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U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

SPECIFICATION

CLOTH, LAMINATED, RADIANT HEAT REFLECTIVE

1. SCOPE

1.1 Scope. This specification covers the requirements for one type of radiant heat reflective laminated cloth. The laminated cloth consists of aluminum foil laminated to glass cloth with a nontoxic, heat resistant adhesive.

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 in effect on the date of the invitation for bids or request for proposals (see 6.2).

SPECIFICATIONS

MILITARY

MIL-Y-1140 - Yarn, Cord, Sleeving, Cloth, and Tape-Glass

STANDARDS

FEDERAL

FED-STD-191 - Textile Test Methods
FED-STD-376 - Preferred Metric Units for General Use by the Federal Government

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Ave., Philadelphia, PA 19111-5094.)

Beneficial comments (recommendations, additions, deletions) and any pertinent data that may be used in improving this document should be addressed to: USDA Forest Service, Missoula Technology and Development Center, Building 1, Fort Missoula, Missoula, MT 59804-7294 by using the Specification Comment Sheet at the end of this document or by letter.

FSC 8305

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 of these documents are those in effect on the date of the invitation for bids or request for proposals.

USDA FOREST SERVICE

5100-1A - Standard Test Method for Determining Acute Inhalation toxicity of Fire Shelter Cloth Laminates

(Address requests for copies to USDA Forest Service, Missoula Technology and Development Center, Building 1, Fort Missoula, Missoula, MT 59804-7294.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those in effect on the date of the invitation for bids or request for proposals.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 579 - Woven Glass Fabrics
D 903 - Peel or Stripping Strength of Adhesive Bonds
D 2240 - Standard Test Method for Rubber Property - Rubber Hardness
D 3951 - Standard Practice for Commercial Packaging

(Address requests for copies to ASTM, 1916 Race St., Philadelphia, PA 19103-1187.)

ALUMINUM ASSOCIATION

Aluminum Standards and Data

(Address requests for copies to Aluminum Association, Publication Department, 818 Connecticut Ave., NW, Washington, DC 20006.)

(Non-Government standards and other publications normally are available from the organizations that prepare and distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of conflict between the text of this document and 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 Materials. The materials used in the laminated cloth shall consist of a woven glass cloth, aluminum foil and adhesive as herein specified.

3.1.1 Glass cloth. The glass cloth shall conform to form 4, class C, ECG-1674 or ECDE-1675 of MIL-Y-1140.

3.1.1.1 Organic content (glass cloth). The organic content, determined by ignition loss, shall not exceed 3.0 percent when tested in accordance with 4.4.2.

3.1.2 Aluminum foil. The aluminum foil shall be in accordance with Aluminum Standards and Data No. 1100 alloy, .0015-inch thick ±10 percent and have a dead soft (0) temper (see 4.1.3).

3.1.3 Adhesive. The adhesive shall consist of two components: Morton International, Inc. type 49002 polyester resin in solution together with Dow Chemical Co. type PAPI 135 or PAPI 2027 curing agent (see 6.6). The polyester resin shall be an isocyanate cross-linked polyester.

3.1.3.1 Type 49002 polyester resin in solution. Morton International, Inc., type 49002 resin shall be dissolved in a methylene chloride solvent system and shall conform to Morton International's Adcote 1217 or National Starch and Chemical Co.'s PETAFLEX 30-6970. Toluene and 1,1,1 trichloroethane may be added to facilitate processing, providing no residual amounts of those solvents remain in the cured adhesive.

3.1.3.2 Other additives. The manufacturer shall use only the resin, solvents, and curing agent listed above and shall not add other materials to those specified (see 4.1.3 and 6.4).

3.2 Construction.

3.2.1 Laminating. The glass cloth (3.1.1) and aluminum foil (3.1.2) shall be laminated with the adhesive (3.1.3), using a quality control process that shall use the minimum amount of adhesive (see 3.2.1.3) necessary to meet the bond requirements in 3.2.1.4 and 3.2.1.5 and break/rupture requirements in 3.2.1.6. During the lamination process only those components specified shall be utilized (see 6.4). It shall be the contractor's responsibility to determine through consultation with the adhesive manufacturer, and through experimentation, the best application rate, cure time, environmental conditions, and other factors necessary to meet all requirements.

