USDA Forest Service
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National Technology & Development Program

Specification 5100-607F: CLOTHS, LAMINATED, FIRE SHELTER, M-2002

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9/1/23	Changes to off-gas toxicity, adhesive identification, silica and alumina content, fluorine content, phosphorous content testing. Additions to required sources. Patent information updating. Grammar and readability edits. Formatted for 508 compliance.

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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.

1.2. Interpretations and Definitions.

1.2.1. Interpretation.

To carry out the provisions of this document, the word “shall” is understood to be mandatory.

1.2.2. Definitions.

Nonconformity: A departure of a quality characteristic from its intended level or state that occurs with severity sufficient to cause an associated product or service not to meet a specification requirement (per ANSI/ASQ Z1.4).

2. APPLICABLE DOCUMENTS

2.1. Government documents and drawings.

The following other Government documents form a part of this document to the extent specified herein. Unless otherwise specified the revision of these documents are those in effect on the date of the invitation for bids or request for proposals. Unless otherwise indicated, copies of federal and military specifications and standards are available online at https://quicksearch.dla.mil/qsSearch.aspx or in hard copy from the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Ave., Philadelphia, PA 19111-5094. Copies of Forest Service specifications are available from the preparing activity, see 6.6.

2.1.1. USDA FOREST SERVICE

Copies are available from the preparing activity, see 6.6.

Forest Service Specification 5100-615 – Protocol for Evaluating Off-gas Toxicity of Fire Shelter Material

Forest Service Drawing MTDC-1000 – Shelter, Fire, M-2002

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. 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.

2.2.1. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

Copies are available from ASTM International, 100 Barr Harbor Dr., West Conshohocken, PA 19428-2959 or www.ASTM.org.

C 169 – Standard Test Methods for Chemical Analysis of Soda-Lime and Borosilicate Glass

D 774 - Standard Test Method for Bursting Strength of Paper

D 1876 - Standard Test Method for Peel Resistance of Adhesives (T-Peel Test)

D 3951 - Standard Practice for Commercial Packaging

SI-10 - Standard for Use of the International System of Units (SI): The Modern Metric System (IEEE/ASTM Standard available from ASTM)

2.2.2. AMERICAN SOCIETY FOR QUALITY (ASQ)

Unless otherwise indicated copies of ANSI/ASQ documents are available online at https://asq.org, or in hard copy from the American Society for Quality, P.O. Box 3005, Milwaukee, WI 53201-3005.

ANSI/ASQ Z1.4 - Sampling Procedures and Tables for Inspection by Attributes.

2.2.3. ALUMINUM ASSOCIATION

Copies are available from Aluminum Association, Publication Department, 818 Connecticut Ave. NW, Washington, DC 20006, https://www.aluminum.org.

Aluminum Association Standards and Data

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. Compliance testing.

Unless otherwise specified the laminated cloths shall be subjected to compliance inspection and testing in accordance with 4.3. The contracting officer shall be informed in writing when a component, or component supplier changes, or manufacturing location changes, or testing source/facility changes. The Government may at any time require samples for testing when changes in materials occur.

3.1.1. ISO registration.

The manufacturer shall be registered to ISO 9001, Quality Management Systems - Requirements. The operation of the quality assurance program shall evaluate and test product production against this specification to ensure that production remains in compliance. ISO Registration shall be maintained throughout the term of any government contract.

3.1.2. Third-party certification.

The Fire Shelter laminated components shall be tested by a third-party certification organization at the initiation of a new contract and annually thereafter as specified in 4.1.5 to ensure compliance to this specification.

3.2. Materials.

3.2.1. Laminates.

3.2.1.1. 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 shall be traceable by a unique lot number.

3.2.1.2. Shell outer laminate.

The shell outer laminate shall be Custom Laminating Corp. (6.4) product number 6077FS, consisting of VSS KA300P-E (3.2.3) and 0.001 inch aluminum foil (3.2.4).

3.2.1.3. Shell inner laminate.

The shell inner laminate shall be Custom Laminating Corp (6.4) product number 6078FS, consisting of 0.0007 inch aluminum foil (3.2.5) and glass cloth (3.2.6).

