

INCH-POUND

MIL-C-44378(GL)  
30 June 1989

## MILITARY SPECIFICATION

## CLOTH, PARACHUTE, NYLON, LOW PERMEABILITY

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

## 1. SCOPE

1.1 Scope. This specification covers three types of nylon cloth for use in the fabrication of parachutes.

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

Type I - 1.12 oz/sq yd (0-3 air permeability) - Rip stop weave  
Type II - 1.11 oz/sq yd (30-50 air permeability) - Rip stop weave  
Type III - 1.12 oz/sq yd (30-50 air permeability) - Rip stop weave

## 2. APPLICABLE DOCUMENTS

2.1 Government documents.

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

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: U. S. Army Natick Research, Development, and Engineering Center, Natick, MA 01760-5014 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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SPECIFICATIONS

FEDERAL

PPP-P-1133 - Packaging of Synthetic Fiber Fabrics

STANDARDS

FEDERAL

FED-STD-191 - Textile Test Methods

FED-STD-595 - Colors

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection  
by Attributes

MIL-STD-851 - Coding: Manufacturer's Color, Nylon Parachute  
Cloth

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

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.)

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

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.3) in accordance with 4.3.

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3.2 Standard sample. The finished cloth shall match the standard sample for shade and appearance and shall be equal to or better than the standard sample with respect to all characteristics for which the standard sample is referenced (see 6.4).

3.3 Material.

3.3.1 Yarn. The nylon yarn used in the manufacture of the cloth shall be a continuous multifilament, bright, high tenacity, light and heat resistant polyamide prepared from hexamethylene diamine and adipic acid or its derivatives. The yarn shall have a melting point of  $489 \pm 10^{\circ}\text{F}$  when tested as specified in (4.4.1.1). The yarn shall not be bleached in any manner or during any subsequent process.

3.4 Color. The color of the finished cloth shall be Gray 26270, Green 34102, or as specified, (see 6.2) conforming to FED-STD-595.

3.4.1 Matching. The color of the finished cloth, layered four times, shall match the standard sample (FED-STD-595 color chip) when viewed under filtered tungsten lamps that approximate artificial daylight and that have a correlated color temperature of  $7500 \pm 200\text{K}$ , with illumination of  $100 \pm 20$  foot candles and shall be a good match to the standard sample under incandescent lamplight at  $2300 \pm 200\text{K}$ .

3.4.2 Colorfastness. The finished cloth shall show fastness to light, laundering, water, and bleeding in damp air equal to or better than the standard sample or equal to or better than a rating of "good". Testing shall be as specified in 4.4.4.

3.4.3 Resistance to heat and light. The finished cloth shall not lose more than 25 percent of its original strength when tested as specified 4.4.4.

3.5 Physical requirements. The physical requirements for the finished cloth shall be as specified in table I when tested as specified in 4.4.4.

TABLE I. Physical requirements

Characteristic	Type I	Type II	Type III
Weight, (ounces per sq yd) max	1.12	1.11	1.12
Thickness, (inches) max	0.003	0.003	0.003
Breaking strength, (pounds) min <u>1/</u> :			
Warp	45	42	45
Filling	45	42	45
Elongation, (percent) min:			
Warp	20	20	20
Filling	20	20	20

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TABLE I. Physical requirements (cont'd)

Characteristic	Type I	Type II	Type III
Tearing strength, (pounds) min <u>1/</u> :			
Warp	5	5	5
Filling	5	5	5
Air permeability, (ft <sup>3</sup> /min/ft <sup>2</sup> )	0-3	30-50	30-50
Yarns per inch, (min):			
Warp	126	124	126
Filling	132	126	132
Yarn twist, (turns per inch) max <u>2/</u> :			
Warp	0.5	5.0	0.5
Filling	0.5	0.5	0.5

1/ No individual test specimen shall have a value lower than the minimum physical requirement.

2/ Interlaced or twisted yarn is permitted in the weaving of types I, II, and III.

### 3.5.1 Weave.

3.5.1.1 Type I and type III weave. The weave pattern for type I and type III cloth shall be as specified in figure 1.

3.5.1.2 Type II weave. The weave pattern for type II cloth shall be as specified in figure 2.

3.5.2 Loom type. The use of flyshuttle or shuttleless loom fabric is acceptable. No chemical means or coatings shall be used to form a selvage.

3.5.3 Identification yarns. Color yarns shall be woven into the selvage edges of the cloth or approximately 1/2 inch in from the last warp yarn to identify the cloth manufacturer to the contracting activity. The colors used shall be those indicated in MIL-STD-851. Additional color yarns may be used to identify the converter (supplier) provided that the converter has identification yarns assigned by MIL-STD-851 or the contracting activity. The dye used in the marker yarns shall have no deleterious effect on the physical properties of the yarn and the dyed yarns shall show colorfastness to light, laundering, water and bleeding in damp air equal to or better than the standard sample or equal to or better than a rating of "good". Testing shall be as specified in 4.4.1.1.

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3.5.4 Width. The width of the finished cloth shall be  $36\frac{1}{2} \pm \frac{1}{2}$  inches,  $48\frac{1}{2} \pm \frac{1}{2}$  inches, or as otherwise specified (see 6.2) and shall be the minimum acceptable width inclusive of the selvage when fly-shuttle looms or shuttleless looms with a tuck-in selvage are used. For all other shuttleless looms, the width measurement shall be made between the last warp yarn on each side excluding the protruding fringe(s).

3.6 Finish. The cloth shall be scoured to remove sizing and other contaminants, at a temperature which will not cause fixation of same into cloth or result in permanent setting of the cloth. The cloth shall be heat treated and may be calendered at such temperature and pressure as required to control the air permeability to level required by this specification. Where calendering is required, the fabric should be turned over each calender run. The cloth covered by this specification shall not be bleached, resinated or treated with oxalic or phosphoric acid in any manner or process (see 6.6 and 6.7).

3.6.1 pH. The pH of the water extract of the finished cloth shall be not lower than 6.0 and not higher than 9.0 when tested as specified in 4.4.4.

