INCH POUND

MIL-PRF-32142
DECEMBER 23, 2003

PERFORMANCE SPECIFICATION

CLOTH, WATERPROOF AND MOISTURE VAPOR PERMEABLE

This specification is approved for use by all departments and agencies of the Department of Defense.

1. **SCOPE**

1.1 Scope. This document covers the requirements for a waterproof, windproof, and moisture vapor permeable camouflage printed cloth.

1.2 Classification. (see 6.2).

Type I - For USMC All Purpose Environmental Clothing System (APECS) Parkas and Trousers

Class 1 – MARPAT Woodland Camouflage

Class 2 – MARPAT Desert Camouflage

Type II – For broad service All Purpose Environmental Clothing System (APECS) Parkas and Trousers

Class 1 – US Woodland Camouflage

Class 2 – Day Desert Camouflage

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Supply Center Philadelphia, Clothing and Textiles Directorate, Attn: DSCP-COCT, 700 Robbins Avenue, Philadelphia, PA 19111-5096 or emailed to jamie.cushner@dscp.dla.mil Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at www.dodssp.daps.mil.

AMSC N/A FSC 8305

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 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 documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

MILITARY

MIL-PRF-63460 - Lubricant, Cleaner and Preservative for Weapons and Weapons Systems (METRIC)
MIL-DTL-83133 - Turbine Fuel, Aviation NATO F-34 (JP-8) and NATO F-35

STANDARDS

FEDERAL

FED-STD-595 - Colors Used in Government Procurement

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 cited in the solicitation.

CODE OF FEDERAL REGULATIONS

16 CFR Part 1500 - Federal Hazardous Substances Act Regulations
29 CFR Part 1910 - Occupational Safety and Health Standards

(Applications for copies of referenced documents should be addressed to U. S. Government Printing Office, Superintendent of Documents, Mail Stop: SSOP, Washington, DC 20402-9328.)

FEDERAL TRADE COMMISSION

Rules and Regulations Under-the Textile Fiber Products Identification Act

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

CODE OF FEDERAL REGULATIONS

Title 40, part 798.4470 (Primary Dermal Irritation)

(This reference may be found on the Internet at www.access.gpo.gov/nara/cfr/cfr-table-search.html.)

FEDERAL ACQUISITION REGULATIONS (FAR)

FAR 52.209 - First Article Testing

(Applications for copies of referenced documents should be addressed to the Superintendent of Documents, P. O. Box 371954, Pittsburgh, PA 15250-7954.)

BUREAU OF ALCOHOL, TOBACCO AND FIREARMS, DEPARTMENT OF THE TREASURY

Formulas for Denatured Alcohol (27 CFR Part 21)

(Applications for copies of referenced documents should be addressed to the Bureau Of Alcohol, Tobacco And Firearms, Department Of The Treasury, 1200 Pennsylvania Ave. Washington, DC 20226.)

ENVIRONMENTAL PROTECTION AGENCY

Regulations for the Enforcement of the Federal Insecticide, Fungicide and Rodenticide Act (40 CFR Part 162)

(Applications for copies of referenced documents should be addressed to the Environmental Protection Agency, 401 M Street SW, Washington, DC 20460.)

DRAWINGS

MARPAT Woodland Pattern Green 474
MARPAT Woodland Pattern Khaki 475
MARPAT Woodland Pattern Coyote 476
MARPAT Woodland Pattern Black 477

MARPAT Desert Pattern Urban Tan 478
MARPAT Desert Pattern Light Tan 479
MARPAT Desert Pattern Highland 480
MARPAT Desert Pattern Light Coyote 481

2-1-1516B - Woodland Pattern
2-1-2240 - 3 Color Desert Pattern

(Copies of drawings are available from the U.S. Army Research, Development and Engineering Command, Natick Soldier Center, ATTN: AMSRD-NSC-IP-E, Natick, MA 01760.)

2.3 Non-Government publications. The following form a part of this document to the extent specified herein. Unless otherwise specified, the issue of documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issue of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM-F-392 - Test Method for Flex Durability of Flexible Barrier Materials
ASTM-D-751 - Water Resistance of Cloth; Water Permeability; Hydrostatic Pressure Method, Strength of Coating
ASTM-D-975 - Specification for Diesel Fuel Oils
ASTM-D-1776 - Practice for Conditioning Textiles for Testing
ASTM-D-1868 – Thermal and Evaporative Resistance of Clothing Materials Using a Sweating Hot Plate
ASTM-D-2582 – Film, Plastic and Thin Sheeting, Puncture Propagation Tear Resistance Of
ASTM-D-3393 - Specification for Coated Fabrics - Waterproofness
ASTM-D-3776 - Mass Per Unit Area (Weight) of Woven Fabric
ASTM-D-3886 - Abrasion Resistance of Textile Fabrics (Inflated Diaphragm Method)
ASTM-D-4485 - Performance Specification for Automotive Engine Oils

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

TECHNICAL MANUAL OF THE AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC-8 - Colorfastness to Crocking: AATCC Crockmeter Method
AATCC-15 - Colorfastness to Perspiration
AATCC-16 - Colorfastness to Light
AATCC-22 - Water Repellency: Spray Test
AATCC-61 - Colorfastness to Laundering, Home and Commercial: Accelerated
AATCC-96 - Dimensional Changes in Commercial Laundering of Woven and Knitted Fabrics Except Wool
AATCC-118 - Oil Repellency: Hydrocarbon Resistance Test
AATCC-135 - Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics

(Applications for copies of referenced documents should be addressed to the American Association of Textile Chemists and Colorists, PO Box 12215, Research Triangle Park, NC 27709-2215.)

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY (TAPPI)

TAPPI Method T-451, Stiffness, Preferred Procedure (1)

(Applications for copies of referenced documents should be addressed to TAPPI Press, Technology Park/Atlanta, P.O. Box 105113, Atlanta, GA 30348-5113.)

SEARS ROEBUCK AND COMPANY FABRIC DEFECT SCALES

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

MISCELLANEOUS

Principles 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)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 4.2).

3.2 Standard sample. The cloth shall match the standard sample for shade and appearance on the face side and shall be equal to or better than the standard sample with respect to all characteristics for which the standard sample is referenced.

3.3 Performance requirements. The cloth shall conform to the requirements specified in Table I and paragraphs 3.4 through 3.14.