3.2.1.4. Floor laminate.

The floor laminate shall be Custom Laminating Corp (6.4) product number 6081FS, consisting of VSS KA180P-E (3.2.2) and 0.0007 inch aluminum foil (3.2.5).

3.2.2. Silica Cloth KA180P-E.

Shall be KA180P-E as manufactured by Valmieras Stikla Skiedra (VSS) (see 6.4) and shall have the physical properties as listed in Table 1. The material manufacturer shall certify to the properties of Table 1.

3.2.3. Silica Cloth KA300P-E.

Shall be KA300P-E as manufactured by Valmieras Stikla Skiedra (VSS) (see 6.4) and shall have the physical properties as listed in Table 1. The material manufacturer shall certify to the properties of Table 1.

Table 1 – Material Properties of VSS Fabric

Properties	Units	VSS KA300PE	VSS KA180P- E	Test Paragraph
Silica (SiO_2) and Alumina (Al_2O_3) (combined) Content	%	97.5 min	97.0 min	4.4.2.8
Alumina (Al_2O_3)	%	5.0 max	5.0 max	4.4.2.8
Fluorine (total)[2]	ppm	-	-	4.4.2.9
Phosphorus[2]	ppm	-	-	4.4.2.10
Weave Style	-	Plain	Plain	-
Fabric Finish	-	Loom Stage with Silane	Loom Stage with Silane	-
Fabric Weight	oz/sq. yd	9.5 ±0.5	5.6 ±0.5	-
Fabric Thickness	Inches	0.016 ±0.002	0.008 ±0.003	-
Roll Length	Yards	250 min	250 min	-
Yarn Count (Fill x Warp)	Ends/inch	20 x 20, +3, -2	25 x 25, +3, -2	-

[1] Unless otherwise specified, every test shall be performed and certified on every lot.

[2] Reference only. Annual testing certification for Quality Assurance.

3.2.4. 1 mil aluminum foil.

The 1 mil thick aluminum foil shall be in accordance with SRM Alloy 1200, 1235, 1100 or 1145; 0.001 inch thick -5%, +10%. The aluminum foil shall meet the requirements of Aluminum Association Standards and Data.

3.2.5. 0.7 mil aluminum foil.

The 0.7 mil aluminum foil shall be in accordance with SRM Alloy 1200, 1235, 1100 or 1145; 0.0007 inch thick ±10%. The aluminum foil shall meet the requirements of Aluminum Association Standards and Data.

3.2.6. Glass cloth.

The glass cloth shall be woven fiberglass cloth and shall have properties listed in Table 2.

3.2.6.1. Silica and glass cloth fluorine and phosphorus content.

Fluorine and phosphorus testing shall be performed annually as part of the third-party certification. The results will be considered Reference Only (no maximum value) to monitor for changes in levels that could impact toxicity. Testing for fluorine to be performed in accordance with 4.4.2.9. Testing for phosphorus to be performed in accordance with 4.4.2.10.

Table 2 - Material Properties of Glass Cloth			
Properties	Units	Values	Test Paragraph
Style	-	1080	-
Weave	-	Plain	-
Fabric Finish	-	Loom Stage	-
Yarn count (warp and fill)	-	60 x 47 ±2	-
Fabric weight	Oz/sq yd	1.38 ±10%	-
Fabric thickness	Inches	0.002 ±0.0005	-
ECD (warp and fill)	-	450 1/0	-
Fluorine [2]	ppm	-	4.4.2.9
Phosphorus [2]	ppm	-	4.4.2.10

[2] Reference only. Annual testing certification for Quality Assurance.

3.3. Testing.

3.3.1. Off-gas toxicity.

The individual laminates shall be tested in accordance with 4.4.2.1 and the results shall not exceed the criteria listed in Table 3.

Table 3 - Criteria for Off-gas Toxicity of Laminates		
Species	Designation	Maximum Allowed
Hydrogen cyanide	HCN	17 ppm
Hydrogen chloride	HCl	100 ppm
Hydrogen fluoride	HF	95 ppm
Nitrogen oxides	NOx	20 ppm
Carbon monoxide	CO	420 ppm

3.3.2. Peel strength.

The minimum peel or stripping strength of the laminated cloths shall be as shown in Table 4 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 4 when tested in accordance with 4.4.2.3.

3.3.4. 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).

