

**U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE**

SPECIFICATION

CLOTHS, LAMINATED, FIRE SHELTER, M-2002

1. SCOPE

1.1 Scope. This specification covers the requirements for the three laminated cloths used in the manufacture of the Fire Shelter, M-2002, as described by Forest Service Specification 5100-606.

2. APPLICABLE DOCUMENTS

2.1 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 1876 - Standard Test Method for Peel Resistance of Adhesives (T-Peel Test)
- D 3951 - Standard Practice for Commercial Packaging
- D 4963 - Standard Test Method for Ignition Loss of Glass Strands and Fabrics
- SI-10 - Standard For Use of the International System of Units(SI): The Modern Metric System (IEEE/ASTM Standard available from ASTM)

(Copies are available from ASTM, 100 Barr Harbor Dr., West Conshohocken, PA 19428-2959.)

ALUMINUM ASSOCIATION

Aluminum Association 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.)

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, 5785 Highway 10 West, Missoula, MT 59808, by using the Specification Comment Sheet at the end of this document or by letter.

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.

3.1.1. Hi-Tech 10. Shall be Hi-Tech 10 as supplied by Hi-Tech Products, Inc. (6.6), and shall have the physical properties as listed in Table I. This fabric shall be tested for conformance prior to being incorporated into the laminate, see 4.3.2.1 and 4.4.2.8.

3.1.2 Hi-Tech 7. Shall be Hi-Tech 7 as supplied by Hi-Tech Products, Inc. (6.6), and shall have the physical properties as listed in Table I. This fabric shall be tested for conformance prior to being incorporated into the laminate, see 4.3.2.1 and 4.4.2.8.

Table I , Physical Properties of Hi-Tech Fabrics (4.4.2.8)

Properties	Units	Hi-Tech 7	Hi-Tech 10
Silica Content (SiO ₂)	%	98.5 minimum	98.5 minimum
Sodium Content (Na ₂ O)	%	0.7 maximum	0.7 maximum
Chloride Content	Ppm	50 maximum	50 maximum
Weave Style	n/a	Plain	Plain
Fabric Finish	n/a	Loom Stage	Loom Stage
Fabric Weight	Oz/sq. yd	6.0 ±0.5	10.0 ±0.5
Fabric Thickness	Inches	0.008 ±0.002	0.016 ±0.002
Fabric Width	Inches	36 ±2	36 ±2
Roll Length	Yards	300 minimum	300 minimum
Break Strength (Fill Yarn)	Lbs./inch	75 minimum	160 minimum
Break Strength (Warp Yarn)	Lbs./inch	75 minimum	160 minimum
Yarn Count (Fill x Warp)	Ends/inch	26 x 26	26 x 26

3.1.3 1 mil aluminum foil. The 1 mil thick aluminum foil shall be in accordance with SRM Alloy 1235, 1100 or 1145; 0.001 inch thick -5, +10 percent. The aluminum foil shall meet the requirements of Aluminum Association Standards and Data

3.1.4 0.7 mil aluminum foil. The 0.7 mil aluminum foil shall be in accordance with SRM Alloy 1235, 1100 or 1145; 0.0007 inch thick ±10%. The aluminum foil shall meet the requirements Aluminum Association Standards and Data.

3.1.5 Glass cloth. The glass cloth shall be woven fiberglass cloth, style 1080, plain weave, warp ECD 450 1/0, fill ECD 450 1/0, 60x47 count, 1.38 OSY and thickness 0.0021 inches.

3.1.5.1 Glass cloth organic content. The organic content determined by ignition loss shall not exceed 3% when tested in accordance 4.4.2.6.

3.2 Construction of laminates. The M-2002 Fire Shelter uses three separate laminated cloths designated as the shell outer laminate, shell inner laminate, and floor laminate. Each lot of each type of laminate produced (see 4.2.2) shall be traceable by a unique lot number.