TABLE I. Performance requirements

Characteristic	Requirement
Weight, oz/sq. yd. (max)	5.8
Tearing resistance, kgf (min)	
Warp	4.0
Filling	4.0
Hydrostatic resistance (to burst) [min psi]	
Initial	90
After diethyltoluamide	90

TABLE I. Performance requirements cont'd.	
Hydrostatic resistance (sustained), (min. - No leakage):	
Initial	
After Strength of Coating	No Leakage
After Abrasion	No Leakage
After High Humidity	No Leakage
After diethyltoluamide	No Leakage 1/
Initial and After Laundering	
After diesel fuel	No Leakage
Initial and After Laundering	
After weapons lubricant	No Leakage
Initial and After Laundering	
After motor oil	No Leakage
Initial and After Laundering	
After JP-8 fuel	No Leakage
Initial and After Laundering	
Evaporative Resistance (Ret) 2/ 10^{-3} m^2 mbar/W	
	9.0
Moisture Vapor Transmission Rate - g/m^2/24 hr initial (min) in correlation with sweating hot plate (Ret)	
Initial	
After synthetic perspiration	4500
	4500
Stiffness, warp only, cm (max)	
At 70° F	
Water permeability (min)	
Initial	
After Synthetic Perspiration	No Leakage
Initial and After Laundering	
After Physical Surface Appearance	No Leakage
After flex (70°F)	No Leakage
Warp	
Fill	No Leakage
After cold flex (-40°F)	No Leakage
Warp	
Fill	No Leakage
After Wet Flex	No Leakage
216 hours	
432 hours	Less than 7%
	Less than 34%

1/ The cloth shall not become stiff and brittle nor soft and tacky and there shall be no evidence of cracking or crazing under visual examination.

2/ **This test will be performed at either the initiation of each new contract or contract option period. The Moisture Vapor transmission rate test method will act as the quality monitor test for the laminate's breatheability during the balance of the contract period.**

3.3.1 Disposal of printed seconds/mill seconds/rejected material. Non-usable seconds or rejected material shall be disposed in one of the following manners: 1) seconds in lengths of 10 yards or less may be disposed by using the contractor's routine practice; 2) contact the USMC to determine if there is an alternate use for the rejected material; or 3) if the USMC does not identify any alternate use, the contractor may sell the material on the secondary market. Rejected materials shall be labeled or indelibly marked "seconds/rejected by USMC".

3.4 Spray rating. Equal to or better than 100, 90, 90 initially and 90, 90, 90 after 5 launderings.

3.5 Resistance to organic liquids. The cloth shall show no wetting to n-tetradecane (rating 4) initially and after 5 launderings.

3.6 Physical surface appearance

3.6.1 After laundering. Both sides of the sample shall be visually examined for any evidence of physical surface appearance changes after 20 laundering cycles as specified in 4.4.4.1. The cloth shall show no change in physical surface appearance.

3.6.2 After continuous wash. Samples shall show no sign of delamination or bubbling in accordance with 4.4.4.2.

3.7 Dimensional stability. The shrinkage or elongation of the cloth shall not be greater than 4.0 percent in the warp direction and not greater than 4.0 percent in the filling direction when tested as specified in Table VII.

3.8 Color.

3.8.1 Type I, Class 1. 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. The color of the backside of the cloth shall approximate the colors of the Woodland MARPAT Camouflage face side or shall be Camouflage Green 483 matching color chip 34094 of FED-STD-595B.

3.8.2. Type I, Class 2. 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. The color of the back side of the cloth shall approximate the colors of the desert Camouflage face side or shall be Light Tan 492.

3.8.3 Type II, Class 1. The color of the face side of the cloth shall be Woodland Camouflage pattern and shall match Light Green 354, Dark Green 355, Brown 356, and Black 357, each area of the specific

color of the pattern in accordance with the applicable standard sample. The color of the backside of the cloth shall approximate the colors of the Woodland Camouflage face side or shall be Camouflage Green 483 matching color chip 34094 of FED-STD-595B.

3.8.4 Type II, Class 2. The color of the face side of he cloth shall be Desert Camouflage pattern and shall match Light Tan 492, Light Khaki 494, and Light Brown 493, each area of the specific color of the pattern in accordance with the applicable standard sample. The color of the backside of the cloth shall approximate the colors of the desert Camouflage face side or shall be Light Tan 492.

3.9 Color matching. The color and appearance of the camouflage printed laminate 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 ± 200 K with illumination of 100 ± 20 foot candles, and shall be a fair match to the standard sample under horizon lamplight at 2300 ± 200 K.

3.10 Colorfastness (all types and classes). The finished camouflage printed laminate shall show fastness to: light (after 40 AATCC standard fading hours or 150 Kilojoules); laundering (after 3 cycles); and perspiration (acid and alkaline). The colorfastness of the cloth shall be equal to or better than the standard sample, or equal to or better than a rating of "3-4" using the AATCC Gray Scale for Color Change and the AATCC Gray Scale for Staining for each of the colors, except the Black 477 which shall have a rating equal to or better than a rating of "2-3". The finished cloth shall show fastness to crocking equal to or better than the standard sample or shall have an AATCC Chromatic Transference Scale Rating not lower than 3.5 for all the colors, except Black 477 which shall have a rating not lower than 1.5 when tested as specified in 4.4.9.

3.11 Pattern execution (all types and classes). The pattern 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 36 ± 1.5 inches for MARPAT Woodland and MARPAT Desert, 27.25 +/- 2.5 inches for Woodland, and 16.75 +/- 1.75 for Desert. 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.

3.12 Spectral reflectance (Types I and II, classes 1 and 2).

3.12.1 Types I & II, Class 1. 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 II, when tested as specified in 4.4.15.

3.12.2 Type I & Type II, Class 2. 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 III, when tested as specified in 4.4.15.

Table II – Types I & II, Class 1 Spectral reflectance requirements
Reflectance Values (percent)

Wavelength,	Black 477& Black 357		Coyote 476, Khaki 475& Light Green 354		Green 474, Dark Green 355 & Brown 356	
Nanometers (nm)	min	max	min	max	min	max
600	-	-	8	20	3	9
620	-	-	8	20	3	9
640	-	-	8	20	3	9
660	-	-	8	20	3	12
680	-	-	10	30	3	16
700	-	20	18	50	5	32
720	-	30	22	54	7	44
740	-	33	30	56	12	52
760	-	33	35	58	18	56
780	-	34	40	62	26	56
800	-	34	55	80	34	56
820	-	35	55	80	42	60
840	-	35	55	84	44	60
860	-	35	60	84	44	60

Table III – Type I, Class 2 Spectral reflectance requirements
Reflectance Values (percent)

Wavelength,	Light Tan 479 & Light Tan 492		Lt Coyote 481, Highland 480 & Light Brown 493		Urban Tan 478 & Light Khaki 494	
Nanometers (nm)	min	max	min	max	min	max
700	38	53	19	36	25	48
720	38	58	20	36	25	52
740	39	62	20	36	25	54
760	40	66	21	36	26	56
780	41	72	21	38	27	57
800	43	76	22	43	28	58
820	45	76	23	45	30	58
840	48	78	24	46	33	58
860	50	78	25	46	36	59

3.13 Toxicity. The finished cloth shall not present a dermal health hazard when used as intended. (see 4.4.16).

3.14 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.

4. VERIFICATION

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

1. First article inspection (see 4.2)
2. Conformance inspection (see 4.3)

4.2 First article inspection. The first article, submitted in accordance with 3.1, shall be inspected as specified in 4.3.2 through 4.4 for compliance with design, construction, workmanship and dimensional requirements.