3.6.2 Permanence of set.

3.6.2.1 Air permeability type I. Type I cloth air permeability readings shall be within  $0\text{--}3 \text{ ft}^3/\text{min}/\text{ft}^2$  after testing as specified in 4.4.4.

3.6.2.2 Air permeability types II and III. Type II and III cloth air permeability readings shall be within  $30\text{--}50 \text{ ft}^3/\text{min}/\text{ft}^2$  after testing as specified in 4.4.4.

3.6.2.3 Thickness. The thickness of the type I, II and III cloth shall not exceed 10 percent of the initial readings after testing as specified in 4.4.4.

3.6.2.4 Shrinkage. Type I, II and III cloth shrinkage shall not exceed 2 percent in the warp and 1 percent in the filling direction after testing as specified in 4.4.4.

3.6.3 Nonfibrous materials.

3.6.3.1 Silicone oil. Type II finished cloth shall be treated with a silicone oil so applied that it is evenly distributed throughout the cloth. The amount of oil added shall be from 0.3 to 0.5 percent based on the weight of the dry cloth. The finisher shall submit a certificate of compliance for each finisher's roll (see 4.4.1.1) indicating that silicone oil was used (see 6.5).

3.6.3.2 Fluorocarbon. Type I and III finished cloth shall be treated with a fluorocarbon so applied that it is evenly distributed throughout the cloth. The finisher shall submit a certificate of compliance for each finisher's roll (see 4.4.1.1) indicating that fluorocarbon was used (see 6.6).

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3.6.3.3 Resistance to organic liquid (Type I and type III). The finished cloth shall show no wetting by n-tetradecane initially when tested as specified in 4.4.4.

3.6.3.4 Chloroform soluble material. The chloroform soluble material of the finished cloth shall not exceed 2.0 percent when tested as specified in 4.4.4.

3.7 Length and put-up. For Government procurements only, unless otherwise specified (see 6.2) the cloth shall be put-up in full width rolls as specified in 5.1, and shall be one continuous length of not less than 200 yards. Shorter lengths may be included provided that not more than 20 percent of the rolls contain more than three pieces and no piece shall be less than 50 yards.

3.8 Roll identification. Each roll of finished cloth shall be marked for identification in accordance with PPP-P-1133. In addition, each piece of cloth in each roll shall be clearly and legibly marked with the finisher's roll number or code and each roll shall have attached a durable tag on which the finisher's roll number or code is listed. The date of manufacture of the cloth shall be included on the tag attached to each roll.

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

3.8.2 Age. The cloth shall be not more than 3-1/2 years old from the date of manufacture of the yarn to the date of delivery of cloth (see 4.4.2).

3.9 Workmanship. The finished cloth shall conform to the quality of product established by this specification and the occurrence of defects shall not exceed the applicable acceptable quality levels.

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

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4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to the requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.1.2 Certificates of compliance. When certificates of compliance are submitted, the Government reserves the right to inspect such items to determine the validity of the certification.

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

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

4.3 First article inspection. When a first article is required (see 3.1 and 6.2), it shall be examined for the defects specified in table III, 4.4.3.3 thru 4.4.3.5, and tested as specified in table V.

4.4 Quality conformance inspection. Unless otherwise specified, sampling for inspection shall be performed in accordance with MIL-STD-105.

4.4.1 Component and material inspection. In accordance with 4.1, components and materials shall be inspected in accordance with all the requirements of referenced documents unless otherwise excluded, amended, modified, or qualified in this specification or applicable purchase document.

4.4.1.1 Component and material certification. A certificate of compliance may be acceptable as evidence that the characteristics listed in table II conform to the specified requirements when tested by the specified test methods.

TABLE II. Component and material certification

Characteristic	Requirement paragraph	Test method
Yarn:		
Multifilament, luster, tenacity, light and heat resistant	3.3.1	_____
Material identification	3.3.1	1530 of FED-STD-191
Melting point	3.3.1	1534 of FED-STD-191
Not bleached	3.3.1	_____

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TABLE II Component and material certification (cont'd)

Characteristic	Requirement paragraph	Test method
Identification yarns (selvage):		
Colorfastness to:		
Light	3.5.3	5660 of FED-STD-191
Laundrying	3.5.3	5614 of FED-STD-191
Water	3.5.3	5630 of FED-STD-191
Bleeding in damp air	3.5.3	4.5.2
Silicone oil identification	3.6.3.1	—
Fluorocarbon identification	3.6.3.2	—

4.4.2 In-process inspection. Inspection of the manufacturing process shall be made to ascertain that the cloth has been treated in accordance with the finish requirements under 3.6 and that the cloth age will be in accordance with 3 8 2. The Government reserves the right to exclude from consideration for acceptance, any material or service for which in-process inspection has indicated nonconformance.

4.4.3.1 End item critical defect examination. Every roll of cloth in every lot, prior to the yard by yard examination in 4.4.3.2, shall be examined over its entire length for the "abraided warp" critical defect listed in table III. Any piece of material containing one or more critical defect shall be rejected. This critical defect examination shall be made a part of the contractor's inspection system or quality program.

4.4.3.2 Yard-by-yard examination. The cloth shall be examined for the defects listed in table III. All defects clearly noticeable at normal inspection distance (3 feet), shall be counted regardless of their proximity to each other. A continuous defect shall be counted as one defect for each warpwise yard or fraction thereof. The lot size shall be expressed in units of yards. The sample unit shall be 1 linear yard. The inspection level shall be II and the acceptable quality level (AQL) expressed in terms of defects per hundred units, shall be 1.0 for major defects and 4.0 for total defects. The number of rolls from which the sample is to be selected shall be in accordance with table IV. The sample yardage shall be apportioned equally among the selected rolls. The finding of any critical defect shall be cause for rejection of the lot.