3.2.1.1 Toxicity. The cloth shall be nontoxic when tested in accordance with 4.4.2.1 (see 6.4). A toxicity test shall be required on the initial preproduction lot. In addition, a toxicity test shall be required whenever the type, class, form, or source for materials cited in 3.1 is changed.

3.2.1.2 Adhesive identification. Adhesive samples removed from the laminated cloth shall have the same spectrum as one of the standard samples (see 6.3) when tested in accordance with 4.4.2.2.

3.2.1.3 Organic content (laminated cloth). The maximum amount of organics allowed in the laminated cloth shall result in a maximum weight loss, excluding water, of 6.0 percent when tested in accordance with 4.4.2.3.

3.2.1.4 Peel strength. The minimum peel or stripping strength of the laminated cloth shall be 1.75 pounds per inch of width of aluminum foil when tested in accordance with 4.4.2.4.

3.2.1.5 Creep. The adhesive bond of the laminated cloth shall have a maximum creep characteristic of 2 inches per 2 inches of foil width per 5 minutes when tested in accordance with 4.4.2.5.

3.2.1.6 Break/rupture. The minimum percent strength retention of the laminated cloth following rupture testing shall be 45 percent in the warp direction and 50 percent in the fill direction when tested in accordance with 4.4.2.6.

3.2.2 Width. Unless otherwise specified, the laminated cloth width shall be 36 inches, -0 +1/4 inch.

3.3 Length and put-up. Unless otherwise specified, the finished laminated cloth shall be furnished on continuous rolls and each roll shall contain not less than 80 yards nor more than 200 yards.

3.4 Deviations and waivers. There shall be no deviations or waivers to the materials or construction specified herein unless authorized in writing by the contracting officer.

3.5 Workmanship. The finished laminated cloth shall conform to the quality and grade established by this specification. The occurrence of defects shall not exceed the applicable point value or defect limit.

3.6 Metric products. Products manufactured to metric dimensions will be considered on an equal basis with those manufactured using inch/pound units, provided they fall within the tolerances specified using conversion tables contained in the latest revision of FED-STD-376, and all other requirements of this specification are met.

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

4.1.1 Non-Government contracts. Quality assurance provisions for non-Government contracts shall be as specified herein. References to "Government" herein shall be replaced by "Certification Organization." Certification Organizations shall conform to NFPA 1977. The contractor shall provide all required information to the Certification Organization.

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

4.1.3 Certificate of compliance. Where certificates of compliance are submitted, the Government reserves the right to check test such items to determine the validity of the certification (see 4.1.3.1). All certificates of compliance from the contractor shall be based on full test reports of the characteristics being certified. These test reports shall be in the possession of the contractor and available for inspection by the contracting officer or contracting officer's representative.

4.1.3.1 Certification. The contractor shall provide certificates of compliance for all materials listed in 3.1 used to construct the laminate. The contractor shall provide the following information on certificates of compliance:

Product description
Fabric, data or style number (fabric, foil, solvent respectively)
Specification or standard (include type, class, and form when applicable)
Manufacturers lot number
Quantity purchased
Purchase source, address and telephone number
Purchase date

4.1.4 Test results. The contractor shall provide copies of all organic content (glass cloth), toxicity, adhesive identification, organic content (laminated cloth), peel strength, creep, and break/rupture test results. All characteristic values shall be shown. Test results shall include:

Manufacturers name, address, and telephone number
Lot number
Date of manufacture
Testing company name, address, and telephone number
Testing date
Testers name and title

4.1.5 Material samples. The contractor shall provide samples to the contracting officer of all materials used to construct the laminate in the following amounts:

Material	Sample size
Glass cloth	1 linear yard
Aluminum foil	1 linear yard
Polyester adhesive solution	1 pint
PAPI curing agent	1 pint
Toluene	1 pint
1,1,1 trichloroethane	1 pint

4.2 Inspection lot. All units of laminated cloth presented for delivery at one time shall be considered a lot for purposes of acceptance inspection and test.

4.3 Sampling for lot acceptance inspection and test. Random samples of laminated cloth units shall be selected from each lot for inspection and test and the sample sizes shall be obtained as specified herein.

