

## Report of the Committee on

### Fire Hose

**John W. Stacey**, *Chair*

Bellevue Fire Department, NE [E]  
Rep. International Association of Fire Chiefs

**Robert Ely**, San Diego, CA [SE]  
**Ray K. Farm**, City of Corvallis Fire Department, OR [U]  
**Thomas G. Farruggia**, Illinois Fire Extinguisher Co. Inc., IL [IM]  
Rep. National Association of Fire Equipment Distributors Inc.  
**Stephen Gilbert**, Los Angeles, CA [SE]  
**Paul Robert Kaveler**, Union Electric Co., MO [U]  
Rep. Edison Electric Institute  
**Gregory Kozey**, Kocheck Co., Inc., CT [M]  
**Allen Leach**, Jaffrey Fire Protection Company, NH [M]  
**Larry Linton**, Washington Twp Volunteer Fire Department, IN [L]  
**William J. Patterson**, Federal Emergency Management Agency, CA [SE]  
**David J. Pritchard**, Apex, NC [SE]  
**Mark Saner**, Akron Brass, OH [M]  
**William H. Smyth**, Underwriters Laboratories Inc., IL [RT]  
**Peter A. Sweeney**, Charlottesville Fire Department, VA [U]  
**Ralph D. Taylor**, USDA Forest Service, CA [U]

### Alternates

**David A. Lord**, Niedner Limited, PQ [M]  
(Voting Alt. to FEMA Rep.)  
**Lois P. Sicking**, USDA Forest Service, CA [U]  
(Alt. to R. D. Taylor)  
**Kenneth W. Zastrow**, Underwriters Laboratories Inc., IL [RT]  
(Alt. to W. H. Smyth)

Staff Liaison: **Carl E. Peterson**

**Committee Scope:** This Committee shall have primary responsibility for documents on the size and design of fire hose connections, and the performance, maintenance, and selection of all types of fire hose, couplings, nozzles, and accessory equipment.

*This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the front of this book.*

The Report of the Technical Committee on **Fire Hose** is presented for adoption.

This Report was prepared by the **Technical Committee on Fire Hose** and proposes for adoption, a complete revision to NFPA 1961, **Standard on Fire Hose**, 1997 edition. NFPA 1961-1997 is published in Volume 9 of the 2000 National Fire Codes and in separate pamphlet form.

This Report has been submitted to letter ballot of the **Technical Committee on Fire Hose**, which consists of 16 voting members. The results of the balloting, after circulation of any negative votes, can be found in the report.

(Log #3)

1961-1 - (Chapter 3): Accept in Principle in Part

**SUBMITTER:** Rod A. Magson, Kidde Fire Fighting

**RECOMMENDATION:** Revise Chapter 3 to read as follows:

3.1 Construction. Hoses shall consist of the following:

- (a) An impermeable elastomeric lining
- (b) A fiber reinforcement

Note: The reinforcement is often referred to as the "jacket."

(c) For Types 2b and 3, an externally applied elastomeric coating or covering applied to the reinforcement

3.2 Types.

Type 1 hose with a single reinforcement to which no external treatment has been applied.

Type 2a hose with an inner and outer reinforcement to which no external treatment has been applied to the outer reinforcement.

Type 2b hose with an inner and outer reinforcement to which an external coating has been applied to the outer reinforcement to provide some protection against the absorption of liquids and to improve resistance to abrasion.

Type 3 hose to which an external elastomeric coating or covering has been applied to, or incorporated in, the single reinforcement to give the hoses very low absorption of liquids and high resistance to abrasion and heat.

3.3 Fiber Reinforcement.

3.3.1 The fiber reinforcement shall be made from one of the following materials:

- (a) Natural fibers,
- (b) Synthetic fibers, or
- (c) Combination of natural and synthetic fibers.

3.3.2 Fiber reinforcements shall be well, evenly, and firmly woven, and as free from unsightly defects, dirt, knots, lumps, and irregularities of twist as is consistent with good manufacturing practice.

3.3.3 All knots shall be tucked under the warp threads.

3.3.4 When mildew treatment for the jacket is specified by the purchaser, the hose manufacturer shall certify that the mildew treatment meets the requirements of USDA Forest Service Specification 5100-186.

3.4 Linings and Covers. See 3.3 of 1961, 1997 edition.

**SUBSTANTIATION:** 1. Clause 1.3 defines Large Diameter Hose as hose with an operating pressure not exceeding 185 psi. Since the service test pressure shall be at least 10 percent above this gives a minimum limiting service test pressure of 203.5 psi. However, clause 2.3.2 requires that large diameter supply hose shall have a minimum service test pressure of 200 psi. If the intention of 2.3.2 was to allow the purchaser to specify a service test pressure greater than 10 percent above the maximum working pressure, then there is no conflict with clause 1.3. However, it would have been less confusing to specify a minimum burst pressure of say 600 psi or 3 times the service test pressure, whichever is the greater.

2. Clause 3.1.1 requires the hose internal diameter to be not less than the trade size except for 2 1/2 in. whose diameter shall be at least 2 9/16 in. Both UL and FM do not call for this, and although there are probably historical reasons for the requirement, it should be recommended that NFPA 1961 is brought into line with UL and FM.

3. Table 3.3.8 and clause 3.3.8.1 give the requirements for the tensile strength and elongation of the lining and cover. Four line items cover natural and synthetic rubber, latex rubber, thermoplastics and all. Recommend deleting the line item described as "all." Some elastomeric materials, neoprene for example, have an acceptable record of use as a lining material but cannot meet the requirements.

4. Clause 3.4.1 requires that the marking start 5 ft from each end of the hose. UL 19 requires the marking to start 3 ft 6 in. to 4 ft 6 in. from the end of the hose, and FM approximately 3 ft (1 m) from the end of the hose. Recommend changing clause 3.4.1 to require the marking to start at 3 ft 6 in. from the end of the hose.

5. Appendix 3.3.1 mentions Standard ZZ-H-451 which has been withdrawn and so should be deleted. The clause should also be amended to reflect that MIL-H-53027A has been superseded by MIL-PRF-53027B.

With regard to the suggestion that NFPA 1961 should include a requirement for friction loss, I do not think that it is appropriate to use the UL 19 limits. The friction loss permitted by UL 19 is much higher than that achieved by good manufacturing practice and its inclusion would weaken the standard.

**COMMITTEE ACTION:** Accept in Principle in Part.

Change the word "jacket" to "reinforcement" throughout the standard.

Add a definition of reinforcement to read: "Reinforcement. The structural support for fire hose that is often in the form of woven yarn."

Add an annex item to the definition of reinforcement to read: "The reinforcement is often referred to as the jacket when it is the exterior layer of the hose construction and hose can have more than one layer of reinforcement. The reinforcement is sometimes coated or covered with protective materials."

Add a definition of Jacket to read: "Jacket. See reinforcement."

**COMMITTEE STATEMENT:** NFPA 1961 is a performance standard, not a manufacturing standard. The committee does not accept the proposed 3.1 and 3.1. Proposed 3.1 is construction specific and the committee does not see a need to define types of fire hose as is proposed in 3.2. However, the committee is in agreement with the concept of 3.3, that being that the fiber is a reinforcement that may or may not be the outer layer or the jacket. The committee has changed the word "jacket" to "reinforcement" throughout the standard and added a definition of reinforcement to read: "

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 16  
**VOTE ON COMMITTEE ACTION:**

AFFIRMATIVE: 15

NOT RETURNED: 1 Farruggia

(Log #2)

1961-2 - (3-1.2.2, 3-1.2.3, 3-1.2.4): Reject

**SUBMITTER:** Paul Curtis, L N Curtis and Sons

**RECOMMENDATION:** Revise text to read as follows:

"No ~~nominal~~ 50 ft (15 m) length shall be less than ~~48 ft (14.6 m)~~ 50 ft (15 m) other than the length from which a burst test sample was taken, which shall not be less than ~~47 ft (14.3 m)~~ 49 ft (14.7 m)."