TABLE III. End item visual defects

Defect	Description	Classification		
		Critical	Major	Minor
Abrasion	Any abrasion mark or streak showing fuzziness <u>1/</u>		101	
	Abraided warp condition <u>2/</u>	1		

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TABLE III. End item visual defects (cont'd)

Defect	Description	Classification		
		Critical	Major	Minor
Biased filling	More than 1 inch from horizontal at greatest point of bias		102	
Bowed filling	More than 1 inch in height (as measured from a straight line chord to highest point of arc)		103	
Break, cut, hole or tear (other than pinhole, etc)	Three or more warp or filling yarns ruptured at adjoining points		104	
Filling bar variation	Over 1/8 inch and up to 1/2 inch in width with 10 percent or less variation above normal pick count			201
	Over 1/8 inch and up to 1/2 inch in width with more than 10 percent variation below normal pick count		105	
	Over 1/2 inch in width with more than 10 percent variation from normal pick count		106	
	1/8 inch or less in width and varying 10 percent or more from normal pick count			202
	Any multiple float 3/16 inch square or more		107	
Floats or skips	Single floats 1/4 inch or more in length		108	
	Continuous pin floats, the sequence of which measures 1 inch or more in length			203
	Multiple floats up to 3/16 inch square			204
	Single floats up to 1/4 inch long			205
	Continuous floats or pin floats <u>3/</u> the sequence of which measures less than 1 inch in length		109	

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TABLE III. End item visual defects (cont'd)

Defect	Description	Classification		
		Critical	Major	Minor
Jerked-in filling	Any jerked-in filling occurring more than four times within 10 linear inches			206
Loops, kinks, or snarls (except selvage)	All over 1/8 inch in length		110	
	Three or more in any linear yard up to 1/8 inch in length			111
Manufacturer's missing identification yarn				112
Mispick	Three or more picks in a shed			113
	Two picks in a shed			207
Missing end	Two or more contiguous, regardless of length			114
	Single: 36 inches or more in length			115
	Single: less than 36 inches in length			208
Missing pick	Two or more contiguous, regardless of length			116
	One missing pick, full width			209
Selvage defects	Any cut, broken, torn, scalloped or clearly noted waviness along selvage edge (check for waviness under no tension)			117
	More than 3 inches of continuous stringy or loopy selvage projecting 1/8 inch or more			118
	Continuous stringy or loopy selvage projecting up to 1/8 inches			210
	Any clearly noticeable roll of edge or edges when tension is released (tight selvages)			119

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TABLE III. End item visual defects (cont'd)

Defect	Description	Classification		
		Critical	Major	Minor
Thick places/ stripback	Any abruptly thickened place in the fabric caused by extraneous material woven in the fabric or a stripback continuing for more than 1-1/2 inches and being more than 1/16 inch wide for that length		120	
	Thick places smaller than 1-1/2 inches long or 1/16 inch wide			211
Smash	Any smash		121	
Weave	Pattern other than specified		122	
Weaver's stain	Any spot, stain, or streak (not dye streaks) of following magnitudes:			
	Single ends or picks 15 inches or more in length		123	
	Double ends or picks 8 inches or more in length		124	
	More than two ends or picks 5 inches or more in length or a clearly noticeable area more than 1/4 square inch in area, whichever is greater		125	
	Single ends or picks 2-1/2 inches up to 15 inches in length			212
	Double ends or picks 1-1/2 inches up to 8 inches in length			213
	Over two ends or picks less than 5 inches in length or a clearly noticeable area 1/4 square inch or less in area, whichever is greater			214

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TABLE III. End item visual defects (cont'd)

Defect	Description	Classification		
		Critical	Major	Minor
Width	Less than the specified width		126	
Wrong draw	Clearly noticeable warp streak more than 18 inches in length <u>4/</u>		127	
Yarn deformations	Over six yarn deformations or shifts of 1/32 inch or more over 6 inches in length occurring within an area equal to a 6-inch diameter circle		128	

1/ Abrasion exhibits damaged yarn filaments that have had the surface gouged, peeled, scraped, or torn, which may or may not be accompanied by melt residue, when viewed under a suitable 100x microscope (see 6.8). This condition appears fuzzy when observed by the naked eye due to the difference in light reflectance observed from the damaged yarn filament surface. Broken yarn filaments caused by abrasion will show surface damage, as described, in the area of the break. Occasional broken yarn filaments that occur within the normal processing of textiles are not to be misinterpreted as abrasion.

2/ Abraded warp condition inspection procedure is as follows:

1 Visual (naked eye) inspection of all warp streaks. A warp streak is defined as a line, mark, smear or band differentiated by color, abrasion or texture from its surroundings.

2 Visual (naked eye) inspection of all cloth on each piece over a dark (preferably black) background with no backlight, a single layer of cloth at one time.

3. Then, further inspection of all visually identified warp streak via a one hundred power (100x) microscope (see 6.8) with no backlight for an abrasion within the streak. Any abrasion found is termed abraded warp condition and rejects that piece.

3/ A pin float is defined as a float measuring 1/8 inch or less. Single pin floats up to 1/8 inch shall not be considered defects.

4/ A wrong draw is produced at the weaving loom when one or more warp ends are drawn through the wrong loom harness, causing the warp and filling to interlace improperly. This condition appears as a warp streak when observed with the naked eye due to the disturbance of the weave pattern.

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4.4.3.3 Roll identification examination. During the yard-by-yard examination, each roll in the sample shall be examined for compliance with the Textile Fiber Products Identification Act. The lot shall be unacceptable if two or more rolls in the sample are not labeled or ticketed in accordance with the Rules and Regulations Under the Textile Fiber Products Identification Act.

4.4.3.4 Overall examination. Each roll in the sample shall be examined over its entire length for the defects listed below. Each defect listed shall be counted not more than once in each roll examined. The sample size shall be the applicable number of rolls indicated in table IV. The lot shall be rejected if the total number of defects in the sample exceeds the applicable acceptance number specified in table IV.

