24 and 25, to prevent residual detergent.

4.4.5.9.4 Antimicrobial test procedure.

- a. Grow test organisms *Staphylococcus aureus* ATCC 6538 and *Pseudomonas aeruginosa* ATCC 9027 in 1x nutrient broth (NB) overnight (approximately 18 hours).

- b. For a single determination for each organism, two incubation times, 0 hours, and 24 hours, shall be examined. Cut each specimen into 48 mm circles in triplicate for each time point. Do not sterilize; plating will be done on medium selective for the test organisms (see step o).
- c. Determine the amount of 0.125x NB/0.15% Triton X-100 that each type of material can absorb within 10-20 minutes. Record mL of inoculum per swatch: \_\_\_\_\_
- d. Determine Optical Density at 600 nm (OD600) of inoculum. If not already determined, find the OD600 that will yield a cell concentration of approximately  $10^8$  CFU/mL (should be approximately 1.00). Dilute the inoculum to this OD600. Record OD: \_\_\_\_\_
- e. Centrifuge 1 mL of cells for 3 minutes at 10,000g and remove supernatant.
- f. Resuspend cells with 1 ml 0.125x (diluted 1:8) NB with 0.15% (w/v) Triton X-100.
- g. Repeat steps e and f. Recheck OD600.
- h. Dilute cells 1:10 with 0.125x NB/ 0.15 % (w/v) Triton X-100 to target concentration of  $1-2 \times 10^7$  CFU/ml. Serially dilute inoculum 10-fold for plating to determine concentration.
- i. For each sample, fill a sterile screw-cap 100 mL bottle or 50 mL tube with D-E broth. Add  $100 \times$  the amount of liquid determined in step b. For example, if 0.20 mL of inoculum was used, use 20.0 mL of D-E broth. For 24 hour samples, also prepare an empty sterile bottle or tube for overnight incubation.
- j. Inoculate each single swatch specimen in a Petri dish with the amount of inoculums determined (in step c) to avoid puddling of inoculum not in contact with the sample.
- k. For 24 hour samples, place swatch into empty bottle or tube and incubate at  $37 \pm 2^\circ\text{C}$  for 24 hours.
- l. For 0 hour samples, place the rolled swatch into a bottle or tube with D-E broth. Agitate vigorously.
- m. After 24 hours of incubation, take 24 hour samples out of bottle or tube and place into prepared bottle with  $100 \times$  the amount of liquid determined in step b.
- n. Serially dilute D-E solution 10-fold in PBS buffer (final dilutions  $10^{-1}$  and  $10^{-2}$  using spiral plating; additional dilution  $10^{-3}$  will be necessary for spread plating).
- o. Spread plate 0.1 ml of the  $10^{-1}$ ,  $10^{-2}$ ,  $10^{-3}$  dilutions in duplicate on selective media; alternatively, spiral plater may be used with  $10^{-1}$  and  $10^{-2}$ . These dilutions are usually suitable to obtain valid counts. Other methods of enumeration such as Most Probable Number (MPN) may be used **if the test facility can demonstrate close correlation to plate counts**. If an alternate method of enumeration is used, please specify.

1. *S. aureus* – BBL Mannitol salts agar (cat # 211407, BD Diagnostic Systems)

2. *P. aeruginosa* – Ceftrimide agar (cat # 7222, Neogen Corp)

p. Incubate plates overnight at 37 ±2°C.

q. After incubation, repeat steps a – o for 24 hour samples.

#### 4.4.5.9.5 Antimicrobial Test Calculations.

##### 4.4.5.9.5.1 Enumeration.

a. Report bacterial counts as the number of bacteria per swatch of fabric, not as number of bacteria per mL of D-E neutralizing solution. To convert from bacteria/mL of D-E to bacteria/swatch, use the following formula:

$$B_N \times V_N = B_S \quad \text{Where:}$$

$B_N$  = Bacteria per mL of D-E Neutralization broth

$V_N$  = Volume of Neutralization broth used per swatch

$B_S$  = Bacteria per swatch

b. For spread plating, use the following formula to determine bacteria per mL of D-E neutralizing solution:

$$B_P \div V_P \times 10^D = B_N$$

Where:

$B_P$  = Colony Forming Units (CFU) of bacteria found on plate

$V_P$  = Volume of diluted D-E Neutralization broth added to plate

$D$  = Number of serial dilutions performed on D-E broth

$B_N$  = Bacteria per mL of D-E

c. If no bacteria are observed from a swatch, report as the higher of:

- Minimum possible result for method of enumeration used.
- $(100 \times V_N)$ .  
Mark with an asterisk.

d. If all plates are too numerous to count, report as the higher of:

- Maximum possible result for method of enumeration used.
- $(10^7 \times V_N)$   
Mark with two asterisks

##### 4.4.5.9.5.2 Evaluation of Results.

1. Use geometric mean to determine average bacterial count for swatches. To calculate geometric mean:

$$\sqrt[n]{(S_1 \times S_2 \times S_3 \dots \times S_{n-1} \times S_n)} = GM$$

Where:

$n$  = number of swatches

GM = Geometric Mean

For example, with 3 swatches, the geometric mean is  $\sqrt[3]{(S_1 \times S_2 \times S_3)}$ .

- To calculate Percent and Log<sub>10</sub> Reduction for a sample:

$$(GM_0 - GM_{24}) / GM_0 \times 100 = R_P$$

$$\log_{10}(GM_0) - \log_{10}(GM_{24}) = R_L$$

Where:

GM<sub>0</sub> = Geometric mean of all 0h bacteria/swatch counts for the sample

GM<sub>24</sub> = Geometric mean of all 24h bacteria/swatch counts for the sample

R<sub>P</sub> = Percent Reduction

R<sub>L</sub> = Log<sub>10</sub> Reduction

4.4.6 End item visual examination. Finished end item blouse and trousers shall be subjected to visual examination after permethrin treatment. All fabric and garment defects shall be scored in accordance with examination descriptions as specified in Table XIII.

