

Specification 5100-187c
March 2006
Superseding
Specification 5100-187b
August 2003

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
SPECIFICATION FOR
FIRE HOSE, LIGHTWEIGHT SYNTHETIC,
LINED, WOVEN JACKET

1. SCOPE AND CLASSIFICATION.

1.1. Scope. The fire hose described in this specification is synthetic, jacketed hose with an elastomeric lining designed for use in wildland firefighting operations. Working pressure is up to 450 psig.

1.2. Classification. The following types and sizes are defined in this specification:

Types:

Type I – Standard synthetic hose, white in color.

Type II – Synthetic hose, abrasion and heat resistant, yellow in color.

Sizes:

1-inch hose with 1-inch 11-1/2 NPSH couplings

1-1/2-inch hose with 1-1/2-inch 9 NH couplings

2. APPLICABLE DOCUMENTS.

2.1. Government Documents. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issue of these documents are those in effect on the date of the invitation for bids or request for proposals (see 6.2 Acquisition Requirements).

USDA Forest Service Standard

5100-190 - Threads, Gaskets, Rocker Lugs, Connections, and Fittings, Fire Hose

USDA Forest Service Specification

5100-108 - Couplings, Lightweight, Fire and Suction Hose

Beneficial comments, recommendations, additions, deletions, and any pertinent data that may be used in improving this document should be addressed to: USDA Forest Service, San Dimas Technology and Development Center, 444 East Bonita Avenue, San Dimas, CA 91773-3103 by using the Specification Comment Sheet at the end of this document or by letter.

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Federal Standards and Test Methods

FED-STD-191 - Federal Standard for Textile Test Methods

FED-STD-601 - Rubber: Sampling and Testing

Federal Acquisition Regulation (FAR) Paragraph 23.403, Recoverable Materials

Copies of federal standards and test methods are available from General Services Administration, Federal Supply Service Bureau, Specification Section, Suite 8100, 470 East L'Enfant Plaza SW, Washington, DC 20407.

Copies of USDA Forest Service Specifications and Standards are available from USDA Forest Service, San Dimas Technology and Development Center (SDTDC), 444 East Bonita Avenue, San Dimas, CA 91773-3103.

2.2. Nongovernment 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 Association of Textile Chemists and Colorists (AATCC)

Method 30 - Antifungal Activity, Assessment on Textile Materials: Mildew and Rot Resistance of Textile Materials

Method 147- Antibacterial Activity Assessment of Textile Materials: Parallel Streak Method

Address requests for copies to the American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709-2215.

American Society for Quality (ASQ)

ANSI/ASQ Z 1.4 - Sampling Procedures and Tables for Inspection by Attributes

Address requests for copies to the American Society for Quality, P.O. Box 3005, Milwaukee, WI 53201-3005.

ASTM International

D 297 - Standard Test Methods for Rubber Products-Chemical Analysis

D 412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension

D 413 - Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate

D 518 - Standard Test Method for Rubber Deterioration-Surface Cracking

D 573 - Standard Test Method for Rubber Deterioration in an Air Oven

D 1149 - Standard Test Method for Rubber Deterioration-Surface Ozone Cracking in a Chamber

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D 3183 - Standard Practice for Rubber – Preparation of Pieces for Test Purpose Products

D 5035 - Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)

G 21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

Address requests for copies to ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

British Standards Institution

BS 6391 - Specification For Non-percolating Layflat Delivery Hoses and Hose Assemblies for Firefighting Purposes

Address requests for copies to British Standards Institution, 5050 Timber Creek, Houston, Texas 77017.

Factory Mutual Research Corporation (FMRC)

Class 2111 - Approval Standard for Fire Hose

Address requests for copies to FMRC, P.O. Box 9102, Norwood, MA 02062

Underwriters Laboratories (UL)

UL 219 - Lined Fire Hose For Interior Standpipes

Address requests for copies to Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062.

2.3. Order of Precedence. In the event of 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. Unless otherwise specified, samples shall be subjected to first article inspection in accordance with 4.4.2. During the term of the contract the contractor shall be required to notify the contracting officer in writing when a component or the component supplier changes in any way, when a major manufacturing process changes in any way, or when a manufacturing location changes. The contracting officer may at any time require the contractor to submit a new first article sample when substantive changes occur during the term of the contract.

3.2. Construction.

3.2.1. Woven Jacket. The woven fire hose jacket shall be seamless. The jacket shall be even and firm in texture, flexible and free from dirt, knots, lumps, irregularity of twist, or other nonconformities that may affect the appearance or serviceability of the hose.

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3.2.2. Lining. The fire hose lining shall be lamination from flat stock, extrusion, or a coated reinforced construction using thin cambric or other reinforcing material. The lining shall extend the full length of the hose providing a reasonably smooth waterway with no ribs, ripples, indentations, overlapping material or any uneven surface.

3.2.3. Couplings. The 1-inch-diameter hose shall be supplied with 1-inch 11-1/2 NPSH couplings, and the 1-1/2-inch-diameter hose shall be supplied with 1-1/2-inch 9 NH couplings. One end of the hose shall be equipped with a coupling female section and the other end with a coupling male section. The couplings shall be properly installed. The couplings shall be in accordance with the minimum requirements of Specification 5100-108.

3.3. Materials. Where more than one type of material is used in various components, there shall be no incompatibility between materials which may cause corrosion.