4.3 Conformance inspection. Sampling for inspection shall be performed as specified in the contract or order.

4.3.1 Component and material inspection. In accordance with 4.1 above, components and materials shall be inspected in accordance with all the requirements of referenced specifications, drawings, and standards unless otherwise excluded, amended, modified, or qualified in this specification or applicable procurement documents.

4.3.2 Examination of the end item. Examination of the end item shall be in accordance with 4.3.2.1. The cloth shall be examined for the defects in Table VI. All defects found shall be counted regardless of their proximity to each other except where two or more defects represent a single local condition in which case only the more serious defect shall be counted. A continuous defect shall be counted as one defect for each warpwise yard or fraction of a yard in which it occurs. The lot size shall be expressed in yards. The sample unit shall be 1 linear yard. The number of rolls from which the sample yardage is to be selected shall be in accordance with the table below. The sample yardage shall be apportioned equally among the selected rolls.

Lot size in yards	Sample size in rolls
1,200 or less 1/	3
1,201 up to and including 3,200	5
3,201 up to and including 10,000	8
10,001 up to and including 35,000	13
35,001 up to and including 150,000	20
150,001 and over	32

1/ If a lot contains fewer than three rolls, each roll in the lot shall be examined.

4.3.2.1 Visual examination. The cloth shall be examined (on both sides) for the defects listed in Table IV.

Table IV. End item visual defects

Defect	Classification	
	Major	Minor
	Major	Minor
Any hole, cut, tear or scratch, including edges	101	
Abrasion resulting in a thin or weak place	102	
Multiple floats or skips, 1/2 inch or more in either warp or filling direction of face fabric	103	
Any pit, blister, tunnel, bubbles, or delamination of components	104	
Crease or wrinkle resulting in doubling or adhesion of surfaces that cannot be corrected by manual pressure, adhesion of surfaces against each other, or any diagonal distortion of face side surface	105	
Any solid lump, defined as a slub C or 4, or knot which exceeds level C on the respective Sears Fabric Defect Scale (see 2.3)	106	
Fabric edges rolled, folded, doubled, scalloped or wavy	107	
Any spot, stain 1/ or foreign matter 2/	108	
Any odor other than that which is characteristic of the component materials of the cloth		201
Any color off shade, not uniform, mottled or spotted (face side only)	109	
Any tackiness	110	
Any pinhole	111	
Any area without waterproof finish (i.e., laminating film, where required)	112	
Any scorch or burn	113	
Multiple floats or skips, 1/2 inch or more in either warp or filling direction of face fabric	114	
Not clean	115	
Camouflage pattern (face side):		
Any skitteriness of pattern exceeding that shown by the standard sample	116	
Pattern design not equal to standard sample	117	
Excessive feathering or spew of pattern	118	
Pattern repeat not equal to the standard sample	119	
Warp wise pattern repeat 36 +/-1.5 inches for MARPAT Woodland and MARPAT Desert, 27.25 +/- 2.5 inches for Woodland, and 16.75 +/- 1.75 inches for Desert.	120	
Any color off shade, not uniform, mottled, or spotted (face side only)	121	

1/ Clearly visible at the normal inspection distance (approx. 3 ft.).

2/ For the back side, any spot, stain, off-shade area, or discoloration that is a result of the distortion of a backing fabric (if used) or a result of uneven dyeing of a backing fabric shall not be scored for this condition. Foreign matter shall be defined as waste, fly, or extraneous material that has been formed into the fabric system.

4.3.3 End item testing. The cloth shall be tested for the characteristics listed in Table V. The methods of testing specified wherever applicable and as listed in Table V shall be followed. The sample unit for testing shall be 15 continuous yards full width of the finished cloth, put up in a manner to prevent folding/creasing. The lot shall be unacceptable if any sample unit fails to meet any requirement specified. All test reports shall contain the individual values utilized in expressing the final results. The sample size shall be in accordance with the following:

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

TABLE V. End item tests

Characteristic	Requirement Paragraph	Test Method
Weight, oz/sq. yd. (max)	3.3	ASTM D-3776 (Method C)
Tearing resistance, kgf (min)	3.3	ASTM D-2582 and 4.4.1
Hydrostatic resistance (to burst) [min]		
Initial	3.3	ASTM D-751 and 4.4.2.1
After diethyltoluamide	3.3	4.4.2.6 & 4.4.2.1
Hydrostatic resistance (sustained), (min. - No leakage):		
Initial	3.3	ASTM D-3393 and 4.4.2.2
After Strength of Coating	3.3	4.4.2.3
After Abrasion	3.3	4.4.2.4
After High Humidity	3.3	4.4.2.5
After diethyltoluamide - Initial and After Laundering	3.3	4.4.2.6, 4.4.2.2, & 4.4.12
After diesel fuel - Initial and After Laundering	3.3	4.4.2.2, 4.4.11 & 4.4.12
After weapons lubricant - Initial and After Laundering	3.3	4.4.2.2, 4.4.11 & 4.4.12
After motor oil - Initial and After Laundering	3.3	4.4.2.2, 4.4.11 & 4.4.12
After JP-8 fuel - Initial and After Laundering	3.3	4.4.2.2, 4.4.11 & 4.4.12

Characteristic	Requirement Paragraph	Test Method
Evaporative Resistance (Ret)* (This test will be required at the initiation of each contract and/or option period.** The Moisture Vapor transmission rate test method will act as the quality monitor of breatheability remainder of the contract.)	3.3	
Moisture Vapor Transmission Rate – g/m^2/24 hr initial (min) in correlation with sweating hot plate (Ret)		ASTM 1868, Part B
Initial	3.3	4.4.6
After synthetic perspiration	3.3	4.4.10 & 4.4.6
Stiffness, warp only, cm (max):		
At 70° F	3.3	4.4.3
Water permeability (min):		
Initial	3.3	4.4.5
After Synthetic Perspiration	3.3	4.4.10 & 4.4.5
Initial and After Laundering		
After Physical Surface Appearance	3.3	4.4.4 & 4.4.5
After flex (70°F)	3.3	4.4.5.1 & 4.4.5
After cold flex (-40°F)	3.3	4.4.5.2 & 4.4.5
After Wet Flex*	3.3	4.4.5.3 & 4.4.5
216 hours		
432 hours		
*** This test will be performed at the beginning of each contract and then after every 10 production lots or on an annual basis, whichever comes first.**		
Spray rating:		
Initial	3.4	4.4.7.1
After 5 Launderings	3.4	4.4.7.2
Resistance to organic liquids:		
Initial	3.5	4.4.8.1
After 5 Launderings	3.5	4.4.8.2 & 4.4.8.1
Physical Surface Appearance	3.6	4.4.4.1 and 4.4.4.2
Dimensional Stability	3.7	AATCC No. 96, Option 1C

Characteristic	Requirement Paragraph	Test Method
Colorfastness to:		
Laundering	3.10	4.4.9.1
Light	3.10	4.4.9.2
Crocking	3.10	AATCC-8
Perspiration	3.10	4.4.10 & 4.4.9.1
Color matching	3.9	4.4.13
Pattern Execution	3.11	4.4.14
Spectral Reflectance	3.12	4.4.15
Toxicity	3.13	4.4.16

4.4 Methods of inspection.

4.4.1 Tear strength. ASTM D-2582 with the following exceptions: Five warp and five filling specimens shall be tested. Specimen size shall be 8-inches by 8-inches. Only one tear shall be made on a single specimen. The specimen shall be positioned with the face side toward the probe and with the designated yarns of the face fabric at right angles to the direction of tear. The test shall be conducted using the standard drop height of 508 $\pm$ 2 mm. If the tear is not straight on face side of the laminate, the result shall be considered invalid and another specimen shall be tested. The thickness of the specimen shall not be measured.