**SUBSTANTIATION:** Consumers read 50 ft and expect 50 ft. To allow for less than 50 ft misleads the consumer. If a fire department orders 50 ft, they expect 50 ft, and should receive 50 ft.

**COMMITTEE ACTION:** Reject.

**COMMITTEE STATEMENT:** A burst pressure test cannot be conducted with only a foot of hose. The committee has revised the requirement, however, to require the length to be between -2% and +4 % of the nominal stated length of the hose. See 5.2.1 in Committee Proposal 1961-4 (Log #CP1).

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 16  
**VOTE ON COMMITTEE ACTION:**

AFFIRMATIVE: 15

NOT RETURNED: 1 Farruggia

(Log #1)

1961-3 - (4-9): Accept

**SUBMITTER:** Harry Hibler, Puget Sound Naval Shipyard

**RECOMMENDATION:** Revise as follows:

"The ozone test chamber shall be regulated to give an ozone concentration of 100 ~~ppm~~ pphm..."

**SUBSTANTIATION:** Standard ozone concentrations listed in ASTM D1149, Paragraph 10.1.1, are from 25 to 200 parts per hundred million (pphm), not ppm.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 16  
**VOTE ON COMMITTEE ACTION:**

AFFIRMATIVE: 15

NOT RETURNED: 1 Farruggia

## NFPA 1961 — November 2001 ROP

(Log #CP1)

1961-4 - (Entire Document): Accept

**SUBMITTER:** Technical Committee on Fire Hose

**RECOMMENDATION:** The Technical Committee on Fire Hose proposes a complete revision of NFPA 1961, Standard on Fire Hose, 1997 edition as shown at the end of this report.

**SUBSTANTIATION:** As part of the complete revision, the committee is restructuring the document to update it to the NFPA Manual of Style. This includes moving material that is not administrative to other chapters, moving the list of referenced documents from chapter 6 to Chapter 2 and the definitions from Chapter 1 to Chapter 3. The metric values were made the primary value with inch-pound units secondary. The numbering has been changed to reflect the new method of numbering and the "Appendixes" renamed "Annexes."

Changes in Chapter 1 include the deletion of procurement related issues from the requirements of the document, the addition of an application statement (see 1-3), an equivalency statement (see 1-4) and the revision of 1-2.4 into a formal retroactivity statement (see 1-5).

In Chapter 2 (now chapter 4), the requirements in sections 2-2, 2-3, 2-4 and 2-5 for each type of hose were revised to better integrate the requirements from section 2-1. The minimum trade size requirement was dropped for all but supply hose as hose sizes below the stated minimum trade sizes are used successfully in actual application. References to large diameter were dropped from supply hose as its minimum trade size makes it large diameter by definition. Positive pressure requirements for hard suction hose were deleted as using hard suction hose for positive pressures is not a practical application.

In chapter 3 (now chapter 5), the requirements for length were changed to just require a tolerance on the nominal length. Throughout the document, the term "jacket" was changed to "reinforcement" as the fabric is not always the outer layer and may be coated but it is still the reinforcement. A cold resistance test was added for all hose, in addition to the special cold resistance testing currently in the standard that some hose is designed to meet.

In Chapter 4, (now Chapter 6) the flexibility and compressibility test method for forestry hose previously referenced to USDA Forest Service specification has been stated in the standard.

Chapter 5 (now Chapter 7) was reorganized around 4 subject areas, quality control, inspection, testing, and certification. The American Society for Quality standard ASQ Z1.4 Sampling Procedures and Tables for Inspection by Attributes, was referenced for sample selection relative to inspections and testing.

The entire document was reviewed and editorially updated to clean up ambiguous language and clarify the requirements.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 16

**VOTE ON COMMITTEE ACTION:**

AFFIRMATIVE: 12

NEGATIVE: 3

NOT RETURNED: 1 Farruggia

**EXPLANATION OF NEGATIVE:**

FARM: I would like to change my vote that reflects the proposed changes made by Smyth and Sicking.

GILBERT: The comments by Smyth and Sicking are well taken. I wish I had noticed the changes observed by Smyth. Also it is important our standard and that of the uses are consistent.

Because of the above I wish to join Smyth and Sicking to change my ballot accordingly.

SMYTH: The following are my reasons for voting negative on Proposal 1961-4 (Log #CP1):

Recommendation: Add text as follows after proposed paragraph 5.3.1:

"Samples of hose made from the threads selected as specified in 5.3.1 shall be submitted to an approved testing laboratory, and shall be determined by the testing laboratory to be suitable as reinforcement for fire hose."

Substantiation: Proposed paragraph 5.3.1, which is similar to existing paragraph 3-2.1, requires materials to be approved. The method for approval, current paragraph 3-2.2, has been removed. We believe that the current and proposed performance tests are not adequate to determine the suitability of new materials for jackets (current standard) or reinforcements (proposed standard).

Specifically, the current performance tests do not test the material for properties such as resistance to repeated bending, pressure cycling, abrasion, heat, and water. Additionally, the current standard includes the method for approving materials in paragraph 3-2.2, which reads "Samples of hose made from the threads selected as specified in 3-2.1 shall be submitted to an approved testing laboratory, and shall be determined by the testing laboratory to be suitable as jackets for fire hose." Should the Committee decide not to reinstate the method for reinforcement material approval, we recommend that material performance testing of the types previously noted be added to the standard.

Recommendation: Add text as follows after proposed paragraph 5.4.2:

"Samples of hose with linings and covers, if provided, made from the materials selected as specified in 5.4.2 shall be submitted to an approved testing laboratory. The testing laboratory shall determine whether the material and thickness are suitable for specified types of fire hose."

Substantiation: Proposed paragraph 5.4.2 which is similar to existing paragraph 3-3.3, requires materials to be approved. The method for approval, current paragraph 3-3.3, has been removed. We believe that the current and proposed performance tests are not adequate to determine the suitability of new materials for linings and covers. Specifically, the current performance tests do not test the material for properties such as resistance to repeated bending, pressure cycling, abrasion, heat, and water. Additionally, the current standard includes the method for approving materials in paragraph 3-3.3, which reads "Samples of hose with linings and covers, if provided, made from the materials selected as specified in 3-3.2 shall be submitted to an approved testing laboratory. The testing laboratory shall determine whether the material and thickness are suitable for specified types of fire hose." Should the Committee decide not to reinstate the method for lining and cover material approval, we recommend that material performance testing of the types previously noted be added to the standard.

Recommendation: Add text as follows to the end of proposed paragraph 6.5.2:

"A protective enclosure shall be used."

Substantiation: We believe that burst testing is potentially hazardous in nature and the optional use of an enclosure poses a risk to life and property. An enclosure shall be mandatory as specified in paragraph 4-5 of the current edition, in case the hose bursts while under test.

Recommendation: Add  $\pm 10$  ppm tolerance to the 100 ppm ozone concentration required by paragraph 6.9.

Substantiation: We do not believe that commercially available Ozone chambers can maintain exactly 100 ppm of Ozone for the 70 hr duration of the test. Other standard writing organizations like ASTM and UL use a  $\pm 10$  percent ozone tolerance."

**COMMENT ON AFFIRMATIVE:**

ELY: I agree with Mr. William H. Smyth's 11-6-00 response, that we need better requirements and tests for the lining and covers of fire hose.

I do not want to stop the progress of bringing the NFPA 1961 Fire Hose Standard up to date but before its final adoption we need to spell out in plain language what requirements and tests are necessary to prove that the linings and covers of fire hose will stand up in the hard use they will receive in the fire service while being dragged around and conveying water to extinguish fires and save lives.

I also agree with the last 5 paragraphs on page 2 of Mr. Smyths letter dated 11-6-00 and are reproduced below:

Recommendation: Add text as follows to the end of proposed paragraph 6.5.2:

“A protective enclosure shall be used.”

Substantiation: We believe that burst testing is potentially hazardous in nature and the optional use of an enclosure poses a risk to life and property. An enclosure shall be mandatory as specified in Section 4-5 of the current edition, in case the hose bursts while under test.