3.3.1 Jacket Material.

3.3.1.1 Type I Hose. The jacket material shall be 100 percent filament polyester yarn.

3.3.1.2 Type II Hose. The weft material shall be filament polyester yarn, and the warp material shall be spun polyester yarn. The jacket construction shall be a 1-2 woven twill pattern with the 2 over-crossing on the exterior of the jacket.

3.3.2. Lining Material. The lining material shall be made of natural rubber, synthetic rubber compound, thermoplastic, or a combination of rubber and thermoplastic materials compounded to meet all other requirements of this specification.

3.3.3. Mildew Treatment. The synthetic hose jacket shall be treated to be resistant to mildew, unless the yarn is certified as mildew resistant. The fungicide or compound shall be applied by thoroughly impregnating the material and shall be nontoxic, insoluble in water, and shall not cause deterioration of the material when exposed to water or the atmosphere.

3.3.4 Coating for Type II Hose. Type II fire hose shall have a mildew resistant elastomeric coating on the exterior of the jacket. Elastomeric coating shall be made of synthetic rubber compound, thermoplastic, or a combination of rubber and thermoplastic materials compounded to meet all other requirements of this specification for Type II fire hose.

3.3.5. Recoverable Materials. The contractor is encouraged to use recovered materials to the maximum extent practicable, in accordance with paragraph 23.403 of the Federal Acquisition Regulation (FAR), provided all performance requirements of this specification are met.

3.4. Hose Conditioning. As required by 4.4 and 4.6.2.3, the hose samples shall be conditioned in a controlled environment of 70 ± 2 °F and 65 ± 5 percent relative humidity for at least 12 hours before testing or inspection.

3.5. Dimensions and Weights. After the hose sample has been conditioned in accordance with 3.4, the hose shall conform to the sizes and weights as indicated in table 1. The hose length shall be 100 feet +/- 2 feet as measured from back to back of the couplings with the hose at a hydrostatic pressure of 10 pounds per square inch gauge (psig).

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Table 1. Hose size and weight

Thread Series Designation	External Diameter at 10 psig Minimum to Maximum, inch	Coil Diameter Maximum for 100 feet, inch		Maximum Weight Dry Hose with Couplings 100 feet, pounds	
		Type I	Type II	Type I	Type II
1 inch 11-1/2 NPSH	1.19 to 1.31	14.00	18.00	9.50	10.00
1-1/2 inch 9 NH	1.69 to 1.81	14.00	18.00	13.00	16.00

3.5.1. Internal Diameter Measurement. When tested in accordance with 4.6.3, the internal diameter shall be not less than 1.0 inch for the 1 inch 11-1/2 NPSH fire hose and not less than 1.5 inch for the 1-1/2 inch 9 NH fire hose.

3.5.2. Recoupled Hose. Hoses that have had sections removed for testing (see 4.3.1.1) may be recoupled and designated as short lengths. Short lengths will not meet the length requirement in 3.5. Recoupled hoses shall conform to the thread series designation and external diameter dimension requirements in table 1.

3.5.3. Dimensional Tolerance. Unless otherwise noted, the following tolerances apply: one place (x.x) +/- 0.1 inch ; two places (x.xx) +/- 0.03 inch and three places (x.xxx) +/- 0.010 inch. Unless otherwise specified, all measurements are in English units.

3.6. Workmanship. Fire hose assemblies shall conform to the quality of product established by this document. The occurrence of nonconformities shall not exceed the applicable acceptable quality levels. There shall be no nonconformities that affect use, appearance, or serviceability.

3.6.1 Laminated Components. There shall be no blisters, pinholes, pits, sink marks, crazing, wrinkles, voids, foreign material, or cracks.

3.7 Marking. Markings on each length of hose shall be with indelible paint or permanent ink. The marking material shall not damage the hose. All letters and numerals shall be at least 0.75 inch high. Markings shall start 2 feet from the back of the female coupling. Marking shall be placed in the following order: contractor's name, trademark or other identification, the month and year of manufacture in numeric form (example, 04/05 for April 2005), "FSS", "450WP", and "187 Type I" or "187 Type II."

3.8. Performance.

3.8.1. Hose Coupling Slippage Measurement. When marked in accordance with 4.6.2.3 and tested in accordance with 4.6.2.6, at a hydrostatic pressure of 600 psig (proof pressure), the couplings shall show no signs of slippage.

3.8.2. Hose Elongation. When tested in accordance with 4.6.2.7, at a hydrostatic pressure of 450 psig, the hose elongation and external diameter expansion shall not be more than 10 percent over the baseline dimensions determined in 4.6.2.4. There shall be no circumferential contraction.

3.8.3. Twist, Warp, and Rise at Working Pressure of Hose. When tested in accordance with 4.6.2.5, at a hydrostatic pressure of 450 psig, the twist of the hose shall not be more than 12 turns in any 50 feet of 1-inch hose or more than 8 turns in any 50 feet of 1-1/2-inch hose. Any twist shall be in the direction that will tighten the couplings. The hose shall not warp more than 25 inches from a reference line and the hose shall not rise more than 8 inches from its original position on a flat smooth surface. In addition, there shall be no leaking or sweating of the hose or coupling.