3.3.5. Organic content of shell inner laminate.

The organic content of the shell inner laminate (3.2.1.3) shall not exceed 10.7% when tested as specified by 4.4.2.5.

3.3.6. Adhesive weight.

The adhesive weight shall be a maximum of 0.9 gm/ft^2 for the shell outer laminate (3.2.1.2), the shell inner laminate (3.2.1.3) and the floor laminate (3.2.1.4) when tested as specified by 4.4.2.6.

3.3.7. Burst Strength.

The Burst Strength of the laminated cloths shall be as shown in Table 4 when tested in accordance with 4.4.2.7.

Table 4 - Physical Properties of Laminates

Laminate	Peel strength (lbs/in width,	Creep (max)	Burst strength Average (min.)	Burst Strength Individual (min.)
Shell outer laminate	1.75	2 inches	240	225
Shell inner laminate	1.75	2 inches	70	65
Floor laminate	1.75	2 inches	190	170

3.4. Width.

The laminated cloth’s widths shall be as required by the sewing contractor to meet the drawings and specifications for the finished product (drawing MTDC-1000, see Section 2).

3.5. Length and put-up.

Unless otherwise specified, the finished laminated cloths shall be furnished on continuous rolls and each roll shall contain not less than 250 linear yards and with not more than six splices.

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 Government.

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 Government.

4.1.2.1. Certificates of compliance.

The contractor shall provide certificates of compliance for materials as shown in Table 5.

Table 5 - Certificates of Compliance

	KA180	KA300	Glass Cloth	1 mil Foil	0.7 mil Foil	6077 FS	6078 FS	6081 FS
Table 1 - Material Properties of VSS Fabrics								
4.4.2.8 Silica Content	X	X						
4.4.2.8 Alumina Content	X	X						
4.4.2.9 Fluorine Content	X	X						
4.4.2.10 Phosphorus Content	X	X						
Other Properties in Table 1	X	X						
Table 2 - Material Properties of Glass Cloth								
4.4.2.9 Fluorine			X					
4.4.2.10 Phosphorus			X					
Other properties in Table 2			X					
3.2.4 1 mil aluminum foil				X				
3.2.5 0.7 mil aluminum foil					X			
Table 3 - Off-gas Toxicity of Laminates						X	X	X
Table 4 – Physical Properties								
4.4.2.2 Peel						X	X	X
4.4.2.3 Creep						X	X	X
4.4.2.7 Burst						X	X	X
3.3.4 Adhesive ID 4.4.2.4						X	X	X
3.3.5 Organic Content 4.4.2.5							X	
3.3.6 Adhesive Weight 4.4.2.6						X	X	X

4.1.2.2. Certificates of compliance information.

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

Product description
Fabric identification or style number Specification or standard (when applicable)
Manufacturer’s lot number
Quantity purchased
Purchase source, address, and telephone number
Purchase date

4.1.3. Test reports.

The contractor shall provide copies of all required test reports. The test reports shall include the following information:

Manufacturer’s name, address, and telephone number
Lot number
Testing company name, address, and telephone number
Testing date

Tester's name and title
Full test result of all samples tested

4.1.4. Material samples.

The contractor shall retain certified raw materials and laminated samples for each production run, in a manner to protect them from contamination, in the following amounts and time periods:

Certified raw Materials	**Sample size**	**Time period**
VSS KA300P-E	1 linear yard	7 years
VSS KA180P-E	1 linear yard	7 years
1 mil Aluminum foil	1 linear yard	7 years
0.7 mil Aluminum foil	1 linear yard	7 years
Glass cloth	1 linear yard	7 years
Laminated Materials	Sample size	Time period
Shell outer	1 linear yard	7 years
Shell inner	1 linear yard	7 years
Floor	1 linear yard	7 years

4.1.4.1. Material Inventory.

Previously approved and certified laminated materials not utilized from a prior contract period may be utilized at the initiation of a new contract period, with certifications.

4.1.5. Third-Party Certification.

The manufacturer of the laminated materials shall initiate an agreement with a third-party certification organization (see 6.4) to certify compliance of the laminate material to this document and to monitor the continued quality of the laminated material production. The agreement shall specifically include an annual test program to verify continued adherence to the specifications of the contract. The manufacturer of the laminated material shall be responsible for this certification.