Recommendation: Add  $\pm 10$  pphm tolerance to the 100 pphm ozone concentration required by Section 6.9.

Substantiation: We do not believe that commercially available Ozone chambers can maintain exactly 100 pphm of Ozone for the 70 hr duration of the test. Other standard writing organizations like ASTM and UL use a  $\pm 10$  percent ozone tolerance.”

SICKING: Recommendation: Section 4.4.1 Requirements for Forestry Hose: In order to be consistent with USDA Forest Service Specification, the maximum weights for 50-ft cotton-synthetic forestry hose needs to be changed to:

The maximum weight of 15 m (50 ft) of lined, cotton-synthetic woven reinforcement forestry hose shall be 4.9 kg (10.9 lb) for 25-mm (1-in.) hose, and 6.7 kg (14.8) for 38-mm (1-1/2 inch) hose.

Substantiation: In order to be consistent with USDA Forest Service Specification, 5100-186c, Fire Hose, Cotton-Synthetic, Lined, Woven Jacket, 1 inch and 1-1/2 inch.

Recommendation: Section A.4.4.2. The correct revision for the document - USDA Forest Service Specification 5100-187a, Fire Hose, Lightweight Synthetic, Lined, Woven Jacket, 1-inch and 1-1/2-inch, is “a”, as in 187a.

In order to indicate the current revision of USDA Forest Service Specification 5100-187a, Fire Hose, Lightweight Synthetic, Lined, Woven Jacket, 1-inch.

## NFPA 1961

### Standard on Fire Hose

#### 2002 Edition

NOTICE: An asterisk (\*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Information on referenced publications can be found in Chapter 2 and Annex B.

#### Chapter 1 Administration

**1.1 Scope.** This standard shall define the design and construction requirements for new fire hose, the testing required to verify the design and construction, and the inspection and testing required of all new fire hose.

**1.2\* Purpose.** The purpose of this standard shall be to establish the minimum requirements for new fire hose.

**1.3 Application.** This standard shall apply to new attack hose, occupant use hose, forestry hose, supply hose, and suction hose.

**1.4 Retroactivity.** This standard shall not be applied retroactively.

**1.5 Equivalency.** Nothing in this standard is intended to prevent the use of systems, methods, or devices, of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard. Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency. The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

**1.6 Units.** In this standard, values for measurement are followed by an equivalent in English pound units, but only the first stated value shall be regarded as the requirement. Table 1.6 shall be used if more precision is required.

**Table 1.6 Conversion Factors**

1 kPa = 0.145 psi	1 psi = 6.895 kPa
1 bar = 14.492 psi	1 psi = 0.0690 bar
1 kPa = 0.3 in. Hg	1 in. Hg = 3.386 kPa
1 mm = 0.039 in.	1 in. = 25.40 mm
1 m = 3.28 ft	1 ft = 0.305 m

#### Chapter 2 Referenced Publications

**2.1** The following documents or portions thereof are referenced within this standard as mandatory requirements and shall be considered part of the requirements of this standard. The edition indicated for each referenced mandatory document is the current edition as of the date of the NFPA issuance of this standard. Some of these mandatory documents might also be referenced in this standard for specific informational purposes and, therefore, are also listed in Annex B.

**2.1.1 NFPA Publication.** National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 1962, *Standard for the Care, Use, and Service Testing of Fire Hose Including Couplings and Nozzles*, 1998 edition.

**2.1.2 ASQ Publication.** American Society for Quality, 611 E. Wisconsin Ave., Milwaukee, WI 53202-3005.

ASQ Z1.4 *Sampling Procedures and Tables for Inspection by Attributes*, 1993.

**2.1.3 ASTM Publications.** American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 380, *Standard Test Methods for Rubber Hose*, 1994.

ASTM D 412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers — Tension*, 1998.

ASTM D 518, *Standard Test Method for Rubber Deterioration — Surface Cracking*, 1999.

ASTM D 573, *Standard Test Method for Rubber-Deterioration in an Air Oven*, 1999.

**2.1.4 U.S.D.A. Publication.** U.S. Forest Service, San Dimas Technology and Development Center, San Dimas, CA 91773.

U.S.D.A. Specification 5100-186C, *Forest Service Specification for Fire Hose, Cotton-Synthetic, Lined, Woven Jacket, 1 inch and 1-1/2 inch*, October 1996.

#### Chapter 3 Definitions

**3.1 General.** The definitions contained in Chapter 3 apply to the terms used in this standard. Where terms are not included in Chapter 3, common usage of the term applies.

#### 3.2 Official NFPA Definitions.

**3.2.1\* Approved.** Acceptable to the authority having jurisdiction.

**3.2.2\* Authority Having Jurisdiction.** The organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure.

**3.2.3 Labeled.** Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

**3.2.4\* Listed.** Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets identified standards or has been tested and found suitable for a specified purpose.

**3.2.5 Shall.** Indicates a mandatory requirement.

**3.2.6 Should.** Indicates a recommendation or that which is advised but not required.

### 3.3 General Definitions.

**3.3.1\* Attack Hose.** Hose designed to be used by trained fire fighters and fire brigade members to combat fires beyond the incipient stage.

**3.3.2 Coating.** An outside layer of the hose that consists of yarn reinforcement that is impregnated, saturated, or coated with protective materials so the outside of the hose is relatively smooth.

**3.3.3 Cover.** An additional layer on the outside of a hose consisting of a continuous synthetic rubber or plastic that is usually thicker than a coating.

**3.3.4 Fire Hose.** A flexible conduit used to convey water.

**3.3.5 Forestry Fire Hose.** A hose designed to meet specialized requirements for fighting wildland fires.

**3.3.6 Hose Assembly.** Hose with couplings attached to both ends.

**3.3.7 Hose Size.** An expression of the internal diameter of the hose.

**3.3.8 Jacket.** See 3.3.12, Reinforcement.

**3.3.9 Large-Diameter Hose.** A hose of 90 mm ( $3\frac{1}{2}$ -in.) or larger size.

**3.3.10 Occupant Use Hose.** Fire hose designed to be used by the building's occupants to fight incipient fires prior to the arrival of trained fire fighters or fire brigade members.

#### 3.3.11 Pressure.

**3.3.11.1 Burst Test Pressure.** A pressure equal to at least three times the service test pressure.

**3.3.11.2 Kink Test Pressure.** A pressure equal to at least 1.5 times the service test pressure.

**3.3.11.3 Operating Pressure.** The highest pressure the hose should be used to in regular operation.

**3.3.11.4 Proof Test Pressure.** A pressure equal to at least two times the service test pressure.

**3.3.11.5 Service Test Pressure.** A pressure equal to approximately 110 percent of the operating pressure.

**3.3.12\* Reinforcement.** The structural support for fire hose that is often in the form of woven yarn.

**3.3.13 Suction Hose.** A hose that is designed to prevent collapse under vacuum conditions so that it can be used for drafting water from below the pump (lakes, rivers, wells, etc.).

**3.3.14\* Supply Hose.** Hose designed for the purpose of moving water between a pressurized water source and a pump that is supplying attack lines.

## Chapter 4 Design Requirements

### 4.1 Requirements for Attack Hose.

**4.1.1\*** Attack hose shall have a minimum design service test pressure of 20.7 bar (300 psi).

**4.1.2** Attack hose shall withstand a test pressure of two times its design service test pressure without movement of couplings, leakage, or breaking of any thread in the reinforcement when subjected to the proof pressure test specified in Section 6.2.

**4.1.3** A test sample of the attack hose shall withstand a test pressure of three times the designed service test pressure without failure when subjected to the burst test specified in Section 6.5.

**4.1.4** A full length of hose shall withstand a test pressure of 1.5 times the designed service test pressure without breaking any thread in the reinforcement when subjected to the kink test specified in Section 6.4.

**4.1.5** The maximum elongation shall not exceed 8 percent for hose sizes through 65 mm ( $2\frac{1}{2}$  in.), 10 percent for 76-mm (3-in.) hose size, and 13 percent for 90-mm ( $3\frac{1}{2}$ -in.) or larger hose size when tested as specified in Section 6.3.