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3.8.4. Kink Pressure. When tested in accordance with 4.6.2.8, the hose shall not burst when a hydrostatic pressure of 450 psig is applied with the hose in a kinked position.

3.8.5. Burst Pressure. When tested in accordance with 4.6.4, the hose shall not burst when a hydrostatic pressure of 900 psig is applied.

3.8.6. Flexibility and Compressibility. When tested in accordance with 4.6.5, the applied load shall not exceed 40 pounds for 1-inch 11-1/2 NPSH hose and 55 pounds for 1-1/2-inch 9 NH hose when the hose is compressed to 0.50 inch for Type I hose and 0.63 inch for Type II hose.

3.8.7. Lining Adhesion. When tested in accordance with 4.6.6, the average separation force shall be 12 pounds minimum when the Machine Method is used. When tested using the Static-Mass Method, the lining shall not separate more than 1.0 inch.

3.8.8 Friction Loss. When tested in accordance with 4.6.7, the friction loss of the hose shall not exceed 18 psig for 1-inch 11-1/2 NPSH hose and shall not exceed 25 psig for the 1-1/2-inch 9 NH hose.

3.8.9. Abrasion Resistance. When tested in accordance with 4.6.8.1, Type I hose shall withstand 1,000 abrasion cycles minimum without leaking or bursting. Type II hose shall withstand 8,000 abrasion cycles minimum without leaking or bursting.

3.8.10. Cold Temperature Resistance. When tested in accordance with 4.6.8.2, the hose shall not leak or burst up to 450 psig.

3.8.11. Burn Resistance. When tested in accordance with 4.6.8.3, the hose shall not burn through and leak in less than 10 seconds. The failure mode for Type II hose shall be a pinhole-type leak.

3.8.12. Fold Resistance. When tested in accordance with 4.6.8.4, the hose shall not leak or burst up to 500 psig.

3.8.13. Lining. When tested in accordance with 4.6.9, hose lining shall meet the following requirements for tensile strength and elongation, before and after oven aging; ozone resistance and water immersion resistance.

3.8.13.1. Tensile Strength and Elongation of Lining. When tested in accordance with 4.6.9.1, the lining shall be capable of withstanding a cross-sectional tensile load of 1,800 psig and an ultimate elongation of 400 percent.

3.8.13.2. Tensile Strength and Elongation of Lining After Oven Aging. When tested in accordance with 4.6.9.2, after oven aging, the lining average tensile strength shall not be less than 65 percent of the original strength as determined in 4.7.9.1. The maximum set in elongation shall not exceed 25 percent after an elongation of 300 percent for a period of 10 minutes, and 10 minutes at rest. The maximum set in elongation for a polyurethane lining shall not exceed 25 percent after an elongation of 200 percent for a period of 2 minutes, and 2 minutes at rest.

3.8.13.3. Lining Resistance to Ozone. When tested in accordance with 4.6.9.3, lining samples shall exhibit no signs of cracking or crazing when viewed under 7X magnification.

3.8.13.4. Lining Resistance to Water Immersion. When tested in accordance with 4.6.9.4, the lining shall retain a minimum of 75 percent of the original tensile strength and elongation as determined in 4.6.9.1.

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3.8.14. Rubber Lining Sulfur Content. When tested in accordance with 4.6.10, a lining consisting of a natural rubber compound shall not contain more than 1 percent sulfur by weight.

3.8.15. Fungi Resistance. When tested in accordance with 4.6.11, the hose material shall retain a minimum of 80 percent of the original tensile strength and elongation as determined in 4.6.9.1.

3.8.16. Bacteria Resistance. When tested in accordance with 4.6.12, the hose material shall retain a minimum of 80 percent of the original tensile strength and elongation as determined in 4.6.9.1.

3.8.17 Jacket Mildew Resistance. When tested in accordance with 4.6.13, the jacket shall retain at least 80 percent of the original tensile strength as determined in 4.6.9.1. The viability controls shall show an abundant growth of *Chaetomium globosum*.

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/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 or tests set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1. Testing With Referenced Documents. The contractor is responsible for ensuring that components and materials used were manufactured, examined, and tested in accordance with referenced specifications and standards unless otherwise excluded, amended, modified, or qualified in this specification or applicable purchase document.

4.2. 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 overall inspection system or quality program. The absence of any inspection requirements in this 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.

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

- a. First Article Inspection (paragraph 4.3.2)
- b. Lot Acceptance Inspection (paragraph 4.3.3)

4.3.1. Lot. All fire hose of one type and size presented together in one delivery shall be considered a lot for the purpose of inspection. A unit shall be one length of coupled fire hose.

4.3.1.1. Recoupled Hoses. All hose lengths that have been cut or have had samples taken from them will be tagged as short lengths and will be accepted if the lot is accepted. The contractor shall recouple the cut lengths without additional cost to the Government. The maximum amount of recoupled hose lengths shall not exceed the amount of samples cut for testing, as indicated in 4.3.3.

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4.3.2 Sampling for First Article Inspection. The contractor shall make available to the Government items from which first articles may be selected. The first article shall consist of three (3) coupled hose assemblies and one set of male and female couplings.

4.3.3 Sampling for Lot Acceptance Inspections and Tests. When inspection and testing is performed, sampling shall be in accordance with ANSI/ASQC Z 1.4. Sampling for inspection shall be performed on coupled hose ready for delivery. The sample size shall be according to special inspection level S-3.