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3.2.1 Shell outer laminate. The shell outer laminate shall be Cleveland Laminating Corp. (6.6) Product number 6077FS, consisting of Hi-Tech 10 (3.1.1) and 0.001 inch aluminum foil (3.1.3).

3.2.2 Shell inner laminate. The shell inner laminate shall be Cleveland Laminating Corp (6.6) Product number 6078FS, consisting of 0.0007 inch aluminum foil (3.1.4) and glass cloth (3.1.5).

3.2.3 Floor laminate. The floor laminate shall be Cleveland Laminating Corp (6.6) Product number 6079FS , consisting of Hi-Tech 7 (3.1.2) between two layers of 0.0007 inch aluminum foil (3.1.4).

3.3 Testing.

3.3.1 Toxicity. The finished cloths shall be nontoxic when tested in accordance with 4.4.2.1.

3.3.2 Peel strength. The minimum peel or stripping strength of the laminated cloths shall be as shown in Table II when tested in accordance with 4.4.2.2.

3.3.3 Creep. The adhesive bond of the laminated cloths shall have a maximum creep as specified by table II when tested in accordance with 4.4.2.3.

3.3.4 Organic content of inner shell laminated cloth. The organic content of the inner shell laminate (3.2.2) shall not exceed 9.5% when tested as specified by 4.4.2.5.

3.3.5 Adhesive identification. The adhesive shall be identified by testing in accordance with 4.4.2.4 and shall match the spectrum of adhesive of the standard samples (6.3).

3.3.6 Adhesive weight. The adhesive weight shall be a maximum of 0.9 gm/ft² for the outer shell laminate (3.2.1), a maximum of .9 gm/ft² for the inner shell laminate and a maximum of 1.8 gm/ft² for the floor laminate (3.2.3) when tested as specified by 4.4.2.7.

3.4 Width. Unless otherwise specified, the laminated cloths widths shall be as specified in table II.

Table II - Physical characteristics of laminates

Laminate	Peel strength (lbs/in width)	Creep	Put-up width (Inches)
Shell outer laminate	1.25	2 inches	31, -0, +1/4"
Shell inner laminate	1.75	2 inches	48, -0, +1/4"
Floor laminate (each bond)	1.75	2 inches	31-1/2, -0, +1/4"

3.5 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 300 linear yards.

3.6 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.

3.7 Workmanship. The finished laminated cloths shall conform to the quality and grade established by this specification. The occurrence of nonconformities shall not exceed the applicable point value or nonconformity limit.

3.8 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 IEEE/ASTM SI-10, 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 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 nonconforming material, either indicated or actual, nor does it commit the Government to accept nonconforming material.

4.1.2 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 4.1.2.1). 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.

4.1.2.1 Certification. The contractor shall provide certificates of compliance for all materials listed in 3.1 used to construct the laminate. The following certificates of conformance shall be provided with test reports:

- Hi-Tech 10 (3.1.1)
- Hi-Tech 7 (3.1.2)
- 1 mil aluminum foil (3.1.3)
- 0.7 mil aluminum foil (3.1.4)
- Glass cloth (3.1.5)

The contractor shall provide the following information on certificates of compliance:

- Product description
- Fabric, data or style number
- Specification or standard (when applicable)
- Manufacturers lot number
- Quantity purchased
- Purchase source, address and telephone number
- Purchase date

4.1.3 Test results. The contractor shall provide copies of the test results for organic content of the glass fabric, toxicity of the three laminates, adhesive identification (FTIR), organic content of the laminated glass cloth, adhesive weight of the laminated silica cloth, peel strength, and creep 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

4.1.4 Material samples. The contractor shall provide samples to the preparing activity (6.8) of all materials used to construct the laminate in the following amounts:

<u>Material</u>	<u>Sample size</u>
Hi-Tech 10	3 linear yards <u>1/</u>
Hi-Tech 7	3 linear yards <u>1/</u>
1 mil Aluminum foil	1 linear yard
0.7 mil Aluminum foil	1 linear yard
Glass cloth	1 linear yard

1/ This is in addition to the initial in-process samples sent in accordance with 4.3.2.1.