**TABLE XIII. End Item Visual Examination**

<b>Examination</b>	<b>Defect Description</b>
Bartacks	Bartacks or bartacks missing, insecure, misplaced, not specified size, stitches loose or broken, bartack/backtack not serving intended purpose
Belt Loops	Belt loops omitted, insecure, not specified size, or opening out of tolerance. (1 ± 1/8 inch wide x 3 ± 1/4 inches long opening)
Buttons & Buttonholes	Trouser fly and pocket flap buttons and button holes out of alignment causing bulge, twist or distortion when buttoned.
	Buttonholes and eyelets omitted, added, not clean cut or securely caught in fabric, not specified type, not specified location.
	Sleeve buttonhole placement not as specified – first buttonhole not aligned with cuff tab button, second buttonhole less than 3 1/8 or more than 3 3/8 inches from first, third button hole less than 1 7/8 or more than 2 1/8 inches from second. Eyelet end of sleeve buttonholes less than 5/8” or more than 7/8” from bottom edge of sleeve hem. Cuff button hole opening greater than 7/8 inch.
	Button color not as specified
Component Part	Component part of blouse or trouser omitted, distorted, full, tight, or twisted; any part of louse or trouser caught in any unrelated stitching, the edge of any component part required to be forced out having folds of more than 1/8 inch. Fullness creating unwanted permanent fold, pleat, or crease in fabric or garments, shade variations within or between parts. <u>1/</u>
Elastic	Trouser waist elastic omitted, not positioned as specified, not attached as specified, width not as specified, not caught in bartack, bartack not required length or positioned as specified
	Trouser cargo pocket elastic does not expand/retract to relaxed condition as specified, omitted, twisted, width not as specified, not caught in bartack,

	bartack not length or position specified, setting distorts trouser leg.
Evenness <u>2/</u>	Blouse:
	Blouse collar front points vary by more than 1/8 inch, collar curls, puckers, pleats, or twists. End of collar and edge of front facing out of alignment by more than 1/8 inch.
	Sleeve lengths vary by more than 1/2 inch. Cuff and cuff tab out of alignment with bottom folded edge of sleeve hem by more than 1/8 inch.
	Trouser:
	Waistband uneven more than 1/4 inch when buttoned
	Inseam and/or outseam lengths vary by more than 1/2 inch from leg to leg
	Bottom openings vary by more than 1/2 inch in half width
	Evenness of length between inseam and outseam varies by more than 1/2"
Eyelets	Omitted, misplaced, improper size or caught in stitching
Hems	Hems at blouse bottom, sleeves, and/or trouser legs twisted, wavy, omitted or not as specified.
	Hem width of blouse bottom and trousers less than 1/2" or more than 3/4". Sleeve hem width less than 2-3/8" or more than 2-5/8". Hem measurement taken from top fold to bottom fold.
Loop	Loop color or size not as specified
Labels	Omitted, incorrect, illegible, not attached where specified; bar-codes omitted, not readable by scanner; human-readable interpretation (HRI) omitted or illegible; bar code not visible on folded, packaged item; bar code attachment causes damage to the item.
Material	Hole, slub, cut, tear, smash, burn, exposed drill hole, run, thin place, color/dye streak, spots and/or stains, slubs, knots, color not as specified, misweave <u>3/</u>
	Fabric used for each blouse and trouser not as specified.
Patches	Elbow, seat and knee patches omitted, not attached as specified, or not positioned as specified in pattern
Packaging	Any blouse or trouser not packaged in accordance with the contract or purchase order
Pleats	Trouser pleats omitted, reversed, i.e. not facing outseam, front panel pleats stitched down less than 2-3/4 or more that 3-1/4 inches from top of trousers.
Pockets and Flaps	Pocket companions not uniform in size or shape
	Pockets twisted, curled or puckered, not stitched or located as specified
	Pocket flap not completely covering pocket opening, not positioned as specified.
	Pocket flaps not centered over pocket opening. Flap width extends pass finished pocket edge by more than 1/8" on each side.
	Sleeve and cargo pocket bellows exposed beyond edge of pockets by more than 1/8 inch
	Sleeve, cargo, and hip pocket out of horizontal alignment by more than 1/2"
	Sleeve pocket flap length at center from setting seam greater than 2 3/4"
Large Cargo pocket elasticized opening less than 6-3/4 or more than 7- 1/2	

	inches in width, forward bottom corner of flap not bartacked down. Bartack not positioned and stitched through both flap and pocket.
	Side Hanging pocket opening less than 6 inches.
Pressing Defects	Unwanted permanent fold, pleat or crease in garments affecting appearance or serviceability.
Stitching	Blouse or trouser seam: open stitching, puckered, distorted, pleated, repaired, wavy, twisted, irregular, loose or tight stitch tension, broken or missing thread or stitch, fullness, needle chew, visible mend, edge or raised stitching sewn too close to edge resulting in damage to cloth, seam allowance not as specified, visible raw edge, raw edge on outside, raw edge on inside along double needle seams, raw edge greater than 1/8 inch on inside of garment.
	Stitching not as specified.
	Double needle intersecting seams staggered by more than 1/4" except the crotch seam which is staggered by more than 1/2".
	Run off of more than 1/2" for edge and raised stitching
	Thread color not as specified