4.4. Inspection and Tests. As required by 3.4, hose shall be conditioned before testing or inspection. Inspection and tests shall be performed on coupled hose ready for delivery.

4.4.1. Lot Inspection. When selected in accordance with paragraph 4.3.3, each sample item shall be inspected in accordance with table 2 to determine conformance with this specification. If the sample is found to have any major nonconformities, as identified in table 2, the lot shall not be accepted. Additionally, if the number of minor nonconformities (table 2) in the sample exceeds an AQL of 2.5 percent nonconforming, the lot shall not be accepted.

Table 2. Lot acceptance inspection and testing.

Nonconformance	Paragraph	Classification	
		Major	Minor
1. Jacket construction not as specified	3.2.1	X	
2. Lining construction not as required	3.2.2	X	
3. Coupling threads not in accordance with 5100-190	3.2.3	X	
4. Female coupling gasket not in accordance with 5100-190	3.2.3	X	
5. Coupling and expansion ring loose or damaged, coupling overexpanded	3.2.3	X	
6. Visible indication of material incompatibility or corrosion	3.3	X	
7. Hose length not as specified	3.5		X
8. Hose coil diameter exceeds specified value	3.5		X
9. Hose weight exceeds specified value	3.5		X
10. Workmanship not as specified (includes 3.6.1)	3.6	X	
11. Markings not as required	3.7		X

4.4.2. First Article Inspection. Unless otherwise specified in paragraph 6.3, the first articles submitted in accordance with paragraph 3.1 shall be inspected as specified in paragraph 4.4.1 (table 2) and in accordance with table 3. The presence of any nonconformity or failure to pass any test shall be cause for rejection of the first article submission.

4.4.2.1 First Article Inspection Package. The contractor shall submit to the Government along with the selected first articles, copies of:

- a. All certificates of conformance, paragraph 4.5.
- b. All certificates of conformance for couplings, in accordance with 5100-108.
- c. Company inspection records, paragraph 4.1.
- d. All test results for the first article samples, paragraph 4.7.
- e. All other information necessary to perform the inspections identified in tables 2 and 3.

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Table 3 – First article inspection.

Nonconformance	Paragraph	Classification	
		Major	Minor
1. Certificates of conformance missing or incomplete	4.5	X	
2. Hose elongation exceeds 10 percent	3.8.2	X	
3. Twist, warp, and rise exceeds specified values	3.8.3	X	
4. Hose bursts during kink test	3.8.4	X	
5. Hose internal diameter less than specified value	3.5.1	X	
6. Flexibility and compressibility load exceeds specified value	3.8.6	X	
7. Lining to jacket adhesion not as specified	3.8.7	X	
8. Friction loss exceeds specified value	3.8.8	X	
9. Hose bursts below 900 psig	3.8.5	X	
10. Coupling(s) show signs of slippage	3.8.1	X	

4.5. Certificate of Conformance. A Certificate of Conformance (COC) shall meet the requirements of USDA Forest Service Standard 5100-190. Where COCs are required, the Government reserves the right to determine the validity of certification. These COCs shall be based on the testing of component materials and may be performed by the component material supplier. The date on the COCs for all textile, natural rubber, and synthetic compounds shall not exceed 2 years prior to the current date. The contractor shall provide certificates of conformance for 3.2.3, 3.3.1, 3.3.2, 3.3.3, 3.3.4, 3.8.9, 3.8.10, 3.8.11, 3.8.12, 3.8.13, 3.8.13.1, 3.8.13.2, 3.8.13.3, 3.8.13.4, 3.8.14, 3.8.15, 3.8.16, and 3.8.17.

4.6. Performance Testing. Hose test samples shall be subjected to the following tests to determine if the samples meet the requirements of the specification. Test samples shall be not be taken from the first 10 feet +/- 2 inches, of either end of the hose. When two or more test samples are required, at least one sample shall be taken from each end.

4.6.1. Fluid Medium. All testing requiring the use of a fluid medium shall be performed using municipally supplied potable water; this shall include, but is not limited to, all hydrostatic testing and burst pressure testing. If the contractor does not have access to a municipal water supply, the testing shall be performed using any clear fresh water normally available for firefighting. Testing performed by the Government will be conducted using municipally supplied potable water.

4.6.2. Hydrostatic Tests.

4.6.2.1. Hydrostatic Hose Test Table. Hydrostatic testing shall be conducted on a clean stainless steel table, at least 112 feet long with a clear space of at least 25 inches on each side of a line drawn through the center of the supply connection parallel to the edges of the test table. The supply connection shall be a male fitting 9.0 inches +/- 1.0 inches above the test table surface. Test equipment shall include a pump capable of providing a hydrostatic pressure of 600 psig minimum.

4.6.2.2. Hydrostatic Pressure Rate. The rate for applying hydrostatic pressure for the following tests shall not be less than 300 psig per minute and not more than 600 psig per minute, i.e., at a uniform rate over a 45 to 90 second time interval.

4.6.2.3. Preparation of Test Samples. As required by 3.4, the hose test sample shall be conditioned before testing or inspection. As required by 3.8.1, the test hose shall be marked at the back of each coupling in order to determine any coupling-to-hose slippage during hydrostatic testing. Connect the female coupling to a water pressure source and position the hose over the reference line on the test table. Attach a petcock to the male coupling. Charge the line and close

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the petcock when all air has been exhausted out of the hose, and place male coupling on test table. Hold the water pressure at 10 psig.