- a. Uncleanliness throughout
- b. Spottiness, poor dye penetration, or off shade of standard range
- c. Uneven weaving throughout

4.4.3.5 Length examination. Each roll of cloth used in the yard-by-yard examination shall be examined for the defects listed below. If the total number of defects in the sample exceeds the applicable acceptable number specified in table IV or if the total of the actual lengths of the sample rolls is less than the total of the lengths marked on the roll tickets, the lot shall be rejected.

Defects

- Any gross length less than the specified minimum length
- Any gross length more than 2 yards less than the gross length marked on the roll ticket
- Any roll containing more than the specified maximum number of pieces

TABLE IV. Lot size and acceptance criteria

Lot size (yards)	Sample size (rolls)	Acceptance number <sup>1/</sup>
3,200 or less	2	0
3,201 up to and including 10,000	3	0
10,001 up to and including 60,000	5	0
60,001 up to and including 150,000	8	1
150,000 and over	13	1

<sup>1/</sup> Applicable to overall and length examinations only (see 4.4.3.4 and 4.4.3.5).

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4.4.4 End item testing. The cloth shall be tested for the characteristics listed in table V. The methods of testing specified in FED-STD-191 wherever applicable and as listed in table V shall be followed. The physical and chemical values specified in Section 3 apply to the average of the determinations made on a sample unit for test purposes as specified in the applicable test method. All test results shall contain the individual values utilized in expressing the final result. The lot size shall be expressed in units of yards. The sample unit shall be 12 continuous yards (full width) of the finished cloth. The lot shall be unacceptable if one or more sample units fail to meet any test requirements specified. The sample size shall be as follows:

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

TABLE V. End item tests

<u>Characteristic</u>	<u>Requirement paragraph</u>	<u>Test method</u>
Colorfastness to:		
Light	3.4.2	5660
Laundering	3.4.2	5614
Water	3.4.2	5630
Bleeding in damp air	3.4.2	4.5.2
Resistance to:		
Heat	3.4.3	4.5.3
Light	3.4.3	4.5.3
Weight	3.5	5041
Thickness	3.5	5030
Breaking strength and elongation (ravel strip method):		
Warp	3.5	5104 $\frac{1}{2}$
Filling	3.5	5104 $\frac{1}{2}$
Tearing strength (tongue method):		
Warp	3.5	5134
Filling	3.5	5134

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TABLE V End item tests

Characteristic	Requirement paragraph	Test method
Air permeability	3.5	5450 <u>2/</u>
Yarns per inch:		
Warp	3.5	5050
Filling	3.5	5050
Yarn twist:		
Warp	3.5	4052
Filling	3.5	4052
Width	3.5.4	5020
pH	3.6.1	2811
Permanence of set:		
Air permeability	3.6.2.1 and 3.6.2.2	5450 <u>2/</u>
Thickness	3.6.2.3	4.5.1
Shrinkage	3.6.2.4	4.5.1
Resistance to organic liquid (types I and III):	3.6.3.3	4.5.4
Chloroform soluble material:	3.6.3.4	2611

- 1/ Except that the jaws of the clamp shall be 1 inch by 1-1/2 inches or more with the long dimension of the jaws perpendicular to the application of the load.
- 2/ Except that the five specimens shall be taken from a 7 inch long by full width swatch of the sample unit with the specimens equally spaced across the width.

4.4.5 Packaging inspection. The inspection shall be in accordance with the quality assurance provisions of PPP-P-1133.

#### 4.5 Methods of inspection

4.5.1 Permanence of set. Two 20 inch square specimens of the cloth shall be prepared. Using a template and indelible ink, an 18 inch square shall be marked on each specimen. The specimens shall be subjected to the resistance to organic liquid test as specified in 4.5.4, and to air permeability and thickness tests in accordance with Methods 5450 and 5030 of FED-STD-191. A container of adequate size to accommodate both specimens, prepared as described below, shall

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be filled to within 3 inches of the top with water which shall be heated to a rapid boil. Both specimens shall be placed in the boiling water in a loop form prepared by stapling the two opposite sides of a specimen together. One specimen shall have the warp yarns vertical in the loop and the other specimen shall have the filling yarns vertical. Each specimen shall then be placed over a glass rod which is 1/4 inch in diameter and 21 inches in length, and approximately  $45 \pm 5$  grams in weight, shall be placed inside each loop at the bottom. Both loops shall then be suspended freely in the boiling water bath by attaching each with twine or wire to glass rods which are 1/4 inch in diameter and of sufficient length to rest on the top of the container. The specimens shall be subjected to the action of the boiling water bath for a period of 15 minutes, after which they shall be removed from the bath and allowed to drain for a few minutes. The staples shall be removed from the specimens and the specimens shall be placed flat on a horizontal screen to air dry. After the specimens are thoroughly dry they shall be exposed for at least 4 hours to a standard atmosphere of  $65 \pm 2$  percent relative humidity and a temperature of  $70 \pm 2$  °F. Each 18-inch square shall be measured to the nearest 0.01 inch in six places, three in the warp direction and three in the filling direction. The results of the warp skein and filling skein for thickness, air permeability, and shrinkage shall be averaged, and acceptance based on the average results. The percentage of shrinkage in either the warp or filling direction shall be computed as follows:

$$18 - \frac{\text{distance between marks after boiling}}{18} \times 100 = \text{percent shrinkage}$$

The specimens shall again be subjected to resistance to organic liquid test as specified in 4.5.4, and to air permeability and thickness tests in accordance with Methods 5450 and 5030 of FED-STD-191, to determine conformance to 3.6.2.

#### 4.5.2 Colorfastness to bleeding in damp air.

4.5.2.1 Preparation of sample. The test sample shall be a 4 inch square consisting of five layers of cloth. The two outer layers shall be 5.6 ounce white cotton cloth enclosing two layers of white rip stop nylon with the specimen of dyed cloth being tested between the nylon. The five layers of cloth shall be sewed together along one edge.