- 1/ Parts suspected of being off shade shall be examined at a distance of 3 feet against a background of the other parts and colors of the garment. When the shade difference is discernible under these examination conditions, it shall be scored as a shaded part.
- 2/ Evenness can be determined by comparing measurements of companion part OR by aligning parts and measuring difference in lengths as described below. Except for the collar, comparisons shall be inspected by extending the portions of the garments in parallel between two hands without stretching and inspecting for evenness. Where evenness defects are found, the garments shall be laid flat on a measuring surface and the difference in lengths recorded.
  - Collar: Evenness shall be assessed by folding the collar at center back and align the collar halves at the setting seam to the front collar ends. Rounded front collar points shall be compared for height, shape and curve.
  - Sleeves: Sleeves shall be aligned from top of shoulder seam, smoothed down along sleeve crease to sleeve hem edge. The aligned sleeve lengths shall be visually inspected for evenness of sleeve lengths, and sleeve pocket placement.
  - Inseam: Inseam shall be aligned with inseam along the top edge, starting from the center of the crotch seam along the inseam down to the trouser hem edge. The aligned trouser legs shall be inspected for evenness of the trouser legs.
  - Outseam: Outseam alignment shall be aligned by folding trousers in half width wise following the permanent press crease of the legs and aligning the top of the waistband. The aligned trouser legs shall be inspected for evenness of trouser length, and placement of companion cargo pockets. The folded trouser shall be turned vertically to enable alignment of the bottom opening widths for comparison.
  - Inseam/Outseam Length: While measuring inseam, the uniformity in length between inseam and outseam shall be inspected for evenness.
- 3/ As defined in FED STD 4B Glossary of Fabric Imperfections.

4.4.7 Finished garment visual examination. The garment shall be inspected after it is gently smoothed by hand and lying flat. Defects are defined in paragraph 4.4.6.

4.4.8 Finished dimensions (all types and classes). The finished and treated blouse and trouser shall conform to the dimension listed in Tables XIV and XV.

**TABLE XIV. Blouse – Finished Measurement (inches)**

<b>SIZE</b>	<b>XX-SHORT</b>	<b>X-SHORT</b>	<b>SHORT</b>	<b>REGULAR</b>	<b>LONG</b>	<b>X-LONG</b>	<b>XX-LONG</b>	<b>TOL.</b>
<u>Half Chest 1/</u>								
X-Small	--	19	19	19	19	--	--	± 3/4
Small	21	21	21	21	21	21	--	
Medium	23	23	23	23	23	23	23	
Large	--	25	25	25	25	25	25	
X-Large	--	--	27	27	27	27	27	
XX-Large	--	--	--	--	29	--	29	
<u>Half Bottom</u>								
<u>Width 2/</u>								
X-Small	--	15-3/4	15-3/4	15-3/4	15-3/4	--	--	± 3/4
Small	17-3/4	17-3/4	17-3/4	17-3/4	17-3/4	17-3/4	--	
Medium	19-3/4	19-3/4	19-3/4	19-3/4	19-3/4	19-3/4	19-3/4	
Large	--	21-3/4	21-3/4	21-3/4	21-3/4	21-3/4	21-3/4	
X-Large	--	--	23-3/4	23-3/4	23-3/4	23-3/4	23-3/4	
XX-Large	--	--	--	--	25-3/4	--	25-3/4	
<u>Back Length 3/</u>								
X-Small	--	29-3/4	30-3/4	31-3/4	33-1/8	--	--	± 3/4
Small	29-1/4	30-1/4	31-1/4	32-1/4	33-5/8	35	--	
Medium	29-3/4	30-3/4	31-3/4	32-3/4	34-1/8	35-1/2	36-7/8	
Large	--	31-1/4	32-1/4	33-1/4	34-5/8	36	37-3/8	
X-Large	--	--	32-3/4	33-3/4	35-1/8	36-1/2	37-7/8	
XX-Large	--	--	--	--	35-5/8	--	38-3/8	
<u>Sleeve Length 4/</u>								
X-Small	--	30	31	32	33	--	--	± 3/4
Small	30-1/2	31-1/2	32-1/2	33-1/2	34-1/2	35-1/2	--	
Medium	32	33	34	35	36	37	38	
Large	--	34-1/2	35-1/2	36-1/2	37-1/2	38-1/2	39-1/2	
X-Large	--	--	37	38	39	40	41	
XX-Large	--	--	--	--	40-1/2	--	42-1/2	
<u>Half Sleeve Cuff 5/</u>								
X-Small	--	6-1/2	6-1/2	6-1/2	6-1/2	--	--	± 1/8
Small	6-7/8	6-7/8	6-7/8	6-7/8	6-7/8	6-7/8	--	
Medium	7-1/4	7-1/4	7-1/4	7-1/4	7-1/4	7-1/4	7-1/4	
Large	--	7-5/8	7-5/8	7-5/8	7-5/8	7-5/8	7-5/8	
X-Large	--	--	8	8	8	8	8	
XX-Large	--	--	--	--	8-3/8	--	8-3/8	
<u>Collar Length 6/</u>								
X-Small	--	17-1/2	17-1/2	17-1/2	17-1/2	--	--	± 1/4
Small	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	--	
Medium	19-1/2	19-1/2	19-1/2	19-1/2	19-1/2	19-1/2	19-1/2	
Large	--	20-1/2	20-1/2	20-1/2	20-1/2	20-1/2	20-1/2	
X-Large	--	--	21-1/2	21-1/2	21-1/2	21-1/2	21-1/2	
XX-Large	--	--	--	--	22-1/2	--	22-1/2	
<u>Collar Height at CB 7/</u>								
								± 1/8

All Sizes	3-1/4	3-1/4	3-1/4	3-1/4	3-1/4	3-1/4	3-1/4	
<u>Collar Height at Front Edge</u> 8/ All sizes	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	± 1/8