#### 4.1.6 Twist.

**4.1.6.1** The maximum twist in turns per 15 m (50 ft) shall not exceed  $4\frac{1}{4}$  turns for hose sizes through 51 mm (2 in.), and  $1\frac{3}{4}$  turns for hose sizes of 65 mm ( $2\frac{1}{2}$  in.) or larger.

**4.1.6.2** The final twist shall be in a direction that shall tighten the couplings when tested as specified in Section 6.3.

**4.1.7** The maximum warp shall not exceed 508 mm (20 in.) when tested as specified in Section 6.3.

**4.1.8** There shall be no rise permitted when tested as specified in Section 6.3.

### 4.2 Requirements for Supply Hose.

**4.2.1** The minimum trade size for supply hose shall be 90 mm ( $3\frac{1}{2}$  in.).

**4.2.2\*** Supply hose shall have a minimum design service test pressure of 13.8 bar (200 psi).

**4.2.3** Supply hose shall withstand a test pressure of two times its design service test pressure without movement of couplings, leakage, or breaking of any thread in the reinforcement when subjected to the proof pressure test specified in Section 6.2.

**4.2.4** A test sample of the supply hose shall withstand a test pressure of three times the designed service test pressure without failure when subjected to the burst test specified in Section 6.5.

**4.2.5** A full length of supply hose shall withstand a test pressure of 1  $\frac{1}{2}$  times the designed service test pressure without breaking any thread in the reinforcement when subjected to the kink test specified in Section 6.4.

**4.2.6** The maximum elongation shall not exceed 10 percent when tested as specified in Section 6.3.

#### 4.2.7 Twist.

**4.2.7.1** The maximum twist in turns per 15 m (50 ft) shall not exceed  $1\frac{3}{4}$  turns.

**4.2.7.2** The final twist shall be in a direction that shall tighten the couplings when tested as specified in Section 6.3.

**4.2.8** The maximum warp shall not exceed 508 mm (20 in.) when tested as specified in Section 6.3.

**4.2.9** There shall be no rise permitted when tested as specified in Section 6.3.

#### **4.3 Requirements for Occupant Use Hose.**

**4.3.1\*** Occupant use hose shall have a minimum design service test pressure of 10.3 bar (150 psi).

**4.3.2** Occupant use hose shall withstand a test pressure of two times its design service test pressure without movement of couplings, leakage, or breaking of any thread in the reinforcement when subjected to the proof pressure test specified in Section 6.2.

**4.3.3** A test sample of the occupant use hose shall withstand a test pressure of three times the designed service test pressure without failure when subjected to the burst test specified in Section 6.5.

**4.3.4** A full length of occupant use hose shall withstand a test pressure of  $1\frac{1}{2}$  times the designed service test pressure without breaking any thread in the reinforcement when subjected to the kink test specified in Section 6.4.

**4.3.5** The maximum elongation shall not exceed 10 percent when tested as specified in Section 6.3.

#### **4.3.6 Twist.**

**4.3.6.1** The maximum twist in turns per 15 m (50 ft) shall not exceed  $1\frac{1}{2}$  turns.

**4.3.6.2** The final twist shall be in a direction that shall tighten the couplings when tested as specified in Section 6.3.

**4.3.7** The maximum warp shall not exceed 508 mm (20 in.) when tested as specified in Section 6.3.

**4.3.8** There shall be no rise greater than 178 mm (7 in.) permitted when tested as specified in Section 6.3.

#### **4.4 Requirements for Forestry Hose.**

**4.4.1\*** The maximum weight of 15 m (50 ft) of lined, cotton-synthetic woven reinforcement forestry fire hose shall be 4.5 kg (10 lb) for 25-mm (1-in.) hose and 6 kg (13 lb) for 38-mm ( $1\frac{1}{2}$ -in.) hose.

**4.4.2\*** The maximum weight of 15 m (50 ft) of lined, synthetic woven reinforcement forestry fire hose shall be 2.3 kg (5 lb) for 25-mm (1-in.) hose and 3.6 kg (8 lb) for 38-mm ( $1\frac{1}{2}$ -in.) hose.

**4.4.3\*** Forestry hose shall have a minimum design service test pressure of 20.7 bar (300 psi).

**4.4.4** Forestry hose shall withstand a test pressure of two times its design service test pressure without movement of couplings, leakage, or breaking of any thread in the reinforcement when subjected to the proof pressure test specified in Section 6.2.

**4.4.5** A test sample of the forestry hose shall withstand a test pressure of three times the designed service test pressure without failure when subjected to the burst test specified in Section 6.5.

**4.4.6** A full length of forestry hose shall withstand a test pressure of  $1\frac{1}{2}$  times the designed service test pressure without breaking any thread in the reinforcement when subjected to the kink test specified in Section 6.4.

**4.4.7** The maximum elongation shall not exceed 10 percent when tested as specified in Section 6.3.

#### **4.4.8 Twist.**

**4.4.8.1** The maximum twist in turns per 15 m (50 ft) shall not exceed 12 turns.

**4.4.8.2** The final twist shall be in a direction that shall tighten the couplings when tested as specified in Section 6.3.

**4.4.9** The maximum warp shall not exceed 635 mm (25 in.) when tested as specified in Section 6.3.

**4.4.10** There shall be no rise greater than 203 mm (8 in.) permitted when tested as specified in Section 6.3.

#### **4.4.11 Flexibility and Compressibility.**

**4.4.11.1** For cotton-synthetic woven reinforcement fire hose, the load required to compress the hose shall not exceed 45.4 kg (100 lb) for 25-mm (1-in.) hose and 56.75 kg (125 lb) for 38-mm ( $1\frac{1}{2}$ -in.) hose when two samples are tested for flexibility and compressibility in accordance with Section 6.13.

**4.4.11.2** For synthetic woven reinforcement fire hose, the load required to compress the hose shall not exceed 18.1 kg (40 lb) for 25-mm (1-in.) hose and 24.9 kg (55 lb) for 38-mm ( $1\frac{1}{2}$ -in.) hose when two samples are tested for flexibility and compressibility in accordance with Section 6.13.

**4.5 Requirements for Suction Hose.** The requirements of Chapters 5, 6, and 7 shall not apply to suction hose except as specified herein.

**4.5.1** The internal diameter of the suction hose shall comply with Section 5.1.

**4.5.2** The internal surface of the suction hose shall be smooth and free of corrugations.

**4.5.3** If a lining is provided, it shall meet the requirements of 5.4.5.1.

**4.5.4** If a cover is provided, it shall meet the requirements given in 5.4.6.

**4.5.5** The suction hose shall be constructed to withstand an internal vacuum of at least 0.78 bar (23 in. Hg) without failure, including the collapse of the liner or the cuffed (soft) ends, when applicable in the coupling bowl area.

**4.5.6** The hose shall be designed for use in ambient conditions ranging from -34°C to 60°C (-30°F to 140°F).

**4.5.6.1** The tensile strength of any elastomeric material shall not decrease by more than 20 percent of the original value, and the elongation shall not decrease by more than 50 percent of the original value when tested in accordance with Section 6.7.

**4.5.6.2** The material used for the tube and the cover, if provided, shall pass the Low-Temperature Test on Tube and Cover of ASTM D 380, *Standard Test Methods for Rubber Hose*, when subjected to the cold chamber for 5 hours at -34°C (-30°F).

**4.5.7** The tensile strength and ultimate elongation shall meet the requirements of 5.4.7.1, 5.4.7.2, and 5.4.7.4.

**4.5.8** All elastomeric material shall show no visible signs of cracking when subjected to the ozone test specified in Section 6.9.

**4.5.9** If the suction hose is designed for use under vacuum only, the hose assembly shall be indelibly marked in letters no less than 4.8 mm ( $\frac{3}{16}$  in.) high with the words "for vacuum use only."