4.4.2 Hydrostatic resistance.

4.4.2.1 To Burst. ASTM D-751, Hydrostatic Resistance, Procedure A (Pressure Application by Mullen Type Hydrostatic Tester), Procedure 1 with water pressure applied to the face side of the test specimens.

4.4.2.2 Sustained. ASTM D-3393, except that a water pressure of 40 psi shall be used and applied to the face side of the test specimens. The test may be performed on any device, which tests the equivalent specimen area at the equivalent pressure.

4.4.2.3 Hydrostatic resistance after strength of coating. ASTM D-751, section 54-58, except that the specimens shall be stretched at 20 pounds. The specimens shall then be tested for hydrostatic resistance in accordance with 4.4.2.2.

4.4.2.4 After abrasion. ASTM-D-3886, except that the test shall be conducted in the multidirectional mode as described: The face side of the cloth shall be abraded for 10,000 cycles using the face side of

the test material as the abradant and a load of six (6) pounds. The specimens shall then be tested for hydrostatic resistance in accordance with 4.4.2.2.
4.4.2.5 After high humidity. Three 4 by 4 inch specimens shall be laid flat, face side up, on a supporting plate and the assembly placed in a desiccator containing water in the lower portion. The water level shall be approximately 1 inch below the specimens. The lid of the desiccator shall be put in place and the desiccator placed in a circulating air oven having a temperature of 125 $\pm$ 2°F for a period of 7 days. At the end of the aging period, each specimen shall be removed from the desiccator and then immediately examined for colorfastness and tested for hydrostatic resistance. The specimens shall then be tested for hydrostatic resistance in accordance with 4.4.2.2.

4.4.2.6 After diethytoluamide. Five specimens shall be laid flat, face side up, on a glass plate 4 by 4 inches by 1/4 inch thick. Three drops of diethyltoluamide containing 75% diethyltoluamide and 25% ethanol (see 6.6) shall be applied to the center of each specimen (Sealed samples shall use 1mL of diethyltoluamide instead of the 3 drops. The challenge fluid shall be applied to the center of the seam sealed area.). A glass plate of the same dimensions shall be placed on the specimen (or specimen area) and a pressure of 0.25 pounds per square inch of glass plate contact area (1 pound per square inch for seam sealed samples) be applied to the assembly. After 16 hours (2 hours for seam sealed samples), the specimens shall be removed from between the glass plates and tested immediately for hydrostatic resistance in accordance with 4.4.2.1 and 4.4.2.2.

4.4.3 Stiffness at 70°F. TAPPI Method T-451, Preferred Procedure (1) except that five test specimens with the long dimension parallel to the warp direction of the cloth shall be tested and that the standard textile test conditions as specified in ASTM D-1776 shall be used.

4.4.4 Physical surface appearance.

4.4.4.1 After Laundering. Conduct 20 laundering and drying cycles in accordance with 4.4.12. Each sample, 48-inches in length by full width shall be cut in half across the width of the cloth. One half of the sample (24 inches in length) shall be laundered and the remaining half retained as the unlaundered portion for the final evaluation, as necessary. After each drying cycle, examine both sides of the cloth for changes in physical surface appearance when compared to the unlaundered sample.

4.4.4.2 After Continuous wash. **This test will be used as part of the fabric source selection criteria. Test data shall be supplied with the PDMs submitted.** Three 14-inch by full width (54-58-inches) samples shall be cut from the sample unit. The samples shall be subject to 96 hours of Kenmore wash (*AATCC Test Method 135-2001, without soap*) run in a continuous manner in increments of 24 hours (detangling the samples every 24 hours) – **see paragraph 6.8 for information on modifying washer to continuous wash**. Samples shall be inspected for signs of delaminating or bubbling. Delamination is defined as an area greater than 1/8 inch in diameter, and is considered failing. **During production, data from this test will be submitted after every 10th production lot or once annually, i.e. – whichever comes first during the 12 months after contract award.**

4.4.5 Water permeability. ASTM D-751, Hydrostatic Resistance, Procedure B, Procedure 2 with a fixed hydrostatic head of 1 psi applied to the face side of the test specimen for 10 minutes. Five specimens shall be tested. The report shall only include measurement for the appearance of water droplets. Leakage is defined as the appearance of one (1) or more droplets of water within the 4-1/2 inch diameter test area. The test may be performed on any device, which tests the equivalent specimen area at the equivalent pressure.

4.4.5.1 Water permeability after Flex at 70°F. One warp and one fill specimen, 8-inches by 12-inches, shall be cut from the sample unit with the 8-inch dimension in the indicated direction (warp or filling, as applicable). The specimen shall be conditioned and flexed as specified in ASTM F-392, except that the specimen shall not be aged, the short edges shall not be heat sealed or otherwise joined, and the specimen shall be flexed for 1500 full flex cycles. Two six (6) inch by eight (8) inch specimens shall be cut from the 8-inch by 12-inch flexed specimen and tested for water permeability in accordance with 4.4.5.

4.4.5.2 Water permeability after cold flex at -40°F. One warp and one fill specimen, 8-inches by 12-inches, shall be cut from the sample unit with the 8-inch dimension in the indicated direction (warp or filling as applicable). The specimen shall be conditioned and flexed as specified in ASTM F-392 except the specimen shall not be aged, the short edges shall not be heat sealed or otherwise joined, and the specimen shall be flexed for 1500 cycles. The 8-inch by 12-inch specimen shall be mounted on the flex test apparatus, placed in a test chamber at the specified temperature for 1 hour, and then flexed in the test chamber at the specified temperature. At the end of the flexing cycle, two 6-inch by 8-inch specimens shall be cut from the 8-inch by 12-inch flexed specimen and conditioned prior to testing for water permeability in accordance with 4.4.5.