The garment shall be zipped and placed flat upon a table and measured as follows:

- 1/ Half Chest – With blouse zipped up, measure from side seam folded edge to folded edge across blouse chest in line with pit of armhole (bottom of seam).
- 2/ Half Bottom Width – Measure from side seam folded edge to folded edge across blouse bottom at bottom edge.
- 3/ Back Length – Along center back measure from collar seam to bottom edge of blouse (in line with grain of fabric for straight line).
- 4/ Sleeve Length – Fold sleeve along underarm seam, measure along folded edge of the top sleeve from the center back to the bottom of the sleeve cuff.
- 5/ Half Cuff – Measure at bottom of cuff along edge from folded edge to folded edge.
- 6/ Collar Length at Neck Seam – Measure along neck seam from front edge of collar to front edge of collar.
- 7/ Collar Height at Center Back – Measure along center back of collar from setting seam to top of collar.
- 8/ Collar Height at Front Edge – Measure along center front edge of collar from setting seam to top of collar.

**TABLE XV. Trouser – Finished Measurement (inches)**

SIZE	X-SHORT	SHORT	REGULAR	LONG	X-LONG	XX-LONG	TOL.
<u>1/2 Waist – Relaxed</u> 1/ X-Small	12	12	12	12	--	--	
Small	14	14	14	14	14	--	- 1/4
Medium	16	16	16	16	16	16	+ 1/2
Large	18	18	18	18	18	18	
X-Large	--	20	20	20	20	20	
XX-Large	--	--	22	22	22	22	
<u>1/2 Waist – Stretched</u> 2/ X-Small	14	14	14	14	--	--	
Small	16	16	16	16	16	--	± 1/2
Medium	18	18	18	18	18	18	
Large	20	20	20	20	20	20	
X-Large	--	22	22	22	22	22	
XX-Large	--	--	24	24	24	24	
<u>Inseam</u> 3/ X-Small	28-1/2	30-1/2	32-1/2	34-1/2	--	--	
Small	28-1/2	30-1/2	32-1/2	34-1/2	36-1/2	--	
Medium	28-1/2	30-1/2	32-1/2	34-1/2	36-1/2	39-1/2	± 3/4
Large	28-1/2	30-1/2	32-1/2	34-1/2	36-1/2	39-1/2	
X-Large	--	30-1/2	32-1/2	34-1/2	36-1/2	39-1/2	
XX-Large	--	--	32-1/2	34-1/2	36-1/2	39-1/2	
<u>Outseam</u> 4/							± 3/4

X-Small	39-3/4	40-1/4	42-3/4	45-1/4	--	--	
Small	40-1/4	40-3/4	43-1/4	45-3/4	48-1/4	--	
Medium	40-3/4	41-1/4	43-3/4	46-1/4	48-3/4	52-1/4	
Large	41-1/4	41-3/4	44-1/4	46-3/4	49-1/4	52-3/4	
X-Large	--	42-1/4	44-3/4	47-1/4	49-3/4	53-1/4	
XX-Large	--	--	45-1/4	47-3/4	50-1/4	53-3/4	
<b>Bottom 5/</b>							
X-Small	17	17	17	17	--	--	
Small	17	17	17	17	17	--	
Medium	17-3/4	17-3/4	17-3/4	17-3/4	17-3/4	17-3/4	± 1/2
Large	17-3/4	17-3/4	17-3/4	17-3/4	17-3/4	17-3/4	
X-Large	--	18-1/2	18-1/2	18-1/2	18-1/2	18-1/2	
XX-Large	--	--	18-1/2	18-1/2	18-1/2	18-1/2	

The trouser shall be buttoned and placed flat upon a table and measured as follows:

- 1/ Half Waist – Relaxed – With elastic inserts relaxed, measure along center of waistband from outside folded edge to folded edge.
- 2/ Half Waist – Stretched – Rotate ½ waist so that elastic is in the approximate center to prevent the hands or stretching device from restricting the elastic from fully elongating. Stretch waist until fully extended without excessive force, measure along center of waistband from outside folded edge to folded edge.
- 3/ Inseam – Measure inseam of trousers from center of crotch seam (center of gusset) to bottom edge of trouser leg.
- 4/ Outseam – Measure from top edge of waist to bottom of leg along outseam.
- 5/ Bottom – Measure across bottom of leg, multiply by two.

4.4.9 End item acceptance testing. Both the blouse and trouser shall be tested for the physical characteristics as outline in Tables I, II, and XII. Garments shall be randomly sampled. Seconds can be utilized for destructive end item testing. Testing shall be performed as specified in 4.4.5.

## 5. PACKAGING

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

5.2 Permethrin packaging. Every box containing permethrin treated uniforms must be labeled according to EPA requirements as stated in the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (see paragraph 2.2.2).

## 6. NOTES

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

6.1 Intended use.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number and date of this document.
- b. Types, classes and sizes 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 2.2. and 2.3).
- d. When first article sample is required (see 3.1, 4.2 and 6.3).
- e. Packaging requirements (see 5.1).
- f. Inspection level (see 4.1 and 4.3)

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 pre-production sample. The contracting officer should specify the appropriate type of first article and the number of units to be furnished. The contracting officer should include specific instructions in all acquisitions documents regarding arrangements for selection, inspection, and approval of the first article.