4.5.2.2 Test procedures The sample shall be immersed in distilled water for 5 minutes. The temperature of the water shall be  $21 \pm 3^{\circ}\text{C}$  ( $70 \pm 5^{\circ}\text{F}$ ). Remove the sample from the water and immediately roll up without squeezing out the excess moisture. The sample shall then be placed inside a 100 milliliter test tube, tightly stoppered, and then placed in an oven for 2 hours at a temperature of  $60 \pm 3^{\circ}\text{C}$  ( $140 \pm 5^{\circ}\text{F}$ ). The sample shall be removed from the oven and the white rip stop nylon examined for bleeding, and for conformance to the requirement in 3.4.2. If there is a perceptible but not an appreciable change in color and staining, the complete test sample is noted as "good" and is acceptable.

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4.5.3 Resistance to heat and light. The test specimens for determining resistance to heat and light shall be so selected that the identical warp and filling yarns are tested originally and after subjection to heat and light. This shall be done by marking all the specimens required with dye resistant ink before cutting. The specimens shall be so cut and clearly marked, so that specimens in each group, i.e., original warp and filling, warp and filling after resistance to light, and warp and filling after resistance to heat, contain identical yarns (see figure 3).

4.5.3.1 Test procedure (resistance to light). The test specimens, (see figure 4), shall be tested in accordance with Method 5804 of FED-STD-191 and the following exceptions:

- a. The specimens shall be suspended on the rotating rack by attaching the corners with wooden clamps (see figure 4) to the rotating rack. Care must be taken to assure that the filling specimens are not shielded by the center specimen rack.
- b. Corex D filters and sunshine carbons shall be used.
- c. The exposure time shall be 50 hours.
- d. The spray heads shall be shut off during the entire exposure period
- e. The drain pan shall contain from 1/2 inch to 1 inch of water during the entire exposure period.
- f. The relative humidity shall be  $55 \pm 5$  percent and the back panel temperature shall be  $155 \pm 10$  °F during the entire exposure period.
- g. The black panel shall be removed and polished every 500 hours of use. When the black surface begins to fade it shall be replaced.
- h. The filter shall range from less than 250 hours to a maximum 2,000 hours.

This is to be accomplished in the following manner:

- (1) Number the filter frames 1 through 8.
- (2) Replace all filters with new filters.
- (3) Change one filter every 250 hours until all filters are changed then repeat the cycle starting with filter No. 1.

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- i. At the end of the exposure period the specimens shall be brought to equilibrium under standard conditions.
- j. The specimens shall then be tested for breaking strength in accordance with FED-STD-191, Method 5104, and the percent of breaking strength loss shall be calculated as follows:

$$\frac{\text{Original average B.S.} - \text{B.S. after aging}}{\text{Original average B.S.}} \times 100 = \text{Percent of B.S. loss}$$

4.5.3.2 Test procedure (resistance to heat). The test specimens (see figure 5) shall be exposed in a circulating air oven at a temperature of  $356 \pm 10$  °F for 1 hour. The velocity of the air shall be adequate to maintain a constant temperature throughout the oven chamber. The velocity shall not be so great that the specimens are forced against the rack or walls of the chamber. The specimens shall be attached to the rack at two corners with wood clamps and suspended free (see figure 5). The oven chamber shall be preheated to  $400 \pm 10$  °F, the rack containing the specimens shall be placed in the chamber, and the 1 hour cycle shall be started immediately. NOTE: When placing the specimens in the chamber, do so as quickly as possible to prevent loss of chamber temperature.

4 5.4 Resistance to organic liquid test. Place a small specimen of the cloth on a smooth horizontal surface, face up. Using a pipette or eye dropper, gently deposit one drop of n-tetradecane on the surface of the specimen. After 1 minute examine the specimen under light at an angle. Absence of light reflectance at the cloth-drop interface shall be taken as evidence of wetting. Three specimens (or areas) taken at various locations across the sample unit shall be tested. Evidence of wetting on one or more specimens shall be considered a test failure.

## 5. PACKAGING

5.1 Put-up and preservation. Put-up and preservation shall be level A or Commercial as specified (see 6.2).

5.1.1 Levels A and Commercial. The cloth shall be put-up and preserved in accordance with the applicable requirements of PPP-P-1133.

5.2 Packing. Packing shall be level A, B or Commercial as specified (see 6.2).

5.2.1 Levels A, B and Commercial. The cloth shall be packed in accordance with the applicable requirements of PPP-P-1133.

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5.3 Marking. In addition to any special marking required by the contract or purchase order, shipments shall be marked in accordance with the applicable requirements of PPP-P-1133.

## 6. NOTES

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

6.1 Intended use. The cloth is intended for use in the manufacture of personnel parachutes and other deceleration devices.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number and date of this specification.
- b. Type required (see 1.2).
- c. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1).
- d. Color required (see 3.4)
- e. First article, when required (see 3.1, 4.3 and 6.3).
- f. Width if other than specified (see 3.5.4).
- g. Length of roll if other than specified (see 3.7).
- h. Levels of preservation and packing (see 5.1 and 5.2).

6.3 First article. When a first article is required, it shall be inspected and approved under the appropriate provisions of FAR 52.209. The first article should be a reproduction 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 acquisition documents regarding arrangements for selection, inspection, and approval of the first article.

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

6.5 Silicone oil. Dow Chemical Company's silicone emulsion ET 112A has been found satisfactory for use in the finishing of the type II cloth (see 3.6.3.1).

6.6 Fluorocarbon. Approval of chemical treatments is the responsibility of the U.S. Army Natick Research, Development and Engineering Center, Natick, MA 01760-5014 and is based on extensive tests including those for toxicity, which are set forth in this specification. Because of the time necessary to conduct full evaluation (approximately 6 months), only those treatments already approved and so listed in the invitation for bids or request for proposal shall be considered acceptable for acquisition of type I and type III cloth (see 3.6.3.2). Information pertaining to approval of new treatments should be obtained from the U.S. Army Natick Research, Development, and Engineering Center. The list of approved treatments may be obtained from the contracting activity.

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6.7 Chemicals. Chemicals used in the processing of the cloth during preparation and dyeing may accelerate fiber degradation and should be selected with care.