4.6.2.4. Baseline Measurement at 10 psig. As required by 3.8.2, length and external diameter measurements at 10 psig shall be obtained. These values shall be used to determine the change in elongation, expansion, and circumferential contraction. Mark the hose 36 inches +/- 3 inches from the inside shoulder of each coupling, and at the center of the hose, +/- 6 inches. Maintain a hydrostatic pressure of 10 psig. The total length of the hose shall be measured from the inside shoulder of one coupling to the inside shoulder of the other coupling. The length shall meet the requirements of 3.5. The external diameter of the hose shall be measured at the center of the hose and at 3 feet from each of the couplings and shall meet the requirements of table 1.

4.6.2.5. Twist, Warp, and Rise at Working Pressure Test. As required by 3.8.3, the hose shall be tested for twist, warp, and rise at working pressure. Increase the hydrostatic pressure to 450 psig. Record the number of twists in the 50 feet with the greatest number of twists. Evaluate the direction of twist in relation to the coupling. Measure warp as the greatest distance of the centerline of the hose from the reference line. The warp measurement shall only be observed between the inlet and point where hose does not return to the reference line. Measure the rise as the greatest vertical distance of the hose from the test table. The coupled hose shall be examined for leaking or sweating.

4.6.2.6. Hose Coupling Slippage Determination. As required by 3.8.1, the marks placed on the hose at the back of the couplings shall be examined for coupling slippage.

4.6.2.7. Elongation Measurement. As required by 3.8.2, with the hydrostatic pressure at 450 psig, the hose shall be tested for elongation, external diameter expansion, and circumferential contraction. The total length of the hose shall be measured from the back of the couplings, followed by measuring the external diameter at the same three locations identified in 4.6.2.4. The percentage elongation, external diameter expansion, and circumferential contraction shall be calculated.

4.6.2.8. Kink Pressure Test. As required by 3.8.4, the hose shall be tested for kink pressure. The hydrostatic pressure shall be reduced to 10 psig and held. The hose shall be kinked, or bent over on itself, at its center as marked in 4.6.2.4, and securely tied at a point approximately 1.5 feet from the kink. The hydrostatic pressure shall be increased to 450 psig, then held for 5 seconds.

4.6.3. Internal Diameter Test. As required by 3.5.1, the hose internal diameter shall be measured in accordance with Test Method 2341 of Federal Standard 601, using a mandrel.

4.6.4. Burst Pressure Test. As required by 3.8.5, the hose shall be tested for burst pressure. Begin the sample 3 to 4 inches into the coil diameter from the outside edge. The sample shall be 40 inches \pm 0.50 inch in length. Couplings or mandrels shall be installed on the hose and a hydrostatic pressure of 900 psig shall be applied. The hose shall be positioned straight or curved in a radius of not less than 27 inches.

4.6.4.1. Hydrostatic Burst Test Stand. Hydrostatic testing shall be performed on a high-pressure test stand. Test equipment shall include a pump capable of providing a hydrostatic pressure of 900 psig minimum.

4.6.4.2. Hydrostatic Pressure Rate. The rate for applying hydrostatic pressure for the following tests shall not be less than 300 psig per minute and not more than 600 psig per minute.

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4.6.5. Flexibility and Compressibility Tests. As required by 3.8.6, the hose shall be tested for flexibility and compressibility.

4.6.5.1. Test Apparatus. The flexibility and compression test apparatus shall consist of a compression tester with plates of nominal 6 inches in length and 4 inches in width. The compression tester shall be an accepted laboratory instrument having a rate of travel of approximately 0.25 inch per minute. See figure 1.

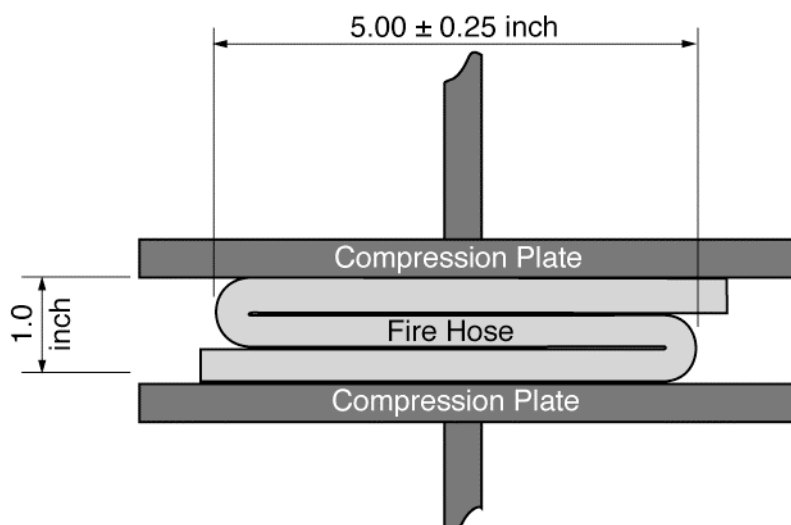


Figure 1. Compression and flexibility test apparatus.