6.4 Suggested Sources.

6.4.1 Woven.

Milliken & Company  
920 Milliken Road, M-159  
Spartanburg, SC 29304  
(864)503-1765

6.4.2. Knit.

SSM Industries, Inc.  
211 Ellis Avenue  
Spring City, TN 37381  
(423)365-7181

6.4.3. FR Foam.

PAC Foam Products  
1685 Toronto Way  
Costa Mesa, CA 92626

6.5 Figures. See attached Figures 1-7.

6.6 Size abbreviation. The size abbreviation on the garment label shall show the combination of one of each of the following size and length abbreviations shown below. The combination of the

two elements shall be designated as Size -(hyphen) Length; for example Small Regular abbreviated designation is Sm-Reg, X-Small X-Short abbreviated designation is XSm-XSht, etc.

<u>Size</u>	<u>Size Abbreviation</u>	<u>Length</u>	<u>Length Abbreviation</u>
X-Small	as XSm	XX-Short	as XXSht
Small	as Sm	X-Short	as XSht
Medium	as Med	Short	as Sht
Large	as Lg	Regular	as Reg
X-Large	as XLg	Long	as Lng
XX-Large	as XXLg	X-Long	as XLng
		XX-Long	as XXLng

6.7 Blouse size/identification/care label example:

**Medium - X-Short**

Height: 59 to 63 in.

Chest: 37 to 41 in.

Stock No: 8415 01 484 5933

**Enhanced FR Combat Ensemble Blouse, Woodland MARPAT™**

Fiber Content

U. S. Patent Nos. D464.790S & D491.372S.

CONTRACT #: DAAD16-01-D-9999

Apparel USA

**Care Information:**

**DO NOT BLEACH, STARCH, DRY CLEAN, OR PRESS**

1. Washing. Machine wash using Permanent Press Cycle or hand wash in warm water using mild detergent that does NOT contain optical brighteners. Rinse completely. Do not overload the machine.
2. Drying. Tumble dry on low heat. Do not overload the dryer.
3. Fabric softener. The use of fabric softeners in not recommended due to potential to adversely affect the flame protection.

6.8 Trouser size/identification/care label example:

**Medium - Short**

Waist: 27 to 31 in..

Inseam: 26-1/2 to 29-1/2 in.

Stock No: 8415 01 484 5933

**Enhanced FR Combat Ensemble Trousers, Woodland MARPAT™**

Fiber Content

U. S. Patent Nos. D464.790S & D491.372S.

CONTRACT #: DAAD16-01-D-9999

Apparel USA

**Care Information:**



**of this garment.**

6.10 Approved EPA permethrin registrations. Permethrin treatment operation for the subject uniforms shall be EPA registered (Such as but not limited to EPA Registration No. 07843-0002 and No. 082392-0001).

NOTE: EPA registration does not certify that the permethrin treatment meets the EFRCE specification requirements.

6.11 Percent bite protection. The following facilities are known to perform percent bite protection in conformance with 4.4.5.6:

Aedes aegypti and Anopheles albimanus:

United States Department of Agriculture  
Center for Medical, Agricultural and Veterinary Entomology  
Agricultural Research Service  
1600 SW 23rd Dr  
Gainesville, FL 32608  
POC: Dr. Ulrich R. Bernier/Research Chemist Mosquito and Fly Research  
Ph: 352-374-5917