4.1.4.1 Sample handling. All samples for testing shall be packaged and labeled "FIRE SHELTER FABRIC (fabric designation) DO NOT HANDLE PRIOR TO TESTING." Samples shall not be handled by bare hands prior to or during this packaging.

4.2 Sample lots.

4.2.1 Inspection lot. For purposes of inspection and testing, except for toxicity testing, all material presented for delivery at one time shall be considered an inspection lot.

4.2.2 Toxicity test lot. All laminates shall be nontoxic when tested in accordance with 4.4.2.1. 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 originally cited in the certificates of conformance submitted with the initial samples change.

4.3 Sampling for lot acceptance inspection and test. Random samples of laminated cloth units shall be selected from each lot for inspection and testing, the sample sizes shall be obtained as specified in 4.1.4.

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. Except where otherwise specified (4.4.2.1, 4.4.2.4, 4.4.2.5, 4.4.2.7) all sampling shall be in accordance with ASQC Z1.4. 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 and cured cloth. The lot size shall be expressed in units of linear yards. Samples shall be packaged and labeled "FIRE SHELTER FABRIC (fabric designation) DO NOT HANDLE PRIOR TO TESTING." Samples shall not be handled by bare hands prior to or during this packaging.

4.3.2.1 Hi-Tech fabric acceptance tests. After approximately 5 days of production on each order, 10 linear yards each of Hi-Tech 7 and Hi-Tech 10 shall be delivered to the Cleveland Laminating (6.6) by fastest possible delivery method for testing for physical properties of table I (4.4.2.8).

4.3.3 Toxicity tests. The contractor shall provide samples to the preparing activity (6.8) of finished and cured laminate. The sample size shall be 5 continuous yards, full width. Samples shall be selected from random selections of the subject rolls. Samples shall be packaged and labeled "FIRE SHELTER FABRIC (fabric designation) DO NOT HANDLE PRIOR TO TESTING." Samples shall not be handled by bare hands prior to or during this packaging.

4.4 Inspection and tests.

4.4.1 Visual inspection. Each sample selected according to 4.3.1 shall be visually examined for nonconformities specified in table III. 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 nonconformities shall be in accordance with table III and lot acceptance shall be based upon Acceptable Quality Levels (AQL's). The AQL's shall be 2.5 for major nonconformities and 6.5 for minor nonconformities.

TABLE III. Classification of nonconformities

Examine	Nonconformity	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	Greater than 6 linear inches in length (applies to shell outer laminate and shell inner laminate only)	X	
	Less than 6 linear inches in length (applies to shell outer laminate and shell inner laminate only)		X
	Note: Wrinkles in floor laminate are acceptable as long as there is no evidence of foldovers or breaks in aluminum foil.		
Evidence of break in aluminum foil	One to six		X
	More than six	X	
Cuts, tears or breaks (other than pinholes) in aluminum foil or	Greater than 1/2 linear inch in length	X	
	1/2 linear inch or less: One to six		X
	More than six	X	

4.4.2 Tests. Each sample of the finished laminates, selected in accordance with 4.3.2, shall be tested for the requirements in table IV. In addition to this, one toxicity test as required in 3.3.1 shall be performed as specified by 4.4.2.1 on an additional sample.

Table IV. Test methods

Characteristic	Requirement paragraph	Test method
Toxicity	3.3.1	4.4.2.1
Peel strength	3.3.2	4.4.2.2
Creep	3.3.3	4.4.2.3
Adhesive identification	3.3.5	4.4.2.4
Organic content		
Glass/Foil/Glass Laminate (3.2.3)	3.3.4	4.4.2.5
Glass cloth (prior to laminating)	3.1.5.1	4.4.2.6
Adhesive weight	3.3.6	4.4.2.7

4.4.2.1 Toxicity. The toxicity test shall be performed by the preparing activity (6.8).

4.4.2.2 Peel strength. Test for peel strength shall be in accordance with ASTM D 1876 except the applied separation rate shall be 2 inches per minute. Samples shall be selected so that different warp and fill threads are tested with each sample. It was found during initial development of this laminate that due to the thinness of the foil, the foil would often tear before the laminate would separate. Failure of the foil (tearing) prior to failure of the bond is acceptable result.