4.1.5.1. Testing for third-party certification.

The third-party certification organization shall witness testing to confirm the following requirements and tests:

3.2.2 Silica Cloth KA180P-E. (visible properties and weight only)
3.2.3 Silica Cloth KA300P-E. (visible properties and weight only)
3.2.4 1 mil aluminum foil. (thickness only)
3.2.5 0.7 mil aluminum. (thickness only)
3.2.6 Glass cloth. (visible properties and weight only)
4.4.2.2 Peel strength. (All laminates)
4.4.2.3 Creep test. (All laminates)

4.1.5.2. Test results review for third-party certification.

The third-party certification organization shall review the test results of the following tests and may accept them as proof of conformance:

4.4.2.1 Off-gas toxicity.
4.4.2.4 Adhesive identification - Infrared test.
4.4.2.5 Organic content of shell inner laminate - Thermogravimetric analysis (TGA).
4.4.2.6 Adhesive weight.
4.4.2.7 Burst Strength Test.
4.4.2.8 Silica and Alumina Content of the silica cloth.
4.4.2.9 Fluorine Content. REFERENCE ONLY
4.4.2.10 Phosphorus Content. REFERENCE ONLY

4.1.6. ISO Registration.

Evidence of current ISO registration (3.1.1) shall be presented with the First Article Sample of the Fire Shelter in accordance with 5100-606.

4.1.7. Third-party certification.

Evidence of third-party certification (3.1.2) shall be submitted with the First Article Sample of the Fire Shelter in accordance with 5100-606, along with the test results of the tests performed in the certification process. The most recent annual third- party certification shall also be included with lot certifications.

4.2. Sample lots.

4.2.1. Inspection lot.

For purposes of inspection and testing, except for off-gas toxicity testing (4.4.2.1, 4.4.2.9, and 4.4.2.10), all laminates produced as a production lot for each product, shell outer (3.2.1.2), shell inner (3.2.1.3) and floor (3.2.1.4) shall be considered an inspection lot.

4.2.1.1. Acceptance tests.

Except where otherwise specified (4.4.2.1, 4.4.2.4, 4.4.2.5, and 4.4.2.6) all sampling shall be in accordance with ASQ Z1.4. The sample size shall be selected in accordance with inspection level S-2 with an AQL of 10. The lot size shall be expressed in units of linear yards.

4.2.2. Off-gas toxicity test lot.

The individual laminates 3.2.1.2, 3.2.1.3, and 3.2.1.4 shall be tested annually as part of the third-party certification in accordance with 4.4.2.1.

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 ASQ Z1.4.

4.3.1. Visual inspection.

For visual inspection, the sample size shall be selected in accordance with inspection level I of ASQ 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. Sample Handling and Labeling.

All fabric samples designated for specified testing (4.4.2.1, 4.4.2.9, and 4.4.2.10) shall be packaged and labeled "FIRE SHELTER FABRIC (fabric designation) DO NOT HANDLE PRIOR TO TESTING." Samples shall not be handled with 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 6. 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 6 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 6 - Classification of nonconformities

Classification Examine	Nonconformity	Major	Minor
Material	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 ¼ square inch in size:		X
	One to six occurrences		X
	More than six occurrences	X	
Creases or mill wrinkles	Greater than 6 linear inches in length (applies to inner shell laminate only)	X	
	Less than 6 linear inches in length (applies to inner shell laminate only)		X
	Note: Wrinkles in floor laminate or shell outer laminate are acceptable as long as there is no evidence of foldovers or breaks in aluminum foil.		
Evidence of break	One to six in aluminum foil		X
	More than six	X	

4.4.1.1. Yarn gaps.

After laminating the outer shell laminate, any areas of yarn in either direction with yarns spread more than 3/16 inch apart and greater than 8 inches in length shall be removed.

4.4.2. Tests.

Each sample of the finished laminates, selected in accordance with 4.2.1.1, shall be tested for the requirements in Table 7.

Table 7 - Test methods

Characteristic	Requirement paragraph	Test method
Off-gas 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	3.3.4	4.4.2.4
Organic content – Shell Inner Laminate (3.2.1.3)	3.3.5	4.4.2.5
Adhesive weight	3.3.6	4.4.2.6
Burst Test	3.3.7	4.4.2.7

4.4.2.1. Off-gas toxicity.

The toxicity shall be performed by the University of Alberta (6.4). The toxicity test shall be conducted in accordance with 5100-615 and shall be conducted annually. Thereafter, during the duration of the contract the test shall be performed when any component changes.