4.3.1 Visual inspection. For visual inspection, the sample size shall be selected in accordance with inspection level I of ASQC Z1.4 and sufficient rolls shall be selected at random from the lot so that by inspecting approximately 2 consecutive yards out of each roll, a total of inspected yardage equal to that required shall be obtained. A unit of laminated cloth shall be 1 linear yard of the finished material.

4.3.2 Acceptance tests. For acceptance tests the sample size shall be selected in accordance with inspection level S-2 with an AQL of 10. The sample size shall be 3 continuous yards, full width, of finished cloth. The lot size shall be expressed in units of linear yards.

4.4 Inspection and tests.

4.4.1 Visual inspection. Each sample selected according to 4.3.1 shall be visually examined for defects specified in table I. Normal inspection distance shall be 3 feet average and samples shall be examined over a uniform light source of 250-foot candles minimum, and all areas of the laminated cloth shall be examined. Classification of defects shall be in accordance with table I and lot acceptance shall be based upon Acceptable Quality Levels (AQL's). The AQL's shall be 2.5 for major defects and 6.5 for minor defects.

TABLE I. End item visual and dimensional defects

Examine	Defect	Classification Major	Minor
Material	Not as specified	X	
	Width not as specified	X	
	Length of put-up not as specified	X	
Blisters and unlaminated areas	Greater than 1/4 square inch in size	X	
	Less than 1/4 square inch in size:		
	One to six		X
	More than six	X	
Creases or mill wrinkles with no evidence of break in aluminum foil or glass cloth	Greater than 6 linear inches in length	X	
	Less than 6 linear inches in length:		
	One to six		X
	More than six	X	
Cuts, tears or breaks (other than pinholes) in aluminum foil or glass cloth	Greater than 1/2 linear inch in length	X	
	1/2 linear inch or less:		
	One to six		X
	More than six	X	
Pinholes	One to 12		X
	More than 12	X	
	NOTE: A pinhole is defined as any transparent or semitransparent opening observed in the cloth under through-light (1/) conditions which may or may not be visible when the laminated cloth is viewed at the same distance in average daylight or the equivalent thereof; a point presenting an opening large enough to allow penetration of a pinpoint of light through.		

1/ The through-light inspection shall be performed in a darkened area using a light table described as follows: It shall have a clear glass top and shall be illuminated with a minimum of two 25-watt fluorescent tubes. The tubes shall be positioned 9 to 10 inches below the glass top and 6 to 8 inches from the sides and ends of the light housing. The spacing between tubes shall be 5 to 6 inches and the interior of the light housing shall be white. During examination of the laminated cloth on the light table, illumination in the darkened room shall be 20 ±5 foot candles of natural or artificial light. An instrument for measuring light intensity, such as the Weston Illumination Meter model 756 or 703, type 8 with viscor filter by Daystrom, Inc., Weston Industries, Newark, NJ, shall be used.

4.4.2 Tests. Each sample selected in accordance with 4.3.2 shall be tested for the requirements in table II. In addition to this, one toxicity test as required in 3.2.1.1 shall be performed as specified by 4.4.2.1 on an additional sample.

Table II. Test methods

Characteristic	Requirement paragraph	Test method
Organic content (glass cloth)	3.1.1.1	ASTM D 579 (1/)
Infrared (adhesive identification)	3.2.1.2	4.4.2.2
Organic content (laminated cloth)	3.2.1.3	4.4.2.3
Peel strength	3.2.1.4	4.4.2.4
Creep	3.2.1.5	4.4.2.5
Break/rupture	3.2.1.6	4.4.2.6

1/ Unless otherwise specified, a certificate of compliance may be submitted and will be acceptable for the stated requirement, provided characteristic values are shown on the certificate.

4.4.2.1 Toxicity. The toxicity test shall be performed in accordance with Forest Service Test Method 5100-1A. Test results shall be reported as "pass" or "fail" (see 6.4 and 6.7).