4.4.2.3 Creep test. The creep test shall be performed using a 50-gram weight in a dead weight, 180-degree angle peel test at a temperature of $425 \pm 5^\circ\text{F}$ and uncontrolled humidity. The 50-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."

4.4.2.4 Infrared test. Test two samples of each laminate (3.2.1, 3.2.2, and 3.2.3) in each production run. The laminates may be separated 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°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 $4,000\text{ cm}^{-1}$. Test results shall be reported as pass or fail.

4.4.2.5 Thermogravimeter analysis (TGA). The TGA shall be performed using two samples from varied areas of the production run. Each sample size shall be $100 \pm 5\text{ mg}$ in weight. The sample shall be placed in a 15 ml coors crucible and heated at 100 to 105°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°C and continuing to 1000°C with a dynamic heating rate of $25 \pm 5^\circ\text{C}$ per minute and an air flow of $150 \pm 25\text{ ml}$ per minute. The average weight loss shall be reported to the nearest 0.1 percent (see 3.3.4).

4.4.2.6 Organic content of glass cloth. The organic content of the glass cloth (3.1.5.1) shall be tested in accordance with ASTM D 4963.

4.4.2.7 Adhesive weight. The adhesive weight shall be measured and documented during the manufacturing process by sampling and weighing the dried adhesive on the foil prior to bonding. Three (3) tests shall be run at the end of every master roll. A master roll is defined as a number of raw material rolls spliced together and run from start to finish without interruption.

4.4.2.8 Hi-Tech fabric acceptance testing. Due to the relatively new nature of the use of this cloth in the US, specific tests for the properties listed in Table I are not specified by this document. Acceptance tests shall be developed and used that use standard laboratory procedure, and are repeatable.

4.4.3 Classification of nonconformities and lot acceptance. Any sample that fails to comply with test requirements specified in 4.4.2.2, 4.4.2.3, 4.4.2.6, shall be classified as a major nonconformity 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, 4.4.2.4, 4.4.2.5, or 4.4.2.7 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

6.1 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.
- (c) Length required if other than specified.
- (d) Arrangements for inspection and test.
- (e) Preservation, packing, and marking required in addition to specification requirements (see section 5).

6.3 Standard samples. Copies of the spectra of standard samples referred to in this specification may be obtained from USDA Forest Service, Missoula Technology and Development Center, Attn: Specifications Project Leader, 5785 Highway 10 West, Missoula, MT 59808.

6.4 Inhalation toxicity. The USDA Forest Service has tested fire shelters manufactured with the specified materials 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 cloths could produce toxicants potentially damaging 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 cloths be manufactured in strict accordance with the specification.

6.5 Testing of previously produced material. When laminated cloths that were produced on a previous production job number are to be used on a current contract, the cloths 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 Required sources.

Hi-Tech Products ,Inc.
12 Stone Tower Lane
Wilmington, DE 19803
302-888-0111

Cleveland Laminating Corp.
2909 East 79th Street
Cleveland, OH 44104
216-883-8484

6.7 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.

6.8 Preparing activity. USDA Forest Service, Missoula Technology and Development Center, 5785 Highway 10 West, Missoula, MT 59808.

6.9 Patent. The fire shelter system, which these laminates are a component of, has a patent pending. Contact the preparing activity for further details.



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
5785 Highway 10 West
Missoula, MT 59808

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.

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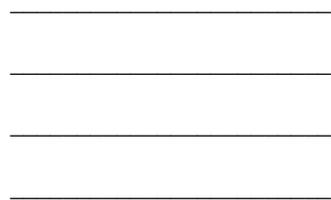
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