**4.5.10** After the hose has been coupled, it shall be subjected to a vacuum of 0.78 bar (23 in. Hg).

**4.5.10.1** Once the vacuum has been established, the hose shall maintain that vacuum for 10 minutes with no loss of vacuum.

**4.5.10.2** The vacuum pump shall not be used to maintain the vacuum during the 10-minute period.

**4.5.10.3** After the test has been completed, the hose and any component shall be visually inspected for any sign of collapse or failure.

## Chapter 5 Construction Requirements

**5.1\* Diameter.** The hose shall have an internal diameter of not less than the trade size of the hose.

### 5.2 Length.

**5.2.1** The length of the hose shall be between -2 percent and +4 percent of the nominal stated length of the hose.

**5.2.2** Each length shall be measured as specified in 6.2.5.

### 5.3 Reinforcement.

**5.3.1\*** Hose reinforcement shall be made from one of the following materials, and the material shall be approved:

- (1) Natural fiber
- (2) Synthetic fiber
- (3) Combination of natural and synthetic fiber

**5.3.2** Reinforcements shall be evenly and firmly woven and shall be as free from defects, dirt, knots, lumps, and irregularities that might affect the serviceability of the hose as is consistent with good manufacturing practice.

**5.3.3** If the hose has a woven reinforcement, all knots shall be tucked under the warp threads.

**5.3.4\*** If the hose has a fabric reinforcement, each layer of reinforcement shall be seamless and shall have the filling woven around the hose throughout its length and the warps interwoven with and substantially covering the filling.

**5.3.5** When mildew treatment for the reinforcement is provided, the hose manufacturer shall certify that the mildew treatment meets the requirements of U.S.D.A. Specification 5100-186C, *Forest Service Specification for Fire Hose, Cotton-Synthetic, Lined Woven Jacket, 1 inch and 1 1/2 inch*.

### 5.4 Linings and Covers.

**5.4.1\*** All fire hose shall be lined.

**5.4.2** Liners and covers, if provided, shall be made from one of the following materials, and the material shall be approved:

- (1) Rubber compound
- (2) Thermoplastic material
- (3) Blends of rubber compounds and thermoplastic material
- (4) Natural rubber-latex-coated fabric

**5.4.3** The lining shall be of uniform thickness.

**5.4.4** The waterway surface of the lining shall be free from pitting, irregularities, or other imperfections that might affect the serviceability of the hose.

### 5.4.5 Lining Adhesion.

**5.4.5.1** The adhesion between the lining and the reinforcement shall be such that the rate of separation of a 38-mm (1 1/2-in.) strip of the

lining from the reinforcement shall not be greater than 25 mm (1 in.) per minute with a weight of 5.4 kg (12 lb) when tested in accordance with 6.6.1 through 6.6.6.

**5.4.5.2** If a rubber backing is used between the lining and the reinforcement, the adhesion between the lining and the backing and between the backing and the reinforcement shall be such that the rate of separation of a 38-mm (1 1/2-in.) strip shall not be greater than 25 mm (1 in.) per minute with a weight of 5.4 kg (12 lb), as specified in 6.6.7 and 6.6.8.

**5.4.5.3** The requirement of 5.4.5.1 shall not exclude a construction that provides no adhesion between the reinforcement and lining along the fold if the surface where there is no adhesion is not greater than 35 percent of the total surface.

**5.4.6** If the hose has a woven reinforcement and is equipped with a cover, the adhesion between the cover and the woven reinforcement shall be such that the rate of separation of a 38-mm (1 1/2-in.) strip of the cover from the reinforcement shall not be greater than 25 mm (1 in.) per minute with a weight of 4.5 kg (10 lb) as specified in 6.6.1 through 6.6.6.

### 5.4.7 Tensile Strength and Ultimate Elongation.

**5.4.7.1** The tensile strength and ultimate elongation of specimens taken from the elastomer material shall not be less than as stated in Table 5.4.7.1 when tested as specified in Section 6.7.

**Table 5.4.7.1 Tensile Strength and Ultimate Elongation for Elastomer Materials in Fire Hose**

Material	Tensile Strength		Ultimate Elongation
	kPa	psi	(%)
Natural and synthetic rubber	8,275	1,200	400
Latex rubber	12,410	1,800	700
Thermoplastic	13,790	2,000	400
PVC	8,275	1,200	400
Other	8,275	1,200	400

**5.4.7.2** If the hose is equipped with oil-resistant liners or covers, the ultimate elongation shall not be less than 250 percent provided that the tensile strength and ultimate elongation do not decrease more than 50 percent when tested in accordance with Section 6.12.

**5.4.7.3** The tensile strength of liners for forestry hose shall not be less than 12,410 kPa (1800 psi).

**5.4.7.4** The tensile strength and ultimate elongation of specimens subjected to the oven aging test, as specified in Section 6.8, shall not be less than 75 percent of the tensile strength and ultimate elongation of specimens not subjected to this test.

### 5.4.8 Ozone Resistance.

**5.4.8.1** For hose intended to be ozone-resistant, the elastomer components shall show no visible signs of cracking when subjected to the ozone test specified in Section 6.9.

**5.4.8.2** Hose that meets the requirements of 5.4.8.1 shall be marked "ozone resistant" in letters and figures at least 25 mm (1 in.) high.

### 5.4.9 Cold Resistance.

**5.4.9.1** All hose except suction hose shall show no apparent damage to the reinforcement or lining when subjected to the cold bending test specified in Section 6.10.

**5.4.9.2** The hose shall not leak nor show breakage of any thread in the reinforcement or slippage of couplings when subjected to the proof test pressure as specified in 6.10.5.

**5.4.9.3 Special Cold-Resistant Hose.**

**5.4.9.3.1** If the hose is designed for use down to  $-54^{\circ}\text{C}$  ( $-65^{\circ}\text{F}$ ), it shall show no apparent damage to the reinforcement or lining when subjected to the cold bending test specified in Section 6.10.

**5.4.9.3.2** The hose shall not leak nor show breakage of any thread in the reinforcement or slippage of couplings when subjected to the proof test pressure as specified in 6.10.5.

**5.4.9.3.3** It shall be possible for one person to uncoil and lay out a 15-m (50-ft) length of hose immediately after it has been subjected to the cold flexibility test as specified in Section 6.11.

**5.4.9.3.4** Hose that meets the requirements of 5.4.9.3.1, 5.4.9.3.2, and 5.4.9.3.3 shall be marked "for use down to  $-54^{\circ}\text{C}$  ( $-65^{\circ}\text{F}$ ) in letters and figures at least 25 mm (1 in.) high.

**5.5 Marking.**

**5.5.1\*** Each length of fire hose shall be indelibly marked in letters and figures at least 25 mm (1 in.) high with the manufacturer's identification, the month and the year of manufacture, and the words "service test to (the service test pressure the hose is designed to) bar (psi) per NFPA 1962."

**5.5.2** These markings shall be in a minimum of two places on each length of hose, beginning  $1.5\text{ m} \pm 150\text{ mm}$  ( $5\text{ ft} \pm 6\text{ in.}$ ) from the ends of the hose unless the hose is marked at continuous intervals not exceeding 3.7 m (12 ft).

**5.5.3 Marking Large-Diameter Hose.**

**5.5.3.1** Each length of large-diameter supply hose meeting the requirements of Section 4.2 shall be indelibly marked lengthwise in letters at least 51 mm (2 in.) high with the words "supply hose."

**5.5.3.2** Each length of large-diameter attack hose meeting the requirements of Section 4.1 shall be indelibly marked lengthwise in letters at least 51 mm (2 in.) high with the words "attack hose."

**5.5.3.3** The marking shall be centered in the first  $1.5\text{ m} \pm 150\text{ mm}$  ( $5\text{ ft} \pm 6\text{ in.}$ ) from each end of the hose and shall be marked in two places, 180 degrees apart.

**5.5.4** No markings referring to pressure, other than the service test pressure specified in 5.5.1, shall appear on the hose.