4.4.5.3 Water permeability after wet flex. **This test will be used as part of the fabric source selection criteria. Test data shall be supplied with the PDMs submitted.** Three 14-inch long by full width (54-58inches) samples shall be cut from the sample unit. The samples shall be subjected to 216 hours of washing in a Kenmore washer (*AATCC Test Method 135-2001, without soap*) run in a continuous manner (detangling the samples every 24 hours) – **see paragraph 6.8 for information on modifying washer to continuous wash**. After the 216 hours of washing is completed, the samples shall be hung to air dry, until fully dry, and then conditioned for 4 hours at *65% RH and 23°C*. The samples shall be subsequently subjected to water permeability testing at 5 sites spread equally along the width of each sample in accordance with the requirements of paragraph 4.4.5. If less than *7%* of the sites fail water permeability (1 leak out of the 15 sites tested), the sample unit is passed. Suter areas should be marked and the three samples from the sample unit should be subject to an additional 216 hours (total of 432 hours on the samples) of continuous wash. After the additional 216 hours of continuous wash, water permeability should be conducted on five sites per sample as described above. If more than 33% of the sites fail (greater than 5 leaks out of the 15 test sites), the sample unit is failed. If less than 33% fail, the sample is considered to be passing. **During production, data from this test will be submitted after every 10th production lot or once annually, i.e. – whichever comes first during the 12 month period after contract award.**

4.4.6 Moisture vapor transmission rate. Five initial and, when applicable, three after synthetic perspiration tests in accordance with 4.4.10 shall be performed. The sample to be tested is placed, with a waterproof but highly water vapor permeable, hydrophobic, microporous membrane (see 6.8), on a ring holder and then put on a water bath so that the membrane comes in contact with the water for 15 minutes. A cup containing a saturated potassium acetate solution, creates a relative humidity of about 23% at the sample's upper face, and when covered with a second piece of the same membrane, is weighed and then inverted above the sample in the ring holder, so that the membrane is in contact with the sample. A net transfer of water vapor through the sample from the water to the cup (see **Figure 1**) will occur. After 15 minutes, the cup is taken off and re-weighed. A control test sample is also performed out to determine the water vapor permeability of the two membranes alone. The water vapor permeability of the sample can then be calculated. The specimen holder shall be a metal or plastic ring

with a milled groove onto which the specimen in conjunction with the membrane is secured, using a rubber ring that fits into the groove, as shown in **Figure 2**. The rubber ring shall fit tightly so that the specimen and membrane are held with tension. The bottom outside edge of the specimen holder should be rounded. The support frame should consist of two plates separated by spacers to support the specimen holders in the water (see **Figure 3**). Both plates should have at least six holes, with the holes in the top plate large enough to allow the holder with specimen and membrane to pass through. The holes in the lower plate shall be smaller than the specimen holder, but larger than the cup opening, and be centered over the holes in the top plate. The support frame is fitted with four vertically adjustable screws so that the specimen holder can be immersed to a depth of 5 ± 2 mm in the water. The holes in the support frame should be sequentially numbered. The water bath consists of a transparent glass or plastic tank, large enough to accommodate the support frame and contains distilled water maintained at 23.0 ± 1 °C by means of an immersion thermostat with a circulation pump. The water temperature shall be measured in at least four positions simultaneously, i.e. adjacent to the four corners of the support frame. To obtain a uniform water temperature distribution, either the inlet or the outlet pipe of the thermostat circulation pump should be extended (by a hose) to the tank end opposite the thermostat. Care should be taken to prevent air bubble formation by either boiling the distilled water prior to use and/or reducing the speed of the thermostat agitator. See **Figures 2 and 3.**

The test procedure is as follows:

Three samples approximately 180 mm in diameter shall be cut. The membrane to be used as the specimen cover in the specimen holder shall have a diameter of approximately 200 mm. When the sample is fitted onto the sample holder, the side that faces the body shall be in contact with the sample holder's membrane. The sample and membrane must be secured without creases or distortion on the sample holder by means of a rubber ring. There must be no air gaps between the sample and membrane. A control sample holder with a membrane must be prepared so the apparatus water vapor permeability can be measured.

Each measuring cup is filled with approximately 120 g of the saturated potassium acetate solution:

Saturated potassium acetate solution shall be made by thoroughly mixing dry potassium acetate (p.a. grade) with distilled water in the ratio of 100 g potassium acetate to 31 g of water. The mixture must be homogeneous and free of lumps; it must be allowed to equilibrate at a temperature of 23 ± 3 °C for a period of not less than 12 hours. It must be fluid enough to cover the membrane when the cup is inverted prior to testing. The solution must remain saturated (indicated by its white or opaque appearance) throughout a test.

Then sealed with a circular piece of membrane. The measuring cup shall be made from transparent plastic and shall have an internal diameter between 85 mm and 95 mm, with a tolerance of ± 1 mm, and a volume of at least 250 ml. For this purpose, the edges of the measuring cup are briefly rolled against a hot iron or soldering iron, while keeping the membrane taut with a rubber band. Excess membrane should be trimmed in order that the contents of the cup can be seen. The cup seal should be tested for leaks prior to each measurement by inverting the cup over absorbent paper for about 3 min, which must not become wet. The potassium acetate solution shall always be saturated (opaque or white) during the test.

The specimen holders each with sample and membrane, and the one with the membrane only are inserted into the support frame at 30 ± 5 minute intervals in sequential order of the holes. Check to see that no air bubbles are between the membrane and water surface. After 10 ± 1 minutes, the samples shall be checked for wrinkles and adjusted, if necessary, without removal from the water bath. The sample holders shall be left on the bath for a total of 15 min before the measuring cup is placed on the

sample. The measuring cups are weighed (m_0), inverted, gently shaken to spread the potassium acetate solution evenly over the membrane, and then centered on the sample surface at intervals of 30 ± 5 minutes in the same order as the sample holders were inserted into the support frame. One cup is centered on the control sample holder with the membrane only. 15 minutes after each cup has been placed on the specimen it is removed and re-weighed (m_{15}). Remove the sample from the sample holder and examine the membrane and the sample for evidence of water leakage. If water leakage has occurred this sample's value will be excluded from the evaluation.

The water vapor permeability of the sample is calculated as follows:

[1]	**Δm**	=	**$m_{15} - m_0$**	**g**
[2]	**WVP_{app}**	=	$\frac{\Delta m_{app}}{a \cdot \Delta p \cdot \Delta t}$	$\frac{g}{m^2 Pa\, h}$
[3]	**WVP**	=	$\left[\frac{a \cdot \Delta p \cdot \Delta t}{\Delta m} - \frac{1}{WVP_{app}} \right]^{-1}$	$\frac{g}{m^2 Pa\, h}$

Note: The relative humidity in equilibrium with saturated potassium acetate solution at temperature T_a is:

[4]	**RH**	=	$22.4388 + 0.156288 \cdot T_a - (0.612868 \cdot 10^{-2}) \cdot T_a^2$	%

If $T_a = T_b = 23.0$ °C, then RH = 22.8 % and then $\Delta p = p_{sb} - \frac{p_{sa} \cdot RH}{100}$ = (2808 – 640) Pa = 2168 Pa

Note: Equation [4] according to L. Greenspan: Humidity fixed points of binary saturated aqueous solutions. J. of Res. 81A (1977) 89-96