4.6.5.2. Preparation of Test Samples. Two 20-inch lengths of hose shall be prepared as stated in 4.6. Each 20-inch sample shall be folded in an “S” shape and flattened manually so that the overall dimension of the “S” loop is as shown in figure 1. The ends of the hose may extend beyond the compression plates.

4.6.5.3. Flexibility and Compressibility Test Method. The hose test sample shall be placed between compression plates of the tester, parallel to the 6-inch axis, and shall be compressed until there is a distance of 0.50 inch between the plates for Type I hose and 0.63 inch between the plates for Type II hose. See Figure 1. The load required to achieve this compression shall be recorded.

4.6.6. Lining Adhesion. As required by 3.8.7, the hose shall be tested for adhesion of the lining to the jacket. The samples shall be taken after the samples from paragraph 4.6.5.2, as stated in paragraph 4.6. The Machine Method or the Static-Mass Method may be used. Regardless of the test method used, all four (4) test samples must pass. The samples shall be prepared in accordance with ASTM D-413, Strip Specimens – Type A (180° peel). Prepare four samples, two from each end of the hose. The samples shall be 2.00 +/- 0.25 inches wide. Adjacent test samples shall be identified by marking a solid line on one side of the jacket prior to separating from the hose. Make each sample into a rectangular-shaped piece by cutting lengthwise adjacent to the fold. Prepare a strip of lining 1.00 inch + 0.13/-0.00 inch wide in the center of the test sample. The lining test strip shall start a minimum of 0.25 inch from the edge of the sample. Do not cut through the jacket. See figure 2.

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4.6.6.1 Machine Method. The samples shall be tested in accordance with ASTM D-413, Machine Method. Using a tension test machine, a tension force shall be applied to the test strips at a rate of 1 inch per minute. The lining-to-jacket separation force shall be averaged and recorded.

4.6.6.2 Static Mass Method. The samples shall be tested in accordance with ASTM D-413, Static-Mass Method, Type A, 180° peel. A tension force of 12 pounds shall be applied for a period greater than 1.00 minute and not to exceed 1.25 minutes. The length of separation shall be measured and recorded.

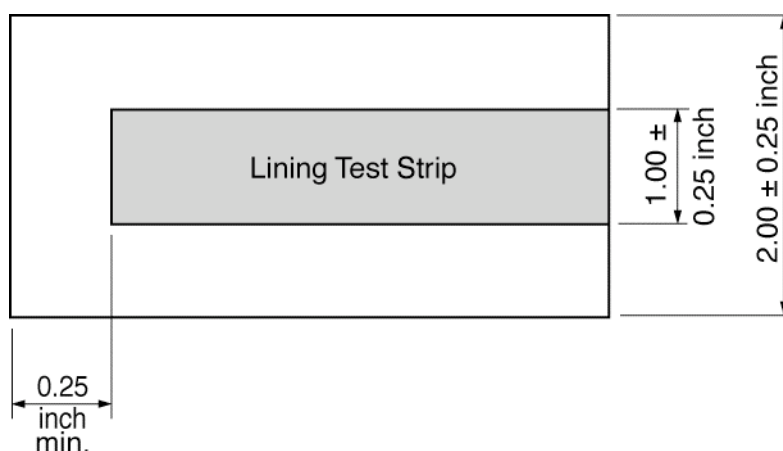


Figure 2. Sample preparation.

4.6.7. Friction Loss Test. As required by 3.8.8, the hose shall be tested for friction loss. A 100-foot test length of hose prepared in accordance with 3.4 shall be used to conduct the test. The hose shall be tested on a level surface. The hose shall be connected to a water pressure source with pressure gauges at the inlet and discharge ends of the hose. The discharge end of the hose shall be restricted to provide a minimum discharge pressure of 20 psig. Pressure shall be increased at the input end of the hose to achieve a flow of 25 ± 1 gallons per minute for 1-inch hose or 60 ± 2 gallons per minute for 1-1/2-inch hose. The pressure gauge at the inlet and discharge ends shall be observed and their values recorded. The difference between the inlet and discharge pressures is the friction loss, which shall be normalized to the 100-foot nominal hose length.

4.6.8. Hose Resistance Tests.

4.6.8.1. Abrasion Resistance Test. As required by 3.8.9, the hose shall be tested for abrasion resistance in accordance with Factory Mutual Research Corporation (FMRC) Approval Standard for Fire Hose Class 2111.

4.6.8.2. Cold Temperature Resistance Test. As required by 3.8.10, the hose shall be tested for cold temperature resistance in accordance with FMRC Approval Standard for Fire Hose Class 2111.

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4.6.8.3. Burn Resistance Test. As required by 3.8.11, the hose shall be tested for burn resistance in accordance with British Standards Institution Specification BS 6391 at a temperature of 788 +/- 10 °F. The burn-through and leak time shall be recorded.

4.6.8.4. Fold Resistance Test. As required by 3.8.12, the hose shall be tested for fold resistance. The Fold Resistance Test shown in paragraph 13 of UL 219 shall be applied to a sample hose. After the hose has been folded, it shall be subjected to the burst pressure test, as identified in 4.6.4.