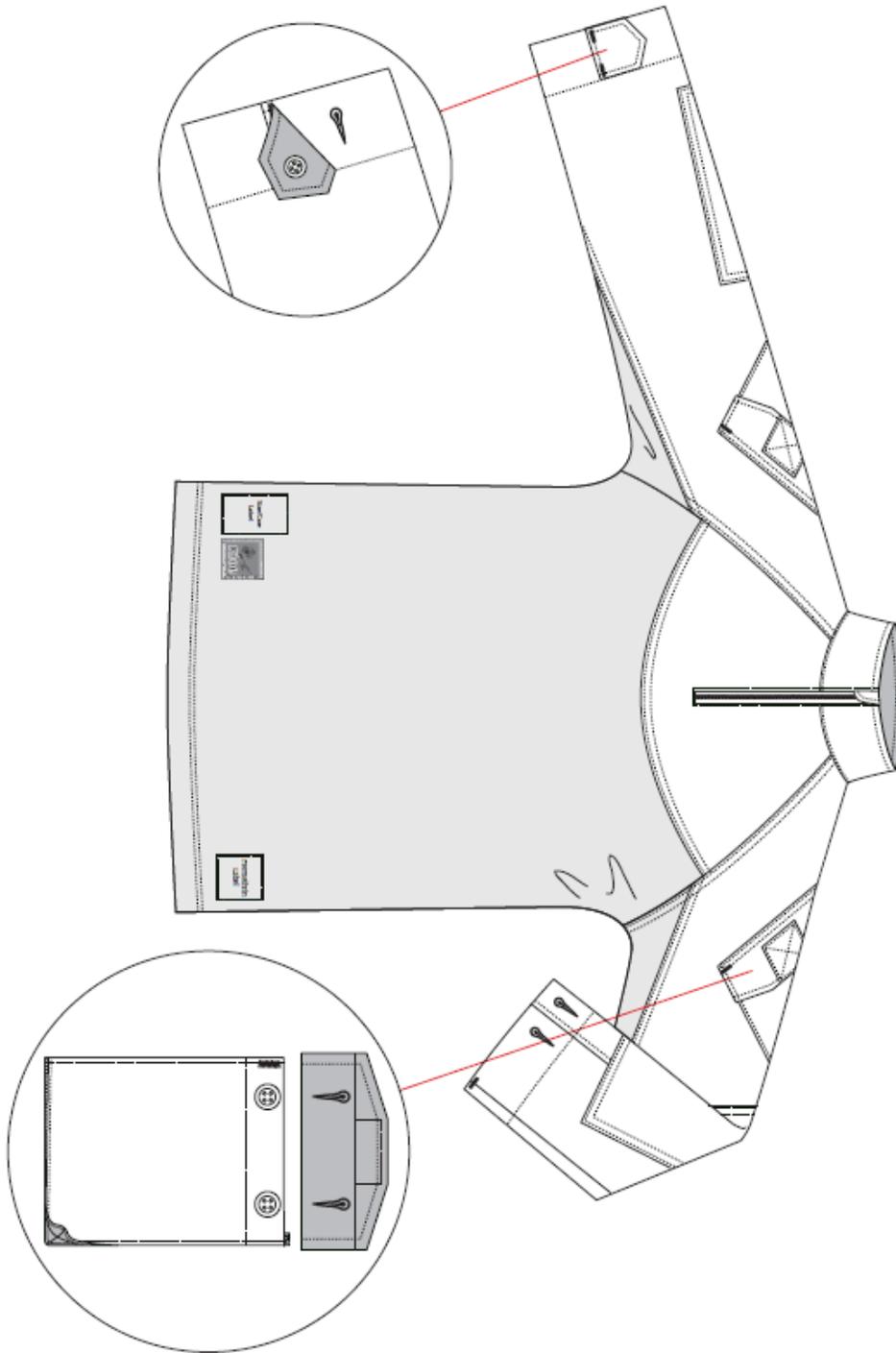


FIGURE 1. Blouse, Front View with pocket and cuff detail

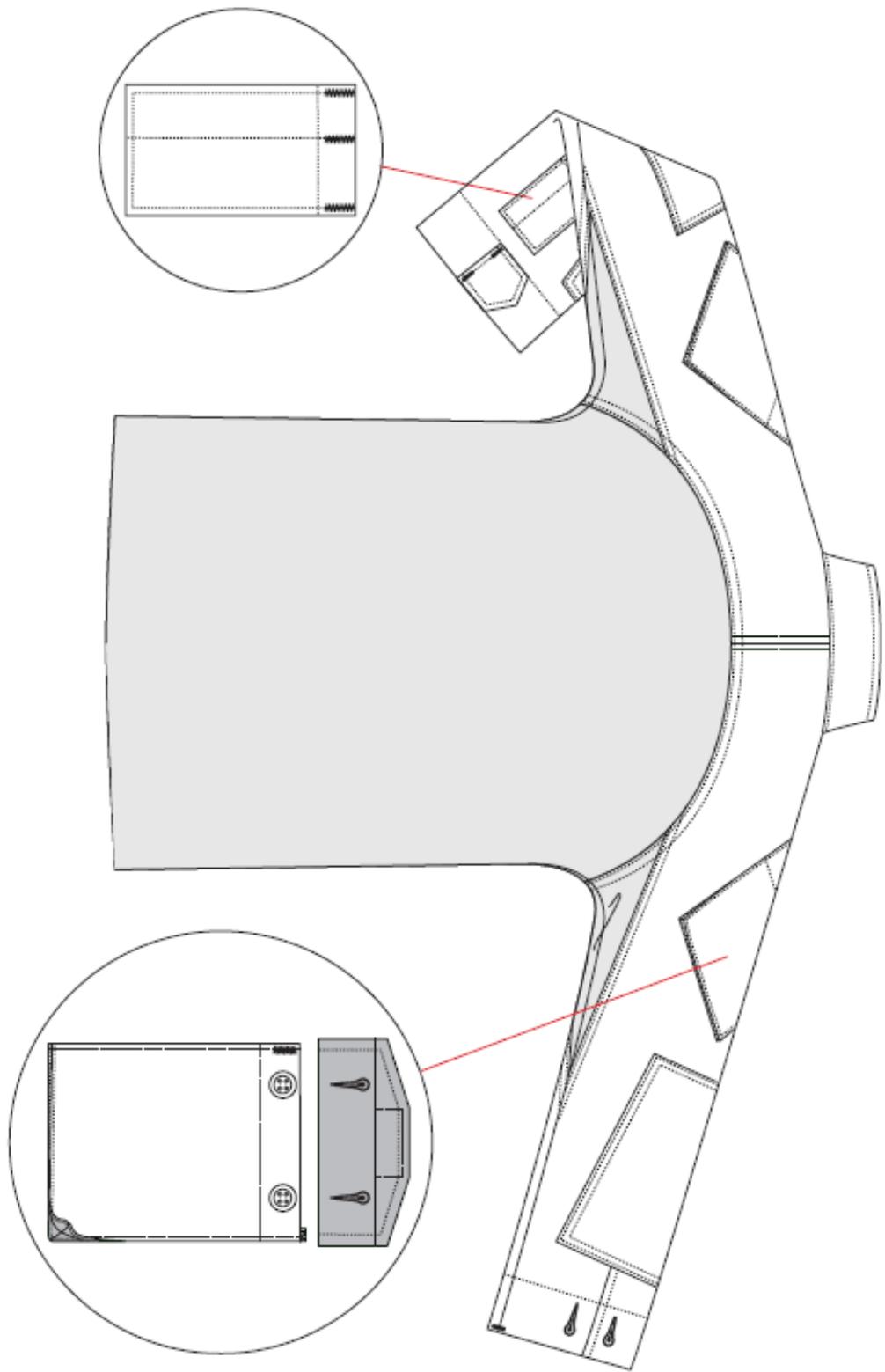


FIGURE 2. Blouse, Rear View with pen and sleeve pocket detail

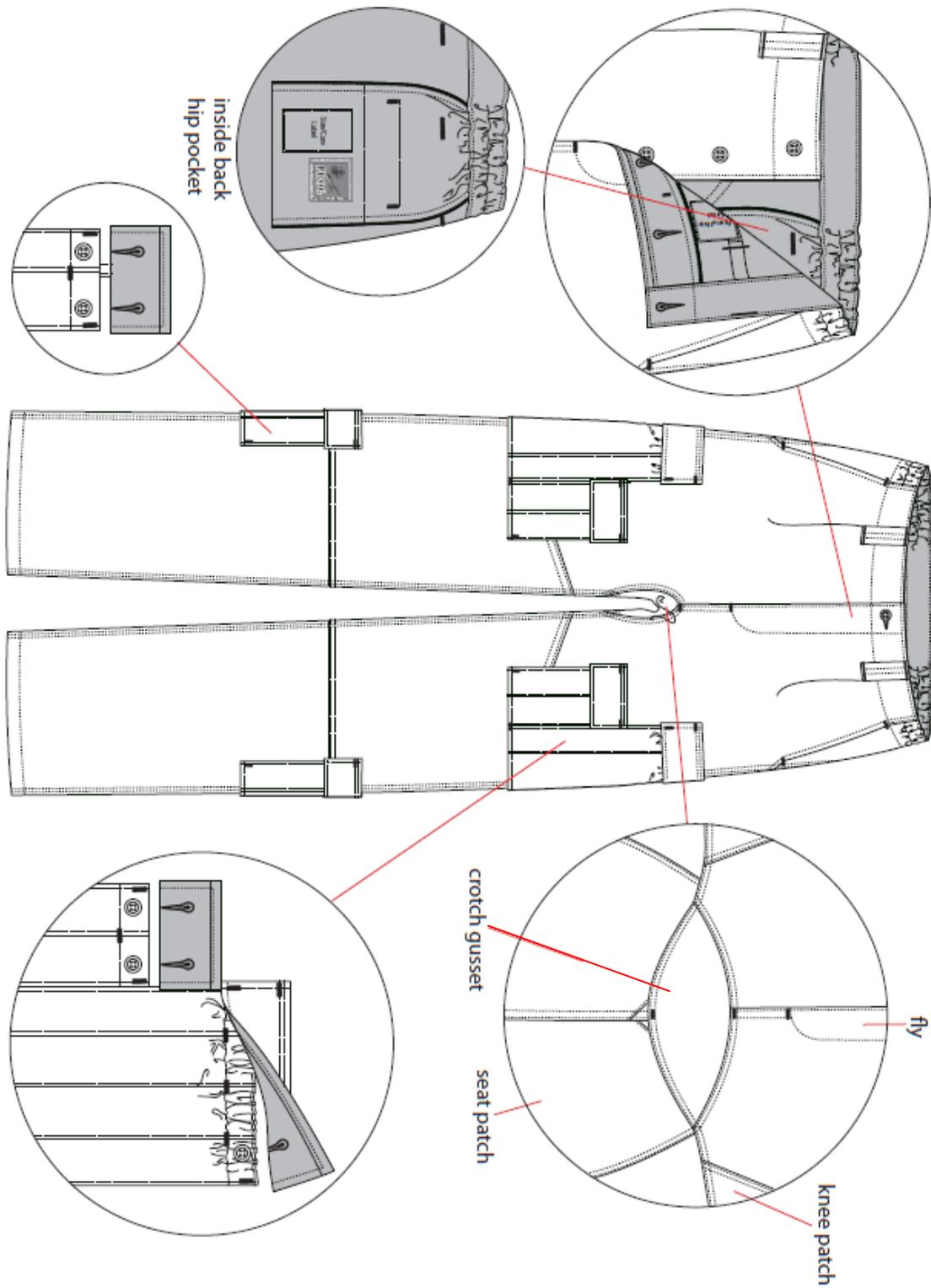


FIGURE 3. Trousers, Front View with pocket, crotch gusset, and label details

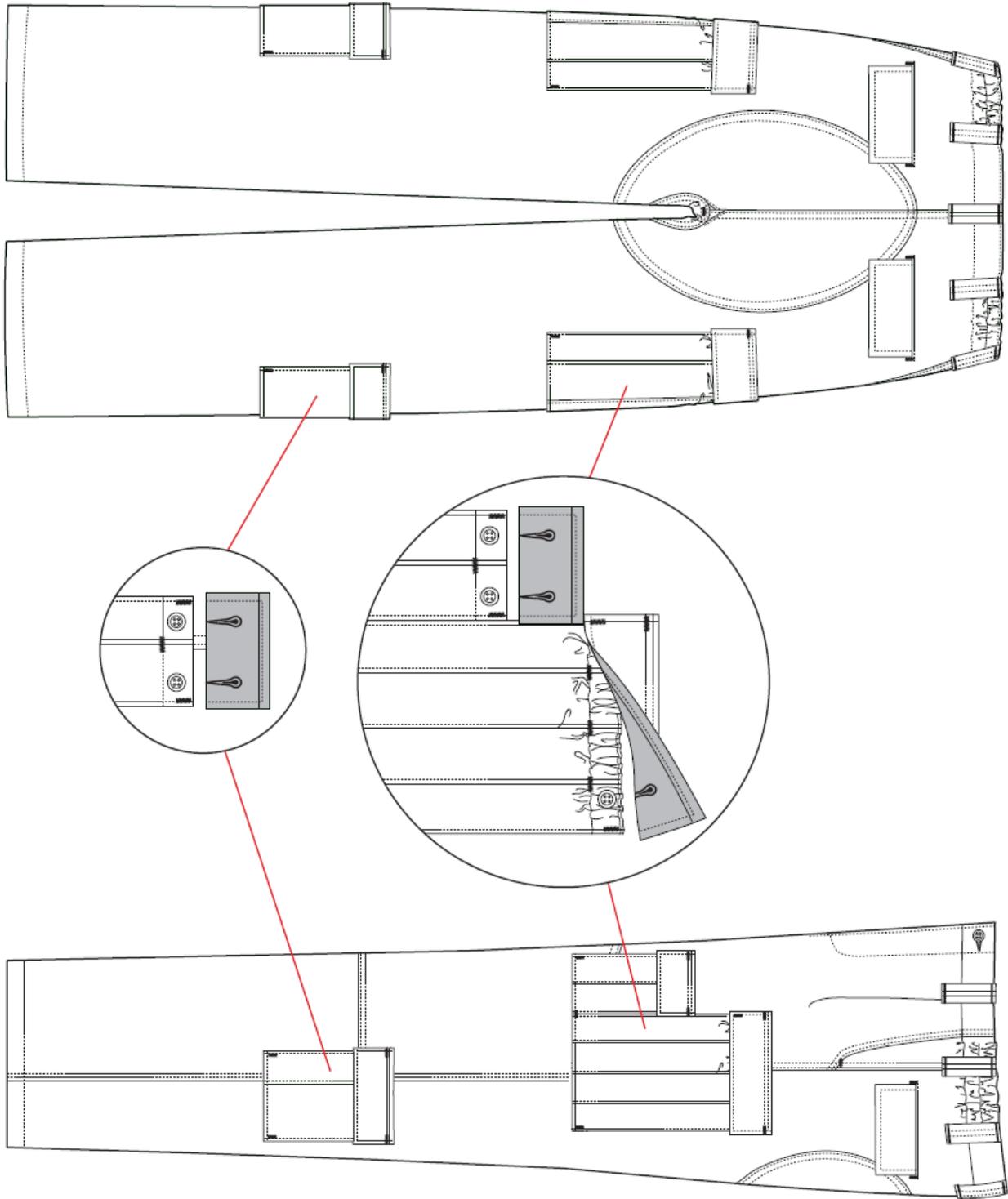


FIGURE 4. Trousers, Back and Side view with pocket detail

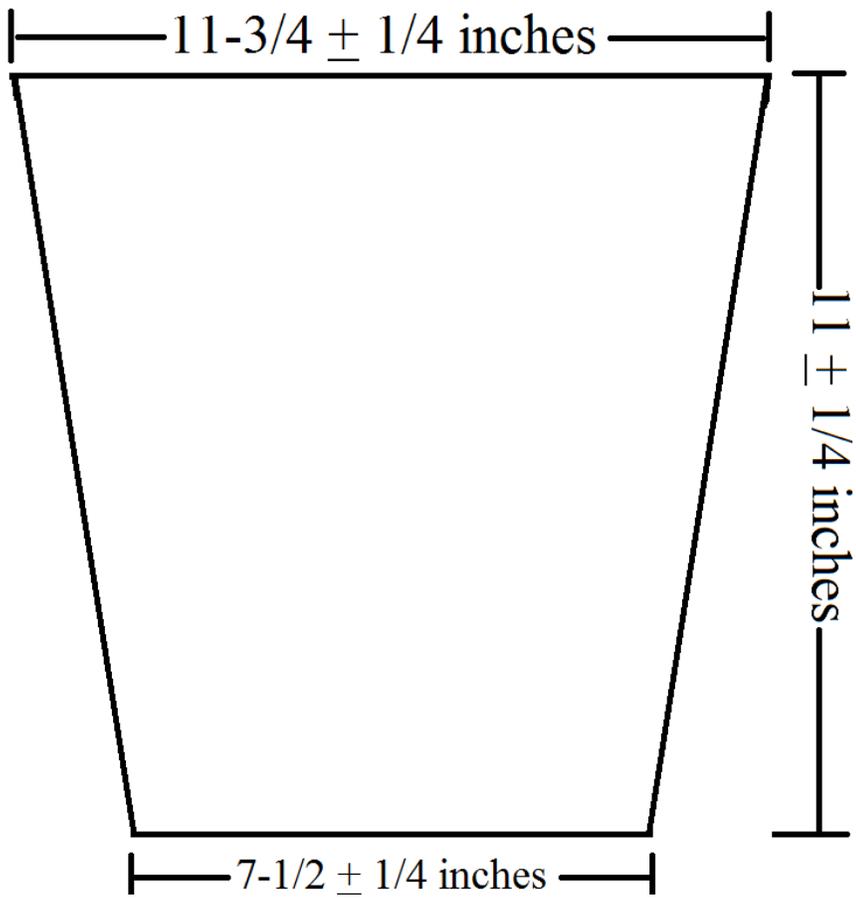


FIGURE 5. Test Specimen, % Bite Protection Test



○

**INSECT TREATMENT COMPANY**  
**INSECT REPELLENT APPAREL**  
TROUSER, FLAME RESISTANT COMBAT ENSEMBLE  
DESERT CAMOUFLAGE  
GARMENT MANUFACTURER  
INSECT TREATMENT COMPANY  
EPA REG. NO.: XXXXX-X  
EPA EST. NO.: XXXXXX-XX-XXX

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\*Do Not Dry Clean,  
Dry cleaning removes active ingredient.  
\*Wash separately from other clothing.  
\*Only launder permethrin treated and untreated garments together  
under field or combat conditions.  
\*Do Not Re-treat with other permethrin products.  
\*Dispose of garment in trash. Do not contaminate water, food or feed by  
storage or disposal. Do not reuse clothing/fabric for purposes other  
than originally intended.

Repels mosquitoes.  
Repellency remains effective for 25 washings

<b>ACTIVE INGREDIENT</b>	<b>%W/W</b>
Permethrin.....	0.52%
OTHER INGREDIENTS (Garment).....	99.48%
TOTAL.....	100.00%

It is a violation of Federal Law to use this product in a manner  
inconsistent with its labeling.

Retain hangtag for future reference on proper handling of this garment.

Figure 7. Garment Hang Tag Example