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 3 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 an 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 ±5°F and uncontrolled humidity. The sample shall be hung by the cloth component and the 50-gram weight shall be attached to the aluminum foil. The test chamber shall be configured such that no movement is induced into the sample due to airflow. The test strips shall be 2 inches wide, and the same length as required for the peel strength test (see 4.4.2.2). 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. Adhesive identification - Infrared test.

This test shall be conducted by Marsh Tech LLC (6.4). Test two samples of each laminate (3.2.1.2, 3.2.1.3, and 3.2.1.4) 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. After the initial separation using acetone, and sufficient elapsed time to evaporate the acetone remaining in the glass cloth, use a 260°C hot plate to heat the sample strip to facilitate additional separation, and exposure of the adhesive surface on the foil. 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 spectra 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”.

4.4.2.5. Organic content of inner shell laminate - Thermogravimetric analysis (TGA).

This test shall be conducted by Marsh Tech LLC (6.4). The TGA shall be performed using two samples from varied areas of the production run. Each sample size shall be 100 □5 mg in weight. The sample shall be placed in a 15 ml coors crucible or aluminum pan 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 ±5°C per minute and an air flow of 150 ±25 ml per minute. The average weight loss shall be reported to the nearest 0.1 percent (3.3.5).

4.4.2.6. Adhesive weight.

This test shall be performed by Custom Laminating Corp. 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.

4.4.2.7. Burst Strength Test.

The Burst Test shall be in accordance with ASTM D 774. A motor drive Model A Mullen Burst Tester shall be used. The Burst Tester shall be driven by a motor speed of 1750 rpm and use a Model 305-B Mullen® Tester Diaphragm supplied by Mullen® Testers. The material shall be tested with the foil against the diaphragm. An average of 3 tests across the material width shall be reported. The lowest value of the 3 tests across the material width shall also be reported.

4.4.2.8. Silica and Alumina Content of the silica cloth.

Sample preparation: Prior to analysis, the “as received” sample is ignited to 1000°C and ground in an agate pot using a ball mill. The results are reported on the “ignited” sample basis. The sample is fused in a mixture of lithium tetraborate/lithium metaborate in a platinum/gold crucible using automated fusion equipment. The melt is poured into a platinum/gold mold. The cooled fusion disk is analyzed for silica and alumina using wavelength dispersive x-ray fluorescence (WDXRF) and similarly prepared standards. This procedure is effectively the same as the one described in ASTM E1621. If the total results of Silica Cloth KA300P-E are below 98% or Silica Cloth KA180P-E total results are below 97.5%, the following testing shall be performed. This test shall be performed by

American Glass Research (6.4). Silica content of the silica cloth (3.2.2 and 3.2.3) shall be tested in accordance with ASTM C169. Alumina content of the silica cloth (3.2.2 and 3.2.3) shall be determined by fusing approximately 0.1 grams of sample in lithium tetraborate in a graphite crucible. The hot melt is poured out into a plastic beaker containing dilute hydrochloric acid and transferred to a volumetric flask when dissolution is complete. The alumina determination is made by inductively coupled plasma spectrometry (ICP) using matrix matched standards.

4.4.2.9. Fluorine Content.

The trace determination of total Fluorine content of the silica and glass cloths (3.2.2, 3.2.3 and 3.2.6) shall be conducted by: Galbraith Laboratories (6.4) using Galbraith test method E9-3B with a 10 ppm detection limit. Sample Preparation: The fluorine is separated from the sample by pyrohydrolysis in a quartz tube with a stream of wet oxygen at a temperature of 1100°C. A V_2O_5 accelerator is mixed with the sample to be pyrohydrolyzed. The fluorine is volatilized as hydrofluoric acid, absorbed in dilute caustic and measure with ion-selective electrode.