4.6.9. Hose Lining Tests.

4.6.9.1. Tensile Strength and Elongation of Lining Tests. As required by 3.8.13.1, the lining shall be subject to tensile strength and elongation tests. Three sample linings shall be taken from the hose. The dimensions shall be suitable for the test apparatus. The jacket shall be removed, and the lining buffed lightly to remove the jacket material. Reinforced linings shall be buffed until all the fabric material is removed. The lining shall be prepared in accordance with ASTM D 3183 and measured in accordance with Test Method 2011 of Federal Standard 601. The lining shall be cut into the shape of a dumbbell along the longitudinal axis of the hose in accordance with ASTM D 412. The lining samples shall be capable of withstanding 1800 psig cross-sectional tensile load when tested in accordance with ASTM D 412. The lining sample shall be capable of withstanding an ultimate elongation of 400 percent when tested in accordance with ASTM D 412.

4.6.9.2. Tensile Strength and Elongation of Lining After Oven Aging Tests. As required by 3.8.13.2, the lining shall be subjected to oven aging and then the maximum set in elongation and the average value in tensile strength shall be determined. Three lining samples shall be prepared in the same method defined in 4.6.9.1. Oven aging shall be conducted in accordance with ASTM D 573. The lining samples shall be subjected to a temperature of 158 ± 2 °F for 96 hours, cooled to room temperature on a flat surface, and allowed to rest for 16 to 48 hours. The average value of tensile strength shall be determined in accordance with ASTM D 412. The maximum set in elongation shall be determined in accordance with ASTM D 412. The lining average tensile strength shall not be less than 65 percent of the original strength.

4.6.9.3. Lining Resistance to Ozone Test. As required by 3.8.13.3, the lining shall be tested for ozone resistance. A lining sample shall be taken from the hose with the backing material intact. The jacket shall be removed, then the lining buffed lightly to remove the jacket material. Reinforced linings shall be buffed until all the fabric material is removed. The lining shall be prepared in accordance with ASTM D 3183 and measured in accordance with Test Method 2011 of Federal Standard 601. The lining samples shall be shaped to the dimensions defined in ASTM D 518, Procedure C, Exposure of Tapered Samples. The lining thickness shall be as produced by the contractor. The lining sample will be stretched and mounted with an overall elongation of 15 percent on suitable wooden frames with the lining backing toward the wood. The lining sample shall be tested in accordance with ASTM D 1149. The lining sample shall be subjected to an ozone concentration of 150 ± 5 parts per hundred million, for 120 hours at 122 ± 1.8 °F. When examined under 7X magnification, there shall be no signs of cracking or crazing.

4.6.9.4. Water Immersion Test. As required by 3.8.13.4, the lining shall be tested for resistance to water immersion. The Water Immersion Test of Linings as described in paragraph 21 of UL 219 shall be applied to a sample hose. After the hose has been subject to water immersion it shall be subject to the tensile strength and elongation tests as identified in 4.6.9.1.

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4.6.10. Rubber Lining Sulfur Content Test. As required by 3.8.14, linings consisting of a natural rubber compound shall be tested for sulfur content, in accordance with ASTM D 297.

4.6.11. Fungi Resistance Test. As required by 3.8.15, the hose lining material shall be tested for resistance to fungi. The lining shall be tested in accordance with ASTM G 21 or AATCC Method 30 Type II agar plate method. Breaking strength shall be determined by ASTM D 5035. The number of test samples shall be 5 for each antifungal treatment and 5 for the control.

4.6.12. Bacteria Resistance Test. As required by 3.8.16, the hose lining material shall be tested for resistance to bacteria. The lining shall be tested in accordance with AATCC Method 147 bacterial tests.

4.6.13. Jacket Mildew Treatment Test. As required by 3.8.17, the jacket material shall be tested for breaking strength before and after the mildew treatment.

4.6.13.1. Preparation of Test Samples. Two sets of hose test samples shall be obtained from sample lengths of hose.

4.6.13.1.1. Breaking Strength Control Test Samples. The first set of 10 test samples shall be prepared as controls for breaking strength on the jacket material before mildew treatment. This set of samples shall have the elastomer lining peeled from the samples before cutting. Peeling must be done in such a manner that the fabric of the samples shall not be affected. The test samples shall be cut 1.50 inches in width and 6 inches in length; and raveled to 1 inch in width.

4.6.13.1.2. Leaching, Sterilization, Inoculation, and Incubation Test Samples. The second set of 10 samples shall be prepared for leaching, sterilization, inoculation and incubation. The elastomer lining shall be left intact on these samples until after the mildew treatment. Following incubation, washing, and drying, these samples shall be prepared for breaking strength tests by carefully peeling off the elastomer lining. Peeling must be done in such a manner that at least 6 inches of fabric of the samples shall not be affected. After peeling, the jacket samples shall be cut 1.50 inches in width and 6 inches in length; and raveled to 1 inch in width.

4.6.13.2. Leaching Treatment. Ten samples shall be leached in a container(s) of suitable size at a temperature of 75 ± 5 °F for 24 hours. Samples having different treatments, either different amounts of the same fungistatic compound or different kinds of compounds shall not be leached together in the same container. During the course of the leaching, the material must be submerged at all times. The ratio of fabric to water (pH approximately 7.0) in the container shall not be less than 1 to 300 by weight and the flow of water shall be so regulated that there are 15 complete changes of water per hour. After leaching, the samples shall be air dried.