**Chapter 6 Test Methods for Manufacturers' Hose Certification**

**6.1 General.**

**6.1.1** The test procedures defined in this chapter shall be performed only under controlled laboratory conditions by the hose manufacturer, its designated agent, or by an approved testing facility designated by the manufacturer.

**6.1.2** The tests shall not be performed by users in uncontrolled, non-laboratory situations.

**6.1.3** All nondestructive hydrostatic tests shall be conducted on hose equipped with couplings to be delivered.

**6.2 Proof Pressure Test.**

**6.2.1** The test shall be conducted on a test table that shall have a clear space of at least 508 mm (20 in.) on each side of a line drawn through the center of the supply connection parallel to the edges of the test table.

**6.2.2** To facilitate the complete removal of air from the hose, the surface of the test table shall be inclined with the supply at the low end.

**6.2.3** The hose shall be filled with water until all air has been exhausted.

**6.2.4** The valve shall be closed and the pressure adjusted to 0.7 bar (10 psi).

**6.2.5** While at 0.7 bar (10 psi) the hose shall be straightened out and the length of the hose between the inside edges of the couplings measured and recorded to the nearest 25 mm (1 in.).

**6.2.6** The hose shall be marked behind the coupling.

**6.2.7** The pressure in the hose shall be increased at a rate of not less than 20.7 bar (300 psi) nor more than 69 bar (1000 psi) per minute until the required test pressure is reached.

**6.2.8** Proof test pressure shall be held for at least 15 seconds and not more than 1 minute.

**6.2.9** The hose shall be examined for movement of the couplings after the test.

**6.3 Elongation, Twist, Warp, and Rise Test Methods.**

**6.3.1** The elongation of the hose shall be calculated from the initial measurement of 0.7 bar (10 psi) and final measurement taken at the proof test pressure.

**6.3.2** The amount of twist shall be measured by following the color line or by noting, in the period during which the pressure is being applied, the turns of the fitting at the free end of the hose.

**6.3.2.1** The amount of twist shall be recorded to the nearest one-eighth turn or 45 degrees.

**6.3.2.2** The direction of twist shall be reported as right or left with a right twist being in the direction that would tend to tighten couplings.

**6.3.3\*** When the hose warps to any appreciable extent and particularly when the allowable limit of elongation is approached, the length at final pressure shall be measured by following the contour of the hose.

**6.3.3.1** For hose that does not warp to any extent, the measurement shall be permitted to be taken parallel to the edge of the test table.

**6.3.3.2** All measurements shall be taken from the inside edges of the fittings.

**6.3.4** For hose having nominal length of 15 m (50 ft), the amount of warping shall be the maximum deviation of any portion of the hose from a straight line drawn from the center of the fittings at one end to the center of the fittings at the other end of the hose.

**6.3.5** For hose having nominal length greater than 15 m (50 ft) and up to 30 m (100 ft), the amount of warping shall be the maximum deviation of any 15 m (50 ft) portion of the hose from an initial straight line drawn from the center of the fittings at each end of the hose.

**6.3.6** The warp shall be measured as the distance from the referenced straight line to the center line of the hose at the point of maximum deviation.

**6.3.7** If the first measurement of warping is excessive, the position of the hose relative to the water supply shall be permitted to be reversed, end for end, and the test for warping repeated.

**6.3.8** Rise shall be measured to the nearest 25 mm (1 in.) and is the distance that the hose rises above the test table when the hose is subjected to the proof test pressure.



#### 6.4 Kink Test.

**6.4.1** The test shall be conducted on a test table that shall have a clear space of at least 508 mm (20 in.) on each side of a line drawn through the center of the supply connection parallel to the edges of the test table.

**6.4.2** To facilitate the complete removal of air from the hose, the surface of the test table shall be inclined with the supply at the low end.

**6.4.3** The hose shall be filled with water until all air has been exhausted.

**6.4.4** The valve shall be closed and the pressure adjusted to 0.7 bar (10 psi).

**6.4.5** The hose shall be sharply kinked 457 mm (18 in.) from the free end by tying the hose back against itself as close to the fittings as practicable.

**6.4.6** The pressure shall be raised as described in 6.2.7 to the test pressure and immediately released.

#### 6.5\* Burst Test.

**6.5.1** One 0.9-m (3-ft) sample shall be cut from the end of two lengths of hose and submitted for testing before the hose is subjected to the proof pressure test.

**6.5.2** One of the samples shall be tested while lying straight and the other while lying curved on a surface having a radius of 685 mm (27 in.).

**6.5.3** The 0.9-m (3-ft) samples shall be connected to the water supply, the air expelled, and the pressure raised until the specified burst pressure is reached.

#### 6.6 Adhesion Test.

**6.6.1** The apparatus required for this test shall consist of a supporting frame, clamps, weights, weight holders, and a timer.

**6.6.2** The supporting frame shall be of such design that specimens, with weights attached, can be suspended vertically and hang freely during the progress of the test.

**6.6.3** The specimen for the adhesion test shall be cut transversely.

**6.6.3.1** The specimen shall be 51 mm (2 in.) wide and shall be cut through so as to give a rectangular sample 51 mm (2 in.) wide and the full circumference of the hose in length.

**6.6.3.2** A strip of lining, or cover if provided, 38 mm (1½ in.) wide shall be cut out accurately, with the cut extending through the rubber but not entirely through the woven reinforcement.

**6.6.4** The lining or cover and the woven reinforcement shall be separated for about 38 mm (1½ in.), and a reference mark shall be placed on the reinforcement at the juncture of the reinforcement and the lining.

**6.6.4.1** The free end of the woven reinforcement shall be gripped in a stationary clamp.

**6.6.4.2** The separated rubber shall be gripped in a freely suspended clamp hanging vertically, to which the prescribed weight shall be attached.

**6.6.4.3** Provision shall be made for supporting and releasing the weight slowly without jerking.

**6.6.5** The distance through which separation takes place shall be noted for a period of 10 minutes or until complete separation occurs.

**6.6.6** The adhesion to the reinforcement shall be taken as the rate obtained by dividing the total distance separated by millimeters (inches), to the nearest 2.54 mm (0.1 in.), by the elapsed time in minutes.

**6.6.7** If a rubber backing is used between the lining and the reinforcement, the adhesion between the lining and the backing and the adhesion between the backing and the reinforcement shall be determined using the methods specified in 6.6.1 through 6.6.6.

**6.6.8** If the adhesion between the lining and the backing or between the backing and the reinforcement cannot be determined because the backing has a tendency to tear during the test, the rate of separation between the separating members shall be considered the adhesion.

#### 6.7 Tensile Strength and Elongation.

**6.7.1** Tensile strength and elongation shall be determined in accordance with the test methods specified in ASTM D 412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers — Tension*, Method A.

**6.7.2** Three dumbbell specimens shall be die cut to the dimensions given in 6.7.3.

**6.7.3** The constricted portion of the specimen shall be 6.4 mm × 33 mm (0.25 in. × 1.30 in.) and the enlarged ends shall be 25 mm (1 in.) wide.

**6.7.4** The constricted portion of each specimen shall be permitted to be buffed to remove fabric impressions or other surface irregularities.

**6.7.4.1** Samples shall be buffed prior to cutting with the die.

**6.7.4.2** If the nature or thickness of the lining is such that buffing cannot be accomplished without damaging the lining, unbuffed specimens shall be permitted to be used for the tensile strength and elongation tests.

**6.7.5** Specimens shall be cut transversely from the sample.

**6.7.6** Three measurements for thickness shall be made in the constricted portion of each specimen.

**6.7.6.1** The minimum value obtained shall be used as the thickness of the specimen in calculating the tensile strength.

**6.7.6.2** The average tensile strength of the three specimens shall be considered the tensile strength of the rubber lining or cover.

**6.7.7** Two benchmarks 25 mm (1 in.) apart shall be stamped centrally on the constricted portion of each specimen.

**6.7.8** If a dumbbell test specimen breaks outside the benchmarks, or if the result of either tensile strength or elongation based on the average of three specimens is not acceptable, another set of three specimens shall be tested, and the results from this set shall be considered final.