Definitions of Symbols and Units:

a = the area of the measuring cup opening, **m^2**
Δ t = the measuring time, **h**
Δ m = the change in mass of the measuring cup during the period **Δ t, gΔ**
m_{app} = the change in mass of the measuring cup on the specimen holder with only membrane during the period **Δ t, g**
Δ p = is the partial water vapor pressure difference across the specimen, **Pa**
p_{sa} = is the saturated water vapor pressure at the test room temperature **T_a, Pa**
p_{sb} = is the saturated water vapor pressure at the water bath temperature **T_b, Pa**
RH = is the relative humidity in equilibrium with saturated potassium acetate solution, **%**
T_a = is the temperature in the test room, **°C**
T_b = is the temperature of the water bath, **°C**
WVP = is the water vapor permeability of the specimen, **g/m^2 Pa h**
WVP_{app} = is the apparatus water vapor permeability, **g/m^2 Pa h**

4.4.7 Spray rating.

4.4.7.1 Initial. Testing shall be conducted in accordance with AATCC 22.

4.4.7.2 After 5 launderings. Testing shall be conducted in accordance with 4.4.12 and 4.4.7.1.

4.4.8 Resistance to organic liquids.

4.4.8.1 Initial. Test in accordance with AATCC 118-1992. Samples must pass a minimum of a 4 rating (n-tetradecane).

4.4.8.2 After 5 launderings. After 5 launderings in accordance with 4.4.12, test in accordance with 4.4.8.1.

4.4.9 Colorfastness.

4.4.9.1 Laundering. AATCC No. 61, Test 1A (3 cycles), except that the 1993 AATCC Standard Reference Detergent (non-phospate) without optical brighteners shall be used.

4.4.9.2 Light. AATCC No. 16, Option A (after 40 fading units) or E (after 150 kilojoules).

4.4.10 Synthetic perspiration test. The specimen, 8-inches by 8-inches, shall be cut and exposed to synthetic perspiration as follows: the synthetic perspiration solution shall be made by combining 3.0 grams sodium chloride, 1.0 gram trypticase soy broth powder, 1.0 gram normal propyl propionate, 0.5 gram of liquid lecithin and 500 ml of distilled water. Cover the solution and stir while heating to 50°C until all ingredients are dissolved. Then, cool the solution to 35°C, remove cover and dispense it immediately with a pipette or other suitable measuring device. Dispense 2 ml of perspiration solution at 35°C, onto the center of an 8-inch by 8-inch by 1/4-inch glass plate. Place the specimen on the glass plate with the back side contacting the glass. Dispense an additional 2 ml of the synthetic perspiration solution onto the center of the specimen. Place a second 8-inch by 8-inch by 1/4-inch glass plate on top of the specimen and then place a 4 pound weight on top of and in the center of the assembly. After 16 hours, remove the specimen (do not rinse) and air dry the specimen before testing.

4.4.11 Contamination procedure. The specimen (or specimen area) shall be laid flat, face side up, on a glass plate. Three drops of the test liquid (1mL for sealed samples) shall be applied to the center of the specimen (or specimen area); as applicable, the test liquid shall be diethyltoluamide (see 6.6), diesel fuel (ASTM D-975, Grade 1-D), weapons lubricant (MIL-L-63460, see 6.7), motor oil (ASTM D-4485, Grade CD-II), and JP-8 fuel (MIL-T-83133). A glass plate of the same dimensions shall be placed on the specimen (or specimen area) and a pressure of 0.0625 pounds per square inch (1 pound per square inch for seam sealed samples) of glass plate contact area be applied to the assembly. After 16 hours (2 hours for seam sealed samples), remove the specimen (or specimen area) from the assembly and test immediately for the required performance property in the center of specimen (or specimen area). For testing the "initial" condition, the test specimen shall be as specified by the applicable test method. For testing the "After laundering" condition the laundering test shall be conducted in accordance with 4.4.12 for one laundering and drying cycle and one laundering sample, 48-inches by the full width of the cloth, for each test liquid shall be marked on the face side (using a laundry marker pen) for the specimen areas for hydrostatic resistance and for leakage; after laundering, the specimen areas may be cut from the laundering sample to facilitate performance property testing. Ten (10) specimens (minimum) shall be tested for each of the Initial and the After Laundering conditions.

4.4.12 Laundering procedure. Place 2.0 ± 0.2 pounds of the cloth and if needed, ballast in an automatic washing machine set on permanent press cycle, high water level and warm (100 + 10°F - 0°F) wash temperature. Place 0.5 ounce (14 grams) of 1993 AATCC Standard Reference Detergent (non-phosphate) without optical brighteners into the washer. The duration of each laundering cycle shall be 30 ± 5 minutes. After laundering, place sample and ballast in an automatic tumble dryer set on permanent press cycle, 150-160°F and dry for approximately thirty (30) minutes or until dry. The laundering equipment, washer and dryer, shall be in accordance with AATCC No.135.

4.4.13 Visual color matching. The color and appearance of the camouflage printed 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 ± 200K with illumination of 100 ± 20 foot candles, and shall be a good match to the standard sample under horizon lamplight at 2300 ± 200K.

4.4.14 Pattern execution. The pattern of the cloth shall be matched to the pattern drawing (see 6.3).

4.4.15 Spectral reflectance. 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 (see 6.4) 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 (see 6.5). The spectral band width 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 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 wavelength accuracy within 2 nm. The standard aperture size used in the color measurement device shall be 1.0 to 1.25 inches in diameter for Woodland and Desert camouflage and 0.3725 inches in diameter for the MARPAT Woodland and MARPAT Desert. Any color having spectral reflectance values falling outside the limits at four or more of the wavelengths specified shall be considered a test failure.

4.4.16 Toxicity assessment. The contractor must furnish information certifying that the finished product is composed of materials which have been safely used commercially or 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 (see 2.2.2) and a repeated insult human patch test (Modified Draize Procedure) (see 2.3). The latter must be conducted under the supervision of a qualified dermatologist using at least 100 free living individuals.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel 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 or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

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

6.1 Intended use. The cloth is intended for use in the fabrication of the All Purpose Environmental Clothing System (APECS) parkas and trousers.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number and date of this specification.
b. Issue of DODISS to be cited in the solicitation and, if required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).
c. Type, and Class required.
d. When first article inspection is required, (see 3.1) the item will be tested and should be a first article sample. The contracting officer should include specific instructions in acquisition documents regarding arrangement for examinations, quantity, and testing and approval.

6.3 Standard sample. For access to samples and the pattern drawing, address the contracting activity issuing the invitation for bids.

6.4 Spectrophotometer. Suitable spectrophotometers for measuring spectral reflectance in the visible/near spectral include the Data Color CS-5, Diano Hardy, Diano Match Scan, Hunter D54P-IR, and the MacBeth 1500 with IR options.

6.5 White standard. Barium sulfate of suitable quality for use as a white reference standard is available from the Eastman Kodak Company. The same source has available magnesium reagent (ribbon). Suitable tiles can be obtained from the National Institute of Standards and Technology or the instrument manufacturers.