6.8 Microscopes. Suitable 100X microscopes with battery operated illumination are:

a. Cat No. J61, 193 with battery operated illumination available from the Edmund Scientific Corporation, 101 East Gloucester Pike, Bearington, New Jersey, telephone no. 1-800-222-0224.

b. Cat No. N116B837 with battery operated illumination available from the Jenson Tools Inc., 7815 S. 46th Street, Phoenix, AZ, telephone no. 1-602-968-6231.

6.9 Subject term (key word) listing.

Equipage  
Deceleration  
Personnel

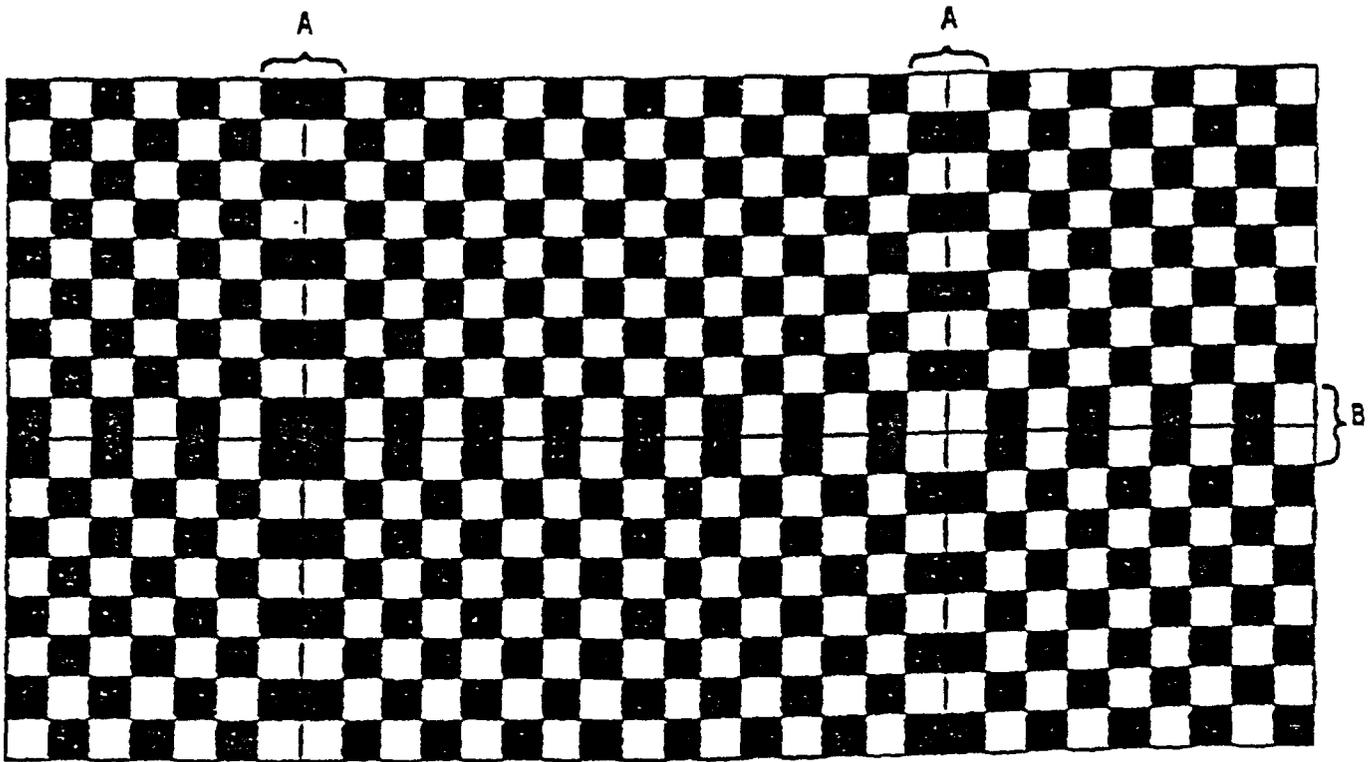
Custodians:  
Army - GL

Preparing activity:  
Army - GL

Review activities:  
Army - AV, MD  
DLA - CT

(Project 8305-0279)

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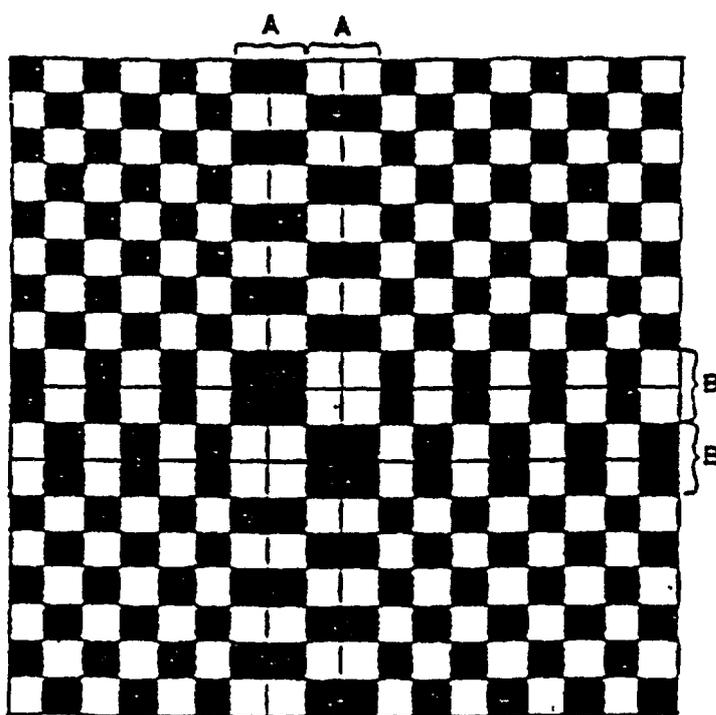


A = Two warp ends woven as one  
B = Two filling picks per shed

NOTE: Reed Plan - two ends per dent (max)

Figure 1. - Weave pattern for Type I and Type III cloth.