**6.7.9** Results of tests of specimens that break in the curved portion just outside the benchmarks shall be permitted to be accepted if within the minimum requirements.

#### 6.8 Oven Aging Test.

**6.8.1** Three specimens shall be prepared as described in 6.7.2 through 6.7.6.

**6.8.2** The specimens shall be conditioned in an oven for 96 hours at 70°C ± 2°C (158°F ± 3.6°F) following the procedures described in ASTM D 573, *Test Method for Rubber-Deterioration in an Air Oven*.

**6.8.3** Two benchmarks 25 mm (1 in.) apart shall be stamped centrally on the constricted portion of each specimen after the conditioning.

**6.8.4** The specimens shall then be tested in accordance with ASTM D 412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers — Tension*, Method A.

#### 6.9 Ozone Resistance.

**6.9.1** Three specimens, sized 85 mm × 25 mm ( $3\frac{3}{4}$  in. × 1 in.), or as close to 25 mm (1-in.) wide as possible from small-diameter hose, shall be cut longitudinally from the liner and cover, if provided, of the sample and mounted in the specimen holder in a looped position in accordance with the procedures outlined in ASTM D 518, *Standard Test Method for Rubber Deterioration — Surface Cracking*, Procedure B.

**6.9.2** The ozone test chamber shall be regulated to give an ozone concentration of 100 pphm and a temperature of  $40^{\circ}\text{C} \pm 1^{\circ}\text{C}$  ( $104^{\circ}\text{F} \pm 1.8^{\circ}\text{F}$ ).

**6.9.3** When constant test conditions have been obtained in the ozone test chamber, and after the mounted specimens have remained in an ozone-free atmosphere for 24 hours, the mounted specimens shall be placed in the test chamber and allowed to remain for 70 hours.

**6.9.4** After the test exposure, the specimens shall be removed from the test chamber and examined with a 7-power magnifying glass.

#### 6.10 Cold Bending Test.

**6.10.1** A 0.9-m (3-ft) sample of the hose shall be provided with test fittings and immersed in a water bath at room temperature for 24 hours.

**6.10.2** The hose shall be removed from the water bath and exposed to room atmosphere for 15 minutes.

**6.10.3** The hose shall be placed in a cold box for 24 hours with the temperature maintained at  $-20^{\circ}\text{C} \pm 1^{\circ}\text{C}$  ( $-4^{\circ}\text{F} \pm 1.8^{\circ}\text{F}$ ) unless the hose is being tested for special cold resistance in which case the temperature shall be maintained at  $-54^{\circ}\text{C} \pm 2^{\circ}\text{C}$  ( $-65^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$ ).

**6.10.4** After 24 hours in the cold box, the hose shall be removed from the box and immediately bent double on itself, 180 degrees, first one way and then the other.

**6.10.5** The hose shall then be allowed to thaw at room temperature for 24 hours and then be subjected to the proof test pressure as specified in Section 6.2.

#### 6.11 Cold Flexibility Test.

**6.11.1** A 15-m (50-ft) length of dry hose shall be tightly coiled and placed in a cold box for 24 hours with the temperature maintained at  $-54^{\circ}\text{C} \pm 2^{\circ}\text{C}$  ( $-65^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$ ).

**6.11.2** After 24 hours in the cold box, the hose shall be removed from the box and an attempt shall be made immediately by one operator to uncoil and lay out the hose.

#### 6.12 Oil Immersion Test.

**6.12.1** A sample of the liner shall be immersed in a petroleum-base oil at  $121^{\circ}\text{C} \pm 1^{\circ}\text{C}$  ( $250^{\circ}\text{F} \pm 1.8^{\circ}\text{F}$ ) for 18 hours and the tensile strength and elongation determined as specified in Section 6.7.

**6.12.2** The oil used in this test shall be a medium-swelling petroleum-base oil with a viscosity of  $100 \pm 5$  Saybolt Universal seconds at  $98.9^{\circ}\text{C}$  ( $210^{\circ}\text{F}$ ), an aniline point of  $93^{\circ}\text{C} \pm 3^{\circ}\text{C}$  ( $199.4^{\circ}\text{F} \pm 5.4^{\circ}\text{F}$ ), and an open cup flash point of  $246.1^{\circ}\text{C} \pm 5.6^{\circ}\text{C}$  ( $475^{\circ}\text{F} \pm 10^{\circ}\text{F}$ ).

#### 6.13 Flexibility and Compressibility Testing.

**6.13.1** The flexibility and compressibility test apparatus shall consist of a compression tester with plates of nominal 152 mm (6 in.) in length and 102 mm (4 in.) in width.

**6.13.2** The compression tester shall be an accepted laboratory instrument having a rate of travel of approximately 6.35 mm (0.25 in) per minute.

**6.13.3** Two lengths of hose each 0.51 m (20 in.) shall be obtained from the uncoupled hose coil, using the hose following the sample taken for the burst pressure test.

**6.13.4** Each sample shall be folded in an “S” shape and flattened manually so that the overall dimension of the “S” loop is  $127 \pm 6.4$  mm ( $5.0 \pm 0.25$  in.) and the hose test sample is placed between compression plates of the tester, parallel to the 152 mm (6 in.) axis, as shown in Figure 6.13.4.

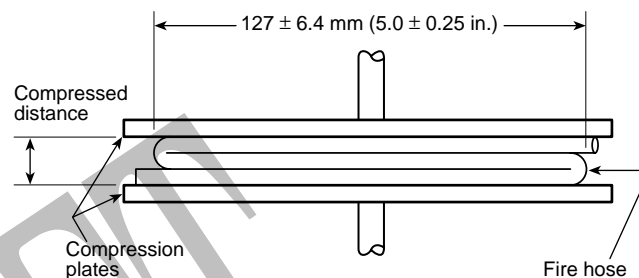


Figure 6.13.4 Compression and flexibility test apparatus.

**6.13.5** If the hose being tested is cotton-synthetic woven reinforcement fire hose, the test sample shall be compressed until there is a distance of 24.5 mm (1 in) between the plates and the amount of load required to achieve this compression recorded.

**6.13.6** If the hose being tested is synthetic woven reinforcement fire hose, the test sample shall be compressed until there is a distance of 12.7 mm (0.5 in) between the plates and the amount of load required to achieve this compression recorded.

### Chapter 7 Sampling, Inspection, and Tests

#### 7.1 Quality Control.

**7.1.1** The hose manufacturer shall have a quality control program in place that assures fire hose manufactured to this standard complies with the requirements of this standard.

**7.1.2** The manufacturer shall keep documentation of all design tests that show compliance with the requirements of this standard.

**7.1.3** Production records of inspection and tests shall be kept complete and available to the purchaser.

#### 7.2 Inspection.

**7.2.1** The manufacturer shall be responsible for performing all inspections required by this standard. Manufacturers shall be permitted to utilize their own facilities or any approved laboratory.

**7.2.3** Samples of the hose ready for delivery shall be selected in accordance with ASQ Z1.4, *Sampling Procedures and Tables for Inspection by Attributes*, for inspection of visual and dimensional characteristics.

#### 7.3 Testing.

**7.3.1** All hose shall be tested to its proof pressure in accordance with Section 6.2 after it has been coupled for delivery and shall show no signs of coupling slippage.

**7.3.2** All hose shall be subjected to elongation, twist, warp, and rise tests performed in accordance with Section 6.3.

**7.3.3** Samples shall be selected in accordance with ASQ Z1.4, *Sampling Procedures and Tables for Inspection by Attributes*, and tested for kink, burst, adhesion, and tensile strength and elongation.

**7.4 Certification.** When requested, the manufacturer shall provide the purchaser a certification that the hose furnished has been tested and is in compliance with the requirements of this standard.

## Annex A Explanatory Material

*Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.*

**A.1.2** This standard is not a detailed manufacturing or purchasing specification but can be referenced in purchase specifications as minimum requirements.