4.4.2.2 Infrared test. The foil may be separated from the glass cloth by dipping an edge in acetone and peeling it back. The separated pieces shall then be placed in a beaker of acetone and gently heated until the adhesive is dissolved. Remove and rinse the foil and glass cloth samples with acetone into the beaker. Allow acetone to evaporate. Add several drops of DMF (Dimethyl Formamide) to dissolve the residue. Place several drops of the adhesive solution on a sodium chloride crystal and cast a thin film which will give approximately 0.8 linear units of absorption. Dry the film at 90 to 100^{o}C for 15 minutes. The resultant film shall be analyzed with an infrared grating spectrophotometer such as a Perkin-Elmer Model 283 or equivalent. As an option the glass cloth may be separated from the aluminum foil and sufficient adhesive collected, by careful scraping, to ensure a valid test. Care shall be taken to avoid the induction of particles of foil or glass cloth into the adhesive test sample. The adhesive sample shall be analyzed by FOURIER transform infrared spectroscopy. The resultant spectrum shall be an exact match of one of the spectrum of the standard samples (see 6.3). Any additional or missing bands shall be cause for rejection. The spectral range shall include wave lengths of 600 to 4,000 cm^{-1}. Test results shall be reported as pass or fail.

4.4.2.3 Termogravimeter analysis (TGA). The TGA shall be performed using three test samples from varied areas of the test material. Each sample size shall be 100 $\pm$5mg in weight. The sample shall be placed in a 15 ml coors crucible and heated at 100 to 105^{o}C for 1 hour to evaporate moisture in the sample. The moisture free sample shall be reweighed and then heated in a furnace starting at a temperature of 30^{o}C and continuing to 1000^{o}C with a dynamic heating rate of 25 $\pm$5^{o}C per minute and an air flow of 150 $\pm$25 ml per minute. The average weight loss shall be reported to the nearest 0.1 percent (see 3.2.1.3).

4.4.2.4 Peel strength. Test for peel strength shall be in accordance with ASTM D 903 except the separation rate shall be 2 inches per minute.

4.4.2.5 Creep test. The creep test shall be performed using a 70 gram weight in a dead weight, 180 degree angle peel test at a temperature of 425 ±5ºF and uncontrolled humidity. The 70 gram weight may be attached to either the aluminum foil or the glass cloth component. The test strips shall be 2 inches wide and the same length as required for the peel strength test (see 4.4.2.4). The test strips may be cut with the warp or weave (machine or X-machine) direction. Results shall be reported as "pass" or "fail."

4.4.2.6 Break/rupture test. The laminate material shall be tested for break strength in accordance with test method 5100 of FED-STD-191. Five samples measuring 6 inches long by 12 inches wide shall be cut in the warp direction; five samples of the same dimensions shall be cut in the fill direction. Each 6 by 12 inch piece shall then be cut into a set of three test samples, each measuring 6 by 4 inches. Each test sample set shall be prepared as follows: One test sample of each set shall remain unfolded. A second test sample of each set shall be folded in half, perpendicular to the test direction, around a metal rod with aluminum foil surfaces facing. The third test sample of each set shall be folded in half, perpendicular to the test direction, around a metal rod with glass cloth surfaces facing. After folding each test sample, the rod shall be removed. Each folded test sample shall be placed on a rubber pad and a steel roller shall be passed along the length of the folded edge of the test sample five times. The centerline of the roller shall be aligned with the sample's folded edge and no upward or downward pressure shall be exerted on the roller. Then each test set composed of two folded test samples and one unfolded test sample shall be tested in accordance with test method 5100.

4.4.2.6.1 Steel roller. The steel roller shall be 2 ±1/8 inches wide, approximately 15 inches in circumference, and shall weigh 10.0 pounds ±1 ounce. A shaft shall pass through the center of the roller with ends of the shaft mounted to a handle. The shaft/handle configuration shall allow the roller to be pushed and pulled smoothly without the need to exert upward or downward pressure on the roller (see 6.7).

4.4.2.6.2 Rubber pad. The rubber pad shall be 3/4 ±1/8 inch thick and shall have a durometer hardness of 60 ±5. The pad shall be a minimum of 8 inches wide and 11 inches long. Hardness shall be tested in accordance with ASTM D 2240 (type A).

4.4.2.6.3 Metal rod. The metal rod shall be straight, a minimum of 8 inches long, with an outside diameter of 1/4 ±1/16 inch. The surface shall be smooth and polished.