*6.6 Diethyltoluamide (DEET Insect Repellent) reagent. The insect repellent reagent should be a solution of 75% by weight (min) of diethyltoluamide and the remainder denatured alcohol. The diethyltoluamide component of the solution should be a technical grade and contain N, N-diethyl-metatoluamide of not less than 95% purity and the remainder should consist of entirely or a mixture of ortho or para isomers of N, N-diethytoluamide. The denatured alcohol component of the solution should be ethanol, U.S.P. 94.9% by volume and denatured in accordance with The Code of Federal Regulations 27 CFR 21, Formula 40 (see 2.1). The insect repellent must be registered with the U.S. Environmental Protection Agency in accordance with the Federal Insecticide, Fungicide and Rodenticide (FIFRA) (see 2.1).

(For guidance purposes only, DEET insect repellent conforming to Type II, Concentration A of O-I-503 has been used successfully as a reagent in testing.)

6.7 Weapons lubricant. MIL-L-63460 weapons lubricant is marketed as "Break-Free CLP" and may be obtained from Break-Free, Inc., Santa Anna, CA.

6.8 Membrane. The membrane for the WVP test should be waterproof, microporous and hydrophobic. It should have a high water vapor permeability, so that two layers of the membrane have a water vapor permeability of more than 1.2g/m^2 Pa h when measured according to the test method. Membranes are obtainable from: Goodfellow Corp, 800 Lancaster Ave., Berwyn, PA 19312-1780.

6.9 Instructions for washing machine timer modification (continuous wash).

For running the water permeability after wet flex test using AATCC approved washers, the following are the list of modifications:

Washing Machine Timer Modification

1) A single pole, double throw toggle switch is installed on top of the control panel of the washer.
2) When the toggle switch is in the closed position it is labeled RUN on the side of the toggle.
3) When the toggle switch in the open position it is labeled BYPASS on the side of the toggle.
4) Two wires are connected to the posts of the toggle switch and extend down to the timer motor.
5) One timer motor lead is cut and the wires from the toggle switch is wired in series with the timer motor lead using wire nuts or butt spices.

These changes will allow the operator to divert power from the timer motor and prevent the timer from advancing to the next cycle.

6.10 Subject term (key word) listing.

Cloth
Physical surface appearance
All Purpose Environmental Clothing System (APECS)

MILITARY INTERESTS:

Custodians
Navy-MC

PREPARING ACTIVITY:

DLA-CT

Project NO. (8305-0842)