4.6.13.3. Sterilization by Steam Treatment. After leaching and air drying, samples shall be placed in 16 ounce screw-cap bottles, such as are used for culture chambers. The samples shall be saturated by filling the bottles with water. The water shall be poured off and drained as completely as possible. The bottles shall be capped loosely and sterilized in an autoclave at 15 psig and 250 °F exhaust temperature for 1 hour. Since a microbiological test is to follow sterilization, the caps shall be tightened when the bottles are removed from the autoclave.

4.6.13.4. Inoculation. Sterilized samples shall be inoculated with the organism *Chaetomium globosum*, culture USDA 1042.4, ATCC-6205.

4.6.13.4.1. Culture Medium. The culture medium shall have composition indicated in table 4. Culture medium pH shall be adjusted to 6.8 with hydrochloric acid or sodium hydroxide. The culture medium shall be melted in an autoclave and poured into 16 ounce bottles, approximately 40 milliliters per bottle. Petri dishes may be used. The bottles shall be sterilized in an autoclave at

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15 psig and 250 °F exhaust temperature for 20 minutes, after which they are placed on their sides to allow culture medium to harden.

Table 4. Culture Medium Composition

Medium Composition	Weight (grams/milliliters)
Sodium nitrate (2.8 g of ammonium nitrate may substituted)	3.0 g
Dipotassium hydrogen phosphate	1.0 g
Magnesium sulfate	0.25 g
Potassium chloride	0.25 g
Agar	10.0 g
Distilled water	1,000.0 ml

4.6.13.4.2. Inoculum. Scrapings from a 100 millimeter petri dish (or equivalent surface) of a ripe fruiting culture of *Chaetomium globosum*, which has been incubated 2 to 4 weeks, shall be added to a flask of 100 milliliters sterile water. The transfer shall be made with a sterile loop made from nichrome, platinum, or tungsten wire. The black spore clusters shall be squeezed against the sides of the flask with a sterile pipette until the tiny spores can be seen to be in suspension.

4.6.13.4.3. Inoculation and Incubation. Leached samples and viability controls shall be sterilized and allowed to return to ambient temperature. One sample shall be placed in contact with the agar medium in each bottle under aseptic conditions. Two milliliters of the inoculum shall be distributed evenly along each sample by means of a sterile pipette. The inoculated samples shall be incubated at a temperature of 82 to 86 °F. The samples shall be removed from the containers at the end of 240 hours, gently washed to remove any growth of mildew, and dried.

4.6.13.4.4. Report of Results. If the viability controls do not show an abundant growth of *Chaetomium globosum*, the test shall be considered inconclusive and shall be repeated.

4.6.13.5. Breaking Strength Samples. The samples shall be conditioned not less than 48 hours in an atmosphere of 73.5 ± 2 °F and 50 ± 4 percent relative humidity. The breaking strength of both sets of samples shall be determined as specified in Test Method 5100.1 of Federal Standard 191.

4.6.13.5.1. Report of Results. A report of the results shall indicate the average breaking strength of the samples before and after exposure and the percentage strength retained.

4.7. Test Results. The contractor shall have available copies of all test results performed to assure the quality or acceptability of the product submitted for acceptance. The test results shall also show the product's acceptable range or expected test result and the item's test value. All test equipment, which shall be used as media of inspection, shall be calibrated and current at the time of testing. Calibration shall be to a recognized State or Federal standard.

5. PACKAGING, PACKING, AND MARKING.

5.1. Packaging, Packing, and Marking. Each section of hose shall be rolled into a compact roll with the male coupling in the center and the hose marking on the outside of the roll. The male coupling shall be protected from damage during shipment. Additional requirements regarding packaging, packing, and marking shall be as specified in the contract or order.

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6. NOTES.

6.1. Intended Use. The fire hose described in this specification is Type I and Type II all-synthetic, lightweight, single jacket hose, with an elastomer lining designed for use in wildland fire operations.

6.2. Acquisition Requirements. Acquisition documents should specify the following:

- a. Title, number and date of this specification.
- b. Type and size of fire hose required.
- c. When first article samples are not required (see 3.1, 4.4.2 and 6.3).
- d. If certificates of conformance are acceptable in lieu of lot by lot testing.
- e. Packaging, packing and marking (see 5.1).

6.3 First Article. When first article samples are required, they shall be inspected and approved under the appropriate provisions of Federal Acquisition Regulation 52.209. The first article shall consist of three (3) coupled hose assemblies and one (1) set of male and female couplings. The contracting officer should include specific instructions regarding arrangements for selection, inspection, and approval of the first article.

6.4. Notice. When Government drawings, documents, 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 or any obligation whatsoever.

6.5. Preparing Activity. USDA Forest Service, San Dimas Technology and Development Center, 444 East Bonita Avenue, San Dimas, CA 91773-3103.

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United States Department of Agriculture, Forest Service
Standardization Document Improvement Proposal

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Standard Number and Title: **Specification 5100-187c, Fire Hose, Lightweight Synthetic, Lined, Woven Jacket.**

Name of Organization and Address:

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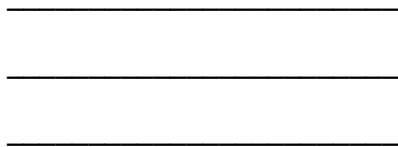
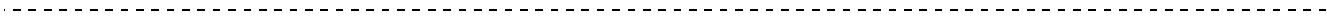
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