4.4.2.6.4 Test report. The break strength values for test samples folded with foil facing and glass cloth facing, shall be divided by the corresponding unfolded test sample value cut from the same three sample test set. The percent of original break strength retained in the folded samples shall be calculated to the nearest 0.1 percent.

4.4.3 Classification of defects and lot acceptance. Any sample that fails to comply with test requirements specified in 4.4.2.3, 4.4.2.4, 4.4.2.5, and 4.4.2.6 shall be classified as a major defect and lot acceptance shall be in accordance with 4.3.2. Any sample that fails to comply with test requirements specified in 4.4.2.1 or 4.4.2.2 shall constitute rejection of the lot.

5. PACKAGING

5.1 Preservation. Preservation shall be in accordance with ASTM D 3951 and as specified herein and in the contract or purchase order.

5.2 Marking. In addition to any special marking required by this specification, marking shall be in accordance with the contract or purchase order.

6. NOTES

6.l Intended use. The laminate cloth specified herein is the basic material used in the fabrication of fire shelters for wildland firefighters. The shelters provide protection from high radiant heat fluxes in the event firefighters become entrapped by wildfire.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of the specification.
b. Width of cloth required when other than specified (see 3.2.2).
c. Length required if other than specified (see 3.3).
d. Arrangements for inspection and test (see 4.1).
e. Preservation, packing, and marking required in addition to specification requirements (see section 5).

6.3 Standard samples. The standard samples of the spectrums referred to in this specification may be obtained from USDA Forest Service, Missoula Technology and Development Center, Attn: Specifications Manager, Building 1, Fort Missoula, Missoula, MT 59804-7294.

6.4 Inhalation toxicity. The USDA Forest Service has tested fire shelters manufactured with cloth made in accordance with this specification for toxicity and found they do not release toxicants in quantities that would be harmful to a shelter occupant. Introduction of unspecified material(s) into the laminate cloth could produce toxicants potentially fatal to the user, however. Because of the critical nature of the shelter and the hostile environment it has been designed for, it is essential that the laminated cloth be manufactured in strict accordance with the specification.

6.5 Testing of previously produced material. When laminated cloth is to be used on a current contract that was produced on a previous production job number, it shall be retested in accordance with 4.3.2, except the toxicity testing. Toxicity testing shall not be required if the laminate cloth has previously been tested in accordance with 4.4.2.1 and a copy of the test results are provided to the procurement activity. The production job number is defined as "that quantity of laminated cloth that is run for one specific contract."

6.6 Adhesive components. The sources for adhesive components shall be:

Morton International, Inc.
Specialty Chemicals Group
100 N. Riverside Plaza10
Chicago, IL 60606-1596

National Starch and Chemical Co.
Specialty Adhesives Group
Finderne Ave.
Bridgewater, NJ 08807-3300

Dow Chemical Co., USA
P.O. Box 4265
Houston, TX 77210-4265

6.7 Suggested sources.

Toxicity test.
SGS U.S. Testing Co., Inc.
291 Fairfield Ave.
Fairfield, NJ 07004

Steel roller
Chemsultants
P.O. Box 1118
Mentor, OH 44061-1118

6.8 Notice. When Government drawings, specifications or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever.

6.9 Preparing activity. USDA Forest Service, Missoula Technology and Development Center, Building 1, Fort Missoula, Missoula, MT 59804-7294.

USDA
Forest Service

Standardization Document Improvement Proposal

This form is provided to solicit beneficial comments that may improve this document and enhance it's use. Contractors, government activities, manufacturers, vendors, and users are invited to submit comments to:

USDA Forest Service
Missoula Technology and Development Center
Building 1, Fort Missoula
Missoula, MT 59804-7294

Attach any additional pertinent information that may be of use in improving this document to this form and mail in a envelope. A response will be provided when the submitter includes their name and address.

NOTE: This form shall not be used to submit requests for waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the document, or to amend contractual requirements.

Document Identification: **5100-321F - CLOTH, LAMINATED, RADIANT HEAT REFLECTIVE**

Submitter's Name (Optional. Please print or type): _____

❑ Vendor ❑ User ❑ Manufacturer

Phone Number:_____

Date:_____

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❑ Has any part of the Document created problems or required interpretation in procurement use?
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