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A = Two warp ends woven as one

B = Two filling picks per shed

NOTE: Reed Plan - two ends per dent (max)

Figure 2. - Weave pattern for Type II cloth.

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NOTES:

Each specimen shall be numbered and the number shall appear in the lower right hand corner, face side up and prefix as follows:

- "W" - Warp direction
- "F" - Filling
- "WO" - Weatherometer

Marking shall be with dye resistant marker.

 Area to be trimmed away after heat and light exposure and before original break.

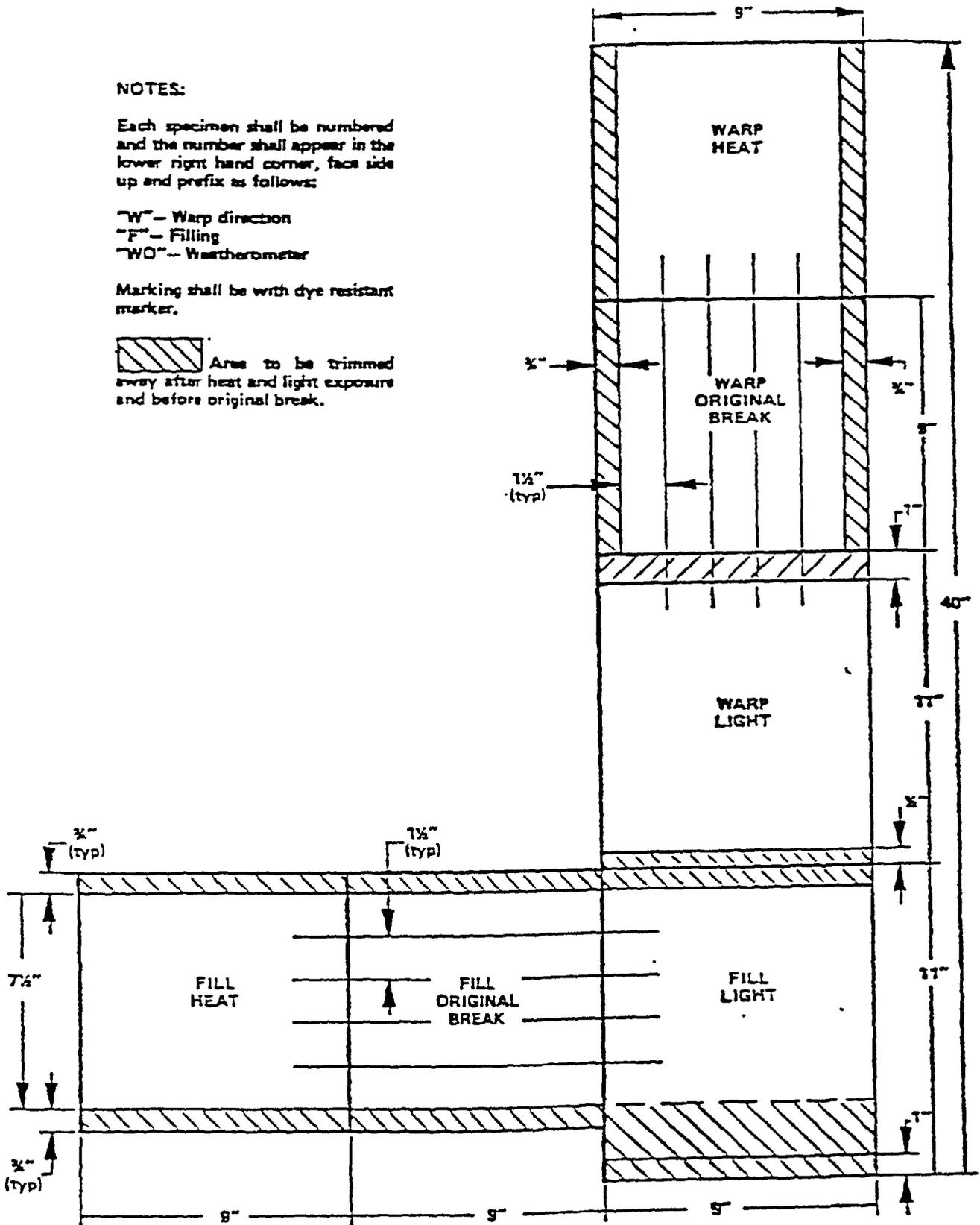


Figure 3.—Test specimens, original break, heat and light

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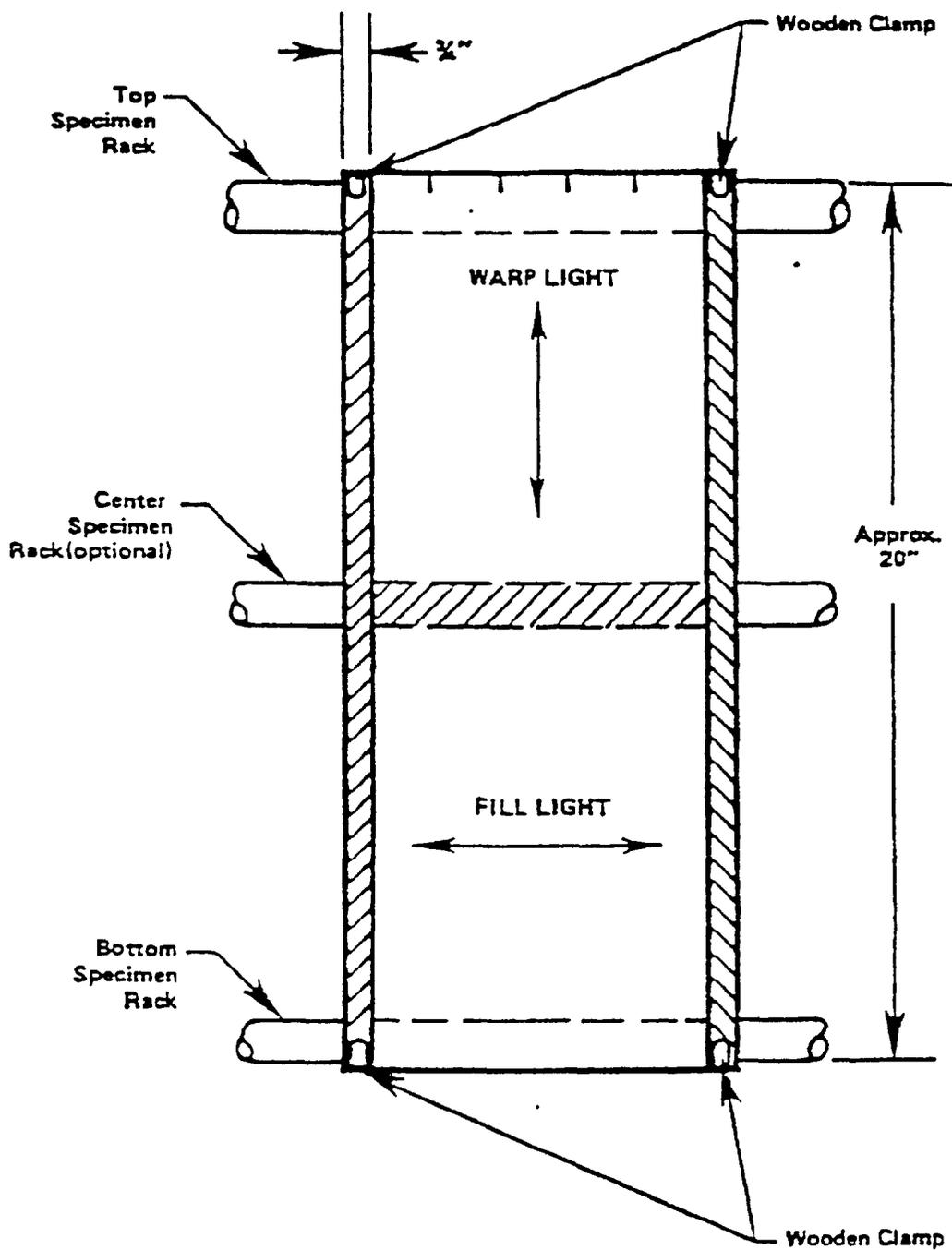


Figure 4.—Test specimens, resistance to light.

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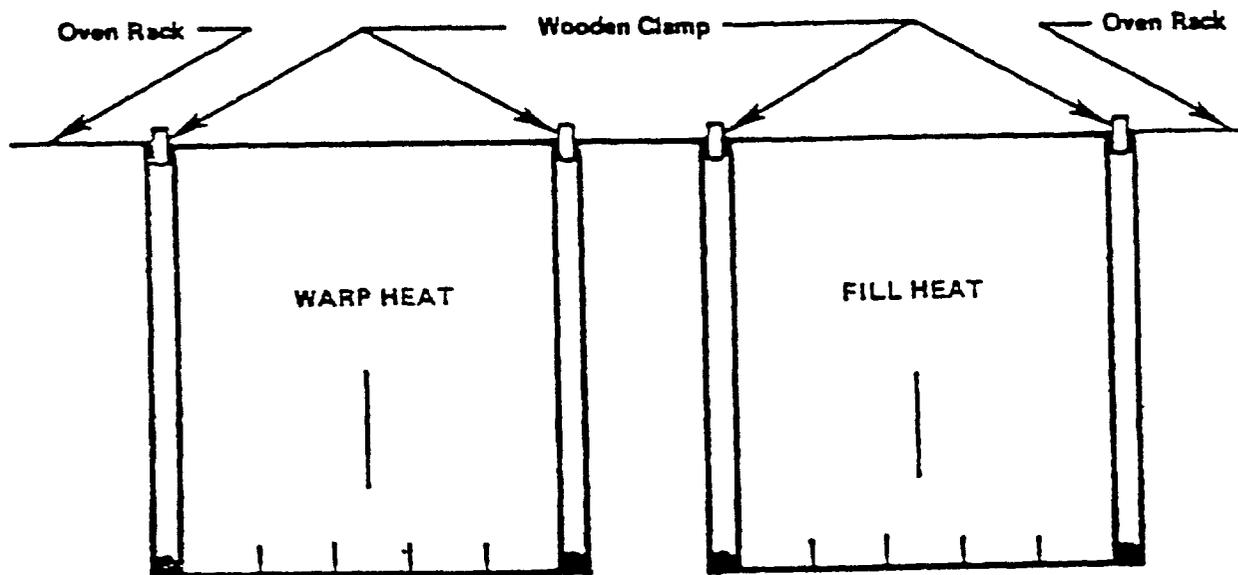


Figure 5.—Test specimens, resistance to heat.