**A.3.2.1 Approved.** The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

**A.3.2.2 Authority Having Jurisdiction.** The phrase “authority having jurisdiction” is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

**A.3.2.4 Listed.** The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

**A.3.3.1** Attack hose is designed to convey water to handline nozzles, distributor nozzles, master stream appliances, portable hydrants, manifolds, standpipe and sprinkler systems, and pumps used by the fire department. Attack hose is designed for use at operating pressures up to at least 19 bar (275 psi).

**A.3.3.12** The reinforcement is often referred to as the jacket when it is the exterior layer of the hose construction, and hose can have more than one layer of reinforcement. The reinforcement is sometimes coated or covered with protective materials.

**A.3.3.14** Supply hose is designed to be used at operating pressures not exceeding 12.8 bar (185 psi).

**A.4.1.1** A minimum design service test pressure of 20.7 bar (300 psi) for attack hose provides a normal highest operating pressure of 19 bar (275 psi). If a higher operating pressure is needed, a hose having a service test pressure of at least 10 percent greater than the highest operating pressure should be used.

**A.4.2.2** Whenever supply hose is being used to supply attack lines, master stream appliances, portable hydrants, manifolds, and standpipe and sprinkler systems, a pressure relief device with a maximum setting of 13.8 bar (200 psi) should be used.

A minimum design service test pressure of 13.8 bar (200 psi) for supply hose provides a normal highest operating pressure of 12.8 bar (185 psi). If a higher operating pressure is needed, a hose having a service test pressure of at least 10 percent greater than the highest operating pressure should be used.

**A.4.3.1** A minimum design service test pressure of 10.3 bar (150 psi) for occupant use hose provides a normal highest operating pressure of 9.3 bar (135 psi). If a higher operating pressure is needed, a hose having a service test pressure of at least 10 percent greater than the highest operating pressure should be used.

**A.4.4.1** This requirement is consistent with U.S.D.A. Specification 5100-186C, *Forest Service Specification for Fire Hose, Cotton-Synthetic, Lined, Woven Jacket, 1 inch and 1 1/2 inch*.

**A.4.4.2** This requirement is consistent with U.S.D.A. Specification 5100-187C, *Forest Service Specification for Fire Hose, Lightweight Synthetic, Lined, Woven Jacket, 1 inch and 1 1/2 inch*.

**A.4.4.3** A minimum design service test pressure of 20.7 bar (300 psi) for forestry hose provides a normal highest operating pressure of 19 bar (275 psi). If a higher operating pressure is needed, a hose having a service test pressure of at least 10 percent greater than the highest operating pressure should be used.

**A.5.1** The friction loss characteristics of fire hoses are not included in this standard but are an important consideration in the selection of hose. Friction loss varies considerably depending on the construction and design of the hose, the roughness of the lining, and its internal diameter, which may be different for different grades of hose. The type of couplings can also affect the friction loss.

Where friction loss is important, side-by-side comparisons are recommended. The following test is recommended.

All comparative tests should use 90 m (300 ft) of each type of hose to be tested laid side-by-side on a level surface. Commercially available line pressure gages should be installed at the inlet and the outlet of the first 90 m (300 ft) of hose to be tested.

A smooth bore nozzle of the size shown in Table A.5.1 should be used for the tests. Pressurize the test hose while the nozzle is fully open until a pitot gage reading of the discharge reads 3.5 bar (50 psi). Read the pressure shown on the inlet and outlet line gages. Subtract the outlet pressure from the inlet pressure and divide by 3 to determine the friction loss per 30 m (100 ft) of hose. Repeat the test for the next type hose to be tested. The hose with the lowest friction loss will flow the most amount of water for a given inlet pressure.

**A.5.3.1** Hose with a reinforcement of all-synthetic fibers is much lighter in weight than the cotton-synthetic reinforcement hose and is considerably more flexible; therefore, a greater amount can be stored in a given space.

**A.5.3.4** The abrasion characteristics of fire hose are not included in this standard but should be an important consideration in the selection of fire hose. In areas where the hose could be subjected to rough usage, two layers of reinforcement (double-jacketed) or rubber-covered hose should be considered.

**Table A.5.1 Recommended Smooth Bore Nozzle Size for Testing Friction Loss in Fire Hose**

Hose Size		Recommended Smooth Bore Nozzle Size	
mm	in.	mm	in.
25	1	13	1/2
38	1 1/2	22	7/8
44	1 3/4	22	7/8
51	2	22	7/8
65	2 1/2	29	1 1/8
76	3	29	1 1/8
90	3 1/2	32	1 1/4
100	4	51	2
113	4 1/2	51	2
125	5	57	2 1/4
150	6	57	2 1/4

**A.5.4.1** Fire hose should not be used for the conveyance of potable water. There are hoses specifically designed for this purpose such as hoses designed to Federal Specifications A-A 59226, *Hose Assembly, Nonmetallic, Fire Fighting, with Couplings*; MIL-H-24606, *Hose, Fire, Synthetic Fiber, Double Jacketed, Treated for Abrasion Resistance, with Couplings, Fire Fighting and Other Water Service*; and MIL-PRF53207, *Hose Assembly, Rubber: Lightweight Collapsible, 6-inch; for Drinking (Potable) Water*.

Linings for these hoses should be approved to NSF 61, *Drinking Water System Components-Health Effects*, or 21 CFR, Food and Drugs, Sec. 177.2600, "Rubber articles intended for repeated use."

**A.5.5.1** Hose manufactured before 1987 will not have the service test pressure stenciled on the hose. Users wishing to mark their existing hose should contact the hose manufacturer for the correct designation prior to marking their hose.

**A.6.3.3** For this purpose, an edge of the table should be marked off in meters and centimeters (feet and inches). Warping in hose tests is the deviation from a straight line drawn from fitting to fitting in a plane parallel to the surface on which the hose rests.

**A.6.5** CAUTION: Hose meeting the requirements of this standard can be supplied with a coupling that will not be capable of complying with the burst test requirements of the hose. The purchaser should request information on the failure point of couplings supplied with the hose.

**A.6.5.2** The burst test is potentially hazardous as the hose can rupture catastrophically. A protective enclosure should be used to prevent injury if there is a hose rupture or other failure.

## Annex B Referenced Publications

**B.1** The following documents or portions thereof are referenced within this standard for informational purposes only and are thus not considered part of the requirements of this standard unless also listed in Chapter 2. The edition indicated here for each reference is the current edition as of the date of the NFPA issuance of this standard.

**B.1.1 Military and Federal Specifications.** Naval Publications and Forms Center, 5801 Tabor Avenue, Attn: NPODS, Philadelphia, PA 19120-5094.

A-A 59226, *Hose Assembly, Nonmetallic, Fire Fighting, with Couplings*, May 18, 1998.

MIL-H-24606, *Hose, Fire, Synthetic Fiber, Double Jacketed, Treated for Abrasion Resistance, with Couplings, Fire Fighting and Other Water Service*, Revision B, August 12, 1994.

MIL-PRF53207, *Hose Assembly, Rubber: Lightweight Collapsible, 6-inch; for Drinking (Potable) Water*, Revision B, March 14, 1996.

**B.1.2 NSF Publication.** National Sanitation Foundation, 3475 Plymouth Road P.O. Box 1468, Ann Arbor, MI 48106.

NSF 61, *Drinking Water System Components-Health Effects*, November 1, 1999.

**B.1.3 U.S.D.A. Publications.** U.S. Forest Service, San Dimas Technology and Development Center, San Dimas, CA 91773.

U.S.D.A. Specification 5100-186C, *Forest Service Specification for Fire Hose, Cotton-Synthetic, Lined, Woven Jacket, 1 inch and 1-1/2 inch*, October 1996.

U.S.D.A. Specification 5100-187C, *Forest Service Specification for Fire Hose, Lightweight Synthetic, Lined, Woven Jacket, 1 inch and 1 1/2 inch*, October 1996.

**B.1.4 U.S. Government Publication.** U.S. Government Printing Office, Washington, DC 20402.

Title 21, *Code of Federal Regulations*, Part 177.2600, "Rubber articles intended for repeated use."