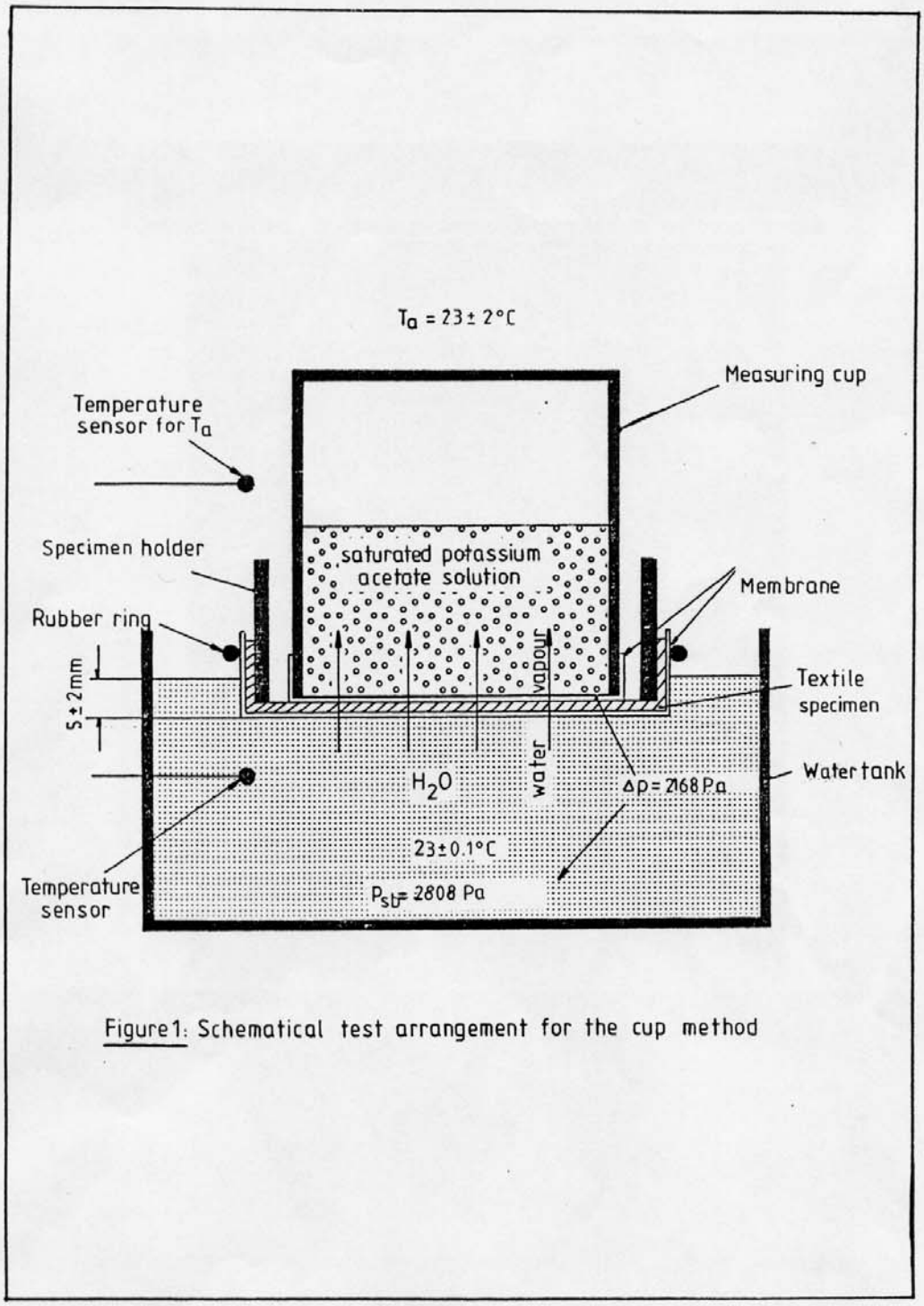

Figure 1: Schematical test arrangement for the cup method

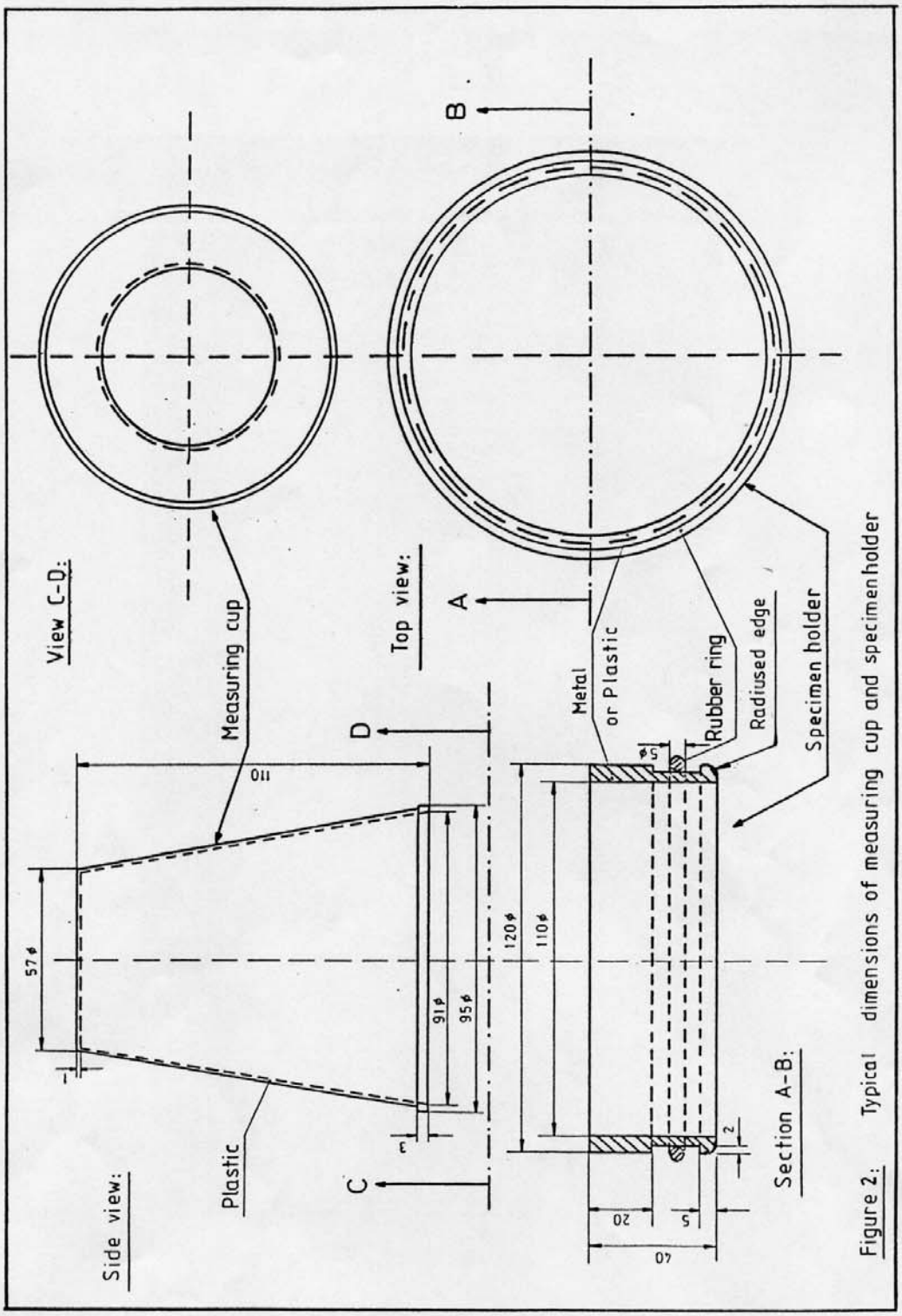

Figure 2: Typical dimensions of measuring cup and specimenholder

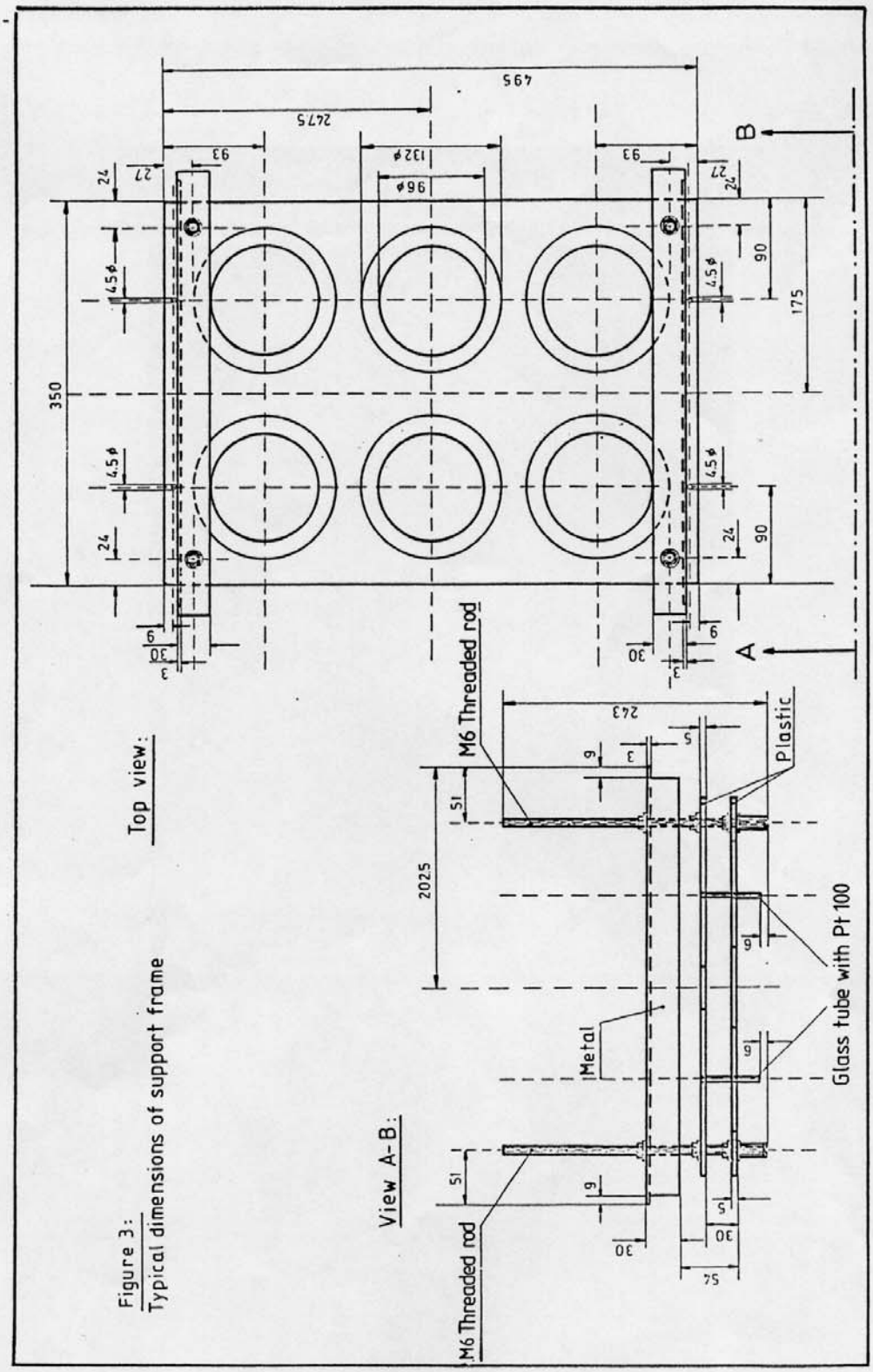

Figure 3:
Typical dimensions of support frame