-or-

Jordi Laboratories (6.4) Combustion Ion Chromatography (CIC): Quantitation of total fluorine content by IEC. IEC is an excellent technique for identification of small ionic components and can provide detection limits in the ppm range. Isolated particulates and aqueous liquids will be subjected to oxidative pyrohydrolytic combustion, a process which pyrolyzes the sample up to 1,100°C in an oxygen rich environment. The vaporized hydrogen chloride (HCl) byproducts become trapped in an absorption fluid of which an aliquot of known volume is injected and analyzed by ion exchange chromatography. Results from Galbraith and/or Jordi will be compared to QC test values from VSS. Fluorine content shall be tested annually on KA300P-E silica fabric, KA180P-E silica fabric, and 1080 glass fabric. One sample of each fabric shall be tested for fluorine content for three repetitions.

4.4.2.10. Phosphorus Content.

The trace determination of leachable phosphorus content of the silica and glass cloth (3.2.2, 3.2.3 and 3.2.6) shall be conducted by Galbraith Laboratories (6.4). Galbraith test method G30B/ICP with 50 ppm detection limit. Leachable phosphorus must be specified at time of test as this method can be used for both leachable and total phosphorus.

-or-

Jordi Laboratories (6.4) Inductively Coupled Plasma Mass Spectrometry (ICP-MS): Quantitation of leachable phosphorus following microwave digestion of the sample. This technique has the advantage of using a highly sensitive mass spectrometer to calculate elemental composition, providing better detection limits than most other elemental techniques. Leachable phosphorus content shall be tested annually on KA300P-E silica fabric, KA180P-E silica fabric, and 1080 glass fabric. One sample of each fabric shall be tested for leachable phosphorous content for three repetitions.

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, shall be classified as a major nonconformity and lot acceptance shall be in accordance with

4.2.1.1. Any sample that fails to comply with test requirements specified in 4.4.2.1, 4.4.2.4, 4.4.2.5, 4.4.2.6, 4.4.2.7, or 4.4.2.8 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. The national stock numbers (NSNs) utilized for the Fire Shelters are 4240-01-498-3184 (regular shelter only), 4240-01-498-3194 (regular complete shelter), 4240-01-529-8804 (large shelter only), and 4240-01-527-5248 (large complete shelter).

6.2. Acquisition requirements.

Acquisition documents should specify the following:

a) Title, number, and date of the specification.
b) Length required if other than specified.
c) Arrangements for inspection and testing.
d) 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 US Forest Service, National Technology and Development Program, Attn: Fire Specifications, 5785 Highway 10 West, Missoula, MT 59808.

6.4. Required sources.

6.4.1. Third-Part Certification Organizations

Underwriter's Laboratory (UL)
12 Laboratory Drive
Research Triangle Park, NC 27709-3995 919-549-1433
www.ul.com

Safety Equipment Institute (SEI)
307 Dolley Madison BLVD Suite 3A
McLean, VA 22101
703-442-5732

www.seinet.org

Intertek
8600 NW 17th St., Suite 100
Miami, FL 33126
305-513-3000
www.intertek.com

6.4.2. Material Sources

Custom Laminating Corp
5000 River Road
Mt. Bethel, PA 18343-5610
570-897-8300
www.customl.com

Valmieras Stikla Skiedra (aka VSS)
Cempu 13 Valmiera LV 4201, Latvia
371-420-2212
https://www.valmiera-glass.com/

6.4.3. Testing Facilities

Marsh Tech LLC
8910 Cambridge Ave N
Brooklyn Park, MN 55443
763-315-5444
www.marshtech.com

Galbraith Laboratories, Inc.
2323 Sycamore Dr.
Knoxville, TN 37921-1700
877-449-8797
www.galbraith.com

Jordi Labs
200 Gilbert Street
Mansfield, MA 02048
508-966-1301
https://jordilabs.com/

University of Alberta
Protective Clothing and Equipment Research Facility
B33 Human Ecology Building
780-492-3832
pcerf@ualberta.ca
https://pcerf.ualberta.ca/

American Glass Research
349 Tomahawk Drive
Maumee, OH 43537
419-897-9000
https://americanglassresearch.com/

6.5. 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.

6.6. Preparing activity.

US Forest Service, National Technology and Development Program, 5785 Highway 10 West, Missoula, MT 59808, 406-329-3900.

6.7. Patent.

This item was patented with the No.: US 7,084,083 B2. Contact the preparing activity for further details.