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Natick, MA 01760-5014

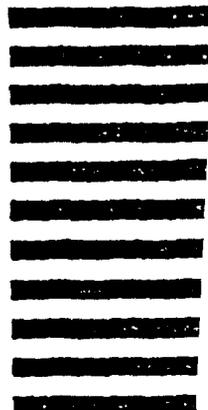


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## STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions - Reverse Side)

1. DOCUMENT NUMBER MIL-C-44378(GL)		2. DOCUMENT TITLE CLOTH, PARACHUTE, NYLON, LOW PERMEABILITY	
3a. NAME OF SUBMITTING ORGANIZATION		4. TYPE OF ORGANIZATION (Mark one)	
b. ADDRESS (Street, City, State, ZIP Code)		<input type="checkbox"/> VENDOR <input type="checkbox"/> USER <input type="checkbox"/> MANUFACTURER <input type="checkbox"/> OTHER (Specify) _____	
5. PROBLEM AREAS			
a. Paragraph Number and Wording:			
b. Recommended Wording:			
c. Reason/Rationale for Recommendation:			
6. REMARKS			
7a. NAME OF SUBMITTER (Last, First, MI) - Optional		b. WORK TELEPHONE NUMBER (Include Area Code) - Optional	
c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional		8. DATE OF SUBMISSION (YYMMDD)	